Greenfield Alternative Study LEU-Mo Fuel Fabrication Facility

July 2008



The INL is a U.S. Department of Energy National Laboratory operated by Battelle Energy Alliance

Greenfield Alternative Study LEU-Mo Fuel Fabrication Facility

July 2008

Prepared by:

Washington Division of URS 7800 E. Union Avenue, Suite 100 Denver CO 80237

For:

Idaho National Laboratory Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Office of National Nuclear Security Administration
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

TABLE OF CONTENTS

EXECU	TIVE SUMMARY	1
1.0	INTRODUCTION	1
1.1	Background	1
1.2	Project Description	2
1.3	Study Basis	7
1.3.1	Objective	7
1.3.2	Work Scope	7
1.3.3	Report Contents	8
1.4	Proposed Future Studies	8
1.4.1	Engineering Studies	8
1.4.2	R&D and Verification Needs	10
2.0 1	PROJECT REQUIREMENTS	1
2.1	Assumptions and Design Basis	
2.2	High Level Functions and Requirements	
2.2.1	Safety Management	
2.2.1	Safeguards and Security	
2.2.2	Containment/Confinement	
2.2.3	Environmental Protection	
2.2.4		
	Nuclear Safety	
2.2.6	Industrial Hygiene	
2.3	Quality Assurance	
2.4	Pollution Prevention and Waste Minimization	
2.5	Decontamination and Decommissioning	
2.5.1	Decontamination	
2.5.2	Decommissioning	
2.6	Maintenance Philosophy	21
3.0	PROCESS DESIGN	1
3.1	Process Overview	4
3.1.1	Block Flow Diagrams	4
3.1.2	Process Flow Diagrams	7

3.1.3	Material Balance
3.2	Facility Throughput Basis
3.3	Process Design Basis and Description
3.3.1	Material Shipping and Receiving9
3.3.2	Ingot Casting9
3.3.3	Hot Rolling/Shearing
3.3.4	Fuel Plate Cleaning
3.3.5	Zr Cladding and Final Rolling
3.3.6	Annealing11
3.3.7	Foil Cleaning
3.3.8	Friction Bonding
3.3.9	Alternate HIP Process
3.3.10	QA Inspection
3.3.11	Plate Finishing
3.3.12	Plate Forming (curved plates only)
3.3.13	Sub-Assembly Fabrication
3.4	Waste Handling and Disposition
3.4.1	Liquid Waste
3.4.2	Solid Waste
3.4.3	Process Off-Gas Treatment
3.4.4	Scrap Management
3.5	Utilities and Consumables
3.6	Project Equipment List
l.0 M	IECHANICAL/EQUIPMENT DESCRIPTION2
4.1	Receiving/Receipt Inspection
4.2	Inner Can Storage6
4.3	Material Handling and Transfer
4.3.1	Pass-Through8
4.3.2	Hand Carts9
4.3.3	Forklifts
4.3.4	Drum grabs
4.3.5	Overhead Cranes
4.4	Alloy Casting

	4.5	Hot Roll to Intermediate Thickness	16
	4.6	Cleaning Procedures used in the FFC	17
	4.7	Canning	18
	4.8	Roll to Final Thickness	
	4.9	Annealing	19
	4.10	Shear Foil to Dimension	20
	4.11	Foil Cleaning	20
	4.12	Friction Stir Bonding	20
	4.13	Alternate HIP Process	21
	4.14	Selection of a bonding process	26
	4.14.1	Friction Bonding Pros	26
	4.14.2	Friction Bonding Cons	27
	4.14.3	HIP Pros	27
	4.14.4	HIP Cons	27
	4.14.5	HIP Implementation	27
	4.15	QA Inspection	28
	4.16	Completion of fuel plate manufacturing	29
	4.17	Sub Assembly Fabrication	31
	4.18	In-Process Intermediate Secure Controlled Storage Area	36
	4.19	Receiving, Shipping and Storage and Dock	36
	4.19.1	Fuel Subassembly Packaging.	36
	4.19.2	Product Storage Area	38
	4.19.3	Waste Storage Area	38
	4.19.4	Fuel Material Storage Area	38
	4.19.5	Dock	39
	4.19.6	Mechanical and Electrical Maintenance Rooms	39
	4.19.7	Air Compressor Room	39
	4.19.8	M/F Water Closets	39
	4.19.9	Trucker's Waiting Room	39
	4.19.10	CCTV Surveillance	39
5.		ACILITY DESIGN AND OPERATION	
	5.1	Facility Overview	
	5.2	Facility Design Requirements	. 6

5.3	Site Layout	7
5.4	FFC Building Configuration	9
5.5	Utility Connections	10
5.6	Facility Areas	11
5.6.1	Administrative Areas	11
5.6.2	Production Areas	11
5.6.3	Storage Areas (including safeguards and security)	11
5.6.4	Safeguards and Security Features	11
5.6.5	Safety and Support Areas	12
5.6.6	Personnel Amenities	12
5.7	Ventilation	12
5.7.1	Task Exhaust	13
5.7.2	Shop Area	17
5.7.3	Office/clean areas	17
5.7.4	Design features of the HVAC system	17
5.8	Shielded Cells	18
5.9	Fire Protection	19
5.9.1	Basic Criteria	19
5.9.2	Fire Protection Design Features	19
5.9.3	Waste Drains	21
5.9.4	Floor Finish	21
5.10	Warehouse	22
5.11	FFC Staff	25
5.11.1	Operational Staff	25
5.11.2	Office Staff	26
5.12	Personnel Protective Equipment	27
5.13	Friskers and Monitors	27
5.14	Facility Operation	27
5.15	Control Room	27
5.16	Utilities	27
5.17	Electrical Service	28
5.18	FFC Communication	28
5.19	FFC Facility Operation	28
5.19.1	Management and Labor	28
5.19.2	Expendable consumables and resources	29

5.19.	3 Maintenance and upkeep of the building and process systems
5.19.	4 Packaging and transportation32
5.19.	5 Utilities and energy use32
5.19.	6 Contracts or subcontracts provided by suppliers and service providers32
5.19.	7 Decommissioning and Disposal32
6.0	INITIAL FACILITY HAZARDS EVALUATION1
6.1	Principal Worker Hazards5
6.2	Hazards Control6
6.3	Criticality Controls7
6.4	FFC Facility Categorization8
6.4.1	FFC Hazard Categorization8
6.4.2	FFC Security Categorization9
6.4.3	FFC Performance Categorization9
7.0	ENVIRONMENTAL STRATEGY1
7.1	NEPA – EIS/EA1
7.2	Other Permits3
8.0	LICENSING REQUIREMENTS1
8.1	Licensing of the LEU-Mo Monolithic Fuel
8.2	Licensing of Fuel Fabrication2
9.0	RISK MANAGEMENT1
9.1	Programmatic Risks1
9.2	Technical Risks4
9.3	Risk Management Plan8
10.0	COST ESTIMATE1
10.1	Assumptions
10.2	Cost Estimate Basis2

			-
1	0.2.1	Quantity Basis	2
1	0.2.2	Pricing Basis.	3
1	0.3	Contingency	4
1	0.4	Estimate Summary	5
1	0.4.1	Base Case Estimate summary	5
1	0.4.2	HIP case (HIP bonding) estimate summary	6
1	0.5	Operations Cost	7
1	0.6	Startup & Testing	7
11.0		CHEDULE ESTIMATE	
	1.1	Introduction	
	1.2	Assumptions and Design Basis	
1	1.3	Key Activity Durations	5
12.0	0 R	EFERENCES	1
AP	PEND	IX A - DRAWINGS AND DATA	
S	Site La	yout/ Facility Layout	1
E	Block F	low Diagrams	2
P	Process	Flow Diagrams	3
F	Equipn	nent Cut Sheets	1
AP	PEND	IX B - ESTIMATE DETAILS	
E	Base C	ase (Friction Bonding): Estimate SummaryB	1
E	Base C	ase (Friction Bonding): Estimate DetailsB	2
F	HIP Al	ternate: Estimate SummaryB	3
F	HIP Al	ternate: Estimate DetailsB	4

EXECUTIVE SUMMARY

This report provides the initial "first look" of the design of the Greenfield Alternative of the Fuel Fabrication Capability (FFC); a facility to be built at a Greenfield DOE National Laboratory site. The FFC is designed to fabricate LEU-Mo monolithic fuel for the 5 US High Performance Research Reactors (HPRRs). This report provides a pre-conceptual design of the site, facility, process and equipment systems of the FFC; along with a preliminary hazards evaluation, risk assessment as well as the ROM cost and schedule estimate.

The FFC is an engineered steel framed structure, with insulated metal wall and roof panels. The FFC has a footprint area of approximately 75,000 sq. ft. and includes a high bay for the primary process operations area and an adjoining low bay for the element assembly and storage functions. The FFC site occupies an area of 12.5 acres; the site also has a warehouse and an electric substation along with an entry control facility. A 6' high barbed wire fence encloses the site area. The site is assumed to be adjoining a national laboratory site in-order to take advantage of the inplace capabilities of security, emergency services, utilities, low level waste treatment, packaging and disposal services and established transportation corridors.

The feed for the FFC comprising of acorns and broken pieces of the LEU-Mo alloy is transported to the FFC in ES-3100 shipping containers from Y-12. The feed material is receipt inspected and stored in critically safe storage racks in a secured controlled storage room. The fuel fabrication process encompasses the following unit operations.

- Casting
- Initial Hot Rolling
- Canning
- Final Hot Rolling
- Annealing
- De-Canning and Trimming

- Cleaning
- Bonding
- Final trimming, finishing and inspection
- Assembly, packaging, and shipping

The FFC is designed to produce up to 17,000 foils (rolled LEU-Mo) a year sufficient to meet the annual needs of the US HPRRs. The FFC is provided with a cascade ventilation system, and a wet pipe sprinkler system. The primary facility hazards are radiological, criticality, fire and industrial hazards. Overall the hazards are low and pose minimal risk to the public. The primary hazards are to the facility worker. The FFC is characterized preliminarily as nuclear hazards category 2, performance category 2 and a security category IV facility. The FFC will have 55 personnel on the shop floor (operators, inspection personnel) and 17 personnel in the office providing management and administrative services.

An integrated timeline has been prepared for the design, licensing, permitting, construction and fuel qualification activities. Initial Critical path activities include licensing and design, which require an early start of conceptual design (10/1/08) in-order to support follow-on critical path activities leading to the hot ops of the FFC by the end of 2012 and conversion of the US HPRRs by the end of 2014 as planned by the NNSA. A DOE 413.3A compliant critical decision approval process has been utilized for the integrated planning timeline.

Based on the facility and process design, a total project cost range for the base case (utilizing friction bonding) FFC is \$62M - \$73M. An alternate HIP bonding process design has also been prepared. The total project cost of the FFC with the alternate HIP process is \$81M - \$93M. A Monte Carlo type risk assessment was performed to determine the project contingency, which has been included in the Total Project Cost. A facility annual operations cost has been estimated at \$15M - \$20M.

1.0 INTRODUCTION

This report comprises the Greenfield Alternative Study for the LEU-Mo Fuel Fabrication Capability (FFC). The study was developed at a pre-conceptual/scoping level to provide a "first look" at the facility footprint, the design of the key process and equipment systems as well as the preliminary process hazards and their mitigation. A Rough Order magnitude cost and schedule estimate range has been provided for the capital and life cycle cost of the facility.

The Greenfield Alternative study is a precursor to the follow-on Conceptual Design, and provides a basis for conceptual project planning and the development of the conceptual functions and operations requirements of the FFC. Additional design development and rigor is required in the following key areas to meet the CDR requirements of DOE O 413.3A:

- Alternatives Evaluation Facility, Process
- Safety Design Documentation
- Cost, Schedule and Risk
- Management Planning and Control documentation
- Scope/technical development of Balance of Plant Systems.

1.1 Background

Since 1978, the US has pursued a policy aimed at reducing the threats posed by civilian commerce in HEU. Since HEU fueled research reactors provide essential services to society, it was recognized that new and advanced fuel technology would be required to replace existing HEU fuels and to accomplish our non-proliferation goals while maintaining the flow of products and services provided by these research reactors.

The National Nuclear Security Agency's (NNSA) Global Threat Reduction Initiative (GTRI) is tasked with enabling the conversion of research reactor fuels from High Enriched Uranium (HEU) to Low Enriched Uranium (LEU) Fuels (The LEU/HEU threshold is defined as material containing 20% of the ²³⁵U isotope). The GTRI supports the DOE's Fuel development program known as the Reduced Enrichment for Research and Test Reactors (RERTR), for developing the technical means for converting these research reactors including the development of new LEU fuels.

The RERTR program cooperates with the research reactor operators to achieve this goal of HEU to LEU conversion while maintaining the reactor performance. The goal of this program is to complete the conversion of the civilian domestic research reactors by 2014. These reactors include the five domestic high performance research reactors (HPRRs) namely: The High Flux Isotope Research Reactor (HFIR) at the Oak ridge National Laboratory (ORNL); the Advanced Test Reactor (ATR) at the Idaho National laboratory (INL); The National Institute of Standards and Technology (NIST) research reactor; The Missouri University research reactor (MURR) at the University of Missouri, Columbia; and the MIT reactor II (MITR-II) at the Massachusetts Institute of Technology (MIT).

The US HPRR fuel elements currently consist of HEU based dispersion fuel meat clad in aluminum plates. The HEU is used due to the high fissile loadings needed to meet HPRR performance requirements. Existing LEU dispersion fuels do not provide the necessary HPRR uranium loadings for LEU fuels, thus forcing development of new ultra high uranium density fuels. The monolithic fuel form has been identified as a promising ultra high density fuel type (U density 15.3 g-u/cm3) that is appropriate for research reactor application. This fuel design

consists of a monolithic U-Mo alloy foil encapsulated (clad) in aluminum plates (Al-6061). The monolithic fuel design provides the maximum in-reactor fuel uranium loading. The result is a uranium loading density that should allow the US HPRRs to maintain their existing performance upon conversion without major modifications. The unique aspects of the monolithic fuel design, necessitates development and implementation of new fabrication techniques and establishment of the Fuel Fabrication Capability (FFC) to meet the fuel needs of the US HPRRs

The development, testing and qualification of monolithic LEU fuel fabrication technology is being aggressively pursued by the national laboratories (INL, ANL and others) in-order to meet the goal of the program to achieve the generic qualification (NRC Approval) of the U-Mo monolithic fuel design by the end of 2012.

In order to meet the programmatic mandate to complete conversion of all civilian domestic HPRR reactors by 2014, the construction of the necessary Fuel Fabrication Capability (FFC) for the fabrication of the U-Mo monolithic fuel must occur concurrently with the completion of the fuel qualification effort. A U-Mo monolithic Fuel Fabrication Facility is therefore required to be on line by the end of 2012, to provide the required capability to manufacture the new LEU fuel for the HPRRs.

1.2 Project Description

The FFC is designed to be a state-of-the-art fuel fabrication facility with a design life of 40 years. It is proposed to be built at a Greenfield location within a DOE National Laboratory site or a NNSA complex site. The FFC is designed to fabricate up-to 17,000 monolithic foils of LEU-Mo alloy per year to meet the needs of the US HPRRs. INL and other national laboratories have developed the monolithic fuel fabrication process, which will be adapted for use in the production scale fuel fabrication capability facility.

The FFC is classified as a Nuclear Hazard Category 2 facility on account of criticality hazards, and will be designed to Performance category 2 requirements for the NPH design. FFC handles/processes LEU which is classified as Category 4, Attractiveness level E material for safeguards and security requirements.

The FFC is housed in a steel framed structure with insulated metal panels for the walls and the roof. The FFC has a high bay process area for the fuel plate fabrication processes and an adjoining low bay area for the fabrication of the fuel assembly, secure controlled storage areas and the shipping and receiving operations. The plate fabrication and fuel assembly areas include a central isle for material handling and transfers, with the process equipment placed on either side of the isle. Overhead cranes (5 Tons) are provided to service operations on each side of the isle.

The fuel fabrication process includes the following key operations:

- Casting: LEU-Mo acorns and broken pieces received from Y-12 are melted using induction furnaces and cast into book molds. Each mold is ½"x 3.5" x 16" long.
- **Initial hot rolling**: The casting are hot rolled to intermediate thickness of 0.1" thick x 40" long. These intermediate U-Mo foils are sectioned into 10 pieces each 4" long.
- Canning: The rolled foils are sandwiched between Zr sheets and sealed inside a welded steel can. The can is coated on the inside with Yttria.
- Final Hot Rolling: The steel can is hot rolled to final foil thickness.
- Annealing: The clad foil is annealed to reduce residual stresses from rolling , reduce waviness and improve flatness

- **De-canning and trimming**: The can is opened. The 0.010" to 0.015" thick rolled foil is then sheared to final size.
- **Cleaning**: The foil is chemically cleaned in a solution containing Nitric acid, DI water and HF followed by a drying step (blowing filtered air or nitrogen and wiping the outside)
- **Bonding**: The cleaned foil is then clad in aluminum plates, and the fuel meat (U-Mo foil) is bonded to the aluminum cladding by either friction stir wedding or by using the Hot Isostatic Press process. For the purpose of this study Friction stir welding is the primary process, the HIP process is considered as an alternate.
- Final trimming, surface finishing, inspection, cold forming and final cleaning: The fuel plates are flattened, surface finished, marked and cold formed to match the required fuel configuration. The aluminum clad fuel plates are next subject to final chemical cleaning. Quality inspections are performed using a number of NDE techniques such as radiography-fluoroscopy, UT and Gamma scanning.
- **Final Assembly, Packaging and Shipping**: Multiple fuel plates are retrieved from interim storage, and fitted within side and end plates to form the fuel element (sub-assembly) for the specific HPRR. The sub-assemblies are machined and cleaned and or autoclaved and dried (blowing filtered air or nitrogen and wiping the outside). The sub-assemblies are inspected, packaged and shipped to the specific HPRR

Offices and support areas (Lunch room, Change rooms) are provided as well as secured controlled storage areas for the storage of incoming feed material from Y-12, and storage of inprocess foils and plates as well as finished plates. Accounting areas are provided within the facility for accountability controls. Zoned cascade HEPA filtered ventilation is provided for ventilation of process areas, local HEPA filtered task exhaust is provided at work stations, and recirculating ventilation system is provided for clean areas. A wet pipe sprinkler system is provided throughout the facility. Provision of fire water collection and disposition is included in the facility design.

Criticality control requirements relative to the storage of the incoming cans of U-Mo as well as storage of in process foils, plates and final assemblies have been addressed in the design of the storage racks and cabinets.

The FFC site is enclosed within a fenced boundary. An entry control facility is provided for access control for personnel and materials. A standalone warehouse is provided for the storage of non SNM materials and consumables for the fuel fabrication process. An electrical sub-station may be required to support the power needs for the project.

As the FFC is to be sited at a DOE National Laboratory or a NNSA complex site, the supporting infrastructure for the FFC is assumed to be in place. The following services are assumed to be provided by the host site: Utilities (water, power, sewer); waste treatment and disposal; emergency management; Site security and established access to transportation corridors and trained nuclear facility operations personnel

An integrated design, construction and NRC licensing strategy have been proposed for the acquisition of the FFC. The strategy conforms to the DOE 413.3A Project Acquisition Order, as well as provides realistic timeframes for these activities and yet meeting the hot ops date for the FFC operations in January of 2013.

A facility layout plan showing the arrangement of the equipment and support areas is shown in Fig. 1-1. An overall facility perspective showing the FFC site and the Fuel Fabrication Facility is shown in Fig 1-2. Detail descriptions of the facility and equipment are provided in sections 4 and 5 of the study report.

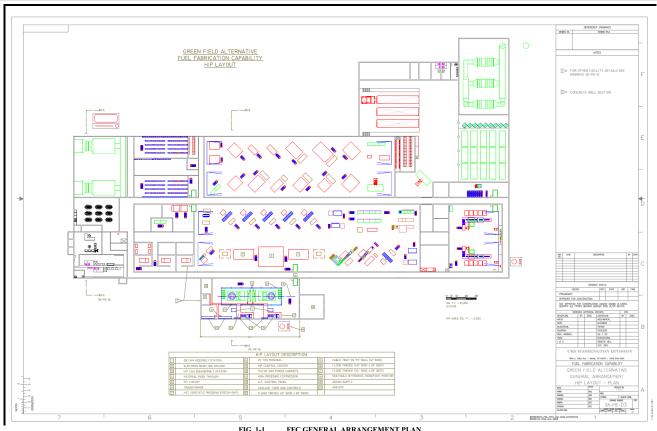


FIG. 1-1 FFC GENERAL ARRANGEMENT PLAN

Greenfield Alternative Study
INL/EXT-08-14577
URS WD PROJECT NO. 17989-325

GREEN FIELD ALTERNATIVE FFC

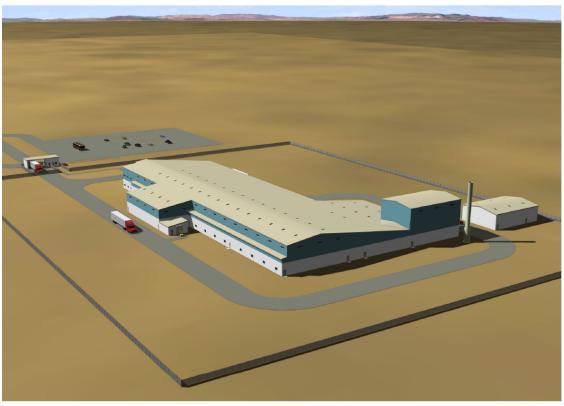


FIG 1-2 FFC SITE PERSPECTIVE VIEW

LEU-Mo Fuel Fabrication Facility PRE-CONCEPTUAL Page 5 of 5

1.3 Study Basis

This section provides an overview of the study objectives, work scope and the study report contents.

1.3.1 Objective

The key objective of the study is to provide an initial scoping level design of the process, facility and equipment required to fabricate the monolithic LEU-Mo fuel for the HPRR. The study also provides a Rough Order Magnitude Cost and schedule for acquiring the FFC.

The study provides an initial concept for the required LEU-Mo monolithic fuel fabrication process, the layout/general arrangement of the facility showing equipment arrangement and support areas, the description of the process equipment, as well as an initial look at the hazards and their mitigation; and Rough Order magnitude cost and schedule estimate of the Total project and Life Cycle cost.

1.3.2 Work Scope

The work scope for this Greenfield Alternative Study includes the preparation of this Greenfield Alternatives Study Report which includes the following:

- Prepare preliminary arrangement, sections and elevations drawings for the FFC, which indicate salient features, access and egress characteristics, major equipment, and major utility routings.
- o Develop facility functional arrangements for the Greenfield FFC.
- Establish rough space allocations for general occupancy and for equipment installation, operation and maintenance.
- Establish and quantify type of construction, significant design features, preliminary hazard classifications and occupancy ratings, and required building systems and/or utilities.
- o Identify sufficient project features to develop the cost estimate. The high-level design description shall describe details not specifically delineated on the drawings.
- Identify preliminary hazards and process conditions and recommend mitigations for control of hazardous material and conditions. Recommend preliminary hazards classification for the facility or, by using a graded approach, portions of the facility.
- o Identify requirements for security, containment, environmental protection, safety and industrial hygiene.
- Establish preliminary flowsheets, which include waste, recycle, utility, mechanical, off-gas, and HVAC requirements. Leverage the production/throughput evaluations provide in the Conceptual Process Description to provide an integrated process throughput that will meet the demand requirements for the 5 domestic HPRRs. Consider process efficiency and estimated maintenance downtimes. Determine the availability and interface locations of existing process and utility systems, Determine preliminary system requirements and provide descriptions of the recommended systems.
- O Some heat applications and machining processes will require ventilation over and above normal HVAC for habitation. Assume minimal shielding and construction options, which meet DOE ALARA requirements.

- o Provide an early NRC licensing strategy recommendation and basis for the recommendation.
- Provide drawings for the FFC plant. The drawings should include a generic site plan, facility and equipment layout and process flow diagrams.
- Provide a process and mechanical equipment list and identify Long Lead time equipment.
- o Identify initial high level technical and programmatic risks.
- Provide an initial Rough Order Magnitude type estimate for the Total Project Cost (TPC) range as well as yearly operations cost.
- O Prepare an overall project schedule addressing design and construction activities addressing the requirements of DOE O 413.3A as well as NRC licensing.

1.3.3 Report Contents

The Greenfield Alternatives Study is presented in one volume, and provides a preliminary understanding of the LEU-Mo monolithic fuel manufacturing process commencing from the receipt of the LEU-Mo feedstock from Y-12 to the final assembly of the fuel elements and shipment for insertion in the 5 US HPRR's; the facility required to house the process equipment and systems as well as the required facility support. The report covers the following key technical areas:

- Basis and Assumptions
- o Process Systems Design
- o Mechanical/Process Equipment Description
- Facility Design
- o Initial Hazards Evaluation
- o Environmental Strategy
- Licensing Strategy
- Risk Management
- ROM Cost Estimate
- Schedule Estimate
- o Supporting Process Flow Diagrams, Site and facility Layout Drawings

1.4 Proposed Future Studies

This section lists the key engineering studies as well as R&D needs to support the design engineering studies

1.4.1 Engineering Studies

The Greenfield Alternatives study provides an initial look at the site, facility, process and equipment systems required for the FFC. A number of alternative and value engineering studies are proposed below to optimize the initial concept included in this report. These studies may be performed as part of the "Alternatives Analysis" at the start of the conceptual design effort.

- Address principles of "Lean manufacturing" in the process operations/facility layout. Perform Discrete Element modeling/Time and Motion modeling to identify any bottlenecks and assure the required throughput can be achieved. In addition the study will address if the requirements for multiple stations, spare parts and redundancy have been established to meet the FFC plant throughput of 17,000 plates per year.
- Perform trade study to evaluate if the casting operations should be conducted in the FFC Vs casting at Y-12. This evaluation will be based on the existing shipping container limitations, but will allow variation of the inner "convenience can" geometry.
- O Perform trade study in conjunction with developmental work to define the most effective means of fuel plate assembly and bonding by using either the friction bonding process or the Hot Isostatic Press (HIP) Process.

In addition, for the HIP process two development tracks have been identified for isolating the fuel from the HIP environment. These two methods are use of a HIP can and the other method is the use of a perimeter weld with either vacuum welding or ultrasonic welding.

With the HIP process, a steel can is built around a stack comprising of a number of plates (Fuel foil sandwiched between aluminum cladding). The plates are sandwiched between rigid strong-backs to keep the fuel plates flat during the HIP process.

The Perimeter welding method eliminates the need for a HIP can. In the perimeter welding method the welded fuel plates are stacked between strong-backs to provide rigidity during the HIP process and to maintain the flatness of the plates.

In the Vacuum perimeter welding method the fuel plate is welded under vacuum to hermetically seal the fuel plate from the HIP media using an electron beam welder.

In the ultrasonic perimeter welding method, a contact probe vibrates the cladding material causing friction and localized welding. When used in a seam welding configuration a hermetic seal is achieved under a vacuum.

- Evaluate the cost and benefit of the waste management strategy of providing limited waste management capability in the FFC of using an evaporator to minimize the volume of liquid waste, as well as perform the required waste stabilization prior to shipping the waste to an on-site Treatment, Storage and Disposal (TSD) facility. The objective is to reduce the operations cost by reducing the waste volumes. In addition ways to minimize Zr clad U-Mo and other mixed alloy waste should be addressed.
- Evaluate the facility expansion required to provide LEU-MO monolithic fuel to 5 reactors in Western Europe in addition to the five US HPRRs.
- Study the cost/benefit of additional automation in the facility
- Perform a trade study to identify the cost effective method of either fabrication of the sub-assembly end-pieces and or cladding plates in house or to out-source the same.
- Perform a source survey to confirm availability of appropriate quality level suppliers of pre-fabricated Al-6061 aluminum cladding plates, end and side pieces for use in the FFC.
- Perform an optimization of the facility layout considering evaluation of the flow of materials and personnel for accomplishing the process operations.

- Perform a source survey to identify quality manufacturers of furnaces, milling and rolling machines as well as HIP, stir welding and ultrasonic inspection machines, as well as the lead to time for supply of these specialized equipment items.
- Evaluate storage requirements for the in coming feed (LEU-Mo) and the final sub assemblies, based on a system study of the HPRR fuel demand and efficient inventory of materials required to meet demand.
- O Perform a trade-study to address the need for the filter blow-back system and filter leaching Vs use of the filter bag-out system.
- O Perform a study using a workable casting line concept for casting plates of LEU-Mo using preheated graphite book molds that function under an inert atmosphere. Study whether microwave or induction melting of alloy within the crucible should be implemented. Microwave melting is an emerging technology that requires a special two part crucible that is more efficient than induction melting and all water cooling takes place outside the inert atmosphere enclosure. Induction melting is the industry standard, however the induction coils that closely surround the crucible containing the melt inside the enclosure require water cooling that poses a safety hazard.
- Conduct vulnerability assessment to define the security requirements considering the proposed FFC operations and inventory
- Conduct RAMI analysis of the process equipment train to confirm proposed facility throughput rates can be achieved

1.4.2 R&D and Verification Needs

The following lists the R&D as well as process validation needs in support of the design of the FFC

- o Conduct performance testing to down-select the fuel plate bonding process between either friction bonding or HIP.
- o Conduct performance testing for down-selecting the diffusion barrier material of either Zirconium, Molybdenum or Silicon.
- Perform required malleability testing of the cast LEU-Mo ingot, to provide the required foil size upon rolling, thereby reducing scrap
- Perform testing to determine the "rollability" parameters and material properties of U-Mo and canned U-Mo foils at room and elevated temperature
- O Perform testing to evaluate the feasibility of the use of microwave melting for the casting operations, which has the potential benefits of eliminating water cooling from the inert gas enclosure surrounding the crucible and reducing energy usage.
- Number of in process non-destructive examination processes (i.e. UT, radiography, gamma scanning and fluoroscopy) have been proposed for the current fuel fabrication process. Some of these methods (e.g. ultrasonic de-bond measurement) need to be qualified on the higher density monolithic fuel form. Work also needs to be done to validate updated measurement processes (i.e. real-time radiography as opposed to the film process that is now used) to make the analysis process more efficient.
- Perform testing to validate the need for an in-can annealing process in a constrained or an un-constrained state.

2.0 PROJECT REQUIREMENTS

The following INL documents provide the High Level Basis for this Greenfield Alternative study:

- Statement of Work for An Engineering Alternative Study for a Greenfield LEU Molybdenum Fuel Fabrication Capability April 2008
- Conceptual process description for the Manufacture of Low Enriched Uranium Molybdenum Fuel; Wachs Et al; INL/EXT-08-13840; February 2008

Additional guidance and specific project design basis and requirements were provided by cognizant INL and Y-12 personnel involved with the development of the monolithic LEU-Mo fuel. Notes of meetings and Notes of weekly teleconference document the programmatic and technical direction relative to the process and equipment requirements. In addition a 35% complete design review was conducted by the cognizant INL and Y-12 personnel, comments and directions resulting from the design review were recorded in the Notes of the 35% complete design review meeting.

The directions, comments received from the cognizant INL and Y-12 personnel during the weekly teleconference, as well as at the design review and Kick-off meetings were considered as design basis requirements and incorporated into the facility and process design.

The Applicable Codes and Standards that provide design basis requirements appropriate for this Study are as follows:

- National Environmental Policy Act (NEPA), 40 CFR 1500
- Resource Conservation and Recovery Act (RCRA)
- Clean Air Act
- Clean Water Act
- Applicable DOE Orders including DOE Order 413.3A
- Federal Regulation 10 CFR 830, Nuclear Safety Management
- Nuclear Waste Policy Act of 1982
- 10 CFR 70, Domestic Licensing of Special Nuclear Materials
- DOE-ID Architectural and Engineering Standards
- ANSI/ANS 8.1 and ANSI/ANS 8.10, Criticality Control
- DOE O 420.1B, Facility Safety

2.1 Assumptions and Design Basis

Table 2-1 provides the listing of Assumptions and Design Basis used for the preparation of this Greenfield alternatives study, including the development of the process and mechanical equipment designs as well as the layout of the fuel fabrication facility.

The Assumptions and design basis are grouped into the following categories:

- Programmatic
- Process
- Facility

- Safeguards and Security, and
- Quality Inspection

TABLE 2-1 – LIST OF ASSUMPTIONS AND DESIGN BASIS

A	PROGRAMMATIC		
1	The FFC will be a Government owned and contractor operated facility. The DOE will provide the necessary safety oversight with guidance from the NRC as appropriate		
2	The Fuel Fabrication Facility (FFC) will be designed with a 40 year life		
3	The FFC will be designed to provide LEU-Mo fuel for the five currently operating domestic High Performance Research Reactors		
The FFC will be built at a Greenfield site located at a DOE National Laboratory. All site services (Fire and emergency response, waste treatment and disposal, site security etc.), utility services (power, water, sewer etc.) and infrastructure are available at the selected site.			
The site selection will be completed by 4/09 in time to support preparation of the Environmental report. The selected site will be free of contamination and will be well characterized.			
The Fuel Qualification effort and the facility design and construction shall be conducted parallel, with completion by the end of 2012.			
7 The FFC will be licensed by the NRC, and will meet all applicable state and federal regulations (DOE, NRC, EPA), as well as National Consensus Codes and Standards.			
The developmental LEU-Mo fuel fabrication line at INL for the R&D program will produce the LTAs for the qualification of the fuel for the first converting reactor wh FFC becomes operational.			
9. The Fuel Qualification Report will be submitted to the NRC –December 2010. Anticipate NRC approval of the Fuel Qualification Report – December 2011. Down selection of the interlayer fuel design and the bonding process will be made by December 2009.			
10.	The NRC has sufficient staff as well as in-place regulations for the licensing of the FFC as planned. A dual track licensing strategy is proposed for the licensing of the FFC (construction permit and operations license for the facility) and for the LEU-Mo fuel (Fuel Qualification reports containing results obtained from the pre-irradiation and post-irradiation tests on miniature plates and full sized fuel elements of monolithic LEU-Mo fuel). A NUREG 1313 type licensing approach is proposed for the licensing of the LEU-Mo fuel.		
	Early involvement of the NRC during the design phase of the project is crucial to the overall timely approval of the construction permit.		
11.	The Fuel fabrication capability acquisition strategy will be approved prior to 9/30/08. Conceptual design effort will commence 10-1-08, in-order to meet the end date for facility hot ops by 1/2013. Site selection needed by April 2009.		

- 12 CD-1 approval documentation per PDRI, comprising of Scope/ Technical, Cost, Schedule, Management Planning and Control, and External factors will be prepared during the CDR effort. DOE's CD-1 approval will be received by 7/1/2009

 12. Sufficient funding as planned will be provided on an annual basis to allow for uninterrupted completion of the design, construction, test and start-up as well as fuel development work required for the completion of the fuel qualification data package
- NNSA will fund the design, construction and start-up of the FFC. DOE/NE will provide the funding for the operations and maintenance of the FFC.

B Process

submittal to the NRC.

1. FFC will receive LEU-Mo cast Feedstock (acorns or broken pieces) from Y-12 in ES-3100 shipping containers.

MC&A will meet the requirements of DOE (DOE O 470.4, DOE M 470.4-6, and DOE M 474.1-2) or the NRC (NUREG/BR-0006)

Induction melting and coupon casting will be performed at the FFC for the purpose of this study. As an alternative a future trade study will be performed to address if the coupon casting work should be performed at Y-12.

Process operations will be conducted in a batch or campaign mode.

2. Up to one core storage of fabricated fuel for each of the five HPRRs must be provided, in addition to storage of up-to a one year supply of LEU-Mo cast feedstock.

Waste will not be allowed to accumulate in the facility for more than 90 days.

- 3. Waste will be packaged and shipped to other facilities on or off the DOE site for treatment and disposal.
- 4. The Al-6061 aluminum cladding machine work (flattening, sizing and pocketing) will not be performed in the FFC. These items as well as fuel assembly side and end pieces will be supplied commercially from an off-site source, with dedicated production and suitable quality assurance capabilities. Configuration of supplied items will be controlled by the FFC.

A future trade study should be performed to evaluate if this task can be performed more cost effectively by outsourcing to an external machine shop or if it might be incorporated into the process line of the FFC.

5. The diffusion barrier layer will be applied by hot rolling a thin layer of Zirconium or other metal on the top and bottom of the fuel coupon in a sealed can at atmospheric pressure that has been evacuated and backfilled with Argon.

A future trade study and performance tests should be performed to evaluate from an engineering and process efficiency perspective if other materials or a thermal spray technique applying an aluminum-silicon alloy would be better.

6.	The fuel plate assembly bonding shall use the friction bonding process. The alternate HIP process will be evaluated and the required floor space to accommodate the HIP process will be determined.	
A future trade study performed in conjunction with the miniplate fuel fabrication development process will evaluate, from engineering and process requirements the appropriate fuel plate bonding process (friction bonding or the HIP process).		
7.	Fuel plate pre-assembly shall be manually performed.	
	A future trade study will be performed to determine if plate pre-assembly (prior to bonding) can be practically automated or a manual operation is required.	
8.	The FFC is designed to provide LEU-Mo fuel for the five US High Performance Research Reactors. No provision for FFC expansion will be made to accommodate the fuel needs of additional foreign research reactors.	
	A future trade study will be performed to identify the additional facility footprint and cost schedule implications as a result of the facility expansion to accommodate foreign research reactors.	
9.	Clean scrap LEU-Mo alloy may be returned to Y-12 or reused within the FFC.	
10.	Aluminum plates of the required size, configuration and thickness, and cans used during rolling of Zr onto the fuel meat will be purchased as outsourced materials.	
11. Equipment will have a 75% availability to allow for maintenance and scheduled or shut-down. C Facility		
		1.
2.	A secure but not hardened controlled storage area is required for the storage of convenience cans containing LEU-Mo acorn/broken pieces received from Y-12 as well as cast ingots, fuel foils, and complete fuel assemblies. Cabinets/racks will be used for the in-process storage of foils.	
3.	A receipt inspection area is required for receiving and un-packaging of the shipping containers, performing the required receipt inspections, and completing the required receiving documentation.	
4.	A 6' high corrugated wire fence will enclose the site. A manned Entry Control Facility (ECF) will be provided at the site boundary for security and access control.	
5.	A warehouse for the storage of materials/consumables, tooling/fixtures etc. and a work	
	shop for minor repairs shall be provided within the site.	
6.		

- 8. The Casting area will be segregated from the balance of the production area by a (2 hr) fire-rated barrier to reduce the potential consequences of a fire in the casting area. This barrier shall not be degraded by activation of any active fire suppression system.
- 9. A high bay shall be provided in the main processing area, including overhead crane/s for material handling as well as for equipment change out. At some point in the life of the plant, any or all stations involved in monolithic fuel manufacturing may require change out.
- 10. The shop floor will be equipped with parts cleaning baths including nitric acid and caustic cleaning solutions. Molten salt baths for pre-heating, prior to rolling, are also incorporated in the plan.

Such baths, and other designated stations that have the possibility to be sources of contamination, will be equipped with pre-filtered exhaust ventilation ducts that induce a draft away from the operator. Face velocity at the opening to the task exhaust duct will be 250 feet per minute.

11. A cascaded negative air pressure (relative to the atmosphere) will be established and maintained within the entire shop floor volume of the FFC at all times. The air flow will be from areas with low or no contamination toward areas of increasing probability of contamination, where it is exhausted.

Air circulation shall be provided to maintain the airborne concentration of uranium below 0.25 mg/m3 which is the permissible exposure limit (8 hour time weighted average) for chemical toxicity for insoluble compounds of uranium (29 CFR 1910.1000 Table Z-1). If soluble uranium compounds are present, the permissible exposure limit is 0.05 mg/m3.

HEPA filtered exhaust from the shop floor area will be released to the atmosphere through a stack outside the building. Redundant HEPA filtration will be provided before release to the atmosphere.

Filtered and conditioned air will be supplied to all areas of the plant.

The FFC is arranged so that material or personnel cannot exit the confinement area to the outside directly without passing through a ventilation buffer area first.

The non process areas of the FFC shall be designed to provide handicapped personnel access in accordance to the requirements of ADA.

D. Safeguards and Security

- 1. The FFC will store and process LEU-Mo material categorized as Attractiveness level E. The SNM inventory for the facility will exceed the reportable quantity, making the FCC a Security Category 4 facility. Facility hardening is not required.
- 2. Material Balance areas shall be established within the facility. Material accountability shall be performed in accordance with DOE O 470.4 and DOE M 470.4-6 unless NRC accountability requirements supersede the DOE requirements.
- 3. Traceability of lot numbers of the LEU-Mo during the casting and foil/sub-assembly fabrication process shall be maintained.
- 4. Partitioned, geometrically safe secure storage racks shall be used for the storage of LEU-Mo shipping cans shipped from Y-12, as well as storage of in-process foils.

E.	Quality Inspection		
1.	An approximately 30'x30' area shall be provided adjacent to the process area for a quality/inspection laboratory. Besides dimensional inspection, ultrasonic testing, radiography and fluoroscopy, metallographic, chemical analysis, and microscopic inspection (including sectioning, polishing and etching) capabilities shall be available in the FFC lab.		
2.	Y-12 will provide the certified chemical and isotopic analysis of the incoming LEU-Mo feed to the FFC. Alloys cast in the FFC will be certified to meet reactor requirements by the FFC. Chemical and isotopic analysis will need to be redone		
3.	During the foil fabrication process, four QA hold points for inspection will be required: Inspection of foil thickness and aluminum thickness (with recess) Inspection of the pre-assembly of the aluminum clad plate Inspection of the assembly prior to bonding of the aluminum clad plates. Inspection of the sub-assembly prior to packaging and storage		

2.2 High Level Functions and Requirements

The LEU-Mo Fuel Fabrication Facility (FFC) will fabricate nuclear fuels using low-enriched uranium (LEU) (less than 20% U²³⁵) that is alloyed with 10% molybdenum. Per Title I of the Atomic Energy Act of 1954, uranium enriched in the isotope U²³⁵ constitutes special nuclear material (SNM) that is subject to nuclear materials safeguards. Possession and use of the feedstock material as well as the fuel assemblies fabricated and the scrap materials generated during the fabrication process are tightly regulated by DOE and/or the NRC.

The nature and amount of nuclear material in the fuel fabrication facility means that nuclear criticality cannot be excluded from the set of accidents that could occur within the facility. The potential for nuclear criticality drives the facility hazard characterization, and therefore, impacts the overall facility design, including cost.

These and other requirements place design and operating constraints on the overall facility that must be integrated into the facility design at the conceptual design stage. Early identification of requirements and integration of these requirements into the facility design helps ensure acceptability of the design for licensing as well as the ultimate operability of the final facility.

This section identifies key topics that define the functions and requirements that must be addressed by the FFC design. These high-level topics are related to permits or licenses required for start-up and operation of the facility and include safeguards and security for protection, control and accountability of the nuclear material; design of the facility for containment and/or confinement of nuclear (and other hazardous) materials; protection of the environment; nuclear safety of the facility; and industrial hygiene/worker safety.

2.2.1 Safety Management

DOE has implemented policy regarding integration of safety management in all phases of its work. This policy, defined in DOE P 450.4, *Safety Management System Policy*, requires that principles of Integrated Safety Management be implemented in all work performed by DOE or its subcontractors. DOE implements this integrated safety management policy in its acquisition of new facilities through DOE O 413.3A, *Program*

and Project Management for the Acquisition of Capital Assets. This order mandates compliance with DOE STD-1189, Integration of Safety into the Design Process. STD-1189 provides implementation guidance for Hazard Category 1, 2, and 3 nuclear facility safety requirements.

This study has been performed at a preconceptual or scoping level, and where possible, has implemented requirements of DOE STD-1189 at an "alternative study level" only. Safety goals and strategy are based on assumptions for the study. Areas of compliance to guide safety in design for this alternative study are as follows:

- Although project functions and requirements have not been formally documented it is expected they will be for Conceptual Design and will mature as the project progresses through the Critical Decision Phases. For this study initial requirements were developed in INL/EXT-6456, Statement of Work for a Greenfield LEU Molybdenum Fuel Fabrication Capability, INL/EXT-08-13840, Conceptual Process Description for the Manufacture of Low-Enriched Uranium-Molybdenum Fuel and through assumptions documented in this study that have been agreed to by the technical subject matter experts from INL and Y-12.
- Based on estimated LEU material quantities, criticality potential and attractiveness levels, the facility has been initially assumed to be a Hazard Category 2, Security Category IV nuclear facility with a natural phenomena hazard performance category of PC-2.
- An initial qualitative assessment of hazards was completed, including identification of principal hazards, and initial control strategies that may have a significant influence on the facility design were identified.
- Initial risks have been identified and obvious mitigation strategies have been considered for the processes and project.
- Initial qualitative evaluations for nuclear safety, nuclear criticality safety, and fire protection have been considered in study design process.
- Developed initial waste management process assumptions
- "In process" (informal) design reviews have been conducted by various DOE Laboratory subject matter experts (SMEs) for criticality safety, nuclear safety, fire protection, safeguards and security, and technical process to help ensure that significant safety elements have been conservatively considered in the preconceptual study.

Full implementation of the DOE requirements for the Preconceptual Phase, Conceptual Design Phase, etc., is assumed to be implemented at the project level. Items not included with this preconceptual alternative study are as follows:

- Formal programmatic High-level Functions and Requirements
- Documented programmatic safety goals and strategy
- Integration of safety for other acquisition alternatives

At the beginning of the Conceptual Design Phase, it is assumed that detailed acquisition and process alternatives analysis will be conducted along with hazards evaluations. Safety related requirements that will need to be implemented for the Conceptual Design Phase include:

- Development of a Safety Design Strategy (SDS)
- Hazards analysis for project alternatives, and process alternatives
- Identification of Safety Systems, Structures and Components (SSCs)
- A formal Preliminary Hazards Analysis and control strategies for the selected Alternative
- Natural Phenomena Hazards (NPH) performance categories
- Site specific hazards analysis
- Risk Management Plan
- Risk Assessment
- Conceptual Safety Design Report (CSDR)
- Integration of safety elements into the Concept Design Report

2.2.2 Safeguards and Security

Nuclear material control and accountability (MC&A) is the joint responsibility of the US Nuclear Regulatory Commission (NRC) and the US Department of Energy (DOE). This responsibility is implemented by the Nuclear Materials Management & Safeguards System (NMMSS) that is administered by NAC International under contract with DOE HS-1.22 (Office of Information Management) that is managed by the DOE Savannah River Operations Office. This program tracks nuclear material flows between and among various governmental, commercial, and educational entities as well as foreign entities to ensure that nuclear materials are not improperly used or diverted for improper use. Although the LEU-Mo materials used in fabricating nuclear fuels for high performance research reactors have low attractiveness for misuse or diversion, they still are subject to the MC&A requirements.

The DOE MC&A requirements are defined in DOE M 470.4-6¹. This manual sets forth the methodology for determining the security category for the facility based on the attractiveness level of the SNM and the amount of SNM contained. The security categorization is used to define additional requirements for physical protection (DOE M 470.4-2²), protective force (DOE M 470.4-3³), information security (DOE M 470.4-4⁴), and personnel security (DOE M 470.4-5⁵), as required.

Enriched uranium (including LEU) is reportable at the one gram level (reference 1, Table I-1). LEU is classified as Attractiveness Level E material (reference 1, Table I-4), making the FFC a security category IV (SC IV) facility. This categorization defines the requirements for the FFC MC&A program as well as additional requirements (e.g., physical protection) from other sections of DOE M 470.4.

Under NRC regulation, the inventory of U²³⁵ that would be present in FFC causes the facility to be categorized as processing "special nuclear material of moderate strategic

¹ DOE M 470.4-6, Chg.1, Nuclear Material Control and Accountability, August 14, 2006, 168 pp.

² DOE M 470.4-2, Chg.1, Physical Protection, August 26, 2005.

³ DOE M 470.4-3, Chg.1, *Protective Force*, August 26, 2005.

⁴ DOE M 470.4-4, Chg.1, Information Security, August 26, 2005.

⁵ DOE M 470.4-5, Personnel Security, August 26, 2005.

significance"⁶. Physical protection requirements for this facility are defined in 10 CFR 73.67. MC&A requirements for this facility are defined in 10 CFR 74.41.

A security category IV facility would have the following basic components for the material control and accountability program (Ref: DOE M 470.4-6; Personal Communication with Roger Haga, INL Safeguards, 12 June 2008)

- Accounting System There will need to be in place a method for tracking and accounting for the nuclear material including
 - o shipping and receiving records,
 - o transfer records, and
 - o procedures for tracking and controlling material movement.
- Inventory Periodic inventory of the nuclear material will be required. They will
 - o be performed annually for security category IV facilities,
 - o include safeguards measurements (typically nondestructive assay) of selected materials
 - o include inspections of the storage and processing areas to verify material locations, quantities, identification numbers, etc.
- Access Control Access to the nuclear material will need to be restricted to authorized personnel.

To facilitate implementation, of the material control and accountability requirements the FFC is divided into Material Balance Areas (MBAs) as shown in Figure 2-1. These MBAs are preliminary.

Eight Mass Balance Areas within the FFC

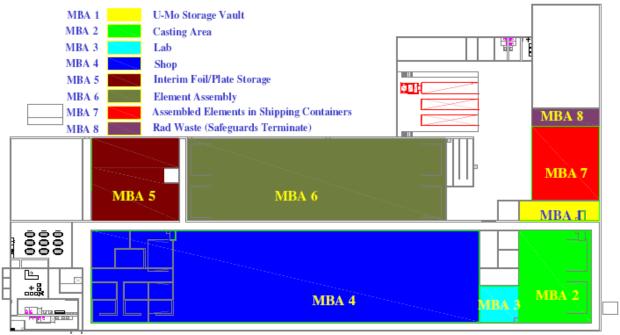


FIGURE 2-1 MASS BALANCE AREAS (MBAS)

_

⁶ The definition in 10CFR70.4 includes: "(2) 10,000 grams or more of uranium-235 (contained in uranium enriched to 10 percent or more but less than 20 percent in the U-235 isotope)". At 20% enrichment, a total uranium mass of 50 kg meets the definition for "moderate" strategic significance.

2.2.3 Containment/Confinement

Fuel fabrication processes include steps involving unconfined nuclear material. For the most part, these fabrication processes involve LEU in non-dispersible, bulk alloy form, and much of the subsequent processing involves this same material with an aluminum cladding. In these forms, the LEU does not require special containment or confinement to protect workers or the public from routine exposures. However, work areas will include local HEPA-filtered ventilation (task exhaust) to capture minor airborne contamination that might be generated from the processes.

Certain processes (especially casting) do have potential for generating airborne particulates. Those processes having increased potential for airborne releases will be conducted within enclosures that contain any airborne materials. These enclosures include appropriate filtration to capture particulates before the filtered air enters the exhaust ventilation system.

The FFC ventilation system for the processing area is designed for cascading air flows from areas of low potential contamination to areas of higher potential contamination. Filtered, conditioned supply air is provided to the processing area via a supply plenum. The supply system is designed to maintain the air supply to the processing area without pressurizing that area with respect to normal atmospheric pressure. Thus, the supply ventilation system is controlled by sensors that maintain a negative differential pressure between the processing area and the atmospheric pressure outside the building. The ventilation supply system includes dampers that close in the event of a fire to prevent backflow of hot exhaust out the air supply system.

The FFC exhaust ventilation system has multiple stages of HEPA filtration. The first stage of exhaust ventilation filtration is located at work areas where the potential exists to generate particulate materials that might become airborne. Examples include machining operations, chemical cleaning operations, and casting operations. Task exhaust systems include local HEPA filters that remove particulates from the exhaust gas before it enters the facility exhaust ventilation system upstream of the building HEPA filters. Task ventilation systems may also include mist eliminators to remove moisture from specific exhaust streams. Future studies will evaluate the need for additional off-gas treatment and/or heating before the HEPA filtration.

The main building exhaust ventilation system includes two-stages of HEPA filtration upstream of the building exhaust blowers. To protect the HEPA filters from accident conditions, especially fires, the exhaust ventilation system will include a deluge spray system, mist eliminators, fire screens, and roughing filters upstream of the first stage of HEPA filtration.

2.2.4 Environmental Protection

The US Environmental Protection Agency is responsible for protecting the environment through regulation of pollutant release to the environment. The EPA administers compliance with key environmental legislation that is applicable to the FFC, including: the National Environmental Policy Act (NEPA), the Clean Air Act (CAA), the Clean Water Act (CWA), the Toxic Substances Control Act (TSCA), the Resource Conservation and Recovery Act (RCRA), and the Superfund Amendments and Reauthorization Act (SARA).

National Environmental Policy Act Requirements

NEPA requirements applicable to the FFC are defined in 40 CFR parts 1500 through 1508. The DOE, as the federal agency responsible for the FFC, is required to follow the DOE NEPA Implementing Procedures defined in 10 CFR 1021 in its planning and decision-making processes. DOE implements the requirements of these regulations following DOE O 451.1B⁷. The NEPA process requires that DOE evaluate whether a major action requires an environmental assessment (EA), an environmental impact statement (EIS), or is categorically excluded from the requirement to prepare either of these documents. The decision to convert high performance research reactors to low enriched fuel might constitute a major action subject to the NEPA process. Siting a new facility for fabricating such fuel will almost certainly require an EA. Preparation of an EA or an EIS will result in additional activity that will increase cost and delay the schedule for construction and startup of the FFC.

If the FFC is to be a commercial fuel fabrication facility licensed by the NRC, the responsibility for NEPA compliance lies with the NRC. NRC implementation of NEPA requirements is defined in 10 CFR 51, and the NEPA compliance process is integrated into the licensing process.

Clean Air Act

CAA requirements that are potentially applicable to the FFC are defined in the following Parts of 40 CFR:

- Part 50 (National primary and secondary ambient air quality standards),
- Part 61 (National emission standards for hazardous air pollutants)
- Part 68 (Chemical accident prevention provisions),
- Part 70 (State operating permit programs),
- Part 71 (Federal operating permit programs).

10 CFR 50 establishes ambient air quality standards for a specific set of air pollutants (sulfur oxides, nitrogen oxides, ozone, carbon monoxide, lead and particulate matter). Except for the construction of a fossil-fuel fired plant to provide electricity or steam for process or space heating, the FFC will not emit any of these criteria air pollutants and will therefore be exempt from 10 CFR 50 requirements.

10 CFR 61 sets requirements for permitting the construction, modification and operation of facilities that could be a source of hazardous air pollutants as defined in section 112(b) of the Clean Air Act. This regulation also defines requirements for monitoring and controlling pollutant emissions. Two chemicals identified as being present in the FFC are found on the list of hazardous air pollutants, hydrofluoric acid and radionuclides. The presence of these chemicals potentially requires the FFC to obtain an operating permit under part 70 or part 71. The low volume of hydrofluoric acid that could be present in the facility could form the basis for waiver of a permitting requirement for this substance. The standard for radionuclides (10 CFR 61.92) sets an effective dose equivalent limit of 10 mrem/year to any member of the public. Public dose from radioactive air emissions can be estimated using the EPA CAP-88 model, and this information is required in a permit application. Further study is required to evaluate the applicability of 10 CFR 61.

_

⁷ National Environmental Policy Act Compliance Program, DOE O 451.1B, October 26, 2000, 12 pp. http://www.directives.doe.gov/pdfs/doe/doetext/neword/451/o4511bc1.pdf

10 CFR 68 describes the requirements for a risk management plan for hazardous chemicals that exceed threshold quantities defined in the regulation. For hydrofluoric acid, the threshold quantity (40 CFR 68.130) is 1000 lb, and radionuclides are not listed in there is no threshold quantity for radionuclides. Because the expected FFC inventory of hydrofluoric acid is far less than the threshold quantity, and there is no threshold quantity for radioactive materials, it seems that the FFC will not be subject to the requirements of this regulation.

10 CFR 70 and 71 are the State and Federal operating permit programs, respectively. Where the state has been granted full or partial approval of its operating permits program, the Part 70 requirements apply. The Part 71 requirements cover those portions of a permit application for which there is no approved Part 70 program. The permits covered by these regulations are those required by other CAA regulations defined above.

Clean Water Act

The Clean Water Act (CWA) regulates point source discharges of pollutants into surface water and groundwater. Regulations that are potentially applicable to the FFC are defined in the following Parts of 40 CFR:

- Part 116 (Designation of hazardous substances)
- Part 117 (Determination of reportable quantities for hazardous substances)
- Part 122 EPA administered permit programs: The national pollutant discharge elimination system
- Part 125 (Criteria and standards or the national pollutant discharge elimination system)
- Part 131 (Water quality standards)

Several substances used in FFC are listed as hazardous substances in 40 CFR 116.4: These include: hydrofluoric acid, nitric acid, and sodium hydroxide. Reportable quantities for these substances (from 40 CFR 117.3) are 100 lb for hydrofluoric acid and 1000 lb each for nitric acid and sodium hydroxide. 40 CFR 117.21 requires that discharge of a reportable quantity of a hazardous substance within a 24 hour period be reported to the EPA (or other cognizant federal agency). (Note: radioactive materials regulated under the Atomic Energy Act are exempt from the definition of "pollutant" in 40 CFR 122.2). Because the FFC use of these chemicals is low compared to the reportable quantity, the FFC should adopt a strategy of ensuring that on-site inventories of these chemicals are always less than the reportable quantities.

The EPA regulates discharges of pollutants from point sources to surface water or groundwater via the National Pollutant Discharge Elimination System (NPDES) program (40 CFR 122). Under this regulation, an NPDES permit is required to release pollutants that could enter surface water or groundwater. The FFC plans to ship liquid wastes to an off-site treatment facility rather than to treat wastes from its processes. Except for sanitary wastes discharged to a permitted sewage treatment plant and stormwater that can be discharged to the environment through a permitted outfall, the FFC does not intend to discharge liquids from the site. However, the FFC must provide for potential discharges from upset conditions, for example, fire water from a fire in the process area. The FFC is designed to collect any such water and to sample the water before releasing this water. The FFC design concept includes a mechanism for collecting, sampling and analyzing collected fire water. The disposition pathway(s) for such water requires further study to define alternatives.

In addition to planned discharges (of treated effluent, for example), this regulation requires permitting of storm water runoff from the site, both during construction and operation of the facility. The FFC would be required to have an NPDES permit for storm water discharge. The EPA regulates stormwater discharges from construction sites of one acre or more, thus, the FFC would require a Construction General Permit for the construction activities. Stormwater runoff from the operating facility will be collected in a stormwater collection system that meets the permit requirements.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) empowers the EPA to regulate the use or distribution (including disposal) of any chemical substance deemed to be hazardous to human health or the environment. EPA classifies chemicals as "new" or as "existing". The list of existing chemicals includes about 75,000 chemical substances, and the public portion of this inventory (not including substances identified as proprietary) is available online at http://www.epa.gov/srs/ (the substance registry system).

All commercially-available substances used in the FFC will already have been entered in this inventory by the manufacturer. Per 40 CFR 720.3(e)(4), special nuclear material is exempt from the definition of chemical substance, and is not subject to reporting requirements per 40 CFR 720.30(a). Thus, there are no TSCA reporting requirements for the FFC.

Solid, Hazardous and Radioactive Wastes

Wastes generated at the FFC include solid⁸, hazardous, and radioactive wastes. Solid and hazardous wastes are regulated by the EPA under the Solid Waste Disposal Act and the Resource Conservation and Recovery Act (RCRA). Solid waste regulations are located in 40 CFR 239 through 259, and hazardous waste regulations are located in 40 CFR 260 through 279.

FFC solid waste streams include normal office trash as well as non-hazardous solid wastes from fuel fabrication activities - non-radioactively-contaminated process wastes from the process area such as metal scrap from the machining and shearing processes; wood, paper and plastic materials; spent equipment and tooling that do not contain hazardous components; etc. The requirements for packaging, storing, and managing these wastes are defined in 40 CFR 243. These wastes would be disposed in permitted municipal solid waste landfills.

FFC waste streams containing RCRA hazardous wastes are listed in Table 2-2. None of the hazardous wastes generated in the FFC are acutely hazardous, one is a listed (toxic) waste, and two wastes are corrosivity characteristic wastes. Waste generators are allowed to store hazardous wastes for periods up to 90 days without a RCRA permit. This storage is subject to the packaging, documentation and other requirements of 40 CFR 262.34.

⁸ The RCRA definition of solid waste is: "garbage, refuse, sludges, and other discarded solid materials, including solid waste materials resulting from industrial, commercial, and agricultural operations, and from community activities, but does not include solid or dissolved materials in domestic sewage or other significant pollutants in water resources, such as silt, dissolved or suspended solids in industrial wastewater effluents, dissolved materials in irrigation return flows or other common water pollutants. Unless specifically noted otherwise, the term "solid waste" as used in these guidelines shall not include mining, agricultural, and industrial solid wastes; hazardous wastes; sludges; construction and demolition wastes; and infectious wastes"

Designation	Waste	Process Source	Estimated Annual Production
Toxic Waste U-listed U134	Hydrofluoric Acid	Cleaning of Zr/U10Mo foils to remove yttrium	240 gallons
Characteristic: Corrosivity D002	Nitric Acid	 Cleaning of U10Mo foils Cleaning of Zr clad U10Mo foils Cleaning of aluminum clad 	6460 gallons
Characteristic: Corrosivity D002	Sodium Hydroxide Solution	Cleaning of aluminum clad	3120 gallons

TABLE 2-2. HAZARDOUS WASTES GENERATED AT FFC

Treatment, storage (for more than 90 days), or disposal of hazardous wastes requires a RCRA permit to perform that activity. The FFC does not intend to perform any activity that would require a RCRA permit. Hazardous wastes accumulated in the 90 day storage area would be appropriately packaged and shipped off-site to a firm that specializes in hazardous waste treatment, stabilization, and disposal in accordance with the requirements of 40 CFR 262.

Some of the solid wastes generated at the FFC will include radioactive materials such as the scrap from trimming Zr-clad LEU-Mo foils or the heels from the casting operation. Wastes containing radioactive materials will be low level radioactive waste (LLW). 10 CFR 61.55 defines four classes of LLW: Classes A, B, C, and "Greater-Than-Class-C" or GTCC, and this regulation provides thresholds for determining classification of a radioactive waste depending on the radionuclide present in the waste. Uranium is not listed in the tables, and by 10 CFR 61.55(a)(6), the radioactive wastes from FFC would be Class A LLW.

Three LLW disposal facilities are licensed by the NRC (or by agreement states) – Barnwell, SC (operated by Chem-Nuclear/Duratek); the Energy Solutions (formerly Envirocare) facility in Clive, Utah; and the US Ecology facility at Hanford, Washington.Barnwell16 and Hanford are licensed to accept classes A-C. The Envirocare facility is only licensed to accept class A LLW. Disposal of DOE-generated LLW is authorized at Hanford, Idaho National Laboratory, Los Alamos National Laboratory, Nevada Test Site, Oak Ridge Reservation and the Savannah River Site. Of these six sites, only Hanford and Nevada Test Site are authorized to receive LLW from off-site (DOE) sources.

The two acid wastes identified in Table 2-2 have the potential of containing uranium, and therefore, these wastes could be mixed low-level wastes that would require treatment of the hazardous components at a RCRA licensed facility before disposal as LLW.

Radioactive waste packaging would require criticality safety evaluation to ensure that there is no potential for a criticality safety event during packaging, storage, transportation or disposal.

Superfund Amendments and Reauthorization Act

Title III of the Superfund Amendments and Reauthorization Act (SARA) includes provision for emergency planning and for informing local governments and the public about chemical hazards in facilities. This legislation is regulated by the EPA (40 CFR 355). Appendix A and Appendix B to Part 355 of 40 CFR set forth lists of "Extremely Hazardous Substances and Their Threshold Planning Quantities". Two chemicals in FFC are on these lists: hydrofluoric acid and nitric acid. The threshold planning quantities for these substances are 100 lb and 1000 lb, respectively. If the FFC inventory of these (or any other chemicals on the lists) exceeds the threshold planning quantities, then the FFC must report the that fact to the state emergency response commission for the state in which the FFC is located.

It is not anticipated that FFC inventories will exceed the threshold planning quantities and therefore, FFC should not be required to report chemical inventories to state officials.

2.2.5 Nuclear Safety

Nuclear safety requirements focus on facility design and operation that protect the public and facility workers from exposure to nuclear materials. For DOE facilities, the regulatory driver for nuclear safety is 10 CFR 830 (Nuclear Safety Management). NRC regulates fuel fabrication facilities under 10 CFR 70 (Domestic Licensing of Special Nuclear Material). Specific NRC licensing requirements for fuel fabrication facilities requirements are detailed in NUREG-1520⁹.

Under DOE regulation, the FFC would be categorized as a Hazard Category 2 (HC2) facility ¹⁰. This characterization results from the fact that sufficient SNM is present at several locations within the facility such that a nuclear criticality event cannot be precluded. This categorization means that a Documented Safety Analysis (DSA) and Technical Safety Requirements (TSR) are required for operating the facility. Included in the DSA/TSR are a number of safety management programs that increase the development, operating and oversight expense of the facility.

Additional design requirements for DOE hazard category 1, 2, and 3 nuclear facilities are defined in DOE O 420.1B¹¹ in the areas of nuclear facility design, fire protection, criticality safety, and mitigation of natural phenomena hazards. This order further establishes a requirement for a Systems Engineer program. These additional requirements are implemented at later design stages, but they must be identified early in conceptual design and integrated into the design process.

Under NRC regulation, the FFC would be required to prepare a license application that includes the same basic information as for a DOE DSA/TSR, but this information would be formatted according to NRC requirements in reference 6.

One significant difference between NRC and DOE processes for review and approval of nuclear safety documents (DSA/TSRs for DOE; license application for NRC) is that the NRC process requires that the license applicant fund the NRC review.

⁹ Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility, NUREG-1520, March 2002, 220 pp. http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1520/sr1520.pdf

¹⁰ Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, DOE STD 1027-92, Change Notice #1, September, 1997, 49 pp. http://www.hss.energy.gov/NuclearSafety/techstds/standard/std1027/s1027cn1.pdf

¹¹ Facility Safety, DOE O 420.1B, December 22, 2005, 65 pp.

2.2.6 Industrial Hygiene

Industrial hygiene involves "anticipating, recognizing, evaluating and controlling workplace conditions that may cause workers injury or illness". Federal regulation of workplace safety is the province of the Occupational Safety and Health Administration (OSHA) of the Department of Labor. These safety regulations are defined in the following subparts of 29 CFR 1910:

- Subpart D. Walking & Working Surfaces
- Subpart E. Means of Egress
- Subpart F. Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms
- Subpart G. Occupational Health and Environmental Control
- Subpart H. Hazardous Materials
- Subpart I. Personal Protective Equipment
- Subpart J. General Environmental Controls (Sanitation)
- Subpart K. Medical and First Aid
- Subpart L. Fire Protection
- Subpart M. Compressed Gas & Compressed Air Equipment
- Subpart N. Materials Handling and Storage
- Subpart O. Machinery and Machine Guarding
- Subpart P. Hand and Portable Powered Tools and other Hand-Held Equipment
- Subpart Q. Welding, Cutting and Brazing
- Subpart S. Electrical

A detailed list of all worker safety requirements that are applicable to the FFC is beyond the scope of this report. The FFC generalized design concept automatically incorporates facility design requirements such as are covered in subparts D, E, H, J, and L. Stationary equipment that will be placed in the facility will incorporate the requirements of subpart O. Safety requirements covered by other subparts involve a combination of engineered controls and administrative controls such as detailed operating procedures. Where the preliminary hazards analysis identifies workplace hazards that are subject to OSHA regulation, the appropriate section of 29CFR 1910 will be used in defining the required controls.

2.3 Quality Assurance

The Greenfield Alternatives study was performed in accordance with good engineering practice for conducting pre-conceptual design studies. Subsequent conceptual, preliminary and final design, as well as procurement of equipment and services and construction shall be conducted in conformance with an established QA program that complies with ASME ANSI NQA-1, as well as 10 CFR 830.120 and DOE Order 414.1C

A graded approach shall be used to determine the appropriate QA requirements to be implemented throughout the life cycle of the project. The Graded approach shall be defined in the implementing project quality documents. The graded approach will utilize a process by which the level of analysis, extent of documentation, and degree of rigor of process control are applied based on risk commensurate with their regulatory significance; importance to safety, safeguards, security and the environment; programmatic mission and any other factors determined important by management.

¹² Industrial Hygiene, OSHA Information Booklet #3143, 1998

Key requirements pertaining to design control during the conceptual, preliminary and detail design include the following: (1) ensure design inputs are traceable to approved documents and are correctly translated into design documents (2) organizational and physical interfaces are identified and controlled; (3) changes to design are controlled in a manner commensurate with the original design; (4) design is independently verified to be adequate; and (5) documentation and records of the design and design verification processes are maintained in accordance with the QA program.

2.4 Pollution Prevention and Waste Minimization

The DOE requires that principles of pollution prevention, waste minimization, sustainable design and energy efficiency be incorporated into the facilities built with federal funds or used to house federally funded operations. The following regulations pertaining to pollution prevention should be considered during the conceptual, preliminary and detail design of the FFC:

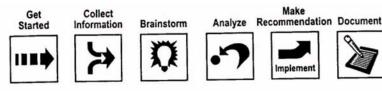
- The design and selection of materials shall consider the federal requirement and DOE goal to purchase EPA-designated items with recycled content except when not available competitively at a reasonable price or that do not meet performance standards (FDD, Executive Order13101, Secretary of Energy Memorandum dated November 12, 1999).
- Sustainable building design and energy efficiency principles shall be incorporated into the design of the new facility (Executive Order 13123, Secretary of Energy Memorandum dated November 12, 1999).
- The design shall consider the federal agency requirements to incorporate waste prevention and recycle into daily operations (Executive Order 13101, Executive Order 13148).
- Source reduction techniques shall be preferred over recycling, treatment, and disposal techniques where technically feasible and cost effective (Pollution Prevention Act of 1990).
- Purity of air and water shall be preserved (pollution prevention) and energy efficiency encouraged (S.C. Code of Laws Title 48).
- System design shall minimize the generation of wastes and minimize the mixing of radioactive and non-radioactive wastes. This will minimize the risk of exposure of the public, the worker and the environment DOE Order 420.1.
- The design shall minimize the generation of Low level Waste DOE Order 435.1.

To the maximum extent practicable, the FFC project shall be designed to integrate the following fundamental pollution prevention goals during the life cycle of the project:

- Minimize the discharge of radionuclide's and other pollutants to the environment
- Minimize waste through source reduction and recycling,
- Meet all effluent release criteria/regulatory standards; and
- Utilize ALARA principles to minimize exposure to workers, the public and the environment from pollutants

During each phase of the design i.e. conceptual and Title Design, a pollution prevention assessment shall be performed, utilizing the following guidelines:

- (1) Commit to performing an assessment and engage all project staff in pollution prevention activities.
- (2) Gather data about key waste generating activities by reviewing existing design
- (3) Identify potential pollution prevention opportunities.
- (4) Research and analyze pollution prevention opportunities for potential waste reduction, cost avoidance, and return on investment.
- (5) Make recommendation for pollution prevention implementation projects based on the waste and cost analysis.
- (6) Summarize the findings.



STEPS IN A POLLUTION PREVENTION DESIGN ASSESSMENT (ENGEL-COX 1999). (GRAPHIC REPRODUCED WITH AUTHORS' PERMISSION)

The following pollution prevention concepts have been included in this Greenfield Alternative Study of the FFC:

- Segregate non-radioactive operations: This minimizes the spread of contamination and the generation of radioactive waste.
- Recycle of U-Mo scrap from the foil fabrication: This minimizes the waste generated and conserves resources.
- Reuse of foil and plate cleaning solution: This reduces the amount of waste

The following trade studies have been proposed to be performed during the conceptual design phase to evaluate potential for meeting DOE's pollution prevention objectives:

- Incorporating an evaporator in the process to minimize the amount of liquid waste to be shipped off-site for treatment and disposal.
- Minimize the amount of scrap resulting from the foil and plate shearing process.

2.5 Decontamination and Decommissioning

The facility shall be designed to facilitate decontamination of equipment for maintenance repair and replacement, and to minimize costs of the eventual decontamination and decommissioning.

2.5.1 Decontamination

The FFC facility shall include a decontamination area within the process or operating area. This area shall be furnished with all necessary cleaning equipment, radioactivity monitors, waste handling capability, and safety features to safely perform equipment cleaning tasks.

Air cleaning devices shall be located as close to the source of contamination as practicable to capture and remove contaminates to avoid the unnecessary spreading of the contamination into ducts, conveyors, or other process areas. This would include the filtration of task exhaust ducts, hoods and glovebox exhaust air prior to the exhaust air entering a duct leading to the exhaust plenum.

Protection shall be provided for bare floors, walls, and ceilings, particularly for structurally important parts of the building. Protection shall be in the form of liners or durable coatings for which effective cleaning methods have been developed. The liners and coatings will selected to be compatible with the process liquids including waste and reagents used.

Surfaces in operating or process areas shall have no seams, cracks, or rough or absorbent surfaces. In some areas, metal liners shall be required. If necessary all cracks, crevices, and joints shall be caulked or sealed and finished smooth to prevent contaminated material accumulation in inaccessible areas.

In areas that are most likely to become contaminated, adequate access shall be provided, such as crawl spaces, piping tunnels, and hatches into ductwork, to facilitate decontamination.

The design of equipment shall include features and characteristics to avoid build-up of materials, so as to minimize its contamination and facilitate decontamination.

In addition, the design shall incorporate as low as reasonably achievable (ALARA) concepts to minimize impacts on the operators, the public, and the environment.

2.5.2 Decommissioning

The facility design shall include features that will facilitate decontamination for future decommissioning. The following design principles shall be considered for FFC facilities:

- (1) Use of modular, separable confinements for radioactive and other hazardous materials to preclude contamination of fixed portions of the structure;
- (2) Location of exhaust filtration components of the ventilation systems at or near individual enclosures so as to minimize long runs of internally contaminated ductwork;
- (3) Use of equipment, including effluent decontamination equipment, that minimizes, the accumulation of radioactive or other hazardous materials in relatively inaccessible areas including curves and turns in piping and ductwork. Accessible, removable inspection covers are encouraged to allow visual inspection;
- (4) Use of materials that are easily decontaminated and reduce the amount of radioactive and other hazardous materials requiring disposal;
- (5) Use of designs that ease cut-up, dismantlement, removal, and packaging of contaminated equipment from the facility (e.g., removal and dismantlement of gloveboxes, air filtration equipment, large tanks, vessels, equipment and ductwork);
- (6) Use of lifting lugs on large equipment; and
- (7) Use of fully drainable piping systems that carry contaminated or potentially contaminated liquids. This is a requirement for facility analytical laboratories.

2.6 Maintenance Philosophy

The FFC availability of 75%, allows an annual, one month long scheduled plant outage period for major equipment maintenance and refurbishing activities.

The maintenance philosophy of the FFC facility design is guided by the following three considerations listed in order of priority:

- a. Maximizing the predictive capability as well as the use of regularly scheduled preventive maintenance (instead of the after-failure corrective maintenance) by adopting conservative system designs and state-of-the-art process condition monitoring techniques.
- b. Maximizing the use of modular designs (i.e., replaceable units for off-line maintenance) of process systems and equipment for quick change out of failed system or equipment during plant operation. The objective is to enhance the on-line availability of the FFC process plant. This approach assumes maximized off-line repair capabilities and appropriate spare inventory of process systems and equipment at the FFC facility.
- c. For process systems and equipment that are impractical to be designed for quick change-out, the systems will be conservatively designed with phased preventative overhaul requirements that can be cost-effectively scheduled during annual, one-month long plant outage period. These systems will also be designed with appropriate redundancy provisions for any unscheduled failure and outage.

The FFC facility design will contain necessary process equipment bypass/isolation provisions and manual control capabilities in addition to automated programmable control to facilitate the maintenance activities required at the plant. Requirements for the equipment redundancy should be evaluated during the conceptual design

The operations of the FFC will be conducted on a campaign basis. Up to 2 campaigns may be conducted concurrently. Adequate in process material storage to allow for equipment change over and re-calibration for the second campaign is provided.

The FFC fabrication process incorporates surge storage between process unit operations, such that if there is any down-steam unit operation outage, upstream processes can be performed normally. When the affected down stream outage is corrected, extra shifts can be worked to resolve the backlog.

All maintenance of the process systems in the FFC facility will be conducted hands-on with state-of-the-art condition monitoring and testing capabilities.

3.0 PROCESS DESIGN

This section describes the design of the Process Systems included in the FFC. The description includes listing of key process assumptions, defining overall throughput as well as the throughput through the various process operations, descriptions of each of the key unit operations, waste estimations and treatment pathways as well as utility and consumable uses through the facility. Included in Appendix A-3 are the Block Flow Diagrams and Appendix A-4 includes the Process Flow Diagrams.

The FFC facility is designed to meet the fuel assembly production requirements for the five U.S. high performance research reactors (HPRR) using low-enriched uranium (LEU) foils instead of highly enriched uranium compacts. The LEU is alloyed with 10% molybdenum (Mo) in order to stabilize the fuel into the gamma-phase. The gamma-phase is crucial to obtain a high density fuel that behaves acceptably during irradiation. The LEU/Mo fuel is coated with zirconium (Zr) to avoid fuel-cladding reaction between the LEU/Mo fuel layer with the aluminum cladding during fuel plate irradiation. This process is described in detail in Section 3.3.

The major processing areas of the FFC are:

- Casting the LEU/Mo into ingots
- Hot rolling to intermediate thickness
- Sectioning
- Cleaning of the fuel ingots
- Canning ingots to apply Zr
- Rolling to final thickness
- Annealing to flatten plates
- De-can and shear foils to size
- Cleaning of the Zr-clad fuel foil
- Friction Stir Welding to clad plates with aluminum (HIP is an alternative process)
- Rough Shear
- Plate Flattening
- Surface Machining
- Final shearing to final plate size
- Final Assembly of the sub-elements
- Autoclave (for ATR sub-assemblies only)
- Final Inspection
- Element Shipping

Storage is provided in locked areas for in-process foil/plates, which provide intermediate processing breaks to accommodate schedule, upstream, or downstream process disruptions, processing strategy such as forming multiple pieces of each size before changing the shear operations to cut different sizes, etc.

Various assumptions have been made in order to design the fuel fabrication capability (FFC) facility. Table 3-1 shows the process assumptions that exist and were used in the design and subsequent cost estimation.

TABLE 3-1 PROCESS ASSUMPTIONS FOR THE FFC

	TABLE 3-1 PROCESS ASSUMPTIONS FOR THE FFC
	Process
1.	FFC will receive LEU/Mo cast Feedstock (acorns or broken pieces) from Y-12 in ES-3100 shipping containers.
	MC&A will meet the requirements of DOE (DOE O 470.4 and DOE M 470.4-6) or the NRC (NUREG/BR-0006)
	Induction melting and coupon casting is required at the FFC.
	Process operations will be conducted in a batch or campaign mode.
2.	Up to one core storage of fabricated fuel for each of the five HPRRs must be provided, in addition to storage of up to a one year supply of LEU/Mo cast feedstock.
	Waste will not be allowed to accumulate in the facility for more than 90 days.
3.	Waste will be packaged and shipped to other waste processing facilities on or off the DOE site for treatment and disposal.
4.	The Al-6061 aluminum cladding machine work (sizing and pocketing) will not be performed in the FFC. These items as well as fuel assembly side and end pieces will be supplied commercially from an off-site source, with dedicated production capability and suitable quality assurance capabilities. Configuration of supplied items will be controlled by the FFC.
	A future trade study should be performed to evaluate if this task can be performed more cost effectively by outsourcing to an external machine shop or if it might be incorporated into the process line of the FFC.
5.	The diffusion barrier layer will be applied by hot rolling a thin layer of zirconium or other metal on the top and bottom of the fuel coupon in a sealed can.
	A future trade study and performance tests should be performed to evaluate from an engineering and process efficiency perspective if other materials or a thermal spray technique applying an aluminum-silicon alloy would be better.
6.	The fuel plate assembly bonding shall use the friction bonding process. The alternate HIP process will be evaluated and the required floor space to accommodate the HIP process will be determined.
	A future trade study performed in conjunction with the miniplate fuel fabrication development process will evaluate, from engineering and process requirements standpoints, the appropriate fuel plate bonding process. (friction bonding or the HIP process).

- 7. Fuel plate pre-assembly shall be manually performed.
 - A future trade study will be performed to determine if plate pre-assembly (prior to bonding) can be practically automated or a manual operation is required.
- 8. The FFC is designed to provide LEU/Mo fuel for the five US High Performance Research Reactors. No provision for FFC expansion will be made to accommodate the fuel needs of additional foreign research reactors.

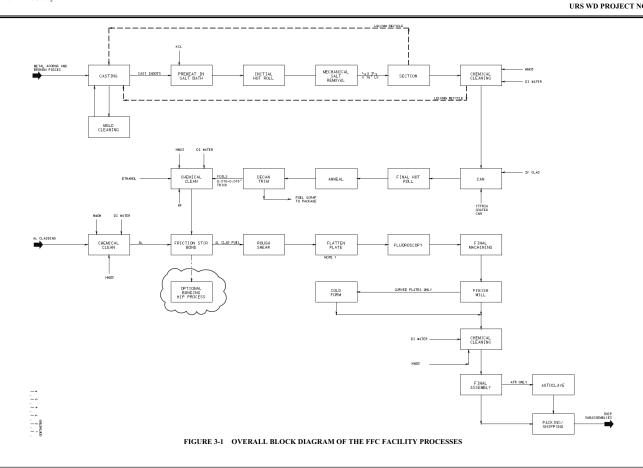
A future trade study will be performed to identify the additional facility footprint and cost schedule implications as a result of the facility expansion to accommodate foreign research reactors.

- 9. Scrap fuel may be returned to Y 12 or reused within the FFC.
- 10. Cans used for rolling of Zr to the fuel meat will be purchased as outsourced materials.
- 11. Equipment will have a 75% availability to allow for maintenance and scheduled operations shut-down.

3.1 Process Overview

3.1.1 Block Flow Diagrams

Block flow diagrams (BFDs) show a very basic outline of the flow through the processing facility. Each major process is shown as a block with inputs and outputs as well as connection streams for recycles and inputs to the next process. The BFD for FFC is shown as BF-1 in Appendix A-3. Figure 3-1 also shows the BFD for the FFC facility for ease in viewing as the various processing areas are discussed in section 3.3.



The major steps in fuel fabrication are as follows:

- Casting: Broken metal feedstock and recycled fuel are melted and cast into ingots for further processing. The ingots are analyzed to ensure the correct isotopic mixture and chemical composition. Each mold is ¼" x 3.5" x 16"
- Hot Roll: The cast ingots are preheated using a salt bath at 650°C and rolled to an intermediate thickness of 0.1" causing the ingot to lengthen to 40". The rolled ingots are sectioned into 10 pieces.
- Salt Removal: The salt bath material adhering to the ingots is removed using mechanical brushing.
- Cleaning: The rolled ingots are cleaned in a nitric acid bath and rinsed with DI water to promote bonding without voids.
- Canning: Zr cladding is added to each side of the LEU/Mo rolled section and this "sandwich" is welded inside a steel can. The interior of the can is coated with yttria (Y₂O₃) to prevent the Zr from bonding to the steel can, allowing for easy removal.
- Final Hot Roll: The steel can is heated in a tunnel furnace and rolled to the final (foil) thickness of 0.010 to 0.015".
- Anneal: The steel can with the Zr-clad LEU/Mo fuel foil inside is placed in an annealing furnace to reduce residual stresses from rolling and flatten the foils. Constraints are placed on top of the foil to help flatten the foils.
- Decan and Trim: The foils are removed from the can and are trimmed to the final size required for each fuel plate.
- Cleaning: Fuel foils are cleaned using a nitric acid/ hydrofluoric acid mixture to remove the yttria and are rinsed with DI water. Ethanol is used as a final wipe.
- Aluminum Hardware Cleaning: Aluminum cladding is cleaned using sodium hydroxide, nitric acid, and a DI water rinse prior to assembly with the fuel foil.
- Friction Stir Welding: The foil is sandwiched between the aluminum plates. A friction stir welder is used to bond the fuel foil to the aluminum. An alternative method of bonding uses a hot isostatic press (HIP).
- Final Preparation: The fuel plates are trimmed to final size, flattened, and prepared for final assembly. Each plate is marked with a unique identifier to meet QA/QC requirements. The plates are degreased following machining steps using nitric acid, soapy water, and hot and cold DI water rinses.
- Plate Inspection: The plates are inspected using various inspections to ensure compliance for reactor specifications such as UT, gamma scanning, and radiography.
- Plate Forming (curved plates only): The plates are pressed over a curved mandrel to the proper curvature.
- Final Plate cleaning: Prior to assembly, the plates are cleaned using nitric acid and a DI water rinse.
- Final Assembly: Multiple fuel plates are collected and secured into sub-assembly hardware for each of 5 US reactors. Sub-assemblies are swaged, welded, and

machined to final tolerance. Following fabrication, the assemblies are cleaned using hot and cold DI water washes (the HFIR plates are assembled using a different method).

- Autoclaving (ATR only): ATR sub-assemblies are processed in an immersion autoclave to form a stable oxide layer on the surfaces of the element.
- Final Inspection: The sub-assemblies are thoroughly examined to ensure compliance with reactor requirements. This includes dimensional, visual, radiological and gap thickness checks.
- Loading and Shipping: Completed sub-assemblies are loaded into shipping containers and stored onsite until they are shipped to the individual reactors.

3.1.2 Process Flow Diagrams

Process flow diagrams (PFDs) define the major pieces of equipment, the process flows, and utilities used within the process. Equipment is tagged and shown in PFDs. This is helpful in constructing the facility equipment list. PFDs show equipment such as filters, pumps, furnaces, heat exchanges, tanks, etc. as well as waste pathways, utilities required, and chemicals consumed. The PFDs are shown in Appendix A-4. The PFDs list is shown below in Table 3-1:

TABLE 3-1 LIST OF PROCESS FLOW DIAGRAMS

Process Flow Diagrams	
Symbols and Legend	SK-1
Front End Processing	SK-2
Fuel Zr Cladding	SK-3
Fuel Al Cladding	SK-4
Final Assembly	SK-5
Inspection	SK-6
Off-Gas Treatment	SK-7
Waste Characterization and Packaging	SK-8
Shipping, Receiving and Storage	SK-9
Alternate HIP Bonding Process	SK-10
Ar Purification and DI Water Supply	SK-11
Final Assembly Machining	SK-12

3.1.3 Material Balance

The material balance was calculated based on the production requirements to meet HPRR refueling schedules shown in Table 3-2. A key process assumption is that the facility will be available 75% of the year. The values shown in Table 3-2 allow for an additional 15% excess capacity for future increases in reactor orders and for process yields throughout the facility. A detailed discussion of the material balance is provided in Section 3.2.

3.2 Facility Throughput Basis

The FFC facility must be capable of providing the required yearly core replacements for each of the five U.S. research reactors. These reactors include the MIT Reactor-II (MITR-II), the National Bureau of Standards Reactor (NBSR), the Missouri University Research Reactor (MURR), the Advanced Test Reactor at INL (ATR), and the High Flux Isotope Reactor (HFIR). The yearly requirements for these five reactors are included in Table 3-2.

					_	
Reactor	Cores/yr	Elements/yr	Plates/yr	Σplates	Foils/yr	Σfoils
MITR	1	38	625		694	
MURR	4	44	1185		1317	
NBSR	2	83	1574	15236	1749	16929
HFIR	10	14	8333		9259	
ATR	3	167	3519		3909	

TABLE 3-2 FUEL REQUIREMENTS FOR THE FFC FACILITY

According to Table 3-2, nearly 17,000 foils are required each year to provide the required output. The facility is assumed to have 75% availability. This allows for approximately 265 operating days per year. This conservative estimate requires the FFC facility to produce 64 foils per day. The capacity has been increased to 67 foils per day to allow for unscheduled shutdown of the facility especially during start-up. The foil production is shown for each major area on the process flow diagrams. All equipment is designed to produce 67 foils per day but the normal operating rate may be lower given the necessary production and storage limitations. These values are based on the process yields for each area as found in the Conceptual Process Description for the Manufacture of LEU/Molybdenum Fuel (INL report INL/EXT-08-13840). Each major process function allows for scrap and reject material. For instance, Table 3-2 shows that the five research reactors require 16,929 foils but only 15,236 plates. This shows that the plate production step has a process yield of 0.90, indicating that up to 10% of the material may be scrapped and will not continue downstream for further processing. The outputs provided in Table 3-2 also provide an additional 15% output incase reactor demand increases in the future. The FFC will have storage space to allow for excess sub-assemblies until the next campaign for each reactor design.

3.3 Process Design Basis and Description

The process flow diagrams (PFDs) included in Appendix A-4 show the following processes along with flows into and out of the process as well as any utility or consumable that is associated with the process. The facility equipment is described in Section 4 and the facility layout is described in Section 5. Figure 3-2 shows how the material moves through the various stages and changes shape as it progresses downstream.

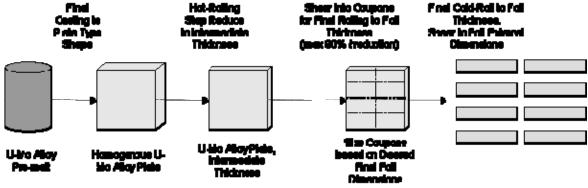


FIGURE 3-2 CONCEPTUAL FFC PROCESSING DIAGRAM

3.3.1 Material Shipping and Receiving

Shipping and Receiving is shown on PFD SK-9. Broken fuel pieces or "acorns" are trucked in from Y-12 using ES-3100 shipping containers. It may be possible for Y-12 to ship cast ingots rather than broken metal pieces. The ingots would still be shipped in cans packaged within ES-3100 shipping containers. This is part of a future study to determine if Y-12 will increase the scope of their delivery method. This report has assumed that the FFC will receive broken pieces so as to bound the facility and the functional requirements. The shipping crane, CRN-001, unloads the shipping container and moves material throughout the shipping and receiving area. Each container from Y-12 contains 3 shipping cans, which each contain LEU/Mo fuel pieces in the proper composition and enrichment. After the cans are unloaded from the shipping container, testing and inspection will be conducted on the cans to make sure that the received material meets the appropriate specifications. A separate, representative sample will be included with each casting batch for chemical and isotopic sampling. Any rejected material will be shipped back to Y-12 while approved material will be placed into a locked storage area, ST-001 until processing. Final sub-assemblies are also packaged in this area to be shipped to the reactor site. The sub-assemblies are packaged in PK-001 packaging area in the appropriate shipping containers.

3.3.2 Ingot Casting

After the representative fuel piece is inspected and approved for processing, the can is opened and may be moved to the casting area for processing. The first step in the process in shown on SK-2 and is cleaning of the LEU/Mo feedstock (fuel pieces require a nitric acid wash prior to casting to remove gross oxide from the surface of the metal) in wash station, WS-015. After cleaning, the material is placed into one of the casting furnaces. The casting furnaces, HT-001 A/B, are located in one of two gloveboxes, GB-001 A/B, to maintain an inert atmosphere (there are two casting furnaces and two gloveboxes, hence the A/B designation). The glovebox maintains an argon atmosphere with a purification system discussed in section 3.5 below. Cast molds are also introduced into the glovebox and are placed on a heater, HT-003 A/B, to help the cast LEU/Mo mixture form to the cast mold and overcome surface tension and limited flow concerns. The cast molds are moved throughout the glovebox on a conveyor belt, CV-001 A/B. The cast fuel is removed from the mold where a filter, FIL-009, and ventilation hood is located to capture any particles that may be released during the mold removal process. The crucible sits within the casting furnace and holds the broken pieces. The crucible will also contain any dross material or heel that may be left after the casting process. Both the crucible and the cast molds are recycled with a cleaning in X-001 and a coating in CT-001 with vttria to allow for easy removal of the LEU/Mo ingot from the casting surface. A ventilation hood and pre-filter, FIL-017, are connected to the mold and crucible cleaning station to collect any chemical fumes and also collect any yttria particles in the air. The off-gas from the casting furnace goes through a roughing filter, FIL-027, which is composed of sintered metal capable of collecting the uranium oxide formed during the This roughing filter will prolong the life of the HEPA filters casting process. downstream. Y-12 has experience with these roughing filters, which do not require a blow-back system. The filters will be replaced when material buildup begins to impact the casting process. Any waste material that is introduced during the casting process will be collected in a geometrically safe collection area and packaged for waste disposal. After the ingots are cast, they are chemically inspected using an ICP-AES-MS to ensure the proper LEU/Mo mix. Once the results prove that the fuel is acceptable for reactor design, the cast ingots can move into further processing.

3.3.3 Hot Rolling/Shearing

After the cast ingots are approved for processing, the next step is to roll the fuel pieces into the proper sizes for fuel foils as shown on SK-2. The cast ingot is approximately 1/4" thick by 3.5" wide and 16" long. The first step of the rolling process is to heat the cast ingot in a salt bath, HT-002, using a mixture of salts including potassium chloride and lithium chloride salts. The bath is heated to between 600°C and 650°C. A local ventilation hood and filter, FIL-001, collect the hot fumes from this furnace (both for waste heat removal and for radiological contamination control). After the ingot is heated, it is rolled through a rolling mill, RL-001, with filter FL-002 collecting any off-gases from this process. The rolled ingot is repeatedly rolled and reheated in the salt until it achieves a thickness of between 0.09" and 0.1". Once the fuel piece has achieved the desired thickness, it is cleaned of the salt using a mechanical finishing mill, FM-001. FIL-018 is a localized ventilation hood and filter to collect any dust particles that occur as the salt is removed from the fuel. After the salt removal station, the fuel is washed in WS-016 to remove any salt particles or scrap material and sheared into 4.5" long pieces using SR-001. The off-gas and fine particles from the shear are collected in FIL-003. The edges are also trimmed to ensure the proper width for further processing. Any trim pieces from this stage are recycled back to the casting furnace to incorporate into future castings. The intermediate rolled foils may be transported to storage or continue on to plate cleaning.

3.3.4 Fuel Plate Cleaning

The fuel plate cleaning process is shown on PFD SK-3. The clean sheared foil at approximately 0.1" thick is cleaned using a 30% nitric acid bath, WS-001. The bath will be sized to hold about 10 plates in each fuel cleaning. The bath will recirculate the nitric acid to promote mixing and agitation of the acid against the plate. The recirculating stream will also have a filter on it to clean out any dirt or other small particles that may be cleaned off the fuel plate. The pH of the bath will be tested daily to ensure the integrity of the acid. Once the acid is below the normal operating pH level, the acid will be packaged for waste and fresh nitric acid will be placed in the bath. A demister pad, FIL-010 is placed above the bath to ensure acid fumes are collected. Any liquid that condenses and collects in the bottom part of the demister will be returned to the bath. Following the nitric acid bath, the fuel ingots are inspected for pass/fail based on dimensions. Any failed pieces are sent to the casting furnace for recycling and recasting. Accepted fuel pieces are sent to the canning station to receive the Zirconium (Zr) clad material.

3.3.5 Zr Cladding and Final Rolling

Acceptable washed fuel foils are transferred to the Zr cladding station as shown on SK-3. The LEU/Mo fuel plate is placed inside an enclosure consisting of zirconium foil tack welded to both sides of a steel can with a layer of yttria between the Zr foil and the steel can to ensure that the Zr will not adhere to the steel can (the cans, complete with Zr and yttria are procured from an outside vendor). This placement of the foil in the can occurs in the canning station, CS-001. A local ventilation hood is placed at the canning station along with a filter, FIL-011. The can has a "pig tail" associated with it that is first backfilled with argon and then connected to a vacuum pump, P-001, to remove any air from the can. The vacuum off-gas is passed through FIL-025 to clean any particles that may be removed from the can through the vacuum process. The air evacuated can then passes through a tunnel furnace, HT-004, before being rolled through RL-002 to a foil thickness of between 0.010 and 0.015". A filter, FIL-016, removes any hot off-gasses

from the furnace while filter FIL-004 collects any particles and off-gas from the rolling mill.

3.3.6 Annealing

Once the foil has been rolled, SK-3 shows that the next step is to anneal the fuel and Zr plates. This process is done to flatten the foil. The process occurs in the can previously used to roll the fuel plate and the Zr clad together. This can remains intact during the rolling process; therefore, the annealing furnace, HT-005, can be in an atmospheric pressure environment. A constraint is recommended to keep the foil flat during the heating process. The carbon steel can forms a eutectic with the fuel foils at temperatures higher than 725°C. Therefore, the annealing process must be regulated to occur between 600°C and 675°C. A ventilation hood and filter, FIL-026, is used to collect the heated off-gas from the annealing furnace. After the annealing process, the can is removed from the fuel foil using SR-002, the can removal shear. FIL-005 filters the off-gas and collects any fines from the can removal process. The can waste is sent to waste packaging for final disposal. The fuel plate is then cleaned to remove any yttria coating and contamination.

3.3.7 Foil Cleaning

Foil cleaning is accomplished after the annealing process to remove contaminants such as oxide and yttria coating from the canning process. The first step is to put the fuel plate in a wash station, WS-002, with a mixture of 50% water (H₂O), 45% nitric acid (HNO₃) and 5% hydrofluoric acid (HF). The HF is essential for etching the Zr cladding to allow the yttria particles to release. This wash station is similar to the fuel plate wash in that it holds multiple plates at one time and uses a recirculating flow within the wash bath to agitate and ensure a thorough cleaning. The recirculation flow is filtered to remove the yttria particles and any Zr cladding that is also etched off the fuel foil. The wash bath off-gas is filtered using FIL-012 in order to remove any acidic fumes from the processing area. The filter contains a demister pad that allows the condensed vapors to flow back into the wash station. The off-gas that passes through the demister will combine with the other ventilation off-gas flows for further processing. A pH meter is used to test the wash solution daily. Once the wash solution is no longer at an operating level for thorough cleaning, the wash solution will be replaced. For waste estimation purposes, the wash solution is assumed to be exchanged once a week.

The second wash process occurs in WS-003 and is a DI water rinse. The FFC facility will have a DI water filtration unit with a storage tank capable of providing the DI water usages for this process. The DI water rinse will remove any residual acids and contaminants from the fuel foil before further processing. The water rinse will be a large basin capable of holding multiple fuel foils with a recirculation pump and filter. A conductivity measurement will be used daily to ensure that the water is an effective cleaning agent. Once the water conductivity is outside of normal operating limits, the water will be removed and replaced with clean DI water. Since this water has contact with LEU/Mo, the water cannot be recycled back to the DI filtration unit, but is rather bottled and packaged for waste disposal.

The third and last step in the fuel foil cleaning is an ethanol cleaning wash using WS-004. The ethanol is used to remove the residual rinse water from the fuel plate. The ethanol vapors are collected using FIL-013. This is important since alcohol vapors are a fire hazard especially in a machine shop area where metal processing could potentially create sparks. The current philosophy for doing an ethanol wash, is to soak a wipe with ethanol and wipe both side of the fuel foil (this serves to both coat the foil with a thin layer of

ethanol and to give mechanical action to help release the yttria particles). However, given the throughput rate of the FFC facility, a more automated way may be preferred. The waste (either from a wipe or from an automated wash basin) is sent to packaging for final disposition. The wipes would be compressed and packaged with other U-contaminated LLW. The liquid would be bottled and packaged for disposal to a liquid treatment facility. This will be resolved by a future study.

3.3.8 Friction Bonding

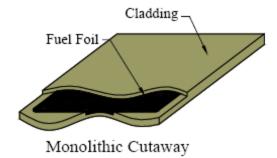
The cleaned fuel foils are now ready to be bonded with the Al cladding. Prior to the bonding, the aluminum is cleaned using a three step process. First, the aluminum is placed in a heated sodium hydroxide solution (NaOH) bath using WS-005. The heated bath has a demister pad, FIL-014, to absorb any chemical fumes that are released from the wash bath. The bath is designed to hold 20 aluminum pieces- enough to support the 10 fuel foils that are washed in each process as explained above. The wash bath uses a recirculating pump and filter to remove any contamination particles. The solution is tested periodically using a pH meter to ensure efficiency of the cleaning solution. Once the solution is exhausted, it is packaged for shipment to a liquid waste treatment facility. It may be possible in future studies to determine if this sodium hydroxide waste can be combined with other wash nitric acid waste and the water evaporated to condense the liquid waste generated from the facility. Following the NaOH wash, the plates are rinsed with DI water using WS-017.

The second wash step that the Al cladding receives is a nitric acid wash with an ultrasonic probe in WS-006. FIL-015 is a demister pad that absorbs any chemical fumes that are off-gassed from the wash bath. The nitric acid bath tank is also sized to hold 20 pieces and is cleaned with a filter in the recirculating line. A pH meter is used to test the pH of the solution daily to ensure proper cleaning. Once the pH is in a level no longer acceptable to the process, the nitric acid is drained and replaced. The spent acid is bottled and packaged for shipment to a waste processing facility.

The third and final wash step is a cold, and then hot DI water rinse to remove any residual nitric acid. The DI water is provided to cold wash station WS-007 and the hot wash station, WS-018 from the facility DI water filtration system. Each DI water wash is capable of holding 20 Al clad pieces and is recirculated through the wash basin with a pump and filter to remove any contaminants. The DI water is tested daily for conductivity. When the conductivity of the water falls out of normal operating range, the water is removed from the wash basin and replaced. Since this water does not have direct contact with the uranium or molybdenum fuel, the water can be recycled back to the DI water filtration unit. The clean aluminum plates are then ready to be bonded with the clean fuel foils.

One section of the aluminum cladding has a pocket machined into one surface sized to fit the fuel foil; the other is a flat sheet. The thickness of the two plates is such that the fuel foil will be centered in the final product. The fuel foil is placed in the pocket of the first sheet and the flat sheet is placed on top. This assembly is then placed in the friction stir welder, FSW-001 A/B/C/D. There are four friction stir welders in order to complete the daily throughput in one shift. The friction stir welder uses pressure and friction to heat the fuel foil and aluminum to a temperature hot enough to plasticize the aluminum cladding, but low enough that the plate does not melt or cause permanent undesired material property changes. The friction stir welding process occurs on both sides of the fuel plate. Figure 3-3 shows a cut-away diagram of the fuel plate after aluminum cladding bonding.

FIGURE 3-3 ALUMINUM CLAD FUEL PLATE CUT-AWAY DIAGRAM



3.3.9 Alternate HIP Process

As an alternative to friction bonding the fuel plates, Hot Isostatic Pressing (HIP) is being considered as a method to bond the fuel plates. HIP uses heat and pressure to create a diffusion bond between the aluminum cladding and the fuel foil. This is done by placing the process part in a pressure vessel and applying a specific time/temperature regime. For HIP it is critical that the interior of the plate (the interface between the two cladding sheets and the interface between the cladding and the fuel) be isolated from the processing media. This is done by sealing the perimeter of each plate in a vacuum by using electron beam welding. For processing, a number of plates are bound together separated by rigid slabs (strongbacks) that constrain the plates during the HIP run to keep them from warping. The plates are processed at 100MPa and 560°C for a 30 minute hold time. With the high thermal mass of the HIP system a single cycle (including loading and unloading) takes nearly 24 hours. The FFC facility layout has included an alternative placement for the HIP process and an alternative flow diagram, SK-10 shows the HIP. Future studies will determine which bonding process will be used to bond the fuel plates to the aluminum cladding.

3.3.10 OA Inspection

A number of inspections must be accomplished throughout the process to provide quality assurance that the fuel plates are fabricated to the technical standards required for nuclear reactor operation. Some of these inspections are visual, some are physical such as weight and dimensions, and some are chemical such as composition and isotopic analysis using an inductively coupled plasma with atomic emission spectroscopy and a mass spectrometer (ICP-AES-MS). Still other inspections occur on structural aspects such as the ultrasonic tester for bond integrity. SK-6 shows some of the analytical equipment that will be used to perform inspection within the FFC facility. Other inspection requirements include dimensional analysis, gap testing, visual inspections, etc.

The various analyzers listed on the PFD are two ultrasonic testing machines, UT-001 A/B, a radiography analyzer, RD-001, a fluoroscopy analyzer, FS-001, an optical microscope, OM-001, the ICP-AES-MS, ICP-001, a scale, W-001, and two gamma scanners, GS-001 for the plate scan and GS-002 for the sub-assembly scan. There is a local ventilation area, FIL-019, to collect any off-gasses from the laboratory equipment during analysis.

The ultrasonic testing stations are used to measure two different things, bond integrity and the thickness of the cladding over the fuel. The debond is measured by a through transmission of ultrasound energy (where the signal has been attenuated from the baseline the bond is shown to be of lower quality) involving a transmitter and receiver on opposite

sides of the plate. The cladding thickness is measured through a time-of-flight indication (the signal bounces back to the transmitter/receiver (this is a separate unit from the debond diction) from any discontinuity in the fuel plate). There are two ultrasonic testers to provide the testing for the daily capacity of production.

Another piece of laboratory equipment is the radiography analyzer. A radiograph uses x-ray waves to produce a visual image of the test item based on density differences. Radiography is used within the FFC both to examine where the fuel foils lie within the Al cladding (and to see if any fuel lies outside the acceptable region of the plate) and also to measure the fuel zone areal density (regions of high fuel loadings are prone to higher heating and may violate the safety case for the reactor).

Fluoroscopy is a real-time x-ray used to locate the fuel within an in-process fuel plate. This apparatus is coupled with a punch system that will drive index holes into the cladding to allow for machining of the fuel plate to its final dimensions.

Optical microscopy is used to analyze the interior of selected fuel plates. As this is a destructive analysis method it is only done on a random selection of plates or on failed plates to help determine processing problems. The optical metallograph and the related equipment (for sample preparation) are all standard commercial equipment.

Chemical and isotopic analyses are done in a small laboratory located on the FFC site. Even through the LEU/Mo feedstock is fully characterized by Y-12 prior to shipment the casting steps that occur at the FFC require the reanalysis of the material (if the ingot casting is moved from the FFC to Y-12 the need for this analysis goes away). The necessary analysis is done by an Inductively Coupled Plasma Mass Spectrometer (ICP-MS), and two "determinators": one for oxygen/nitrogen and the other for carbon and sulphur. The ICP-MS measures the uranium isotopic composition and the amount of molybdenum in the material while the determinators measure the amount of impurities in the material. The analysis equipment is all available as off-the-shelf equipment and will only need to be located inside containment.

Scales are used throughout the facility to weigh the process material (both fuel and scrap), keep accountability records, and also ensure that the fuel plates meet physical specifications. Each scale will have an accuracy of at least 0.1 g.

One last piece of laboratory equipment accounted for in the inspection system are two gamma scanners- one for the plate and one for the element. The gamma scanners are non-destructive tests used to assay the final products to determine correct make-up of the plates and final sub-assemblies.

Inspection areas are shown on the flow diagrams as an A in a circle. However, not all analyzers will be used at each inspection area. Some of the inspections will be done on every plate while other inspections use statistical analysis, especially the inspections such as optimal microscopy, which involve destroying the sample by cutting a cross-sectional sample.

3.3.11 Plate Finishing

Once the LEU/Mo and Zr clad foil has been friction bonded to the aluminum cladding, the fuel plate is ready to be cleaned and prepped for final assembly of the sub-assembly elements. The first step after friction stir welding is to do a rough shear using SR-005. Any trim collected from the shear is weighed for accountability and packaged for waste shipment (as potentially contaminated). FIL-024 is a ventilation hood with a pre-filter that collects any fines and particles from the shear process. The next step is to flatten the

plate using RL-003, the roller leveler. This unit may be used multiple times as needed during the plate finishing process in order to ensure the plates are flat before pressing to the final shape required by the reactor design. After this rolling, the fuel plates can be sent to storage until further processing.

Process flow diagram SK-5 shows the next steps in the process. The first step is to locate the fuel inside the plate using the fluoroscopy analyzer, which will index the location of the fuel by punching reference holes in the plate. From this point, the plates will be processed by a series of finishing mills (FM-002 A/B/C/D/E) on which the plates will be cut to final thickness, have a final surface finish applied and cut to final dimensions (using the reference holes for a datum point). Other special geometry (the 'fins' in the MIT plates) will be added at this point. The machined scrap material from this process is considered suspect contaminated and is packaged for shipment to a waste processing facility. A ventilation hood with filter FIL-008 is used to collect any fines and particles that may result from the shearing operation.

Each plate is marked using the marking station, MK-001, for material accountability purposes. The marking must occur after the friction stir welding, which obliterates any markings on the surfaces that will be on the final plate, but before the final assembly of the sub-assembly element. The marking station puts a permanent mark such as a laser etch or permanent press marking into the plate that can be traced back to the LEU/Mo batch that the plate came from and various processing steps that are controlled by QA/QC.

After the plate is marked, the plate is washed using a two stage process. The first wash step is to use soapy water in WS-008 to degrease the plates from the cutting process. The second stage is to use a hot DI water wash in WS-009. These two wash processes will remove any fines and contaminants from the shearing, marking, and finishing mill processes. Since there is no fuel interaction with the liquids, the liquids can be flushed to the firewater collection tank. The firewater collection tank has a series of pencil tanks that are geometrically configured for criticality control associated with the firewater collection tank. The liquid waste enters the pencil tanks where recirculation occurs to ensure mixing. A sample port is located on the recirculation line. Samples can be taken of these wash liquids and analyzed for contamination. If any contamination is measured, the waste will be extracted from the firewater tank, packaged, and sent to a waste treatment facility. If the is no contamination measured, the waste will be sent to the firewater collection tank until enough is collected to warrant an extraction where the solution is sent to a water treatment facility. Once the plates have been washed, they can either go back to storage or continue on for further processing.

3.3.12 Plate Forming (curved plates only)

Following plate fabrication, the plates requiring a curved shape are formed into shape using a mandrel in a hydraulic press.

Each plate must be cleaned before entering the final assembly process. This cleaning involves three steps. The first step occurs in WS-010, which is a 30% nitric acid wash. A demister filter, FIL-029 is used to collect any acid fumes from the wash station. The second wash is a cold DI water rinse to remove the nitric acid and the third and final wash is a heated DI water rinse, WS-011 and WS-012 respectively. The nitric acid wash is tested daily with a pH meter to ensure proper cleaning efficiency. When the pH is outside of normal operating range, the acid is removed from the wash station and packaged for shipment to a waste treatment facility. Even though the nitric acid wash does not have suspect contamination, it is acidic and must be treated properly before

being safe to dispose of. The water rinses can be disposed of through the firewater collection tank and sample for contamination. All three wash stations use recirculation pumps and filters to recycle fluid through the wash and stimulate agitation for thorough cleaning.

3.3.13 Sub-Assembly Fabrication

After washing the plates, the plates are ready for final assembly, as shown on SK-12. This area includes swaging, hydraulic pressing into curved forms according to the reactor design and other mechanical manipulations as described in Sections 4.0 and 5.0 below.

Final sub-assemblies are cleaned prior to being packaged for shipment. The sub-assemblies are washed in cold water, WS-013, and then hot water, WS-014, before being dried using a dry air spray, DRY-002, over the sub-assemblies. The water from these wash stations can be sent to the firewater collection tank and tested for contamination prior to being packaged for shipment to either a waste treatment facility if contaminated or a water treatment facility if there is no contamination present. The water rinses are designed to remove any contamination and residues from the final assembly process. The dry air will be provided either by compressing and drying atmospheric air or by using pressurized gas cylinders such as nitrogen to remove any of the water particles from the thin spaces in the final assembly.

One additional step that is only pertinent to ATR sub-assemblies is to heat the sub-assembly in an autoclave, HT-006. The autoclave is a cylindrical pressure vessel with an integrated heater. The vessel is filled with DI water and the elements (up to four elements at one time are placed into the autoclave) are immersed in the water for processing at elevated pressure and temperature to place a prefilm on the surface. After processing, the unit is cooled and the water is drained prior to unloading. A ventilation hood with filter, FIL-022, is used to collect the heated off-gas from the furnace after opening.

The sub-assemblies are ready to be packaged and shipped to the appropriate reactor site after cleaning and autoclaving (for ATR only).

3.4 Waste Handling and Disposition

The FFC facility will not have any capabilities for processing waste. For example, sodium hydroxide is used as an aluminum cladding wash step and nitric acid is used to clean the fuel plates. These two solutions would be packaged separately for shipment to a hazardous waste treatment facility. Waste will be packaged in its current state (liquid, solid, scrap trims, etc.) and be shipped either to a treatment or storage and disposal facility. As the FFC is likely to be located at a DOE National Laboratory, it is probable that RCRA-permitted waste treatment facilities exist at the site, and the hazardous wastes could be treated locally. Table 3-3 provides a list of the wastes generated from FFC processing.

TABLE 3-3 LIST OF WASTE GENERATION, ANNUAL VOLUMES, AND DISPOSAL PATHWAYS

		ISPOSAL PATHWA	
	Waste Source	Generation	Disposition
Liquids	Fuel Receipt Wash (HNO ₃)	240 gallons/ year	Contaminated (sub-accountable), mixed LLW to treatment
	LEU/Mo Ingot Wash (HNO ₃)	240 gallons / year	Contaminated (sub-accountable), mixed LLW to treatment
	LEU/Mo/Zr Foil Wash (HNO ₃ /HF)	480 gallons / year	Contaminated (sub-accountable), mixed LLW to treatment
	LEU/Mo/Zr Foil Wash (DI Water)	480 gallons / year	LLW to treatment
	LEU/Mo/Zr Foil Wash (ethanol)	480 gallons / year	LLW to treatment
	Al Wash (NaOH)	3120 gallons / year	Hazardous, non-contaminated waste to treatment
	Al Wash (HNO ₃)	3120 gallons / year	Hazardous, non-contaminated waste to treatment
	Al Wash (DI Water)	3120 gallons / year	Sent to firewater collection tank for sampling and disposition
	Plate Wash (soapy water)	3120 gallons / year	Sent to firewater collection tank for sampling and disposition
	Plate Wash (Hot DI Water)	3120 gallons / year	Sent to firewater collection tank for sampling and disposition
	Final Plate Wash (HNO ₃)	3120 gallons / year	Hazardous, non-contaminated waste to treatment
	Final Plate Wash (Cold DI Water)	3120 gallons / year	Sent to firewater collection tank for sampling and disposition
	Final Plate Wash (Hot DI Water)	3120 gallons / year	Sent to firewater collection tank for sampling and disposition
	Final Assembly Wash (Cold DI Water)	5000 gallons / year	Sent to firewater collection tank for sampling and disposition
	Final Assembly Wash (Hot DI Water)	5000 gallons / year	Sent to firewater collection tank for sampling and disposition
Solids	LEU/Mo/Zr trim	523 kg/ year; 1.5 ft ³ / yr	LLW to NTS for burial
	LEU/Mo/Zr/Al trim	15,500 kg/ year; 210.5 ft ³ / yr	LLW to NTS for burial
	Failed samples and foils/ plates	Up to 5000 pieces in various forms (foils, Al clad plates, etc.)	Possible re-use at Y-12; LLW to NTS for burial

	Waste Source	Generation	Disposition
	Rolling Cans	6,660 kg/ yr; 50 ft ³ / yr	LLW to NTS for burial
	Spent Equipment		Refurbish any useable equipment (shears, rolls, etc); LLW to NTS for burial
	Filters (HEPA/ Demisters/ Sintered Metal Filters/ Pre-Filters)		Compaction/ shear if possible; LLW to NTS for burial
	Spent Molds/ Crucibles		LLW to NTS for burial
	Job Control Waste/ PPE/ Misc. Processing Waste		LLW to NTS for burial
	Slag/ Dross/ Heel from Casting		Possible re-use at Y-12; LLW to NTS for burial
	Spent Salt from Salt Bath		LLW to NTS for burial
Gases	Dry Air for Final Assembly Drying		Tanks are re-filled through vendor; air goes through ventilation and offgas treatment
	Argon for Inert Casting Furnace Glovebox		Regenerated through filters and driers; purged to ventilation and offgas treatment

3.4.1 Liquid Waste

There are a few sources of liquid waste in the FFC facility. The main source of liquid waste is from the fuel plate and assembly cleaning steps. Some of these steps, such as when the Zr clad fuel plates are washed in acid and water, will contain radioactive material. Other wash steps, such as the DI water rinse of the final assembly, will not contain radioactive material and can be characterized as non-hazardous and sent to the firewater drain system for clean-up and recycling. Other sources of liquid waste are purges from the DI water system and process water chiller system, liquid effluents from the demister pads, janitorial wastes, spent hydraulic oil, and various other minor sources.

Any waste that has probable radioactive contamination will be packaged in bottles to minimize leak potential. The bottles will then be packaged in cans and stacked in 55-gal drums for shipment to a facility that will treat the liquid waste. Spent hydraulic oil will be collected and discarded through a vendor. The vendor will make regular stops to switch out the dirty 55-gal drum with a clean drum for further disposal. Each 55-gallon drum of contaminated oil will cost about \$3300 for treatment and an additional \$6000 - \$8000 for transportation costs, which is usually split over the cost of the load (>10 drums). However, it is not estimated that multiple drums of oil will be processed from this facility. Therefore, the maximum cost per drum of oil will be approximately \$11,300.

Process knowledge of where the liquid waste came from will be used to estimate contamination potential for radioactive material. Liquid waste that may not be

contaminated will be sent into the fire water collection system and sampled. If the sample returns a negative result for contamination presence, the liquid can be sent to a waste treatment facility for clean-up. This will only be effective for non-hazardous chemicals. This pathway would follow for the soapy water rinse of the plates, any janitorial water such as dirty mop water, and the DI rinse of the aluminum cladding. The sodium hydroxide solution, even though it is non-contaminated, will not go into the firewater collection drain since it has chemical components that the waste treatment facility would not be able to dispose of. The sodium hydroxide will be bottled and packaged for shipment to a waste processing facility.

Liquid waste estimates were calculated based on the assumption that wash solutions will be changed out weekly, through the entire year (365 days). This will allow for solutions that may sit and still lose cleaning efficiency or have natural reduction in acidity/ basicity of the chemical compound. As stated in section 3.3, the wash stations are designed to hold multiple fuel plates at a time. For the LEU/Mo and LEU/Mo/Zr fuel foils, each wash station is designed to hold 10 plates at a common size of 3.5" x 10" x 0.1" before final hot rolling and 3.5" x 50" x 0.015". This equates to the wash bin being approximately 8" x 12" x 8" for the pre-final roll wash, which is assumed to be the same size as the pre-cast wash to clean the acorns and broken pieces, and 8" x 55" x 4" for the 3 post-final roll washes. This equates to a total volume of 3.3 gal and 7.6 gal respectively. Each wash basin has a recirculation loop with a pump and filter, therefore each wash basin is assumed to hold 5 gallons or 10 gallons. There is a 90 day maximum temporary storage for hazardous materials, so if the solutions are changed out every 7 days, after 90 days, there are 60 or 120 gallons of waste for each wash solution. The 90 day temporary storage will be required to be emptied 4 times per year. Therefore, each wash basin produces 240 gallons of solution for two washes and 480 gallons for three washes. This is a total of nearly 2000 gallons. Each 55-gal drum of contaminated waste costs \$600 for treatment and each load costs less than \$100 for transportation. Assuming a 75% fill availability of the 55-gal drum, the 2000 gallons of waste would require approximately 50 drums. If a load consists of 10 drums, the total cost for treatment and transportation of these wash solutions is \$29,300 per year.

Aluminum fuel plates also receive a five cycle wash prior to being bonded to the fuel foil. Each piece of aluminum is 0.050" thick and the widest piece is 3.6" thick. Since the fuel wash basins hold 10 foils, the aluminum wash basins are designed to hold 20 pieces. Each wash basin is sized to be 16" x 56" x 14" for a total of 54 gallons. With the recirculation line, pump, and filter, the actual volume of liquid is assumed to be 60 gallons. The general assumption of a full change out every 7 days is used for the aluminum washes also. Therefore, in 90 days, there are 780 gallons of wash produced. This equates to 3120 gallons per year for each of the three wash stations (sodium hydroxide, nitric acid, and DI water). Since the aluminum has not come into contact with the fuel foil, the wash solutions are not anticipated to be contaminated with radioactive elements. Therefore, the three DI water washes can be sent to the DI water system where a water softener removes any metallic contamination and a DI generator removes any ions within the water. If the water is not recyclable, the non-suspect contaminated water can be sent to the firewater collection tank for sampling and removal to a water treatment facility. However, since the other two aluminum washes are with hazardous chemicals, they must be packaged and sent to treatment. Using the assumption that liquid will occupy 75% of a 55-gal drum during packaging, each of the two washes will require 76 drums for a total of 152 drums per year. The cost for each drum is \$500 and transportation of a load (assume 10 drums) is \$30 - \$40. The cost for treatment of the drums equates to \$76,000 with an additional \$640 for transportation costs. Therefore, the aluminum wash liquid wastes will cost approximately \$76,650 per year.

After the fuel plates are bonded together, there are multiple washes that occur; however, most of these washes are with DI water and soapy water. Since these washes have no interaction with radioactive fuel, these non-hazardous washes can be sent to the firewater collection system and sampled for safety. They will then go down the normal water drains and be treated in a water treatment facility, most likely on the DOE site where the FFC facility is located. There is one additional nitric acid wash that occurs for the fuel plates prior to final assembly. This wash basin will be very similar in size to the aluminum wash basins. Therefore, it is assumed to be 60 gallons worth of material that is replaced every 7 days. This equates to 3120 gallons per year as discussed above. This will be non-radioactive, hazardous waste. It will require 76 drums for packaging at a cost of \$500 per drum and 8 shipments at \$40 per shipment for transportation costs. This equates to an additional \$38,320 in transportation and treatment costs for fuel plate cleaning.

Table 3-4 provides a summary of the liquid waste generation and costs associated with treating the wastes.

TABLE 3-4: LIQUID WASTE SUMMARY

Source	Yearly Generation	Packaging Requirement	Treatment Cost	Transportation Cost	Total Cost
Receipt Fuel Wash	240 gallons	6 drums	\$600 / drums = \$3600	\$100	\$3700
LEU/Mo wash (HNO ₃)	240 gallons	6 drums	\$600 / drum = \$3600	\$100	\$3700
LEU/Mo/Zr wash (HNO ₃ /HF)	480 gallons	12 drums	\$600 / drum = \$7200	\$200	\$7400
LEU/Mo/Zr rinse (DI water)	480 gallons	12 drums	\$600 / drum = \$7200	\$200	\$7400
LEU/Mo/Zr wash (ethanol)	480 gallons	12 drums	\$600 / drums = \$7200	\$200	\$7400
Al wash (NaOH)	3120 gallons	76 drums	\$500 / drum = \$38,000	\$320	\$38,320
Al wash (HNO ₃)	3120 gallons	76 drums	\$500 / drum = \$38,000	\$320	\$38,320
Final plate wash (HNO ₃)	3120 gallons	76 drums	\$500 / drum = \$38,000	\$320	\$38,320
				Total Yearly Cost	\$144,560

An annual cost range of \$150K - \$500K for the treatment, transportation and disposal of liquid waste.

3.4.2 Solid Waste

Solid waste will be generated in the FFC facility in many forms. Solid waste will come from personal protection equipment (PPE), fuel plate wipes for cleaning, spent equipment, process scrap, as well as many other forms. Any spent equipment that can be refurbished such as rollers or dull shear blades will be shipped off-site after decontamination for refurbishment at the supplier or approved vendor.

A large volume source of solid waste will be spent filters. There are nearly 30 local ventilation filters that will require periodic change-out of pre-filters, HEPA filters, and/or demister filters. There are also 3 sets of 4 x 5 HEPA filter banks for process and building ventilation. This equates to 180 filters in the HEPA banks. The pre-filters will be changed out once a year while the HEPA filters can be changed out every five years. The secondary HEPA filter should never require changing as it should only receive small doses of radioactivity during breakthrough of the first HEPA filter. The local ventilation on the hoods should capture most of the radioactive contamination; therefore, the HEPA filter banks should receive little contamination. One other filter is the sintered metal filter on the casting exhaust. This filter will collect the uranium oxide that forms from the dross during casting. These filters will be changed out once a year. There is currently no facility for treatment of filters in FFC; therefore, the filters will be bagged out of the operation and placed in a waste container. Filters could potentially be compacted in CM-001, the compactor, or sheared to smaller volumes in the waste area.

One of the largest volumes of solid waste generated will be the rolling cans from the zirconium cladding process. The dimensions of the can are 6" x 7" x 0.2" for a total volume of 8.4 in³. Each plate requires a separate can for rolling, so the maximum production will be 17,000 cans (and plates) per year. This equates to a yearly consumption of 142,800 in³/year. The density of steel is 4.9 g/cm³; therefore, the total weight of can waste is approximately 11,500 kg per year. This waste will be LLW since it has direct contact with the low enriched uranium fuel plate. This waste can be compacted and placed in a cargo container and sent to NTS, for example, for disposal. Each cargo container holds 1,280 ft³ at a cost of \$5000. The cargo container will hold 174 55-gal drums with a recommended weight limit in each drum of 500 pounds. 11,500 kg is equivalent to 25,300 pounds, which will require 51 55-gal drums for disposal. This corresponds to nearly 30% of the cargo containers, which has a dedicated cost of approximately \$1500.

3.4.3 Process Off-Gas Treatment

Process Off-gas is collected throughout the facility using localized ventilation hoods. A hood is placed wherever a process is used that may create acid or basic fumes that are not recommended for personnel inhalation or fines that may contain radioactive particles. Examples of these locations are the shear machines that cut off thin strips of fuel plate and nitric acid washes that would release nitric acid fumes whenever a batch is inserted or removed from the wash area. The assumed flowrate based on common HVAC best practices for hood ventilation is 150 ft/s at a distance of 3 inches from the face of the hood. Section 5.5 explains that this equates to a face velocity at the hood inlet of 250 ft/s. This will allow for dust particles in the processing areas to be collected by the ventilation hoods and not disperse into the occupied space. Each ventilation hood has a localized HEPA filter for dust suppression. The filtered off-gas along with purge gas from the argon purification system and any other gas supplies will be combined with the building ventilation gas prior to entering the final HEPA banks. SK-7 in the PFDs shows the flow for the off-gas treatment. Three trains of 4 x 5 HEPA filter banks (FIL-020, FIL-021, and

FIL-023) filter the off-gas before exiting through the stack (STK-001). Three blowers (one for each train) (BL-001, BL-002, and BL-003) overcome any pressure differentials due to filtering as well as maintain a negative pressure relative to atmosphere in the shop. The blowers also allow for excess flow capacity so that any leaks in the ventilation system will force air into the ventilation filtering rather than allow radioactive elements to escape prior to capture. The HEPA filter banks consist of three levels of protection. A pre-filter collects most large particles within the off-gas stream. The second level of filter protection is HEPA filters that collect any radioactive isotopes or dust particles. Continuous monitoring of the off-gas downstream of the HEPA warn of break-through within the HEPA filter, which is captured by the third layer of filtering- a second HEPA filter. If a break-through is detected, the train is shut down until the filter can be replaced. Fire protection exists before each layer of filtering to protect the filters against off-normal process upsets.

3.4.4 Scrap Management

Scrap management will be a key feature in the FFC facility due to the large volume of plate production. Any trim scrap of the LEU/Mo fuel that is produced before the Zr cladding is added to the fuel can be mixed with the incoming fuel pieces for casting. After the Zr cladding is added to the LEU/Mo plate, the trim pieces are no longer recyclable within the facility and must be sent back to Y-12 for processing or disposed as LLW. Future design efforts could focus on scrap minimization techniques perhaps using optimization and automated cutting lathe or larger castings for multiple fuel pieces per roll. It may also be possible for another facility to remove the Zr from the LEU/Mo and ship the LEU/Mo back to Y-12 for incorporation into more fuel pieces; however, this is subject to further study and not part of this scope. Any scrap produced from the shear processes must be collected and weighed regularly for accountability purposes. Since this material is special nuclear material (SNM) and 20% enriched Uranium, it must be tracked to the 1 gram level +/- 0.5 grams. Therefore, it is imperative for accountancy measures to collect the scrap and weigh the material.

Estimations of the waste generated from scrap removal have been calculated. For the shear that occurs after the LEU/Mo is coated with Zr, the plate has been rolled to a thickness of 0.015" and is an average of 25" long and 2.8" wide with 0.15" of trim on each long edge and 1" of trim on each short edge. Assuming the maximum of 17,000 plates per year, the scrap produced from this shear is 0.015" x (0.15" x 25" x 2 + 1.0" x 2.8" x 2) = 0.1965 in³ per plate. This equates to a yearly scrap rate of around 3340 in³/yr or 54,740 cm³/yr. Assuming the uranium density of the alloy is 15 g/cm³, the weight of this waste is 54,740 cm³/yr x 15 g/cm³ x 1kg/1000 g = 821 kg per year of scrap waste. Information from Idaho National Laboratory shows that storage at NTS can be achieved at no current cost. However, there are transportation costs of approximately \$4000 - \$5000 per cargo container. Each cargo container is capable of holding 174 55-gal drums with each drum holding 500 pounds. Converting the 821 kg to pounds results in a yearly waste generation of 1810 pounds. This will require 4 ea 55-gal drums for packaging and equate to only 3% of the space in a cargo container. The transportation cost directly related to shipping this waste to LLW storage is approximately \$115 per year.

The 500 pounds per 55-gal drum assumes that the scrap will be combined with other LLW and sent to a shallow burial facility. If the material is to be re-cycled, the scrap cannot be mixed with other LLW, but must remain with the other scrap material. This would require packaging to accommodate criticality concerns. Therefore, each ES-3100 drum would hold three cans with a maximum of 11 kg of scrap material per can, which is the shipping requirement for receipt to FFC. This would allow each ES-3100 to carry a

maximum of 33 kg or approximately 72 pounds. Using the above example of the LEU/Mo/Zr scrap, the shipping containers would increase from 4 55-gal drums to 12 ES-3100 shipping containers. Each ES-3100 container also costs \$3000 to refurbish the container as well as replace the seals and leak check the container. Using the ES-3100 to recycle the LEU/Mo scrap material will add significant costs to the operation of the facility, but could potentially lessen the amount of material required to be processed. A future study should be done to determine the disposal pathway for scrap material.

The waste from the shear after the Al cladding is bonded to the fuel plate is also suspected LLW from contamination with the fuel foil. The assumption made for waste estimation is that an additional 3-4" of aluminum is added on each side for the brackets to hold down the fuel plate during friction stir welding. The thickness of the plate is 0.05" with the widest plate being about 3.5" wide and 50" long. For conservative estimation purposes, the maximum production of 17,000 fuel plates is assumed. Therefore, the scrap removed from this shear operation is calculated as follows: 0.05" x (4" x 50" x 2 + 4" x 3.5" x 2) = 21.4 in³ per plate. 21.4 in³ x 17,000 = 363,800 in³ / yr or 5,961,614 cm³/yr. The density of this alloy cladding material is nearly identical to aluminum at 2.6 g/cm³. Therefore, the yearly weight of waste produced from this scrap source is 5,961,614 cm³ /yr x 2.6 g/cm³ x 1 kg/1000 g = 15,500 kg. Each 55-gal drum can hold 500 pounds, so this waste will require 31 drums for packaging. The cargo container, which can hold 174 drums based off of the 1280 ft³ information, will be nearly 20% occupied from this waste stream. Since each cargo container costs \$5000 to ship, this waste corresponds to \$1000 per year in transportation costs to LLW storage.

These two sources are the largest contributors to scrap management waste. Combined, these two sources of LLW contribute just over 20% of the capacity of a cargo container. This equates to a shipping cost of approximately \$1000. Fortunately, the disposal cost of burying the LLW at Nevada Test Site (NTS) is currently free, but if conditions were to change, this could increase the cost of disposing of this waste.

3.5 Utilities and Consumables

The fuel production processes in the FFC facility require process utilities and consumables in order to produce the sub-assemblies. The FFC facility has a large list of consumables within the process to create fuel plates and sub-assemblies. Some of the major consumables are carbon steel cans for rolling, crucibles, casting molds, and wash solutions including nitric acid, hydrofluoric acid, and sodium hydroxide. Other consumables within the facility include yttria coating, filters (HEPA, prefilters, demisters, and sintered metal). Still other consumables are included in the final product such as Zr coating, Al cladding, and non-fuel bearing components such as end pieces and sub-assembly hardware. Table 3-5 shows a list of the chemicals and consumables involved in the FFC processing facility.

 TABLE 3-5
 FFC PROCESSING CHEMICALS AND CONSUMABLES

	Component s	Use	Disposition	Consumption
Solids				
	U10Mo	acorns, ingots, coupons, foil	fuel meat	5288 kg/yr
	U10Mo	foil trimmings	scrap for recycle	
	Zr	foil	diffusion barrier in fuel	17,000 foils
	Zr	foil trimmings	solid or low-level waste	
	Nb	foil	diffusion barrier in fuel	17,000 foils
	Nb	foil trimmings	solid or low-level waste	
	Al - 6061	metal shapes	fuel clad	17,000 plates (x2 sides)
	Al - 6061	milling scrap (cuttings & dust)	solid waste	
	grafoil	flexible graphite sheeting	consumable	
	steel	can for rolling Zr U10Mo sandwich (consumable)	solid or low-level waste	6660 kg/year
	yttria	coating on inside of steel can (consumable)	solid or low-level waste	
	W	welding electrodes (consumable)	solid or low-level waste	
	W	friction bonding tool (consumable)	solid or low-level waste	
	paper, plastic	cleaning supplies (consumable)	solid or low-level waste	
	graphite	crucible (consumable)	solid or low-level waste	
	yttria	coating on graphite crucible (consumable)	solid or low-level waste	
	KC1	salt for heating U10Mo	process feed	67 lbs/yr
	KCl	contaminated/spent salt	solid or low-level waste	67 lbs/yr
	LiCl	salt for heating U10Mo	process feed	67 lbs/yr
	LiCl	contaminated/spent salt	solid or low-level waste	67 lbs/yr
	slag	from melter	solid or low-level waste	
	steel	convenience cans	solid or low-level waste	
	steel (HR- 160)	Steel molds for casting	reusable	

	Component s	Use	Disposition	Consumption
		Off-gas absorbers (if required)	solid or low-level waste	
		HEPA filters	solid or low-level waste	
		Job control wastes	solid or low-level waste	
		Spent equipment	solid or low-level waste	
Liquids				
	HNO ₃	(30%) cleaning UMo alloy, cleaning Zr sandwich, cleaning Al 6061	spent solution to stabilization, off gas	6700 gallons at 30%, 240 gallons mixed with HF
	HF	Hydrofluoric acid cleaning solution	spent solution to stabilization, off gas	24 gallons mixed with HNO3/DI
	NaOH	(75 g/lit) cleaning Al 6061	spent solution to stabilization, off gas	3120 gallons per year
	H ₂ O, DI H ₂ O	cooling, rinsing acid cleaning solutions	spent solution to stabilization, off gas	20,000 gallons per year in process plus cleaning/ cooling
	ethanol	wiping cleaned foil assemblies	spent solution to stabilization, off gas	480 gallons/ yr
	KCl	molten salt bath (liquid & vapors)	off-gas treatment	
	•	janitorial supplies	solid or low-level waste	
		hydraulic fluids	spent liquid	
		off-gas scrubber chemicals (if required)	spent solution to stabilization	
		vacuum pump oil	spent oil	
Gases				
	Ar	inerting, inert gas welding		
	Не	leak testing of shipping containers		
	process off gas	off-gas treatment		
	furnace off gas	off-gas treatment		
	dry air	Final assembly drying	off-gas treatment	Lab tanks <20/yr

Some utilities will be provided from the adjacent federal site such as electrical power and fire water. Even though electrical power is provided close to the site, the FFC facility will include a sub-station that will reduce the high-voltage to the 480V, 3 phase AC electricity outputs appropriate for the fabrication machines. Other utilities such as process chilled water, DI water, argon, dry air, and vacuum will be provided within the FFC facility. The liquid utilities will be recirculated and cleaned within the facility with a purge to the sewer drain or waste packaging as appropriate. Argon will be used in the casting furnace for inert atmosphere control as well as cooling of the cast ingots. Argon gas will be recirculated throughout the glovebox and cleaned using a drier and filter. An argon purge will be used as necessary through the stack to ensure efficient and clean argon. Dry air will be used to dry the sub-assemblies after cleaning and will be collected by the ventilation system and sent out of the FFC stack. No collection or recycling will occur with the dry air.

3.6 Project Equipment List

The project equipment list for the FFC facility is included in Table 3-6. Included in the equipment list are all process equipment that are shown in the process flow diagrams as well as mechanical equipment such as cranes, tables, forklifts, etc. Where applicable, the equipment list shows the number of pieces of equipment, the equipment tag number, the sketch that the equipment is found on as well as important notes in determining the size and cost of the equipment. For example, the first piece of equipment in the process equipment list (see Table 3-6) is CV-001 A/B, the Mold Feed Conveyor. The Area Code refers to the part of the process that this equipment supports and is shown in Table 3-7. Area 1 is the casting of the fuel pieces. The sketch is SK-2 showing that the conveyor is pictured on the PFD SK-2. The A/B designation shows that there are two pieces of equipment that serve the same function. This is also shown in the quantity column. The name is shown along with the description column, which is used to relay any notes that may be helpful in sizing or pricing the equipment. This equipment list was used to estimate the construction cost of the FFC for the majority of the processing and storage areas. Also included is a count on office space, which was used to estimate cost for office furniture, conference room tables, and other functional areas.

TABLE 3-6 FFC EQUIPMENT LIST

Area Code	Sketch	Equipment ID	Equipment Name	Description	Quantity
1	SK-2	CV-001 A/B	Mold Feed Conveyor	Conveyor for casting mold	2
1	SK-2	GB-001 A/B	Argon Inerted Glovebox		2
1	SK-2	HT-001 A/B	Casting Furnace		2
1	SK-2	CT-001	Coating Station		
1	SK-2	X-001	Recycle Station		
1	SK-2	HT-003 A/B	Mold Heater		2
1	SK-2	FIL-009	Prefilter #9		
1	SK-2	FIL-017	Prefilter #13		
1	SK-2	FIL-027	Sintered Metal Filter		
1	SK-2	WS-015	Incoming Fuel Wash Station	HNO ₃	

Area Code	Sketch	Equipment ID	Equipment Name	Description	Quantity
1	SK-2	FIL-028	Demister #6		
2	SK-2	HT-002	Molten Salt Bath		
2	SK-2	RL-001	Roll Mill		
2	SK-2	FIL-001	Prefilter #1		
2	SK-2	FIL-002	Prefilter #2		
3	SK-2	FM-001	Salt Removal Finishing Mill		
3	SK-2	WS-016	Ethanol/Water Wash Station		
3	SK-2	FIL-007	Prefilter #7		
3	SK-2	SR-001	Shear Machine	0.1" thick U-Mo	
3	SK-2	FIL-003	Prefilter #3		
3	SK-2	FIL-018	Prefilter #14		
3	SK-3	WS-001	HNO ₃ Wash Station for U/Mo Fuel		
3	SK-3	FIL-010	Demister #1		
4	SK-3	CS-001	Canning Station	Welder, can motion, interlock	
4	SK-3	P-001	Clad Vacuum Pump	Purge cans with inert gas	
4	SK-3	FIL-011	Prefilter #10		
4	SK-3	FIL-025	Prefilter #17		
5	SK-3	HT-004	Tunnel Furnace		
5	SK-3	RL-002	Heated Zr Clad Roller		
5	SK-3	FIL-016	Prefilter #12		
5	SK-3	FIL-004	Prefilter #4		
6	SK-3	SR-002	Can Removal Shear		
6	SK-3	HT-005	Annealing Furnace	Air Atm	
6	SK-3	FIL-005	Prefilter #5		
6	SK-3	FIL-026	Prefilter #18		
7	SK-3	WS-002	HNO ₃ Wash Station for U/Mo/Zr		
7	SK-3	WS-003	DI Water Rinse for U/Mo/Zr		
7	SK-3	WS-004	Ethanol Hand Wipe Station		
7	SK-3	FIL-012	Demister #2		
7	SK-3	FIL-013	Prefilter #11		

Area Code	Sketch	Equipment ID	Equipment Name	Description	Quantity
7	SK-4	WS-005	Heated NaOH Wash Station		
7	SK-4	WS-017	DI Water Rinse for NaOH		
7	SK-4	WS-006	HNO ₃ Wash Station for Al Clad		
7	SK-4	WS-007	DI Water Wash Station for Al Clad		
7	SK-4	WS-018	Heater DU Rinse for Al Clad		
7	SK-4	FIL-014	Demister #3		
7	SK-4	FIL-015	Demister #4		
8	SK-4	FSW-001 A- D	Friction Stir Welders		4
3	SK-4	SR-003	Rough Shear	Foil rough shear	
8	SK-4	RL-003	Final Flatten/ Level Mill	Plate flatness	
8	SK-4	FIL-006 A-D	Prefilter #6 A-D		4
8	SK-4	FIL-024	Prefilter #16		
9	SK-5	MK-001	Marking Station		
9	SK-5	FS-001	Fluoroscopy Analyzer		
9	SK-5	FM-002 A-E	Final Assembly Finishing Mill	one mill dedicated to cutting grooves	5
9	SK-5	WS-008	Soapy water bath for plates		
9	SK-5	WS-009	Heated DI rinse for plates		
11	SK-5	WS-010	HNO ₃ Wash Station for plates		
11	SK-5	WS-011	DI rinse for plates		
11	SK-5	WS-012	Heater DI rinse for plates		
11	SK-5	FIL-029	Demister #5		
10	SK-6	OM-001	Optical Microscopy	etching, polishing, saw	
10	SK-6	PT-001	Pull Tester		
10	SK-6	UT-001 A/B	Ultrasonic Tester		2
10	SK-6	RD-001 A/B	Radiography Analyzer		2
10	SK-6	ICP-001	ICP AES		
10	SK-6	W-001	Scale (balance)		
10	SK-6	FIL-019	Prefilter #15		
10	SK-6	GS-001	gamma scan - plates		
10	SK-6	GS-002	gamma scan - fuel subassembly		

Exhaust SK-7 FIL-020 HEPA Bank #1 Exhaust SK-7 FIL-021 HEPA Bank #2 Exhaust SK-7 FIL-023 HEPA Bank #3 Exhaust SK-7 BL-001 Off-gas Blower #1 Exhaust SK-7 BL-002 Off-gas Blower #2 Exhaust SK-7 BL-003 Off-gas Blower #3 Exhaust SK-7 STK-001 Stack SK-8 CM-001 Compactor SK-8 CS-003 Liquid Bottling Station SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packagi 8 SK-10 HIP-001 A/B Hot Isotatic Press 1 SK-11 DRY-001 Ar Drier	4 X 5, 3 banks (2X2 HEPA)
Exhaust SK-7 FIL-021 HEPA Bank #2 Exhaust SK-7 FIL-023 HEPA Bank #3 Exhaust SK-7 BL-001 Off-gas Blower #1 Exhaust SK-7 BL-002 Off-gas Blower #2 Exhaust SK-7 BL-003 Off-gas Blower #3 Exhaust SK-7 STK-001 Stack SK-8 CM-001 Compactor SK-8 CS-003 Liquid Bottling Station SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packaging 8 SK-10 HIP-001 A/B Hot Isotatic Press	HEPA)
Exhaust SK-7 FIL-023 HEPA Bank #3 Exhaust SK-7 BL-001 Off-gas Blower #1 Exhaust SK-7 BL-002 Off-gas Blower #2 Exhaust SK-7 BL-003 Off-gas Blower #3 Exhaust SK-7 STK-001 Stack SK-8 CM-001 Compactor SK-8 CS-003 Liquid Bottling Station SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packaging 8 SK-10 HIP-001 A/B Hot Isotatic Press	
Exhaust SK-7 BL-001 Off-gas Blower #1 Exhaust SK-7 BL-002 Off-gas Blower #2 Exhaust SK-7 BL-003 Off-gas Blower #3 Exhaust SK-7 STK-001 Stack SK-8 CM-001 Compactor SK-8 CS-003 Liquid Bottling Station SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packaging 8 SK-10 HIP-001 A/B Hot Isotatic Press	
Exhaust SK-7 BL-002 Off-gas Blower #2 Exhaust SK-7 BL-003 Off-gas Blower #3 Exhaust SK-7 STK-001 Stack SK-8 CM-001 Compactor SK-8 CS-003 Liquid Bottling Station SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packaging 8 SK-10 HIP-001 A/B Hot Isotatic Press	
Exhaust SK-7 BL-003 Off-gas Blower #3 Exhaust SK-7 STK-001 Stack SK-8 CM-001 Compactor SK-8 CS-003 Liquid Bottling Station SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packaging 8 SK-10 HIP-001 A/B Hot Isotatic Press	150 HP
Exhaust SK-7 STK-001 Stack SK-8 CM-001 Compactor SK-8 CS-003 Liquid Bottling Station SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packaging 8 SK-10 HIP-001 A/B Hot Isotatic Press	150 HP
SK-8 CM-001 Compactor SK-8 CS-003 Liquid Bottling Station SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packagi 8 SK-10 HIP-001 A/B Hot Isotatic Press	150 HP
SK-8 CS-003 Liquid Bottling Station SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packagi 8 SK-10 HIP-001 A/B Hot Isotatic Press	70" dia, 25' above building roof
SK-8 CS-002 Canning Station for ship SK-8 PK-002 Waste Packaging Station 11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packagi 8 SK-10 HIP-001 A/B Hot Isotatic Press	
SK-8 PK-002 Waste Packaging Station 11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packagi 8 SK-10 HIP-001 A/B Hot Isotatic Press	
11 SK-9 CRN-001 Overhead Crane 11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packagi 8 SK-10 HIP-001 A/B Hot Isotatic Press	pping
11 SK-9 ST-001 Secure Storage Room 11 SK-9 PK-001 Final Assembly Packagi 8 SK-10 HIP-001 A/B Hot Isotatic Press	1
11 SK-9 PK-001 Final Assembly Packagi 8 SK-10 HIP-001 A/B Hot Isotatic Press	(2) 5 Ton (shop); (2) 7 1/2 Ton (Assembly) 4
8 SK-10 HIP-001 A/B Hot Isotatic Press	
	ng
1 SK-11 DRY-001 Ar Drier	Alternate to HIP 2
1 SK-11 HT-007 Ar Heat Exchanger	argon cooler
1 SK-11 FIL-024 A/B Ar Purification Filter A/	recirculation fan, bleed and feed 2
1 SK-11 WT-001 DI Water Treatment Uni	it
1 SK-11 TK-001 DI Storage Tank	
1 SK-11 WSF-001 Water Softener	prepares water for further purification
11 SK-12 AF-001/-005 Assembly Fixture	Includes holding parts in alignment, final assembly, and swaging 5
WDS-001/- Welding Station and Fin Assembly	al 3
11 SK-12 MS-001/-003 Machine Station	3
11 SK-12 WS-013 Element DI Wash	
11 SK-12 WS-014 Hot Element DI Wash	

Area Code		Equipment ID	Equipment Name	Description	Quantity
11	SK-12	DRY-002	Element Dryer	Description	Quantity
11	SK-12	HT-006	Autoclave		
11	SK-12	FIL-022	Prefilter #14		
11	SIX-12	11L-022	Channel Probe 1		
11			Channel Probe 2		
11			Inspection (tables)		
11			Inspection (tables)		
11			Steam Boiler		1
			Water Chiller	w/ Air cooled condenser	1
			Supply Air Handling Fans	W/ All cooled condenser	2
			Supply Filters & Conditioning	Pre Filter 30% & Bag Filter, steam coil, chilled water, dehumidification, drains, radiant heater on inlet louvers to keep frost off	2
1			Casting Molds (set) - Carbon	2 ea. specific to each fuel plate type & Size	32
1			Crucible	graphite 6" ID	20
Bldg			Fire Suppression System	Sprinkler (building) @ 10' O.C. both ways, and low flow BETE Type N nozzles (for HEPAs)	
Bldg			Automatic Fire Alarm System	FACP, sensors, alarm bells & lights, connect to CAS	
Bldg			Emergency Lighting		
Bldg			Signage	Warehouse, FFC, Guard shack and Site	
			Public Address System		
			Personnel Accountability System	ensures all personnel are accounted for in an emergency	
Bldg			Personnel elevator	Hydraulic two story, with pit	1
			Truck Bay Rollup Doors	7' X 15'	3
			Warehouse rollup door	7' X 15'	

Area Code	Sketch	Equipment ID	Equipment Name	Description	Quantity
			Forklifts - electrically powered	2 Ton	4
			Forklift Charging Station	4 station	4
			Forklifts - electrically powered	Warehouse	
			Forklift Charging Station	Warehouse	
Bldg			UPS System	Battery backup for Crit alarms and CAMs	
			Network Server		
			Material Accountability Server		
			Material Accountability Stations		
			Warehouse Inventory Tracking	Computer, Bar code, software	
			Analytical balances		12
			Dock scale		
			Hand & Foot Monitors	Eberline	5
			Personnel Contamination Monitors	Eberline	3
			Radiological Surveying Equipment		Lot
			Radiological Surveying Equipment	Storage Area	
			Radiological Surveying Equipment	Calibration Area	
			Radiological Surveying Equipment	HIP	
			Counting Equipment	Counter	
			Office Ventilation System	Recirculating, offices, warehouse, inspection	
1			Crucible Tilter		1
1			Slag & Heel Removal	Glovebox for mold and crucible cleaning	
1			Waste Drum for Slag & Heel		
			Material Pass-through to Storage	Secured controlled storage to Casting & Shop with scissor cart on tracks	2
			Material Pass-through to HIP		1

Area Code	Sketch	Equipment ID	Equipment Name	Description	Quantity
1			Casting Mold Entry Airlock	for Argon inerted casting g'box	1
1			Casting Mold Exit Airlock	for Argon inerted casting g'box	1
1			Glovebox for crucible cleaning		1
1			Jib Crane	for crucible handling, furnace bell jar	2
1			Motion Table	for casting mold filling	2
1			Mold Pre-Heater Power Supply		
1			RF Heating & Cooling Coils	for induction furnace	2
1			RF Generator	for induction furnace	2
1			Vacuum System	for induction furnace	2
1			Argon Supply	Dewar, auto pressurization system, vaporizer, regulator, fill, thief	1
			Argon Supply	Dewar, auto pressurization system, vaporizer, regulator, fill, thief	
1			Scissor Lift	Access to crucible loading	1
			Scissor Lift	HVAC Room Filter change	1
			Material Carts		20
			Specialty Rack for alloy storage	geometrically favorable	20
1			Day Storage Casting Cabinet		20
1			Heel Storage Cabinet		1
			included in AS-001	Tooling rack for Press	1
11			Hydraulic Press: 50 Ton	for coutouring plates	1
2			Salt Bath Staging Area		
2			Salt Bath Loading/Removal Equipment	Material handling system: indexing, racks	1
2			Salt Bath Heater Power Supply & Control	for HT-002	1
			Local Task Ventilation Ducts		25
			Hood, enclosure, with sash		5
			Plate Scrap Bin		

Area Code	Sketch	Equipment ID	Equipment Name	Description	Quantity
			Scissor Cart - Rolled Plate Storage		
			Fuel Plate Day Storage	cabinet	
			Critically Safe runoff Water Collection System	Geometrically favorable sumps, 6" dia.tube tanks, recirculating & transfer pumps, filters, 8400 gal horizontal underground storage tank w/ hemispherical heads, sampling system	1
			Mech/Elect Maint. Equip		lot
			Fuel Alloy Can storage rack	5 movable shelves w/ inserts & gates, 5h	
			Fuel Subassembly storage rack		10
			Motor Control Ctr w/ starters & CB		2
			Electrical Substation w/ 480 V Xmfrs		
			Granite Surface Table w/ parallel		5
			Coordinate Measuring Machine		1
			Stack Monitor (CEMS)		1
			Alpha CAMs and Central Control	Battery backed	
			Criticality Detectors	Battery backed, Vacuum pump and facility wide distribution system, connect to CAS	
			Air Compressor	10 HP	1
			Instrument Air dryer	25 CFM	1
			Instrument air filter		1
			N ₂ Bottle regulator		2
			Off-Line Programming Station	software and computer	2
			Waste Size Reduction Shear	for aluminum trimmings	1

Area Code	Sketch	Equipment ID	Equipment Name	Description	Quantity
			video surveillance equipment	Cameras in secured controlled storage areas and dock, security monitors, recording equip	lot
			fenced security areas	dock	3
			drum handling equipment		5
			Filter bagout		

TABLE 3-7 FACILITY FUNCTIONAL AREA BREAKDOWN

Area Code	Function		
1	Ingot Cleaning, Casting, Mold and Crucible prep		
2	Hot roll unclad U-Mo to ~0.1" thick		
2	Heated Salt Bath (prior to rolling cast plates)		
3	Sectioning (four plates cut from each pre-rolled U-Mo strip)		
3	Salt Removal (sanding or media blasting prior to sectioning)		
4	Canning (automatic weld station load / unload)		
5	Hot rolling of Zr Clad U-Mo in purged C'Stl can		
6	De-canning, foil trimming, can scrap management		
6	Anneal		
7	Chemical Cleaning (Al plates and Zr Clad U-Mo are cleaned in separate baths)		
8	Friction Bonding		
9	Fuel Element Trim, flattening and Surface Finish		
9	Fluoroscopy (verify position of foil inside bonded Al cladding)		
10	QA		
10	Rad Tech		
10	Lab - UT		
10	Lab - Radiologist		
10	Lab – Microscopy and sample prep		
10	Lab – Metallography / Chemistry		
10	Dimensional Inspection / Setup		
11	End piece Machining, Element Assembly, swaging, Autoclaving Final Product Assembly		
11	Fuel Element Shape Forming (Press)		
12	Shipping and Receiving (Product packaging + shipping container unloading)		
12	Storage Area, order picking and stocking, Accountancy		

4.0 MECHANICAL/EQUIPMENT DESCRIPTION

The Mechanical Equipment in the FFC is shown on the drawing SK-ME-1 and listed on the FFC equipment List. The fuel manufacturing process is outlined on the Overall Block Flow Diagram BF-1. Equipment for the various steps in the process and outline descriptions of what takes place in the various areas within the plant are described in this section.

The FFC is arranged as a typical machine shop, foundry and assembly area, complete with 21st century technology for fabrication of LEU-Mo plate fuel subassemblies. The shop area has a central aisle for forklift and hand-cart traffic, the predominant means of production material handling. The shop itself provides primary ventilation confinement, and is surrounded by the personnel corridor. This corridor provides a place for personnel to walk to the vicinity of their work station without conflict with hand-cart or forklift movement. Viewing windows into the shop are present all along the length of the corridor accommodating tour visits without need for entry, and allowing site personnel to observe activity within the shop. The shop is a high bay area with overhead bridge cranes. Suspended shop lighting hangs above the bridges, and the ceiling of the shop is open to the trusses.

Two bridges on parallel runways run the length of the shop including the casting area. This permits heavy maintenance procedures (such as roller replacement or motor or bed removal) to be performed on any piece of shop equipment, and allows spent machinery or replacement items to be moved to or from the dock area. There are no central runway crane support columns, because they would interfere with forklift travel. The inner runway rails are suspended from the overhead roof trusses. The outer runway rails are supported by columns offset from the building columns as shown in Figure 4-1 below. This allows exhaust duct risers and electrical trays to be routed against the shop walls, and below the crane rails, to be brought into the shop floor area horizontally above head height such as for a ventilation hood duct. This arrangement avoids interference with use of the overhead cranes.

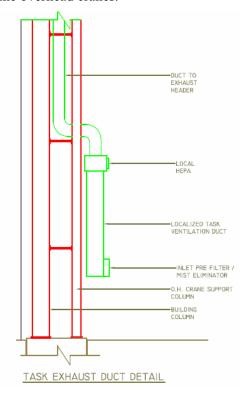


FIGURE 4-1 BRIDGE CRANE RUNWAY OUTER SUPPORT COLUMNS

Air is exhausted from the shop and carried to the exhaust filters and fans via overhead ducts. which run amongst the roof trusses. The amount of airborne contamination from activities conducted in the FFC is expected to be small. The ventilation system is designed to meet personnel safety requirements and good practices. At the end of the shop closest to the office area, the opposite end from the foundry, all in-process fuel material is clad; hence this is the 'cleanest' area from a contamination standpoint, which is also where the majority of the fresh ventilation supply air flows into the shop from the normally uncontaminated Personnel Corridor. The primary activities expected to produce radiological material contaminates are casting, cutting and rolling operations. Non radiological sources of dust are associated with grinding and media blasting activities. All such locations where these activities are conducted are provided with task exhaust systems, preventing spread of contamination into the work environment. The exhausted air is drawn mainly from the 'back' of the shop, near the foundry, where bare alloy fuel material is being handled, or the 'dirtiest' end, thus air flows from the area of lowest potential for contamination to the areas with a higher likelihood of contamination. All air leaving the shop is filtered via HEPA filters before it is released to the atmosphere. Many hoods and task exhaust ducts are present drawing air from the shop; these constitute more than 20% of the exhaust air flow.

The foundry area houses two induction furnaces where cast 'acorns' or buttons and broken pieces of LEU-Mo alloy from Y-12 are melted and cast into plates ¼" thick. Furnace capacity is such that a single batch per day is poured from one of the two furnaces, meeting the needs of production. In the shop, the cast plates are then hot rolled to an intermediate thickness (~0.1"). The plates get longer in the same proportion as are rolled and become thinner. Following the initial roll, the U-Mo plates are sectioned into lengths suitable for canning. The surfaces of the rolled plates are covered with zirconium metal shim stock which serves as a diffusion barrier, and the Zr-fuel-Zr sandwich is canned between steel sheets welded together. The canned fuel plates are hot rolled, and the rolled cans are opened, exposing the Zr clad U-Mo foils at their final thickness, 0.010" to 0.015" thick depending on the final application. The foils are trimmed to the final rectangular dimensions (maximum of 3.5" wide X 48" long) then the aluminum cladding is applied. At this point, the monolithic fuel foil is completely confined.

The assembly area is where completed LEU-Mo plate fuel elements are assembled into completed research reactor fuel subassemblies. Extensive machining, welding, swaging and inspection operations are performed here, and modern equipment workstations are provided to suit the varied needs of the different fuel sub-assembly configuration required to support the five domestic reactors serviced by the FFC.

The fuel manufacturing steps and facility features are explained further in the report sections that follow.

4.1 Receiving/Receipt Inspection

LEU-Mo raw material, in the form of 1.5" acorns or broken pieces, is shipped in ES-3100 containers, shown in Figure 4-2, from the foundry at the Y-12 Plant at Oak Ridge in Tennessee. The alloy fuel material is inside sealed stainless steel shipping containers, 43" tall, resembling a 'stretched' 30 gallon drum as shown below. The outer drum assembly houses an inner containment vessel with up to three inner containers, described as paint cans, packaged in the center of the shipping container. The inner containment vessel, Figure 4-3, is 32' tall and 5" diameter and is also stainless steel. The lid is closed with a sealing nut and two o-rings are present beneath the lid to allow the inner container to be purged and sealed.

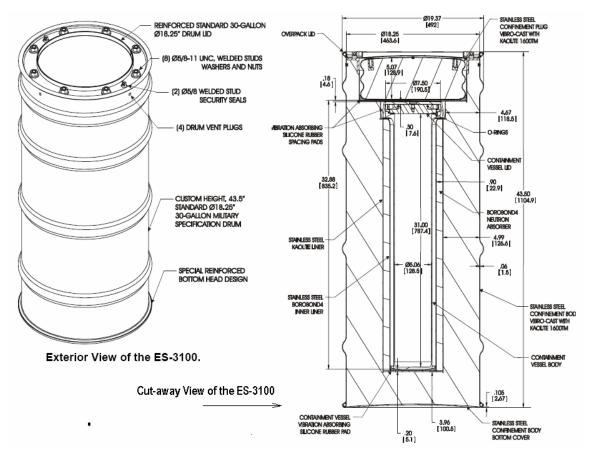
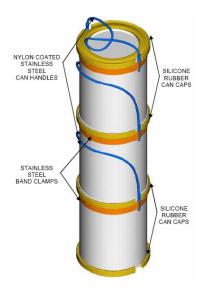


FIGURE 4-2 ES-3100 SHIPPING CONTAINER



Each of the three 10" tall inner cans contain up to 11 kg, to a maximum of 33 kg of LEU-Mo per ES-3100 package.

FIGURE 4-3 INNER CAN

The drums are secured to pallets, and the pallets are shipped across country in covered trucks. They may be shipped by commercial carriers including UPS. There are no criticality constraints on the shipping containers because they are both internally insulated and shielded. The containers are rated for other uses including HEU. The maximum gross weight of the package is 420 pounds including the contents.

Trucks are admitted to the FFC through the entry control facility and shipments are scheduled in advance. The trucks are backed into an indoor dock area of the FFC which provides year-round weather protection. Space heaters are present in the dock, and up to three vehicles may be parked within the enclosed dock area with the rollup doors closed. Door controls are such that vehicle and cargo storage is secure overnight. An elevated dock suitable for forklift passage into the trucks is featured in the FFC arrangement. Dock parking bumpers are present. A tip down ramp is placed between the vehicles and the dock and secured allowing the fork lift vehicles to enter the bed of the truck to off load pallets of drums. A typical shipment of LEU-Mo alloy from Y-12 may consist of 64 drums (16 pallets), which would be about 2 tons of alloy, and must be scheduled a year in advance to get in to the normal production run. Such shipments may be in 4 month deliveries, or otherwise at the convenience of the customer, and some material may be stockpiled at Y-12. The FFC uses about 6 tons of alloy yearly. The fork lift will be equipped with a drum carrier attachment for handling single drums. A sea-land cargo type container (for larger shipments) may also be parked at one stall within the dock, in which case unloading will be at grade with the fork lift elevating drums to the dock.

4.2 Inner Can Storage

While a shipment of raw material is still on the truck at the dock, a receiving inspection is conducted, Figure 4-5. A physical drum count is made to assure agreement with shipping documents, and a scan for gross gamma is made using a hand-held instrument. A pallet of drums at a time is moved with a forklift to the U-Mo secured controlled storage area. Individual container weights are measured as the drums are de-palletized to evaluate shipper/receiver differentials and any differences are tracked. Prior to transfer of the drums to the unloading area, smear tests for contamination are conducted. Contaminated drums are wiped clean. Inner cans are removed from the shipping container in the container unloading area within the U-Mo secured controlled storage area. Lids are removed from the individual drums, and the inner containers (shown above) are individually weighed and stored in the storage rack within the storage area. A chemical check sample is included by Y-12 in a package separate from the inner cans. This allows the FFC to leave the inner cans sealed while the chemistry and isotopic composition is verified. The secured controlled storage area is equipped with specialized moveable shelving units as shown below in Figure 4-4.



Commercially available moveable storage shelves allow the aisle to be located at the position orders are being placed. The storage area is compact, yet accessible. The shelving racks move on sets of upper and lower tracks. Shelves are seismically rated and occupy ½ the area occupied by shelves with aisles between racks.

FIGURE 4-4 MOVEABLE SHELF EXAMPLE

Each area of storage is marked, and each storage area has inserts dedicated to the stated purpose. In addition to the marking, the storage positions are uniquely sized to accommodate the material in the particular in-process state that it is in when it is stored. Due to the large quantity of fissile material stored in the secured controlled storage area, dedicated storage racks ensure that engineering controls are present in the storage area in addition to the administrative controls. Fuel material in cans is stored in criticality-safe stacks such that no stack of cans is closer than 12" from its neighbors. For raw alloy, a storage 'bin' or pocket in the shelf is contoured to fit a single 10" tall can, and only one can fits in a storage location. A lockable 'gate' is closed over the can, which secures it to the shelf so in a seismic event; the cans do not fall out of the shelves. The 'gate' permits visual identification that the can is present and the tracking number on the can is visible without opening the 'gate'. Individual can identification permits lot and batch tracking. This may be by bar-code, printed and affixed when the cans are received, or by the markings present on the can (if such markings are present when shipped from Y-12). Upon receipt of the material, the FFC accountancy process begins. Custody of the material is transferred from the shipper to the receiver. Later, cans may be opened and material samples analyzed for impurities,

chemistry and isotopic verification. A contingency plan will be prepared for disposition of any off-spec material received.

The storage racks for raw material (cans) are moveable on tracks in the floor (and ceiling). This allows a single aisle to be located anywhere within the rows of shelves that access is required, thus saving space. When the shelves are in their most compact position, cans are still separated with an 8" gap between neighboring cans. As shown in the arrangement on SK-ME-02, there are nine double sided shelves, containing cans in columns five high, 12 inches apart for a total of 540 cans; one year's supply of raw LEU-Mo, enough for about 17,000 foils.

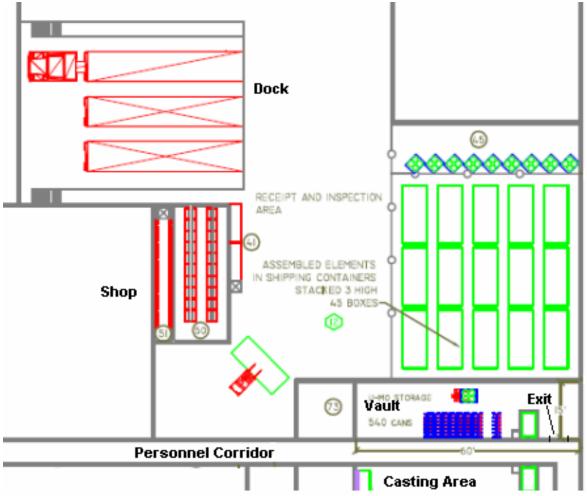


FIGURE 4-5 SHIPPING/ RECEIVING AREA

The interior of the U-Mo secured controlled storage area, the entrance vestibule, and the other temporary storage areas around the dock are equipped with CCTV cameras for security. Admittance is controlled by security approved access control methods. The emergency exit door from the secured controlled storage area (to the personnel corridor) has hardware such that it can only be opened from the inside for emergency egress, thus avoiding any 'confined space' implications. When a vulnerability assessment is performed on the FFC (future), some details may be subject to modification or refinement.

4.3 Material Handling and Transfer

Orders made from the floor are picked manually from shelves in the secured controlled storage area, placed on movable carts and passed via the pass through below the personnel corridor to the shop. The weight of the containers moved to casting is tracked for accounting purposes.

4.3.1 Pass-Through

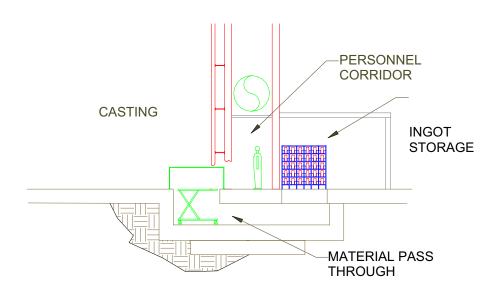


FIGURE 4-6 MATERIAL PASS-THROUGH EXAMPLE

There are two material pass-throughs in the FFC, shown in Figure 4-6 above. The instance shown above is used to pass the raw fuel alloy from the U-Mo secured controlled storage area, on the right, to the casting area, and the second is used to pass material to and from the inspection area or shop to and from the intermediate storage area. A third would be present if the HIP option is invoked, which allows canned work packages, made up in the shop, to be passed to the HIP, and back again for disassembly. The purpose of the Material Pass-Through (MPT) is to be able to pass material from one primary confinement zone to another with out exposing non contaminated zones to 'contaminated' material. Another reason for having a material pass-through is to minimize personnel movement.

The MPT operates within a concrete lined trench which houses a rail mounted transfer cart with a scissor lift. The unit is electrically powered and is equipped with end of travel limit switches and interlocks that allow the lift to function only at endpoints of travel. The system is controlled with a simple control system from which workers will control the transfer of material. The trench has a safety rail around it to keep workers away from the trench. A locally mounted terminal on both sides will be used to place 'orders' for material and account for material moved from one material balance to another area.

4.3.2 Hand Carts

Hand carts, such as in Figure 4-7, will be used through out the FFC for material transfer between different work stations and for general movement throughout the shop. Heavy duty steel platform trucks with a flush platform measuring up to 60" x 30" x 11" tall are used. Commercially available flat platform carts will be outfitted with special compartmentalized racks to hold the inprocess fuel material securely, to ensure material is not stacked too deeply (which could cause criticality concerns) and to keep the material being transferred organized (shown right).

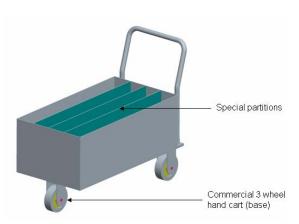


FIGURE 4-7 HAND CART EXAMPLE

The trucks are manually pushed and roll on two rigid and one or two swiveling rubber tired casters for tight turns and smooth maneuverability. Each hand cart will be equipped with a removable handle and a floor lock to keep the truck stationary when it is parked at a work station.

4.3.3 Forklifts

A three-wheel stand-up counterbalanced forklift, shown below in Figure 4-8, with a 2 ton load capacity is featured in the FFC design for material transfer and loading and unloading of fuel or material shipments from trucks. A three-wheel, stand-up forklift has a reduced turning radius for greater maneuverability and easier material handling in tight spaces.

The battery powered forklift emits no exhaust and is equipped with quick tine disconnects to allow for easy and quick change between forks and drum grabs or other attachments as needed.

A powered pallet truck is used where tight spaces may be encountered and the need to stack pallets is not needed; such a place is the LEU-Mo secured controlled storage area. The powered pallet truck is used to move a pallet of LEU-Mo alloy shipping containers to the secured controlled storage area where the drums of alloy resting on a pallet are unloaded from the ES-3100 manually by a worker.



FIGURE 4-8 FORKLIFT

4.3.4 Drum grabs

Forklift mounted mechanical drums grips as shown below, Figure 4-9, are used to move and stack drums in the FFC. Auto-Grip drum handlers allows a single operator to easily slide the drum handler on the fork tines to pick-up, transport and unload empty or full drums up to 1500 pounds.



FIGURE 4-9 EXAMPLES OF DRUM HANDLERS

When empty or full drums are moved from one location to another and the need for a forklift is not required, four-wheel drum carts, shown on the right, may be used.

4.3.5 Overhead Cranes



FFC Overhead Cranes

- Two parallel Runways

 Entire length of bays

 Shop and Assembly Areas
- Rail Supports

Posts on outside (allow duct routing for hoods) Ceiling truss suspension inside Unobstructed center fork lift aisle

- Cross-Over from bridge to bridge Two locations each: Shop and Assembly Areas
- Hoist can be used for:

Machinery movement Service and maintenance Remove and replace components





FIGURE 4-10 OVERHEAD CRANES

Overhead cranes, like those shown in figure 4-10, are used in the FFC to facilitate heavy maintenance procedures, and are not generally used for material handling. Cranes fall under a different category for nuclear material handling (ASME NUM-1), and that requirement is not currently being considered for the FFC. The 5 ton (shop) and 7.5 ton (Assembly Area) rating is suitable for support from the building roof trusses. The load

rating, and distance under the hook shown in the elevation drawings (see Appendix) may be subject to change based on detailed support mission studies (future). Some of the functions that the overhead cranes may be used for in the shop are listed above.

4.4 Alloy Casting

The castings are 90% Uranium and 10% Molybdenum (eutectic gamma phase) with a melting point of 1150°C. The alloy is melted within a bottom pour graphite crucible surrounded by water cooled induction coils within a bell jar operating at a vacuum. Temperature is measured using an optical pyrometer through a hole in the cover of the crucible. After a 15 minute dwell at +50°C superheat, the vacuum in the jar is broken with argon then the melt is poured into a preheated book mold inside an inert atmosphere enclosure. Casting molds are moved beneath the furnace using an indexing material handling system. Preheating of the molds utilizes an infrared radiant heating system. After the mold is filled it is moved to the quench area within the enclosure where cooled gas is forced against the mold as the next mold is being filled. A full day's supply of alloy is present in the 6" dia. single batch crucible and a 20 % heel (containing the dross) remains after filling the molds. Seven ingots are poured during this casting run, approximately 1/4" thick X 3.5" X 16" long. Following the quench and when the plates are below ~500°C the molds cool by natural convection inside the enclosure to a safe handling temperature (below 120°F) in the exit airlock. The molds are manually cracked open and the ingots are inspected, weighed, serialized and sent to the roll mill. A slight draft in the molds facilitates ejection of the cast plates. Book molds (which hinge on the bottom and produce a flat vertical cast plate) are used because the alloy material does not gravity level and uniform ingot dimensions are necessary for rolling such that a minimum of trimming is required. Molds are likely to be carbon to avoid formation of an alloy with the fuel material. Two runners are present on the top of the casting cavity of the mold. Molten material is added to the fill sprue until it overflows the vent assuring the mold is full. Trimmed alloy material and sprue volumes are recycled to a following melt.

One casting line is used one day, and as the plates are stripped from the molds in the A line, the next melt batch is being prepared in the B line. The casting area arrangement may be seen in the plan view below. Fuel alloy material is manually cleaned in nitric acid, then rinsed and dried prior to crucible loading to remove oxides and any organics that may be present. The alloy used to prepare a batch may be from a single lot of acorns and broken pieces from Y-12, or may be mixed from left-over from other lots or mixed with heels and/or pieces retained and accumulated from previous runs. Such mixed batches will be analyzed at the FFC for certification of alloy chemistry and isotopic composition to assure fuel specifications are met. Fuel alloy material is retrieved from the secured controlled storage area via the pass-through in convenience cans which are weighed before and after the fuel is readied for use. Molds and crucibles are refurbished and reused. Within hoods, molds and crucibles are cleaned and any appreciable amounts of residual alloy fuel material is saved and weighed for accountability purposes. Fines are disposed of as LLW following accounting for the material lost. Release compound is applied to clean molds and crucibles prior to re-use. Crucibles have a finite life. Spent crucibles are cleaned prior to disposal as LLW.

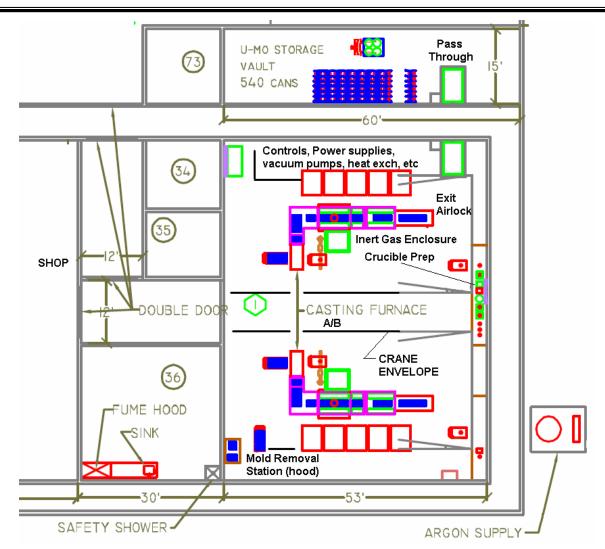


FIGURE 4-11 ALLOY CASTING AREA (PLAN)

The induction furnace featured in the FFC study was selected for use because it is in common production use in similar industrial facilities. Induction casting of thin plates made from U-Mo allov been successfully implemented since the early http://www.osti.gov/bridge/servlets/purl/4836788-7KCcrK/). According to existing experience at Y-12, sufficient induction stirring takes place within the melt to ensure adequate homogeneity, with the oxides floating to the top of the melt and remaining in the dross. Due to the presence of oxides in the top layer of the crucible, and the potential for formation of dispersible particulate, a sintered metal filter is present between the vacuum chamber and the vacuum pump. Spent filters, expected to contain LEU oxide, are disposed of as LLW because no filter leach capability exists at the FFC.

The exact casting technology to be used in the production plant is subject to further study (future) and it has been noted that a microwave furnace offers a potential advantage in that the water cooling is contained within the control cabinet and not in the argon enclosure as is the case with the induction furnace. It is also energy efficient compared with other furnace types. It is also possible that cast ingots of the proper size complete with alloy certification may be supplied from Y-12, in which case the casting area and lab instrumentation to certify fuel alloy feedstock for

impurities, isotope and chemistry would be eliminated from the FFC floor plan. Studies to compare costs, benefits and risks and related value engineering activities will be conducted during the Conceptual Design phase of the project.

The bell jars (for vacuum service surrounding the crucible) are lifted and moved out of the way, for crucible loading and unloading, by a small jib crane located at each furnace. The induction melter, Figure 4-12, has a cooling water system which requires a water to water heat exchanger, and chiller and air cooled condenser (mounted outdoors) for heat removal, a radiofrequency power supply (which is also water cooled), the water cooled induction coils within the vacuum bell jar, a water cooled chill plate, vacuum pump with 5 micron non-woven mesh, sintered metal filter, an operators control and instrument console that executes the pre-programmed recipe, interlocks (including evacuation timer and leak down), an argon venting system with pressure relief, and is constructed on a integrated modular basis allowing for factory testing and field service of components. A schematic of a generic induction heating furnace is shown below for reference.

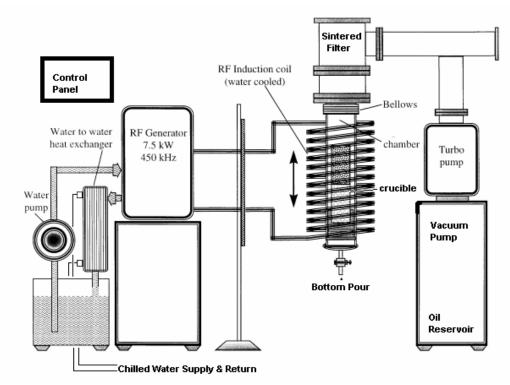


FIGURE 4-12 INDUCTION HEATING FURNACE SCHEMATIC

In addition to the induction furnace, a control console and power supply is present for the high intensity quartz lamp mold preheating system, and for the material handling systems, mold cooling systems and argon filled enclosure and enclosure inlet and outlet airlock doors.

The casting area, Figure 4-11, is in a room by itself and equipment inside may be serviced by the shop bridge cranes. The walls surrounding the lab area, between the shop and casting area, although they do not reach to the roof, provide a measure of fire spread prevention. Spent vacuum pump oils and spent filters from casting are disposed of as contaminated waste.

4.5 Hot Roll to Intermediate Thickness

U-Mo material cold rolls with properties similar to stainless steel and hot rolls similar to Zirconium. On Roll Mill RL-001 hot roll the 1/4" thick X 3.5" X 16" long wide cast ingots to 0.1" thick. One ingot makes 10 pieces. Approximately seven ingots are cast and rolled each day. The rolled plates are roughly 40" long. Prior to rolling, the cast plates are heated. The heating process used is a molten salt bath at 630°C. The salt coating on the parts retards oxidation and provides a protective coating on the plates and transfers to the rolls. A custom material handling technique removes the heated plates from the bath and feeds it to the roll mill. Conceptually, a rack securely holding a 1" thick stack of plates, spaced apart slightly, is used to lower the plates in the salt bath. The rack has long handles that extend above the molten salt surface when the rack with plates is immersed. After suitable retention time, a chain wheel retracts the handles and raises the stack of plates. An indexing feeder pushes the plates one at a time between the rolls. A reversing roll mill is envisioned with the material taking multiple passes through the rollers. It may take multiple passes through the mill rolls to obtain the desired plate thickness with a reheat between passes while the operator resets the rolls to the final nip (gap between rolls).

Following rolling, the 40" long fuel plates are then cut (sheared) into 10 pieces 4" long. The edges perpendicular to the rolled length are also trimmed. The trim material, being pure U-Mo, is recycled back to casting.

Hydraulic force against an adjustable chock is used to control the separating forces between the rolls, and the synchronized rolls are rotated by a variable speed electric motor operating through a gear box. It is desirable to obtain calibrated digital readouts on the roll gap, which is remotely set from the operator's console. An example is shown in figure 4-13. Such equipment will be procured to have a 40 year life. The furnaces for heating the input parts may or may not be part of the vendor's offering, if they are, the furnace controller will be part of the vendor's supply. Rolls (such as on the canning mill that are uncontaminated) may be periodically refurbished via a service contract. When the equipment is purchased representatives of the FFC project will witness a factory test. Roll-ability tests using surrogate material may be performed to determine rolling characteristics. The roll mills will feature an extremely rigid frame and heavy duty bearings to achieve and maintain high accuracy and good surface finish, with less than ~.0005" thickness variation across the foil. The drive will be by motorized gear drives or by high torque hydraulic motor.



FIGURE 4-13 MODERN ROLL MILL WITH ROLLERS THAT SLIDE OUT FROM THE FRAME FOR INSPECTION. THE HYDRAULIC CYLINDER THAT CONTROLS SEPARATION FORCE IS VISIBLE WITHIN THE FRAME IN THE BACK.

4.6 Cleaning Procedures used in the FFC

A number of cleaning procedures are performed as the fuel fabrication process is executed in the FFC. Ingots are cleaned prior to casting, salt from the heating bath is removed from the cast plates following the initial roll, the rolled plates are chemically cleaned prior to application of the zirconium diffusion boundary, and the foils and cladding are chemically cleaned prior to bonding. The bonded plates are cleaned following surface finishing prior to ultrasonic inspection, and the completed fuel subassemblies are cleaned prior to packaging for shipment. Although not a cleaning process per-se, the completed ATR fuel subassemblies are autoclaved to fix an approved oxide layer on the surface of the aluminum.

For cleaning, foils and aluminum cladding plates are typically immersed in sequential cleaning baths. The liquid cleaning solution may be heated or at room temperature and the baths are recirculating to provide agitation and continuously filtered. Parts placed in open racks are immersed, and soaked then removed. Racks drip drain above the bath and are then moved to the next cleaning solution or dried after rinsing. The volume and dimensions of the bath tank and rack is such that the process is geometrically favorable. Racks limit the number of parts that may be immersed at any time, and the potential for 'double batching' can be avoided using techniques such as hinging the rack so that it must be lifted from the tank prior to loading. Design studies (future) shall determine the practical level of automation present for use during the various cleaning procedures.

Space for cleaning stations, convenient to the workstations to which they apply, has been allotted in the arrangement.

4.7 Canning

After cleaning, the 4" long cut and cleaned U-Mo plates are then sandwiched between two pieces of .005" thick Zirconium shim stock that acts as a diffusion barrier material between the fuel alloy and the aluminum cladding to which the fuel material is bonded in a process described later in the text below. The shim stock is tack welded to the inner surfaces of the cans to ensure everything in the stack remains in place during rolling. The sandwich is then enclosed in a flat can made of 1018 carbon steel and the edges of the can are then seal welded using low carbon filler material on an automatic wire feed TIG welding station, in Figure 4-14 below. The can plates are 0.10" thick therefore the can is \sim 0.3" thick. The can is evacuated then purged with argon, via a short pigtail attached. The nozzle to which the pigtail is attached is stamped in to the two can halves, and seal welded around the perimeter when the can halves are welded. The pigtail is secured to the nozzle by welding. The inert gas prevents oxidation of the internal parts. Prior to assembly, the inside surfaces of the can are spray coated with Yttria to prevent bonding of the Zirconium with the can.



Automatic Welder - to be equipped with parts feeder and weld curtain (not shown). Weld parameters are continuously monitored during welding to ensure weld quality. Following welding the can may be leak checked to verify integrity prior to rolling.

FIGURE 4-14 AUTOMATIC WELDER

At the automatic can welding station, a dual sliding part feeder is envisioned. The operator loads the can stack in a fixture on one side, this then slides to the vicinity of the welder, inside the curtain, which automatically executes the weld path. The just welded part, on the other side, slides out simultaneously, and the operator unloads that side, and re-loads it with another stack. By that time the other part is complete, it slides out and the next one slides in. The operator never enters the curtain enclosure surrounding the welder except when the machine requires service or consumables. Welding capability is locked out during service.

4.8 Roll to Final Thickness

The can produced in the step above is roughly 6" long, 6" wide X 0.3" thick with fully welded edges. The plate is heated in the can in an air atmosphere tunnel furnace and the hot cans are automatically fed to mill RL-002. Approximately 70 pieces per day are so processed. The Zr clad U-Mo is then rolled in the sealed can to a can thickness of 0.030" to 0.45" thick. A tandem roll mill is envisioned with three pairs of rollers, like those shown in figure 4-15, and it may take multiple passes through the mill train to obtain the canned film thickness with a reheat between passes while the rolls are reset by the operator to the subsequent and final nip. Heat contained by the parts transfers to the rollers during the time of contact. By closely spacing the rolls, the individual stages are self feeding from roll to roll and the heat is retained in the part as it passes between the individual rolls. Threading guides between the roll stages ensure the cans are fed properly to the next stage.

Rollers used on the roll mills have a high surface finish. Over time with repeated use, the surface degrades. Rollers are refurbished as needed, usually by service contract. Contaminated rollers are disposed of as rad-waste.



FIGURE 4-15 MILL ROLLERS

4.9 Annealing

Annealing of the can containing the rolled fuel foil is performed in an air furnace at 650-675 (deg C). If the heat is too high, bonding of the fuel to the can may take place. The cans may be accumulated and annealed in a batch that can be processed concurrently. Processing of the fuel material in the FFC is administratively controlled such that quantities within any particular area are below levels where criticality considerations become a concern. The Fe-U eutectic forms at 725°C so any canned annealing will be performed below 700°C. The parts dwell at the annealing temperature for ~30 minutes. The parts cool slowly in the furnace while temperature is monitored. Following the cooling, the parts are safe to handle (below 120°F) and the furnace may be opened and the parts removed. If necessary a constraint fixture will be present in the furnace. This may be in the form of a heavy weight placed on the stack of parts in the furnace.

Because the can weld seams are subjected to plastic deformation and they must endure high strains (during rolling) while maintaining integrity, failures may occur. Such failed foils oxidize during annealing, and are rejected.

4.10 Shear Foil to Dimension

Shearing is used as a method of opening the rolled can. The can is opened to remove the foil and the can becomes contaminated scrap. The foils, removed from the can, are rough sheared outside the final dimensions. Finally, cans are sheared into pieces suitable for disposal. Therefore, three shearing processes are in use at this point in the fabrication process, and space in the FFC layout has been made to accommodate the shear stations, shown in figure 4-16, and their support systems. To facilitate packaging and minimize waste volume, a scrap shear and a scrap bin are provided to facilitate size reduction and minimize labor input. Waste must be carefully surveyed to ensure alloy fuel material is segregated from can scrap. Cans are thin-wall following rolling and can be easily sheared open. Assuming the steel can rolls like the fuel foil inside, when the can is opened a fuel foil 0.010" to 0.015" thick will be inside. The foil size, after roughly trimming oversize, will be on average 40" long (range from 48" to 24").



Metal Shear for can removal may be hydraulic actuated. Operator safety is enhanced by requiring use of material hold downs to secure stock prior to cutting.

FIGURE 4-16 HYDRAULIC METAL SHEAR

4.11 Foil Cleaning

Yttria, transferred from the can, will be present on the surfaces of the Zr clad foils that must be removed. Removal of the Yttria is necessary because it would interfere with the bonding of the foil to the Aluminum cladding. Yttria isn't soluble in nitric acid, so within a hood, the foils are wiped with an HF cleaning solution, which slightly dissolves the Zr, freeing the Yttria, allowing it to be wiped off by a nitric acid wipe.

4.12 Friction Stir Bonding

Aluminum cladding is bonded to the foil using a friction stir bonding technique using tooling developed and successfully demonstrated at INL FASB.



FIGURE 4-17 EXAMPLES OF FRICTION STIR BONDING AND MILL

Pressure applied to the rotating mandrill in the mill similar to the one shown above, Figure 4-17, generates friction on the aluminum cladding plate heating it to ~60% of its melting point while it is under a high normal force, creating a bond between the cladding plate and the foil. The surface representative of the cladding after bonding is shown close-up on the left. A license from The Welding Corporation (TWC) for friction stir bonding (a \$50,000 allowance is included in the estimate). Formation of a bond throughout the entire surface, on both sides, without any voids is necessary to produce acceptable fuel plates. In order to perform the stir bond, the cladding requires a perimeter margin around the finished part for clamping. Clamps are engaged by the operator to hold the aluminum-fuel-aluminum sandwich securely to the mill table. After the part is bonded on one side, the operator unclamps the part and turns it over, reclamps the part, then bonds the other side. An 'area filling' routine is executed by the mill's numerical control program to ensure the whole foil face area is covered without dependency on operator skill.

The friction bonding technique requires two cooling systems, one for the tool head and one for the anvil. The tool head uses a closed loop chiller and the anvil is cooled via building cooling water. The capability to control both coolant flows is necessary, and an alarm or operator notification is needed if capacity requirements are not being met.

4.13 Alternate HIP Process

Use of a Hot Isostatic Press, Figure 4-18, process to produce the bond between the fuel foil and the aluminum cladding is a successfully demonstrated technique for meeting high performance plate fuel fabrication goals. The HIP has the capability to produce a uniform, controllable and completely void free bond on both sides of the plate, in an entire stack of plates at once without a lot of hand work, or need to turn the plates to do the other side. The plates are processed by placing the foil between the aluminum cover plates. This perimeter of this assembly is welded under vacuum in the electron beam welding unit. This forms a hermetically sealed assembly which is placed into the hip unit without an additional over pack. A batch of the assembled plates is bound together with rigid spacers to prevent warping of the plates during the HIP process.

The use of HIP bonding versus the Friction Stir bonding technique will be a future alternative study and value engineering activity performed during the conceptual design phase of the project. One bonding technique or the other will be selected; the deselected method will be deleted

entirely from the FFC scope. Issues unique to each process and differences between the methods of bonding implementation are described in detail below.



FIGURE 4-18 EXAMPLE OF A HOT ISOSTATIC PRESS

For monolithic fuel fabrication for high performance research reactors, a 20" diameter X 60" long void work cavity is needed, similar to the unit shown.

- Pressure Vessel Assembly
- Furnace & Heatshield Assembly
- Part Support Tooling
- Control /System
- Process Gas Handling & Compression System
- Vacuum System
- Electrical Power Distribution System

Two HIP units are indicated to achieve the production throughput. Each system includes the subsystems and components shown. In addition to electrical service, and connection to the control system and interlocks, an overhead monorail hoist and trolley is present to load and unload parts. A crane is not expected to be necessary to service the pressure vessel and the moveable external yoke over the 40 year life of the facility.

A pit area is necessary within the FFC to accommodate the HIP units. For this option, the HIP room has been added to the FFC arrangement, as a lean to structure, or wing, adjacent to the Shop, on the opposite side from the Assembly Area. The HIP room is entered from the Personnel Corridor. Material is passed from the shop using the Pass-Through provided, which maintains the primary confinement integrity of the shop and avoids movement of potentially contaminated material through the normally non contaminated corridor. All fuel material is handled within a can in the HIP room. Since bare fuel is not handled the HIP room operates as an uncontaminated area. Contamination would be present only in the event of an off-normal event such as a ruptured can or HIP vessel seal leak. The HIP room is suitably isolated from the environment and the personnel corridor such that any contamination present could be cleaned up without spread to adjacent areas.

Sealed HIP work packages are made up in the shop. The plate assemblies are placed between the strongbacks and the stack is bound together.



FIGURE 4-19 HIP CAN EXAMPLE

The work package is passed through from the shop to the HIP room, and using the monorail and handling device, it is lowered into the HIP vessel inside the furnace cavity. Chairs inside the furnace position the work package at the proper position and elevation. The heat shield is stacked on top inside the cavity and the vessel lid is positioned. Using the motion control rack, the yoke is moved laterally to constrain the top and bottom vessel covers. Under high heat and pressure, 560°C and 15,000 psi, the plate assemblies are compressed, bonding the inside faces of the aluminum cladding plates to both sides of the fuel foil. The Zr coating on the foils acts as a diffusion barrier preventing diffusion of the U-Mo into the aluminum. The HIP process is initiated by the operator and the heating and pressurization sequence is performed automatically. Following the sequence and after cooling and depressurization of the HIP vessel, the can is removed and moved via the transfer port back to the shop where it is opened. During routine operation the HIP room operates in an uncontaminated state.

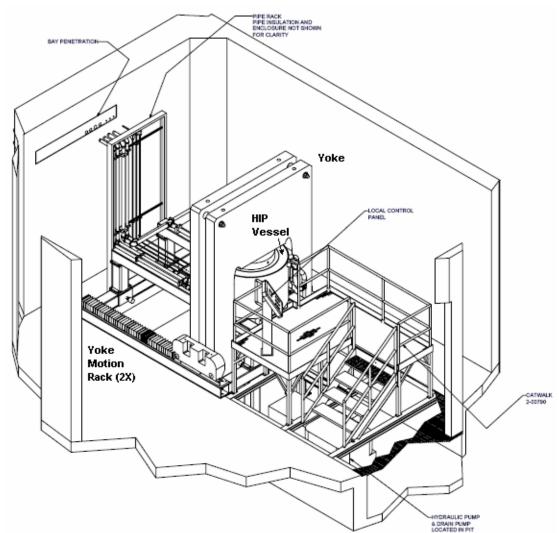


FIGURE 4-20 EXAMPLE OF A HIP ROOM

In the arrangement shown above (from an unrelated project), the yoke is visible as well as the HIP vessel itself. The yoke moves back (on the rack shown) allowing the vessel top cover to be lifted for access to the work zone inside the furnace contained within the vessel. The vessel and its covers, yoke, furnace, heat shield and work package are structurally supported by a steel stand anchored to the floor of the pit. The grade level pit cover is covered with removable floor plates and plate support structure. The 17' wide x 60' long rectangular pit, 13' deep, accommodates both HIP units. Forklifts may be brought through the airlock in from outside, but do not travel over the pit, although shop and maintenance personnel and hand-cart traffic routinely travel across the pit covers. The pit is accessed by stair cases with gates at either end; lighting drainage and ventilation systems are present in the pit. Oxygen monitors with alarms are present in the pit; the HIPs operate with an internal argon atmosphere which is heavier than air. Control panels are located away from the units, in a concrete walled HIP control room and automatic interlocked sequences are remotely engaged or concluded. Lockouts will be in place when servicing the units. A 5 ton overhead monorail, with dual hoists and trolleys, used for work-package removal/placement and routine component removal for periodic inspection testing, is present over the pit area. The hoist may also be used for heat shield removal, furnace removal, work support

chair, or top or bottom cover removal for maintenance or inspection purposes. The work package size is limited by criticality considerations. The HIP process is supported by utilities including vacuum pumping, compressed air, liquid argon vaporization, gas pressurization and recovery systems, furnace controller, yoke motion and top cover interlock, cooling water and external connections to the facility alarm systems. Many of the supports are routed to the HIP stations via trenches in the floor of the pit. The pit will be equipped with sumps which can be drained with a sump jet.

To reduce facility costs, the need for an overhead crane system suitable for removing the yoke or the vessel has been eliminated from the design following checking with a potential supplier of HIP systems for the FFC. During a chain of correspondence: the following dialog was provided by the Sales Manager for EPSI:

"...to do a valid NDT vessel inspection on an EPSI vessel design there is no need to remove the vessel or yokes. We have qualified procedures to inspect the vessel and yokes with minimal disassembly of the HIP unit. Therefore the overhead crane only needs to be rated to lift the closure assembly or the heaviest items located in the pit or the heaviest item the customer will be lifting. EPSI would suggest a 5 ton crane at this point to be safe, but will confirm crane capacity needed when the design is finalized."

This cost saving recommendation reduces equipment cost (eliminating the need for a 25 to 30 Ton crane) and lowers the roof and ceiling height over the HIP room, which reduces air conditioning costs. In-place NDE will require a service outage for removal of the upper and lower heads, but it will be of a shorter duration then complete disassembly and removal of the yoke or vessel, shipment, turnaround, reinstallation, and re-commissioning. Other suppliers of HIP equipment may not have the inspect-in-place configuration; therefore the final design of the FFC should take this into account.

4.14 Selection of a bonding process

The two fabrication processes described above (HIP and friction bonding) targeted to bond monolithic fuel plates are emerging technologies. As such, development in many areas is still ongoing and the best educated opinions available from subject matter specialists were utilized to prepare this study report.

Because the selection of one method over another has significant consequences on the overall design and cost of the fabrication facility, it was decided to (at a fundamental level) leave the option open for either process (a process down select milestone is shown in the project schedule [See Section 11]).

Although both techniques have been successfully demonstrated on mini-plates, for the purposes of this report friction stir bonding has been chosen as the reference method. The HIP option has been broken out as a special case in the project cost estimate. An outline of pros and cons associated with each method is provided below. It must be stated that these are 'as understood at this time', and as with any ongoing R&D effort the actual progression may move in an unanticipated direction.

4.14.1 Friction Bonding Pros

- Lower equipment capital cost
- Fewer utility costs (lower power consumption, no argon usage etc.)
- Less waste generation (with the HIP can requirement)

• Smaller facility footprint/cost

4.14.2 Friction Bonding Cons

- Single-pass process (both sides of each plate must be machined)
- Lower success rate (on test plates fabricated to date)
- High degree of operator attention required
- More operators required/higher personnel costs

4.14.3 HIP Pros

- Batch process
- Higher success rate (on test plates fabricated to date)
- Less operator attention required
- Fewer operators required/lower personnel costs

4.14.4 HIP Cons

- High equipment capital cost
- High utility costs (power, argon etc.)
- High waste generation (with the HIP can requirement)
- Larger facility footprint/cost

4.14.5 HIP Implementation

In addition to the choice between Friction Bonding and HIP there is still ongoing development in how best to perform and implement each process. Specifically the method used to isolate the HIP plates from the processing media (the interface between the cladding in a stack of plates and the interface between the cladding and the fuel foil) must be hermetically sealed, under vacuum to achieve a successful HIP bond. Two methods have been employed:

A. HIP Can Method

To make the HIP can assembly, a steel can is built around a stack consisting of a number of plate assemblies (two aluminum cladding plates with a fuel foil sandwiched in between). These spacers are in the form of rigid 'strongbacks' that keep the fuel plates flat during processing. This method has the advantages of providing very good isolation from the HIP media and being leak testable but has the disadvantages of being expensive in time and material as well as a tendency to fuse the plates to the strongbacks, necessitating special precautions.

B. Vacuum welding method:

Vacuum welding of the perimeter of the plates themselves is a newer method employed to prepare the plate assemblies for HIP with a focus on lowering production costs during mass production (by eliminating the can). In this method the perimeter of the fuel plate assembly is welded under vacuum to hermetically seal the fuel plate from the HIP media. In this method the welded plate assemblies would be stacked between strongbacks to provide rigidity during the HIP process to keep the plates flat (unlike the hip can method, the strongbacks would be exposed to the HIP media).

1. Perimeter Weld with Electron Beam Welder

The method for achieving the plate perimeter weld is still being investigated. Currently an electron beam welder is the reference method. E-Beam welding uses a tightly focused beam of excited electrons to provide the energy to fuse materials together. Due to scattering of the electron beam in air the process is almost universally performed in a high vacuum. E-beam welding is currently being used in monolithic R&D (but is admittedly in its early stages) and is the reference method for HIP fabrication. The downside of E-Beam welding is the high capital cost (~\$4M) and large footprint of the equipment.

2. Perimeter Weld with Ultrasonic welder

A second method for achieving the plate perimeter weld that has the potential to emerge as the favored technology is ultrasonic welding where a contact probe vibrates the material causing friction and localized welding. When used in a seam welding configuration a hermetic seal can be made. While UT welding is typically performed in air, vacuum operation is well known in the industry. The advantages of this method are lower cost (~\$200k) and a smaller footprint.

4.15 QA Inspection

Many in-progress and quality assurance tests and measurements are performed in the FFC. A micro-hardness tester for rolled foils a tensile testing machine (shown below) for testing of swages made during final assembly, and an optical microscope for microstructure inspection are used. Analytical lab instruments are also present to qualify and verify fuel alloy chemistry, isotopic content and purity such as an AES and an ICP-MS. A deep throated micrometer is provided for foil thickness measurements and a vernier is used to verify length. A coordinate measuring machine (CMM), similar to one model shown below, Figure 4-21, is provided to conduct flatness and dimensional inspection of clad fuel plates.



CMM for plate measurements can detect flatness variations and can measure overall part dimensions. Measurements can be automated or manually directed.

FIGURE 4-21 COORDINATE MEASURING MACHINE (CMM)



Floor stations exist where in-process measurements and verification of setups can be made. These stations consist of a granite flats on a stand with parallels and measurement instruments.

FIGURE 4-21 EXAMPLE OF A FLOOR STATION

It is assumed that the FFC will be located on a DOE site where analytical lab capabilities exist, and no highly unusual or specialized lab equipment will be needed. QA holds are interspersed throughout the manufacturing process and include alloy, chemical and isotopic properties, alloy impurities (Oxygen, Nitrogen, Sulfur and Carbon), determination of foil thickness and position, fuel density measurement, and dimensional inspection of the aluminum cladding thickness (including the machined recessed pocket) and fuel subassembly end pieces. Inspection holds are utilized prior to assembly of the fuel foils with the aluminum cladding plates and inspection of the fuel plate following fusing of the Al cladding plates with the foils. Space in the arrangement has been allotted to accommodate instruments, personnel access, support systems and controls. Storage space has been allotted for holding material during pre-and post inspection periods.

4.16 Completion of fuel plate manufacturing

The fuel manufacturing process steps following bonding are outlined below.

- 1. Mark plate ID (using a temporary mark: see note below)
- 2. Friction Bond (or HIP)
- 3. Rough-trim (remove clamping boundary)
- 4. Flatten plate
- 5. Finish both surfaces of plate (on mill)
- 6. Flatten plate (as needed) on roller leveler (shown schematically below)

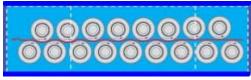


FIGURE 4-22 ROLLER LEVELER

- 7. Fluoroscope
 - a. Locate fuel within cladding
 - b. Punch index holes
 - c. Move back to shop
- 8. Final Serial number marking (this mark shall be the final plate marking, see below)
- 9. Final Trim (on mill) using index holes punched in step 7 above, and Deburr
- 10. Degrease plate (clean using water based cleaning solution, then rinse and dry)
 - a. Perform subsequent handling steps using white cotton gloves
- 11. Perform dimensional and surface inspection

- 12. Radiography (on either 130 or 225 kV Real Time Direct Radiography machines, set up to advance part in one direction as scan takes place, producing a 25 μ and 0.5 μ (micron) micro-focused image)
 - a. Density
 - b. Fuel location
 - c. Retain Data (image is stored digitally, large amounts of data are kept throughout life of fuel)
- 13. Automated Ultrasonic test (UT) inspect for:
 - a. Bonding
 - b. Discontinuities and defects
 - c. Minimum aluminum cladding thickness
 - d. Retain data (large amounts of data are kept throughout life of fuel)
 - e. Part is automatically scanned using 'terrain following' feedback technique, under water (through and echo) and complete coverage is achieved
- 14. Cold work finished and marked plates using hydraulic press and special tooling dedicated to plate number and fuel type. Plates are cold formed (stamped to a concave or spiral shape as viewed from the end) to meet the fuel configuration requirements of the various reactors. Some types use flat plates and this step is not necessary.

Note that the fuel plate and subassembly configuration varies for each of the five HPRR reactors for which fuel is fabricated at the FFC. The list above is intended to be general, or typical. Specific peculiarities, for example, such as 'grooving' or finning of the 0.080" thick MIT fuel plates, which requires a dedicated machine, have been accounted for the in the FFC design and layout, even if not mentioned here.



FIGURE 4-23 EXAMPLE PART MARKING



FIGURE 4-24 COMMERCIALLY AVAILABLE MARKING EQUIPMENT

Note on Maintaining plate ID:

An important part of keeping the accountancy record clean and balanced will be tracking of the fuel at all times during the fabrication process at the FFC. Batches of ingots (and even foils) can be tracked as a group of multiple items (so long as the mass can be checked). As soon as an individual foil is split off the main batch, such as for bonding, or for inspection purposes, it must be assigned a unique ID that accompanies the plate during each step that it is subjected to.

While friction bonding will obliterate the processed area, the plate assembly can be marked on the perimeter of the frame and this identifier can be moved inward by re-marking as the outer sections are removed during

processing. After fluoroscopy (where the final plate region is defined) the final marking can be made. This procedure will be amended as necessary as the design ensues and process methodology evolves. In any event, following plate surface finishing and edge trimming, the final mark shall be present and easily visible on the finished fuel plate, and this identity shall preserve traceability all the way back to the alloy (melt) from which it originated which captures the enrichment, alloy purity, isotopic and chemical composition. Once the fuel subassembly is completed, its identity shall be comprised of the identities of the individual fuel plates.

4.17 Sub Assembly Fabrication

The Sub-Assembly Fabrication area is approximately 12,000 ft^2. It is north of the shop and is located convenient to the secured controlled storage area (where completed plates are stored and accumulated), the inspection area, and the shop. The assembly area is uncontaminated: bare alloy fuel material is never present in the assembly area.

The fuel element subassembly build-up process involving the completed fuel plates are outlined below.

- 1. Transfer the daily lot of fuel plates from the secured controlled storage area to the Assembly Area. Track accountability of material.
 - Completed fuel plates of all of the various sizes are stored in the secured controlled storage area and accumulated until all parts are present and a given fuel sub-assembly campaign is executed.
- 2. Clean plates (using nitric acid followed by cold DI water rinse, followed by hot DI water rinse—to be done within 72 hours of swaging)
 - a. Fuel plates
 - b. Side plates
- 3. Move fuel plates from cleaning to assembly station
- 4. Gamma scan plates (individually)
- 5. Place fuel subassembly end pieces on dedicated swaging assembly fixture
 - a. Swage plates into side plates; one at a time, building out from one side.

- b. The swaging process involves a roller that passes along the full length of the fuel plate, closing the gap between the 'comb' or grooved fuel subassembly side piece and the fuel plate. This retains the plate while allowing it to expand thermally along its length during service.
- 6. Perform quality inspection
 - a. Dimensional
 - b. Pull Test: Note: typically a mockup will be built to periodically test swaged joints on surrogate fuel plates and ensure sage machines are properly adjusted. Actual fuel sub-assemblies will NOT typically be tested.*
 - c. Inspect Channel gap
 - d. Clear QA hold [NOTE: it may take some time to complete this inspection (and also the quality inspection below)—unfinished assembly to be placed in interim storage in the assembly area]
- * Note that the swages securing the individual plates may be tested with a pull test apparatus such as an Instron testing machine. This is done on a prototypical basis, and the equipment performance is periodically re-verified.



FIGURE 4-25 TENSILE PULL TEST APPARATUS FOR PROTOTYPE FUEL SUBASSEMBLY

- 7. When assembly is complete (all elements are present) and swaged, weld on end boxes on dedicated welding fixtures
- 8. Final machining of fuel subassembly (end pieces)
- 9. Quality inspection of fuel element

- a. Dimensional
- b. Channel gap
- c. Clear QA hold
- 10. Final subassembly cleaning
 - a. Cold Deionized water
 - b. Hot Deionized water
 - c. Blow dry with compressed filtered dry instrument air or bottled N2
- 11. Gamma scan fuel subassembly
 - a. Part is rotated as scan takes place, and by either translating the part or the instrument, scan the full length of the subassembly throughout 360° of rotation.
- 12. Autoclave (ATR Only)
 - a. The autoclaving process generates the desired oxide film
 - b. Drain water from autoclave
 - c. Dispose of spent water
 - d. Allow element to air dry
- 13. Place the (dry) element in plastic bag
- 14. Move back to the secured controlled storage area (Transfer custody to the secured controlled storage area)
- 15. Store, accumulate sub assemblies
- 16. Accumulate until shipping quantity is reached
- 17. Package in shipping container
- 18. Move to Packaged Fuel Element Storage Area. Store loaded shipping containers within secure storage area. Containers are accumulated until such quantities are available that a full core can be shipped. This relates to 6 months of storage for example: 20 boxes of four completed element subassemblies.
- 19. Following the accumulation of packaged completed fuel subassemblies and compilation of the required 60 80 pages of QA documentation that accompanies the shipment, shipping containers are moved from the accumulation area to the shipping dock and a forklift is used to load the truck. Elements are then shipped to the destination.



FIGURE 4-26 ATR FUEL SUBASSEMBLY

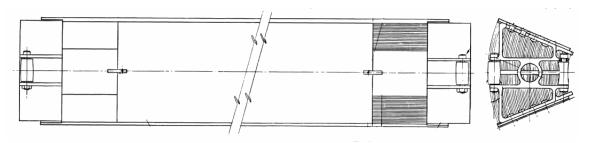


FIGURE 4-27 MURR FUEL SUBASSEMBLY



FIGURE 4-28 END OF MIT FUEL ELEMENT SHOWING FUEL PLATES

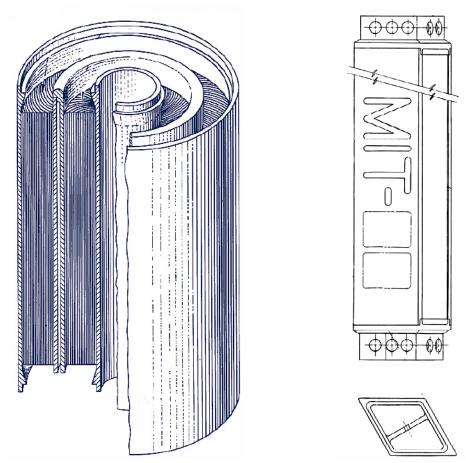


FIGURE 4-29 HFIR (LEFT) AND MIT FUEL SUBASSEMBLIES

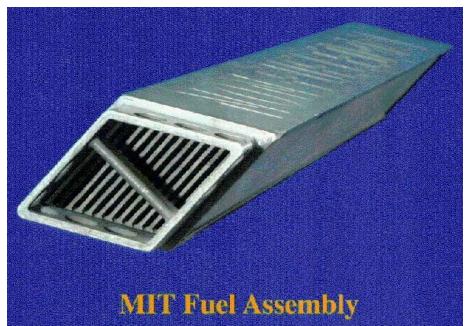


FIGURE 4-30 RENDERING OF MIT FUEL ASSEMBLY

4.18 In-Process Intermediate Secured controlled storage area

In-process fuel forms are stored in the secured controlled storage area and accumulated and staged for efficient fuel campaign management. The intermediate secured controlled storage area, located adjacent to the shop, is equipped with a custom storage rack system. The secured controlled storage area has a pass-through which passes below the Personnel Corridor for efficient fuel material transfer to and from the shop. The in-process intermediate storage secured controlled storage area is not generally used for storage of raw fuel alloy material. Dedicated storage locations with geometrically favorable configurations exist for up to six days of production of each stage of the fuel manufacturing process. This maintains fuel in all its interim configurations in stacks 1" thick separated from the next stack by at least 12". Sets of racks are present for two fuel types providing storage capacity for each of the intermediate in-progress stages which may be processed concurrently. A QA hold area is also present in the intermediate secured controlled storage area for in-process material awaiting inspection or awaiting completion of certifying documents. Since unclad alloy fuel forms will be present, the intermediate secured controlled storage area will be maintained within primary ventilation confinement. Activities within the storage area are such that appreciable quantities of respirable sized particles will not be generated, and no hoods or task exhaust ducts are present.

4.19 Receiving, Shipping and Storage and Dock

Staging areas of three types are present in the receiving, shipping and storage area near the dock. Co-location of these staging areas near the dock is utilized to accelerate loading of outgoing shipments of waste and finished fuel product, and to accelerate unloading of shipments of raw alloy fuel and re-shipment of empty fuel packaging containers which are returned to the fuel alloy supplier Y-12. The temporary storage areas are each enclosed by a locked security fence displaying appropriate signage. The indoor dock has space for unloading of three trucks simultaneously. This may be for incoming or outgoing shipments of equipment, product, provisions, fuel alloy, packaging materials or waste. Housekeeping procedures will be routinely performed on the dock. Compatible packaged and labeled liquid wastes are stored within divided berms with a chemically compatible liner that provides spill protection and prevents commingling of incompatible materials during storage. All accumulation areas are under CCTV surveillance and are inventoried regularly. All personnel access the dock from the Personnel Corridor, and friskers are present to ensure contaminated material does not get passed through to the dock from the confinement area.

On the dock, and in staging areas, swipes and smear samples will be obtained from incoming shipments of radiological material, and for free release (on public roadways) of shipped product, or empty packaging and/or material returned to Y-12. The receiving inspection of alloy fuel shipments (for gross rad count and contamination) will be followed by recording of the container weight which involves de-palletizing drums and weighing each container individually. Any shipper/receiver differential will be evaluated and any differences will be tracked. Empty containers will be surveyed (can, inner packaging, outer container) for presence of any remaining alloy fuel material contents and for removable contamination.

4.19.1 Fuel Subassembly Packaging

Completed Fuel Subassemblies are packaged in specialized dedicated containers that suit the physical size of the parts and the quantities that are ship and are suitable for ground travel over long distances and are geometrically favorable such that any number of packages can be stacked together in any arrangement including a tightly stacked cubical array without criticality concerns. Shipping container descriptions for the ATR and HFIR fuel (which has an inner and an outer part) are provided below.

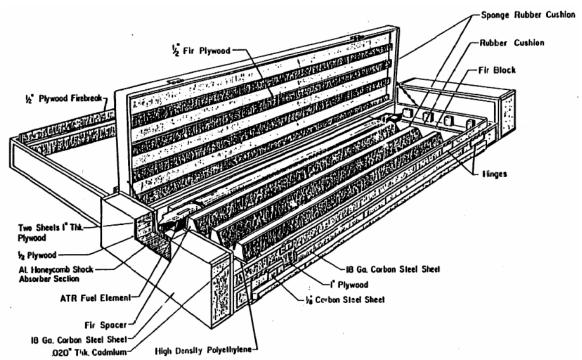


FIGURE 4-31 SKETCH OF ATR FRESH FUEL SHIPPING CONTAINER CAPABLE OF HOLDING FOUR COMPLETE SUBASSEMBLIES

The packaging for the inner HFIR fuel element has overall dimension of 25 inches OD by 45 inches high, a 10-7/8-inch diameter by 30-1/4-inch deep cavity, and a 660 pound gross weight.

The packaging for the outer HFIR fuel element has overall dimensions of 31.5 inches OD by 45.75 inches high, a 17-3/8-inch diameter by 31-1/8-inch deep cavity, and a 1,050 pound gross weight.

HFIR Fuel Element Shipping Container Description

Single Containe Dimensions Empty Weight Max Weight	8 x 8 x 73	Dimensions for the "New" ATR Shipping Container (dimensions in inches)
Full Rack Dimensions Containers	71 x 36 x 77 12	

4.19.2 Product Storage Area

Packaged fuel is stored in shipping containers in 'road-ready' configuration. Space is available for a 6 month supply of each of the five research reactors supported by the FFC. The ATR Fresh Fuel Shipping Container (capacity: four fuel subassemblies) was used as the basis for determining the storage area floor space requirements, and may be subject to revision during FFC detail design, to account for each of the individual reactors' shipping containers, which may decrease the space allotment. The ATR assumption is conservative because the containers are designed for an infinite stack in three directions without criticality concerns.

4.19.3 Waste Storage Area

Storage of packaged waste takes place using contamination free, properly labeled 55 gallon drums or similar DOT Spec. 7A Type A containers suitable for temporary storage and transport of hazardous waste. Separate bermed areas which each provide spill containment are provided for storage of liquid wastes that may be incompatible if mixed, such as spent acid and spent caustic. The berm must be lined or painted with a material that is compatible with the material stored within, therefore marked dedicated storage areas are available for each of the waste types expected to be produced as a result of routine operations of the FFC. The drums will be closed, non-vented, and the waste storage area will be completely enclosed by a security fence with a locked gate. A 90 day accumulation of waste is stored in drums secured to pallets which may be stacked. Pallets are handled by forklift. Besides the fence, which allows visibility of the contents without entry, the Waste Storage Area is subject to surveillance by CCTV camera to ensure loss does not occur. Drums are stored in a manner, as shown on the plans, that allows visual inspection of the containers' exterior to ensure degradation is not taking place.

4.19.4 Fuel Material Storage Area

The Fuel Material storage area is for receiving and storage of LEU/Mo in the inner containers. Storage racks are described above (Section 4.2), and Y-12 has informed the project that it is not necessary to open containers for assay to verify material characteristics; that lab sized coupons of the material will be shipped separately with each lot. Therefore, open containers will not be present in the secured controlled storage area, therefore primary ventilation confinement is not necessary. Although the Storage Area may be configured as a primary confinement area (such as the Shop is), this allows the room to be ventilated normally during routine operation. A spill could occur, such as by a dropped or ruptured container, but the material inside is usually foil wrapped and it seems reasonable that even a dropped container that came open would not release a quantity of any appreciable size, and housekeeping procedures could be invoked that would clean up any spilled contamination and verify that the area is contamination free. The capacity to store a one year's supply of alloy fuel material is provided, along with an area to open outer containers and inner vessels and to survey containers' exteriors, weigh and mark the containers, and a terminal is present to allow the operator to register the accountable material into the tracking system, or to transfer custody of material via transfers to the Casting Area

4.19.5 Dock

Space is available for parking three trucks simultaneously, with space along both sides with steps and personnel doors to outside. 48" high dock with bumpers. Tip down ramps for forklift access. Individual roll up doors, 15' high, are present on each bay. Doors roll up into a drum outside the building, in a configuration that does not interfere with dock overhead lighting when doors are raised.

4.19.6 Mechanical and Electrical Maintenance Rooms

Space has been provided for these functions in the FFC. Minor equipment maintenance or calibration will be performed in these spaces, and a limited supply of instruments and tools will be available as well as miscellaneous part storage, benches, utility outlets and lighting.

4.19.7 Air Compressor Room

A small room has been set aside for an air compressor, reservoir, regulator, air filtration and drying. A piping network will be routed throughout the plant for service air uses which will be throughout the shop and assembly area, and the mechanical room.

4.19.8 M/F Water Closets

Water closets for male and female occupants of the FFC are available near the dock. A drinking fountain is also present. The water closets will be connected to the FFC floor drain system.

4.19.9 Trucker's Waiting Room

A small lounge has been provided to allow transportation personnel to wait in while shipments are loaded or offloaded from vehicles parked in the dock. This area has a water fountain, coffee machine and chairs and table.

4.19.10 CCTV Surveillance

The receiving and storage areas and dock area is under 24 hour surveillance by CCTV cameras. Images from the cameras may be viewed on monitors at the control area (behind the receptionist). Electronic records are kept for an interval that exceeds material accountancy periods, and can be reviewed, if necessary, following any events that involve unauthorized movement of material. CCTV surveillance may be extended to the lot with opposite facing cameras positioned at each corner of the building, the entry control facility, and the lobby. The perimeter fence is equipped with exterior lighting. The intent of the cameras is more oriented towards safety than security, although security purposes, which would include the parking lot, may be achieved to some extent.

5.0 FACILITY DESIGN AND OPERATION

The 76.000 square foot arrangement of FFC for the Greenfield Alternative Study is shown in figure 5-1. The facility layout provides a bounding arrangement of the shop, assembly and storage areas, lab and personnel areas and incorporates the necessary facility requirements needed to operate the building. All known FFC requirements have been accommodated and depicted in a reasonable and realistic configuration.

Drawing SK-ME-01 shows a plan view of the FFC, General Design criteria is provided in section 2, and a brief summary description of the Greenfield Alternative is provided below.

5.1 Facility Overview

The FFC is a modern, state of the art facility with a design life of 40 years. Energy conserving practices have been incorporated in the facility design and layout. Located at or adjacent to an existing NNSA Complex or DOE National Lab, it is assumed that infrastructure, security and utilities are available (specifics will be dependent on the actual DOE site chosen). As shown in the rendering below, the FFC is an above ground, two bay (three bays with HIP option) free standing, rigid steel framed structure with insulated metal siding and roofing. The buildings will be finished to conform to the color and appearance theme of the surrounding structures. In addition to the main building a storage warehouse also exists on site to serve the FFC.

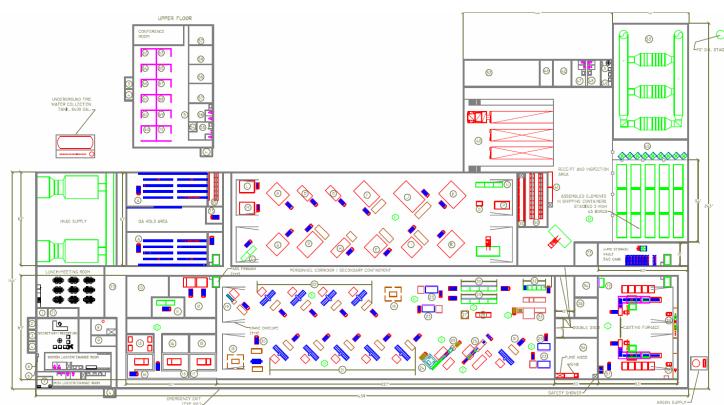


FIGURE 5-1 FFC GENERAL ARRANGEMENT PLAN



FIGURE 5-2 FFC GREEN FIELD ALTERNATIVE

A two story administrative area is located in the main building (adjacent to the production area) and serves as the primary entry point for the facility. This area contains the bulk of the offices and has restrooms and meeting/break rooms.

The production area is comprised of a high bay shop, a low bay assembly area, a shipping/receiving area, secured controlled storage areas for storing fuel alloy feed material, inprocess nuclear material and finished fuel subassemblies, labs and inspection areas, mechanical rooms to provide the required utilities and the necessary production control offices.

The high bay shop is where fuel plates are manufactured. This area is serviced by two overhead bridge cranes running the length of the area. The heavy equipment is configured in a compact arrangement and machining stations are located down the sides within the crane envelopes. The central aisle between crane envelopes serves as the route for primary traffic and material handling (personnel, forklifts, carts, etc.). Building construction is such that the central aisle is unencumbered by columns. The casting area is located at the end farthest from the administrative area. This area is separated from the rest of the high bay shop by a production office and lab area (these areas are low ceilinged to allow passage of the overhead cranes). The high bay shop is the primary fabrication floor where the U-Mo foils are rolled and bonded into fuel plates and machined and formed into their final form. Adjacent to this is the inspection area (which lies between the primary fabrication floor and the administrative area and is outside the overhead crane envelope) which houses specialized equipment to non-destructively examine the fuel plates.

The low-bay Assembly Area is located adjacent to the high bay (separated by a personnel corridor) and is serviced by two overhead cranes on parallel runways. This room houses the equipment needed to fit the finished plates into the element hardware and to perform all fuel subassembly fabrication and quality analysis steps. Like the high bay, the heavy equipment is located under the cranes with an aisle down the center.

Shipping and receiving is located centrally such that the secured controlled storage area for LEU-Mo fuel alloy material received, and finished fuel elements (product) to be shipped are efficiently located in close proximity to the dock. Likewise, supplies or new machinery unloaded from trucks at the dock can be easily brought in to the shop area or to final assembly. Secured controlled storage areas are present both for locked storage of incoming fuel alloy (one year's supply) and for interim storage of the various configurations of the fuel plates as they proceed throughout the fabrication process. Storage also exists for completed fuel assemblies. As sub-assemblies are completed in the assembly area, they are packaged and stored 'road-ready' in shipping packages in a locked indoor storage area near the dock. Sheltered space is present for up to three trucks to dock at the same time and ample space is available for receiving and inspection.

Nuclear material not being processed is stored in one of a number of secured controlled storage areas strategically located around the production area. The placement of the secured controlled storage areas allows the material to move through the facility in a logical pattern and serves to keep the amounts of fissile material on the working floor within criticality safety limits. These secured controlled storage areas have a higher fissile material limit than the production floor due to geometric configuration control.

At either end of the main production floor are low ceillinged lab and inspection areas. These are placed to conform to the typical path of the production parts through the laboratory. They are comprised of destructive (wet chemistry and metallography) and non-destructive (ultrasonic and radiography) analysis equipment

Offices and support areas such as a lunch room and change rooms are provided as well as a conference facility and reception area. A central control area (for monitoring ventilation, alarm systems, etc.) is on the main floor inside the front door to the office area. Other areas in the FFC house utilities mechanical rooms and offices in support of the production area (shop supervisor's office, calibration rooms, etc.).

Fuel subassemblies for the five domestic reactors requiring plate fuel serviced by the FFC are manufactured on a campaign basis. A standalone warehouse is featured in the design adjacent to the dock to facilitate campaign change-over between fuel campaigns. This houses supplies (both for the office area and shop operations), non radioactive material stocks, and tooling for off-duty fabrication campaigns.

The building has an engineering confinement ventilation system with cascaded ventilation zones and HEPA filtered exhaust ensuring that nuclear material is not released to the environment. Local HEPA filtered task ventilation and hoods at a number of work stations provide protection to the facility operators wherever necessary. The confinement area (shop) is completely surrounded by a Personnel Corridor which ensures that a ventilation barrier exists at all times between the shop and the environment. A zoned pressure differential approach is featured in the design to ensure airflow is from areas of less potential for contamination to areas of higher potential for contamination. Pressure differential shall be maintained between the zones and atmosphere. The exhaust system shall be designed to withstand anticipated normal, abnormal, and accident system conditions and maintain confinement integrity. Materials of construction should be appropriate for normal, abnormal, and accident conditions. Ventilation system design shall comply with DOE regulations and good practice. Conditioned air is recirculated in clean areas and offices for energy conservation.

The building is completely protected by a wet pipe sprinkler system, and impoundment of fire water runoff is included in the facility design. The FFC, stack, warehouse and substation is enclosed within a fenced boundary, and an entry control facility is provided to control access of personnel and materials.

5.2 Facility Design Requirements

Pertinent AE requirements at the site selected will be followed for facility design requirements as well as the general design criteria specified in section 2. Site and facility layout drawings are provided in Appendix A1. Equipment arrangement concepts are provided in the body of the report and selected cut sheets are provided in Appendix A4.

This section provides a summary of the design basis requirements and initial study level descriptions of the FFC site and facility. The FFC will be designed, licensed, constructed, and operated in compliance with the applicable Federal, state, and local regulations, and will comply with NRC and DOE regulations and national consensus codes and standards.

The programmatic and technical design basis requirements are presented in the Statement of Work for an engineering alternative study for a Greenfield LEU-Mo Fuel Fabrication Capability and the processing requirements are contained in the Conceptual Process Description of LEU-Mo Fuel. Additional key design basis requirements include the following:

- 40-year Facility design life.
- Facility will be built at a Greenfield DOE site in the continental US. The Federal Facility to which the FFC adjoins will provide all support infrastructures.
- Fuel fabrication and product storage areas will be designed to Hazard Category 2 and Security Category IV.
- Facility Availability: ~75% (equivalent 255 full operating days in a calendar year).
- All waste (Hazardous, LLW) will be packaged shipped for treatment and disposal by others at approved disposal sites.
- Facility will be designed to produce 17,000 foils/year.

5.3 Site Layout

The FFC Site is shown on drawing SK-ME-06, and is reproduced below.

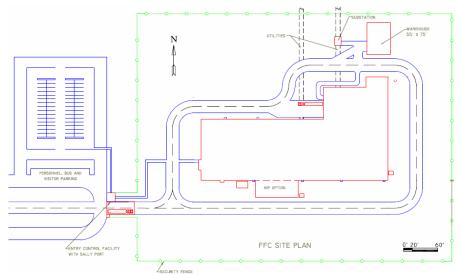


FIGURE 5-3 FFC SITE ENCLOSED WITH SECURITY FENCE, WITH ECF, BUILDING, WAREHOUSE, AND SUBSTATION

The following are key requirements for the layout of the FFC:

- The facility layout and equipment arrangement shall provide to the extent practical, efficient and functional support to the operation and management of the FFC. The facility design shall also provide for life safety of occupants and support of LEU-Mo Alloy Fuel processing, environmental control, and routine maintenance functions, including safe storage, shipping, and receiving functions.
- The facility arrangement shall include all necessary floor space and systems, including safeguards and security, material handling equipment, material control and accountability equipment, product handling, packaging and storage facilities, alloy fuel processing equipment and systems, sampling and analysis systems, and waste management systems and equipment to package waste for shipment to waste treatment and disposal sites.
- Processing and storage areas shall be designed to control spread of contamination, and control emissions to acceptable levels and limit the extent of potential contamination in the unlikely event of an accident. The design shall provide for ease of personnel access, material handling, decontamination, process operations, and adequate ventilation. Radioactive materials shall be contained within acceptable packages and handled openly only within engineered confinement zones. Fuel subassemblies shall be packaged for safe storage, handling and transportation. All concrete surfaces within areas expected to be contaminated or have the potential to become contaminated shall have surfaces coated to facilitate decontamination.
- HVAC equipment and auxiliary mechanical and electrical services shall be provided from service areas that facilitate access, efficient space utilization, and low installation and maintenance cost while providing energy efficient building utilities. Limited capabilities shall be provided for routine maintenance and repair services for mechanical, electrical, and instrumentation components.

The layout of the alloy fuel foil and reactor subassembly fabrication operations in the FFC is guided by the following design considerations:

- Process flow continuity and operational efficiency Process facility layout facilitates a oncethrough operation, from the fuel receipt through shipment of the fabricated research reactor subassemblies.
- Segregate the 'bare' alloy processing operations from the "clad" fuel processing, fuel fabrication and product storage operations, minimizing spread of contamination and ensuring that the final product and packaging is not contaminated.
- Typically, during high temperature processes, including melting and rolling, the fuel alloy will be exposed only to inert gas atmospheres to minimize oxidation. A noted exception is salt bath heating of cast alloy plates and rolling in air. During canned hot rolling of foils or HIP bonding, the inert atmosphere is contained within the can.
- Facility safety All work stations that impart mechanical action to exposed alloy surfaces shall be provided with task ventilation that prevents dilution of contamination into the occupied workspace.
- Physical security Entry control facilities are present for access to the FFC buildings, with a security fenced perimeter around the site.
- Close proximity between the analytical capabilities and the fuel processing operations.
- To the extent practical, Modular equipment systems shall be utilized to facilitate operation as well as factory testing, and removal and replacement of components or whole subsystems for service and minimize downtime for overhaul. Replacement intervals shall be preventative and performed prior to the point that performance degradation or safety implications occur.
- Reliability, Availability, Maintainability and Install-ability (RAMI) considerations will be utilized (during future design studies) to assure necessary production rates can be met and to minimize the facility footprint. All maintenance operations are performed manually.
- Work areas are provided within the FFC for decontamination and maintenance of failed equipment as part of normal operations in the facility. Articles that have been exposed to nuclear material will be decontaminated to the extent practical before disposal as rad-waste.
- Radioactive waste collection, treatment, packaging and shipping systems are provided within the FFC. The facility shall also be designed to minimize hazardous and radioactive waste generation.

The FFC site is to be built on a level lot, without contamination or existing structures, within the boundaries of an existing Federal Facility. The site is well characterized and in close proximity to utilities (water power sewer, phone and internet) and a transportation corridor. A property protection fence surrounds the entire site (parking lot is outside the fence). A roadway encircles the building, and simple gravel landscaping is present between the road and the structure. Outside the road, natural vegetation will be present; no landscaping is included in the estimate. An underground fire water loop will surround the road with hydrants every 300°. A paved parking lot for 60 vehicles plus bus parking is outside the fence. All pedestrians, vehicles and service trucks enter via the entry control facility, and a sally port is present to allow security personnel to screen incoming and outgoing vehicles. A 55° truck turning radius has been incorporated for delivery and tanker trucks. The site plan shows the HIP option because this bounds the depth of the 10 acre site. The warehouse is located convenient to the dock, and an allowance has been made in the paved road to allow trucks to back in to both the dock and the warehouse.

5.4 FFC Building Configuration

The FFC has a central high bay over the shop and low bays on each side for the assembly area and the HIP room (one side lean-to without the HIP option). Standard steel roof trusses are shown below in the building cross-section, from drawing SK-ME-04.

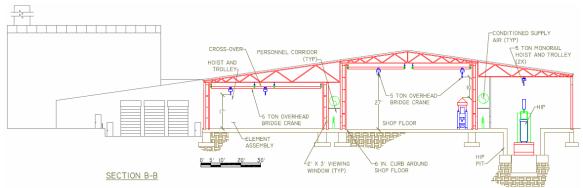


FIGURE 5-4 HIGH BAY (SHOP) WITH LEAN-TO'S ON EACH SIDE



Standard roof trusses have a number of advantages

- Non Combustible, UL rated
- Long Span without central supports
- Design to suit crane runway
- Pre-engineered, lightweight
- Economical, low design costs
- Trusses, connections and bolting purchased as a package
- Prefabricated trusses facilitate installation
- Seismic rated, Commercially available
- Competitive lead times
- Long life
- Ample area for lighting, ducting, electrical trays and sprinklers to meet project needs

FIGURE 5-5 INCLINED ROOF BENEFITS

The slope of the pitched roof versus a flat roof, using flat roof trusses, is an issue that will be resolved in later phases of the project (future) and will include considerations for the local annual precipitation and climate at the site selected. One possible disadvantage of a flat roof has to do with drainage and snow load considerations, whereas with a pitched roof, the volume of the room increases if the trusses are exposed (as they are in the shop), increasing the ventilation load and 24 hour per day horsepower usage. A pitched roof concept has been prepared in lieu of a flat roof. In the pitched roof concept shown, there is a suspended ceiling in the assembly area, because it is not part of engineering confinement, so the severity of the later disadvantage is lessened (the area above the ceiling is un-heated and only naturally ventilated). The concept shown 'won out' over a concept with three gables (which reduces the area volume enclosed by the 'lean-to' trusses by 50%), due to the potential for drainage problems in the valley.



Trusses such as these galvanized steel long span sectional trusses may be used over the Dock and Shipping and Receiving area.

Roof may be pitched or flat.

FIGURE 5-6 TRUSS SECTION

5.5 Utility Connections

The building is erected on a slab on grade on a flat lot graded for precipitation runoff and although there may be a 13' deep pit (in the HIP option) the FFC does not have a basement. Utilities are routed underground after the underlying soil has been prepared and before the slab is poured. From the electrical substation underground power conductors pass under the building floor slab in conduits and penetrate the floor of the two motor control centers. Water and sewer likewise penetrate the floor slab at the appropriate locations, and sumps are spaced throughout the floor of the shop in lieu of floor drains. Utility connections including communications lines (site alarms, emergency notifications, phone and internet) are branched from the adjoining federal facility. Electrical services are routed in trenches independent from water services, and sewer is routed independently from potable water.

5.6 Facility Areas

The FFC is comprised of a number of functional areas that differ by design, arrangement, ventilation barrier criteria, or materials of construction, to accommodate the activities performed within. Areas are broken down by function and footprint below.

- 5.6.1 Administrative Areas: 6,485 ft²
 - A. Reception Area
 - B. Second floor offices, meeting rooms
 - C. Elevator, stairs
- 5.6.2 Production Areas
 - A. Casting Area: <u>3,624 ft^2</u>
 - B. Chemical/metallography lab
 - C. Production offices
 - D. Shop (Fuel Fabrication, Rolling and Bonding): 15,438 ft²
 - E. Non-destructive inspection area
 - F. Assembly area: <u>11,771 ft^2</u>
- 5.6.3 Storage Areas (including safeguards and security)
 - A. Dock, Shipping and Receiving Area: 8,521 ft^2
 - B. Secured controlled storage area for U-Mo Alloy feed material: 892 ft²
 - C. Casting and crucible heel Storage Areas
 - D. Interim storage areas (for in-progress material): 2,352 ft²
 - E. Material control areas
 - F. QA hold area
 - G. Storage room
 - H. Assembled element storage
 - I. Completed Subassembly storage area (fuel elements, road-ready, in shipping packaging): 2,746 ft^2
 - J. Waste staging area: 664 ft^2
 - K. Warehouse (external to the FFC): 4,125 ft^2
- 5.6.4 Safeguards and Security Features
 - A. Security Fencing
 - B. Entry Control Facility (Guard House and Sally Port)
 - C. Central Control Room
 - D. Security Cameras

5.6.5 Safety and Support Areas

- A. Air Handler room: $3,259 \text{ ft}^2$ (also houses packaged boiler)
- B. Exhaust Fan and Filter rooms (2 stories): $3,795 \text{ X } 2 = \underline{7,590 \text{ ft}} ^2$
- C. Safety showers and eye wash stations
- D. Decon areas
- E. Dosimetry
- F. Mechanical and Electrical maintenance areas: 878 ft²
- G. Personnel Corridor: allows personnel to move to their workstation without conflicting with work carts or forklifts movement down the central aisle of the shop. Viewing windows allow observation of shop activities prior to entering the shop. Emergency exits are accessed from the observation corridor.
- H. Battery room

5.6.6 Personnel Amenities

- A. Change Rooms, locker room
- B. Lunch room, meeting room, conference room
- C. Water closets upstairs and downstairs with handicapped access, trucker's lounge/waiting room, WC in shop, drinking fountains

5.7 Ventilation

The shop is the primary engineering confinement zone. The air exhausted from the shop is conveyed via large main ducts near the roof above the cranes. Air exits the shop either via inlet registers in the main ducts or via branch ducts carrying air removed from the shop by a number of task exhausts or hoods. The personnel corridor surrounds the shop and is the secondary confinement area. The supply air headers are routed above the personnel corridor and diffusers supply filtered and conditioned air to the corridor which passes through the wall to the shop, via barometric dampers. Personnel exiting the shop must pass through the personnel corridor before exiting the building. To exit the personnel corridor they must monitor for the presence of radioactive contamination. Unclad fuel material, in general, is not passed through the personnel corridors. The personnel corridor is normally non-contaminated but is a radiologically controlled zone and is frequently 'swept' by health physics personnel and maintained clean by housekeeping procedures. The color coded general engineering confinement zone map is shown below. Unshaded areas operate at atmospheric pressure.



FIGURE 5-7 PERSONNEL CORRIDOR (SECONDARY) SURROUNDS
THE PRIMARY CONFINEMENT AREA

5.7.1 Task Exhaust

Task exhaust ducts are present in the AFCF whenever operators are involved in operations involving machining or cold working fuel material such as cutting, shearing, trimming, rolling, that may expose material. The task exhaust duct is shown below. Some operations may require a greater level of isolation of the work environment from the operator, which requires use of negative pressure hoods, with the operator's hands within a moveable sash. Most operations anticipated for the FFC will not generate large volumes of particulate susceptible to respiratory uptake by the operators. Any exceptions, such as cleaning out used molds and crucibles, media blasting, or working with potentially contaminated liquids such as salt baths or cleaning baths, or dissolved fuel solutions will be performed in the FFC within enclosed hoods. Ducts from task exhausts or hoods connect to the main exhaust ventilation headers. Although discharge from hoods and task exhausts are HEPA filtered, the remainder of the air exhausted from the shop area is drawn from inlet registers located in the main branch headers therefore the exhaust headers are equipped with hatches in the duct work to allow cleanout.

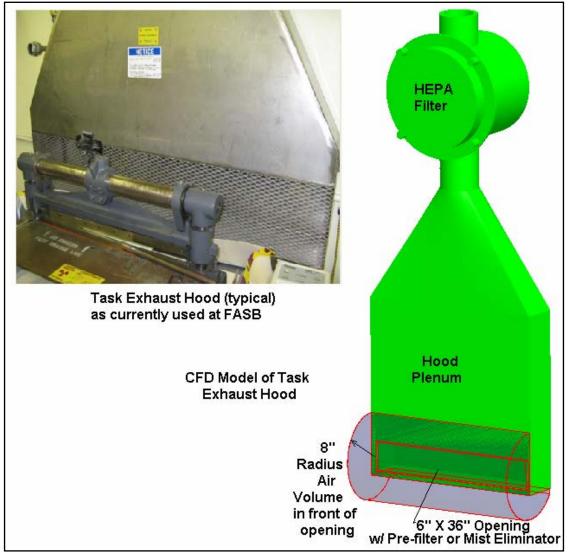


FIGURE 5-8 TASK EXHAUST

The photo above shows a task exhaust duct in FASB, behind a small shear. The CFD model used to simulate the air flow in three dimensions around the duct inlet us shown on the right.

- The criteria for the local task exhaust duct concept follows.
- Local task exhaust system captures and removes emitted contaminants before dilution into the workplace ambient air can occur.
- Basis Airflow criteria: 100ft/min 'capture velocity' three inches from the face of the opening.
- Boundary condition is 250 ft/min across the 6" X 36" opening of the task exhaust duct.

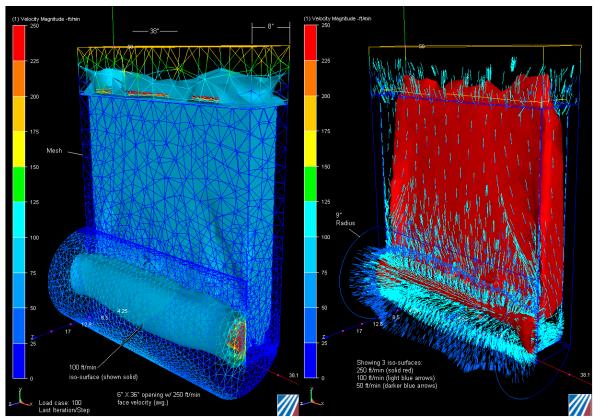


FIGURE 5-9 CFD MODEL – AIRFLOW TASK EXHAUST

The finite element mesh representing the model is shown on the left along with a (solid) 100 ft per minute iso-surface. The left view shows isosurfaces of 250 (solid) fpm, 100 fpm (arrows) and 50 fpm (dark blue arrows).

The CFD model results show that the 250 fpm face velocity boundary condition produces flow rates of 100 ft./min. approximately 4" from the face of the opening, and 60 ft./min. approximately 8" in front of the opening.

Note that the Occupational Exposure Limit (for U) is 0.2 mg/m3. For lead (not present in the FFC), the exposure limit is 133X tighter (1.5 μ g/ m3).

Task exhaust ducts must be located in direct proximity to the mechanical action imparted to the alloy fuel material (such as from shears and rollers). Off gas, such as from the enclosures on the furnaces, shears, roll mills, milling machines and baths, require HEPA filtration. Task exhaust duct inlets are fitted with a pre-filter to reduce HEPA change outs, and exhausts from baths are equipped with a mist eliminator (in addition to the local HEPAs). NaOH when exposed to aluminum gives off hydrogen gas, and HNO₃ gives off NOX, and this off gas is exhausted through the ventilation system. The heated salt bath generates chlorine gas above the liquid level and also requires exhaust ventilation. There are local vents on the casting furnace vacuum pumps, rolling mills, the cleaning stations shears, and on the friction bonding stations, (which also requires dust removal).



Hoods, with a moveable sash, are present in the lab, and where ethanol cleaning and HF etching takes place.

FIGURE 5-10 VENTILATION HOOD

A table documenting the location of the task exhaust ducts and hoods used to estimate the combined flow is provided below.

TABLE 5-1 AIRFLOW ESTIMATION CHART

FFC Ventilation Air Flow Needs		Face Velocity 250		ft/min	
#					
	Ventilation Hood	Size Ht (ft)	Size Lg (ft)	Area (ft^2)	CFM
1	Cast plate cooling	0.5	4	2	500
2	Crucible & mold recycle	0.5	4	2	500
3	Raw alloy wash station	0.5	4	2	500
4	Plate Rolling	0.5	3	1.5	375
5	Salt Bath	0.5	2 3 3 3	1	1000
6	Trimming (4 shears)	0.5	3	1.5	375
7	Salt removal	1	3	3	750
8	Cleaning Nitric plate	0.5		2	500
9	Can welding	1	3	3	750
10	Tunnel Furnace	2	4	8	2000
11	Foil Rolling	0.5	4	2	500
12	Can opening	0.5	5	2.5	625
13	Cleaning Nitric Foil	0.5	4	2	500
14	Cleaning Ingot Nitric	0.5	4	2	500
15	Ethanol Wipe	0.5	4	2	500
16	Cleaning Caustic	0.5	4	2	500
17	Cleaning Nitric Al	0.5	4	2	500
18	Autoclave	1	2	_	500
19	Friction Bonding 1	0.5	3	1.5	375
20	Friction Bonding 2	0.5	3	1.5	375
21	Friction Bonding 3	0.5	3 3	1.5	375
22	Friction Bonding 4	0.5	3	1.5	375
23	Friction Bonding 5	0.5	3	1.5	375
24	Lab hood (3 stations)	0.5	4	2	1500
	Total: (from hoods)	CFM			14750

5.7.2 Shop Area

Since in the shop bare alloy material is present and undergoing processing, the shop is the primary confinement within the radiological material control zone. controlled storage areas and labs, in which unenclosed fuel alloy material is handled, are also confinement zones. The shop area of the FFC is surrounded by the Personnel Corridor which provides secondary ventilation confinement. It serves as an air-lock for personnel entering or exiting the shop. Ventilation supply air is ducted in and distributed throughout the length of the personnel corridor. The shop and other primary areas are operated and maintained at a slight negative pressure (minus ~1/2" H₂O gage) compared to the atmosphere. The Personnel Corridor is at about minus 1/4", and the office and clean areas are at atmospheric pressure. This assures that air flows from a vicinity of no or low probability of contamination to an area of higher potential for contamination. Unpackaged alloy fuel material is handled only in the shop, Interim secured controlled storage area, casting and lab areas. A minimum of four fresh air changes per hour pass through the shop. Approximately 20% of the air is exhausted from the hoods and task exhaust ducts (regions of highest contamination potential), the remainder being exhausted via inlet registers in the main exhaust ducts (headers) that run the length of the shop within the trusses, below the roof.

Filtered supply air, discharged from the air handling units, flowing to the personnel corridors and passing through barometric dampers mounted in the shop walls may become contaminated as it passes through the shop. Shop air is exhausted by two means: by the hoods and task exhaust ducts, and directly into the exhaust headers. Air exhausted

from the primary confinement area (shop, casting and interim storage area) is released to the atmosphere via the HEPA exhaust filters and fans. The exhaust filters provide secondary and tertiary HEPA filtration, while hoods, enclosures and task exhaust ducts are equipped with local (primary) HEPA filters as well as pre-filters or mist eliminators to minimize duct contamination. A control damper in the supply duct upstream of the branch headers to the personnel corridor prevents 'pressurization' of the shop should the exhaust fans fail to provide the necessary flow to maintain negative pressure in the primary confinement area. (This might occur in the off-normal case wherein the supply fans continue to operate when the exhaust fans do not.) Each of the local filters and pre-filters, as well as the main exhaust filters, have 'bag-out' capability. Spent filters are compacted and packaged as rad. waste when removed from service.

5.7.3 Office/clean areas

Filtered and conditioned supply air is provided to the office and clean areas of the plant, and this air is returned to the inlet section of the air handling units. Recirculating conditioned air in offices and clean areas provides a measure of energy conservation, decreasing energy usage. Conditioned air passing through the shop is exhausted via the building HEPA Filters and discharged to the atmosphere through the stack; passing through the building only once.

5.7.4 Design features of the HVAC system

The air handling room has inlet louvers below the ceiling that are placed in the exterior wall of the building. Inside there are two Supply Air Handlers. The inlet louvers are equipped with radiant heat panels for frost removal in cold climates. The fresh outdoor air passes through pre-filters and bag filters after passing through steam and chilled water heat exchangers for heating and cooling. During the summer air conditioning season the incoming air is sub-cooled and reheated for dehumidification prior to distribution in the Drains are present in the inlet section to remove condensed humidity. Recirculated air from the offices and clean areas is mixed with fresh air upstream of the intake filters. Two large supply air fans, mounted to the floor slab in the room, drawing on a common plenum provide air from the inlet conditioning and intake filter units. Flow from the air handler fan outlet plenum is distributed throughout the building to provide effective circulation, maintain ventilation confinement barriers and ensure there are no dead spaces. Two main supply ducts run the length of the FFC along the length of the personnel corridor above the suspended ceiling and diffusers distribute fresh air throughout the length of the personnel corridor via control valves operated by the central ventilation control unit. Supply and return air registers are also provided in the air handling room and a branch of the supply air duct runs to the Exhaust Fan Room. Supply air is also ducted to uncontaminated areas such as the dock and assembly area.

The two-story Exhaust Fan Room has three exhaust fans which remove air from the shop, casting area, secured controlled storage areas and labs. Two large exhaust headers collect air from branches leaving the shop, from hoods, task exhausts, off-gas systems, labs and secured controlled storage areas. Air is exhausted from primary confinement areas maintaining these areas at below atmospheric pressure at all times. Air drawn from these areas is supplied from inlet valves along the length of the personnel corridor penetrating the wall into the shop. The two main exhaust ducts, below the roof in the high bay, run to a common inlet plenum in the Exhaust Fan Room which discharges via prefilters and fire

screens to three 4 by 5 HEPA filter units. Each of the three units has 2' X 2' HEPA filter banks in two columns 2 filters wide X 5 high. There are 6 such banks, 5 are capable of handling the whole exhaust flow. When changing HEPA filters, any one of the six banks can be isolated for testing or for filter bag-out. A moveable scissor man lift or portable platform is needed to access the upper bays on the second floor. In addition to pre-filters, two stages (secondary and tertiary) of HEPA filters are provided. The three units lead to a common exhaust plenum which is exhausted by three 150 hp exhaust fans on the ground floor. The outlet flow from the fans leads to a common exhaust duct then to a 70" diameter stack outside the building. The stack ends 25 feet above the peak of the building roof and is equipped with an isokinetic stack monitor.

The facility ventilation air flow is based on four air changes per hour for the entire building. Distribution and exhaust branches are arranged and controlled such that most flow is drawn from the casting and rolling areas, and air in other areas of the shop flows toward the highest areas of contamination probability.

The exhaust HEPA filter banks are equipped with low flow water mist fire suppression nozzles required by DOE regulations and the filter units are equipped with drains that overflow a normally oil filled P-trap. Spent fire suppression water collects on the floor.

5.8 Shielded Cells

No radiological shielding is necessary for the fuel material as it LEU only very slightly radioactive. Three reinforced concrete (on walls and ceiling) shielded cells are present in the FFC for radiography and fluoroscopy. These cells are shown with labyrinth entries which are effective at preventing reflected energy from penetrating occupied areas, and a warning light system or locking door will be provided as required to ensure personnel are not present in the cells when exposures are being made. In the direction that the x-rays are emitted from the source, they will directly impinge on the wall which will be made thick enough to prevent exposure to personnel on the opposite side of the wall. For purposes of this study, 12" thick walls are shown.

5.9 Fire Protection

5.9.1 Basic Criteria

Revision 1

The FFC has a fire protection strategy based upon DOE STD 1066-99, NFPA 101, NFPA 801, Life Safety Code, and the IBC. The building has been determined to be a Special Purpose Industrial Occupancy in accordance with NFPA 101.

In accordance with the IBC, for H-type occupancy, the FFC will be of Type II-B construction.

Safe practices are in use such as to limit flammable and combustible material accumulation, separation of oxidizers from corrosives (by distance or containment), the use of regular fire safety inspections, and through the use of special protocol procedures, unique to the FFC, and techniques that encourage the high levels of fire safety required by DOE STD 1066-99.

5.9.2 Fire Protection Design Features

A. Fire Water Supply and Duration:

It is assumed the existing federal facility fire water system, to which the FFC is connected, is capable of providing the required fire water flows, pressures and duration to meet the design criteria for the FFC.

B. Fire Sprinkler Systems:

The entire building is protected by a wet-pipe automatic fire sprinkler system as required by DOE STD 1066-99, Chapter 7. The system will be designed and installed in accordance with the requirements of NFPA 13. The fire sprinkler system will be designed for Ordinary Hazard Group 2 criteria: 0.18 GPM/ft² over a design area of 2500 ft², with an outside hose stream allowance of 250 GPM. Although there are no unventilated areas within the FFC, anti-freeze systems will be utilized in any unheated area, if required.

C. Building HEPA filters:

The building HEPA filters will be protected in accordance with DOE STD 1066-99, Chapter 14. The deluge fire protection systems shall be designed to deliver 0.25 GPM over the entire filter face areas. In order to minimize system overage, low flow BETE nozzles will be utilized, in additional to the possible use of pressure control valves on the HEPA filter deluge risers.

D. Fire Alarm System:

The building fire alarm system will be compatible with the existing fire alarm systems currently in use at the Lab Site where the FFC is constructed. The fire alarm system will comply with NFPA 72. Manual pull stations, indicating devices, and detection devices will be installed as required by DOE STD 1099-99 and NFPA 101. The fire alarm system will also monitor all fire sprinkler system pressure switches, tamper switches, and solenoid valves for triggering of the HEPA filter deluge systems.

E. Fire Extinguishers:

Fire extinguishers will be of a type required for the specific hazard and located in accordance with DOE STD 1066-99 and NFPA 10.

F. Exiting:

Building exits will be arranged such that the travel distances, including common paths and dead-end distances, will be in accordance with NFPA 101, Chapter 42.

G. Fire Water Loop:

An 8" diameter underground fire water loop encircles the FFC, and hydrants are present outside the roadway sufficiently spaced (approximately every 300'). The loop is supplied with fire water from the adjoining federal facility.

H. Exit Signage and Emergency Lighting:

Exit signage shall be located in accordance with NFPA 101. Emergency lighting, consisting of self-contained lighting with battery packs will be located as required by NFPA 101.







FIGURE 5-11 EXAMPLES OF EMERGENCY SINAGE

I. Alloy Fuel Fire Control

Although the alloy fuel material is not pyrophoric, the potential exists for a metal fire within the FFC. If such a fire occurred, the fire would be allowed to burn itself out prior to allowing water to be applied. This may require the automatic fire sprinkler system be turned off in order to prevent application of fire sprinkler discharge over the burning metal. Such a condition would be required to be addressed in the building policy and procedure manual. The FFC will certainly include in its policy a mandate for use of safe practices such as limited flammable material accumulation, isolating oxidizers from corrosives, regular fire safety inspections, and use of protocol procedures and techniques that encourage fire safety.

The Site on which the FFC is located must have a fire water supply capacity capable of delivering water to 2500 ft² at 0.18 gpm/ft² for 60 minutes (27,000 gal).

J. Fire water and disposition

Fire water dispensed during an event accumulates in the shop area on the floor. The collection depth on the floor of the shop is 6 inches deep, more than sufficient to allow accumulation of the discharge from 15 heads for 30 minutes. This necessitates flat concrete floors, ramps at the doors, and geometrically favorable sumps. Should fissile material 'burn' in a fire event, and become 'smoke particles' which wash down and accumulate on the floor because of the sprinkler discharge, the floor provides a suitably flat geometrically safe plane. Six inch diameter sumps, located throughout the shop, are each equipped with a drain jet which routes spent fire water to tube (or pencil) sampling tanks with an ID of 6" or less. The array of three tube tanks fits vertically in the underground secured controlled storage area. The tanks are fitted with pumps and valves to provide recirculation capability to suspend settled solids in the runoff water allowing a representative sample to be taken of the water drained from the sumps. If fissile material is not present in the sample, the water in the tube tank may be drained into the under ground accumulation tank via a filtration unit. The water in the tank, having been shown to be free of fissile material, is then disposed of as waste water. Any fissile material collected in the filter is disposed of as low level rad. waste. The drain water callection 1 tank is sized to receive 30 minutes discharge from 15 heads, or about 8400 gallons. The size of the collection tank in the underground secured controlled storage area is 8' diameter X 24' long. This size is based on the Casting Area in the FFC which is approximately 50' X 50' or 2500 ft². This area requires 25 Heads at 10' O.C. both ways. Sprinklers discharge at 18 gal per head (0.18 gal / ft²). Say one of two casting areas are affected by fire (> ½ the casting area), then 15 heads produce 280 gpm. For 30 minutes of discharge, the result is 8400 gallons.

5.9.3 Waste Drains

Since sumps will be present, spaced regularly through out the FFC along the shop perimeter, and the sumps are geometrically favorable (less than 6" diameter), then these sumps could be used for convenience-disposal of non-reactive liquids and generally uncontaminated waste water, such as dirty mop water, or spent rinse water used for cleaning lab equipment, or final rinses following a spill cleanup and similar dirty but non hazardous liquids. Any material thus dispatched must be compatible with the drainage and tank material, and acids, bases, salt solutions, organics, radioactively contaminated solutions, volatiles or flammables are expressly excluded. Each sump is equipped with a sump level indicator which triggers an indication on the central plant monitor that liquid is present in the sump. An extensive control system is not envisioned, however, a local operator could energize a local valve allowing an air energized jet to discharge the sump liquid to the tube (sample) tanks, allowing a sample to be taken after recirculating the liquid in the tube tank. When sample analysis shows that the material is free of nuclear material, this would be transferred to the underground fire runoff water collection tank via a filter which removes the solids. If used in this manner, the accumulation tank would require a level control to indicate that sufficient empty volume to capture fire runoff water remains available. Over time, as the level in the collection tank increases with convenience use, the tank will need to be pumped out and the spent water solution transferred to a liquid waste treatment facility (LWTF). Vendor service as needed will be contracted to remove waste liquid, using a tank truck, for transport to the LWTF.

5.9.4 Floor Finish

The floor of the shop areas of the FFC is coated with a durable epoxy coating, which will be maintained as needed in high traffic areas. The floor finish and other construction details present in the FFC facilitate decontamination and cleanup.

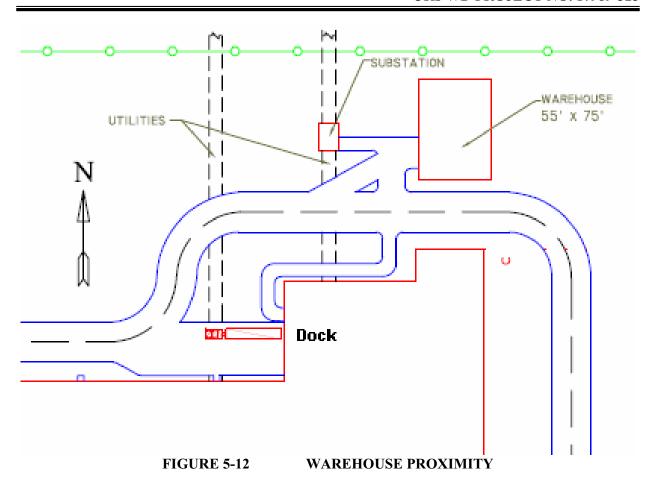
Revision 1

5.10 Warehouse

The 55' X 70' warehouse is used at the FFC to facilitate efficient operation of the plant. The warehouse is used for storing non nuclear material, packaging, provisions, seasonable items, consumables, tools and supplies. Between campaigns, tooling and specialty items related to specific fuel types not being processed are stored in the FFC Warehouse. Empty shipping containers and other packaging materials such as drums are stored here along with cold chemicals (in totes), spare parts, and mechanical and electrical supplies. Pallets on racks are the dominant storage theme. Using a pallet rack two high, in five rows, 7 pallets long with forklift aisles between (two rows are back to back), up to 70 pallets can be accommodated, occupying a 40 X 53' footprint. A preliminary takeoff shows this warehouse occupies approximately a 55' X 70' footprint, one story, 12' under the trusses, and includes a dock, single rollup door, a small office, and a water closet. The building has a concrete floor, and is a non-combustible metal structure equipped with automatic fire sprinklers, emergency lighting and fire alarm. An electric forklift is used for access to storage and material handling, and an inventory / database system provides minimum quantities, and keeps track of stock on hand. A networked data entry terminal is present in the warehouse.

Tools or fixtures that are used or have been used for fuel manufacture are likely to have traces of fixed contamination. Decontamination of this equipment will be undertaken to reduce levels as approved by health physics. No items possessing accountable material will be stored in the warehouse. Contaminated materials will be packaged under the direction of health physics using acceptable practices (such as in heavy poly bags, and no sharp corners) and will be stored in labeled boxes. Tool decontamination or maintenance procedures are not performed in the warehouse. There is no provision for material control or confinement or ventilation barriers, or accountability.

The insulated metal warehouse building is single story, 12' under the trusses, and includes a dock, single rollup door, two personnel doors, a small (prefabricated) office, and a water closet with a small hot water heater and drinking fountain. The building has a reinforced concrete floor with floor drains, and is a non-combustible structure equipped with automatic fire sprinklers, emergency lighting and fire alarm. Suspended under-truss lighting and task lighting systems are utilized. There will be roof drains that runoff into the surrounding paved lot, and connections will be made to potable water, sanitary sewer, and electrical service. Admission to the warehouse is controlled, and the property is secured and locked and all doors are closed when not occupied.



The warehouse is situated close to the FFC dock, because material is frequently moved between these two areas. It is within the fenced perimeter and is accessible by delivery truck and on-site site vehicles. Vehicles must pass through the entry control facility prior to moving to the warehouse dock to make deliveries. A roadway for delivery trucks and fire-truck access exists (outdoors) between the warehouse and the FFC. Entrances to the FFC, the dock, or access portals in the main building for equipment load-out (such as for HIP vessel removal) will not be blocked by the warehouse. A paved walkway is shown between the warehouse and dock for pedestrian traffic, and a grade level personnel door is available next to the dock to allow material moved on a 2 wheeler to be moved back and forth between the buildings.

A material takeoff is provided below to determine space requirements and is factored into the study estimate.

 TABLE 5- 2
 ESTIMATION TABLE FOR SPACE REQUIREMENTS

		FFC Wareho		
Туре	Contents	Characteristic	Campaign Related	Sq Ft
Provisions	Office Items	Boxes		16
	Signage			
	Barriers			
Supplies	Cleaning	Boxes		16
	Inventory, Files	Computer		80
Material	Cladding		5 sets	80
(fuel related)	Rolling Cans]	5 sets	80
	Zr dadding	1		
	Subass'y End Pieces	1	5 sets	40
Consumables	Spray mold release	Cans		
	Spray mold release Cold Chemicals	Totes		64
	Salt	Bags		16
Tools	Casting Molds		5 sets	80
	Crucibles	1		
	Inserts for storage bins	1	5 sets	80
	Inserts for Vault storage	1	5 sets	80
	Constraint fixtures	†	-	
	Press dies	19 sizes	5 sets	72
	Swaging tools	1 3 31253	5 sets	16
Packaging	Empty Drums	Pallets	0 3013	32
raukaging	Shipping Boxes	Pallets	5 sets	360
	Bottles	railets	3 3613	360
	Empty containers	Pallets	-	32
Cu avaa				
Spares	Rollers Hold Downs	Pallet	-	16
		4		
	Air Hose	4		
	Sump Pump Weld filler	4		
		4		40
	Lifting Equipment	4		16
	Heating elements	4		L
	Mechanical	4		32
	E lectrical	4		32
	Scales		_	
	Stir Welder mandrill	Box	_	
	Spare Filters	1		
	Dessicant cartridge spare		_	
	Chucks	Box		16
Warehouse	Fork lift, charging station			64
Operation	Pallets			16
	Rack/Shelving System	Pallet Rack: 2		2120
		high, 7 long, 5		
		rows = 53' X 40'		
	Packaging]		400
	Heating Equipment			
	Dock Door			
	Building System			55' X 70'
	Rest-room			80
	Drinking Fountain			4
	Eye Wash			4
	Shipping/Recv'g office]		96
	Lockers			8
	Carts			32
	Dock			600
	Fire Extinguishers			
	Fire Protection	1		
	Receiving Area & tools	1		320
	Lighting	1		
	Communication	1		8
	,	55' X 70' =	3850	

5.11 FFC Staff

For the purposes of this study, the number of personnel present on a daily basis has been estimated for development of life-cycle costs, rest-room stalls, locker room capacity, etc. The total count consists of operational staff (including machinists, inspection personnel, health and safety specialists and technicians) that work in the shop, and professional or office staff (including security personnel). The personnel and the breakdown of where they work are in the table below. The allocation of offices occupied by the office staff is also shown. The drawing SK-ME-1 shows the office layout, restrooms, and conference or lunch rooms on both floors and the shop layout in which the FFC Staff work.

5.11.1 Operational Staff

TABLE 5-3 FFC SHOP PERSONNEL TALLY

Area Code	Function	Number of personnel
1	Ingot Cleaning, Casting, Mold and Crucible prep	3 *
2	Hot roll unclad U-Mo to ~0.1" thick	2
2	Heated Salt Bath (prior to rolling cast plates)	=
3	Sectioning (four plates cut from each pre-rolled U-Mo strip)	1
3	Salt Removal (sanding or media blasting prior to sectioning)	-
4	Canning (automatic weld station load / unload)	1
5	Hot rolling of Zr Clad U-Mo in purged C'Stl can	2
6	De-canning, foil Trimming, can scrap management	2
6	Anneal	-
7	Chemical Cleaning (Al plates and Zr Clad U-Mo are cleaned in separate baths)	1
8	Friction Bonding	4
9	Fuel Element Trim, flattening and Surface Finish	-
9	Fluoroscopy (verify position of foil inside bonded Al cladding)	-
10	QA	3
10	Rad Tech	2
10	Lab - UT	1
10	Lab - Radiologist	2
10	Lab – Microscopy and sample prep	1
10	Lab – Metallography / Chemistry	1
10	Dimensional Inspection / Setup	1
11	Element swaging, welding, machining, autoclaving and final product assembly	11
11	Fuel Element Shape Forming (Press)	1*
12	Shipping and Receiving (Product packaging + shipping container unloading)	2
12	Storage Area, order picking and stocking, Accountancy	-
	Radiation Control	2
	Runner	1
	Programmer (shop floor programming area)	2*
	Mechanical Maintenance	2*
	Electrician / Calibration	1*
	Waste Management / SNM Accountability	2
	Warehouse	2
	Housekeeping (shop & warehouse)	2
	Shop Supervisor	1
	Total Shop Personnel	55

Notes:

• Floating Personnel indicated by * available to support efforts elsewhere such as filling positions noted by "-".

• Area codes refer to markers on Layout Plan and Flow Diagrams.

5.11.2 Office Staff

TABLE 5-4 FFC OFFICE PERSONNEL TALLY

Function	Number of personnel
Production Manager	1
QA Manager	1
Maintenance Manager	1
Security (2 at gate)	3
Secretary / Receptionist	1
Records management	1
Procurement / Purchasing	1
Rad Con, ES&H, Environmental Compliance	1
Scheduling	1
Facilities Manager (HW)	1
Guest	1
Safety and Environmental Compliance	1
MC&A	1
Total Office Personnel	17

Notes:

- Total count includes two guards in Entry Control Facility that are part of the assigned staff and will make use of the FFC rest rooms.
- Guests may be representatives or QA personnel from reactors with ongoing fuel manufacturing campaigns.

Total FFC Personnel	72
10001110101001	· -

TABLE 5-5 OFFICE SPACE DESIGNATION

			Area	Hard walled (HW) offices	Cubicl es
Engineering	(HW)	2	QA Manager		1
Production Manager	(HW)	1	Maintenance Manager		1
Women's Rest Room/ Change Room	(HW)	-	Men's Rest Room/ Change Room	(HW)	-
Upstairs Women's Rest Room	(HW)	-	Upstairs Men's Rest Room	(HW)	-
Housekeeping (supply closet)		-	Rad Con, ES&H, Safety & Environmental Compliance manager		1
Security, Central Control (ground floor)	(HW)	1	Scheduling		1
Secretary / Reception (ground floor)	(HW)	1	Facilities Manager	(HW)	1
Records (lockable)	(HW)	1	Guest		2
Procurement / Purchasing		1	Safety and Environmental Compliance		1
Lunch / Vending / Meeting (ground floor)		-	Copier/ Fax/ Office Supplies		-

5.12 Personnel Protective Equipment

PPE for personnel in the FFC includes lab coats, shoe covers over foot wear suitable for the industrial environment, work gloves, cotton gloves and safety glasses. No respiratory protection is in use beyond local task exhaust ducts and hoods, and casual use of nuisance dust filters such as for cleanup or maintenance tasks.

5.13 Friskers and Monitors

Full body friskers and hand and foot monitors will be present at entrances/exits to the RBA which are at the Locker-room/Change room exit to the Personnel Corridor, and between the Personnel Corridor and the Receiving, Shipping and Storage Area. Within small alcoves, there is a personnel waiting area, separated by a handrail from the corridor, at each monitoring station. In addition to the stack monitor, there are battery backed criticality alarms present within the shop and fuel accumulation areas, as are continuous air monitors (CAMs). The multiple CAM samplers, which are located at face level near each personnel work station involving working with unclad fuel, make use of a central vacuum and distribution system. The small individual filters in the samplers are replaced and counted periodically by industrial health personnel.

5.14 Facility Operation

The facility operates normally in a single (day) shift mode. However, the FFC can accommodate up to three shifts per day to resolve production bottlenecks or increase production. Some small personnel presence may be required for certain backshift operations, primarily monitoring long run process steps (such as autoclave or HIP processes). Campaign changeovers are accounted for in the production schedule. The facility operating basis is a six day week and 260 days per year of availability. The FFC is designed for a 40 year facility life, wherein it may be necessary to change out any piece of equipment or control system component during the plant life.

5.15 Control Room

The central facility control room is located on the first floor in the common office area behind the receptionist. CCTV monitors display images from cameras in the storage areas, dock, building entrances ECF, warehouse and lot. Recordings are made from the camera signals and stored for a period of time for security reasons. HVAC control, door monitors, stack monitor, sump monitors, central alarm annunciators, and communications are available in the central control room which in addition to the office space needed for the operator, also includes a desk, computer, a small server farm, and I/O. The central control room will be the lead point for the incident command function during operation of the FFC.

5.16 Utilities

Utilities present at the FFC include electrical service, potable water, deionized water, fire water and sanitary sewer. No emergency power needs are identified that would require a standby generator; however alarms for criticality and air monitoring are battery backed. An argon dewar provides a supply of gas at atmospheric temperature and pressure for bleed and feed to the furnace enclosures and for the entry and exit airlocks in the casting area. If the HIP option is utilized, a second argon dewar will be provided because the HIP attains pressurization in part by

vaporizing and heating argon gas Some 400 gallons of liquid argon may be consumed during a HIP run, but with additional equipment, much of this can be recycled..

5.17 Electrical Service

High voltage is stepped down to 480 VAC service using transformers at a substation located outside the FFC. The majority of the machines utilize 480VAC, in combination with 120 VAC. Lighting, heating (including steam generation) and ventilation loads dominate the power usage because these are typically 24 hour per day services whereas machine loads are intermittent, however 25HP machine tools are common. The three 150HP exhaust fans used to maintain facility ventilation confinement are the largest attached loads.

5.18 FFC Communication

At the time of preparation of this study report, in-plant wireless communication details are insufficiently defined to allow INL security personnel to definitively predict what the rules will be concerning radio communication for the FFC. Crane controls, inventory tracking, material orders made up for production batch use, material packages sent to interim storage, monitoring information and alarm summaries could be made available throughout the plant using a local wireless network. However, if encrypted radio frequency signals are not allowed, hard wired communications are acceptable. Accountability tracking data transfer will be accomplished using a hard wired or local (plant wide) fiber-optic network. Communication connections from the Federal Site, to which the FFC adjoins, will be made to service the connection with the public communication network and site alarms.

5.19 FFC Facility Operation

Facility operation and cost to operate the FFC consist of 1) a management and labor component, 2) use of expendable consumables and resources, 3) maintenance and upkeep of the building and process systems, 4) packaging and transportation, 5) utilities and energy use and 6) contracts or subcontracts provided by suppliers and service providers that fulfill various aspects required to meet the needs of daily use and delivery of fuel to the reactors serviced. A cost must also be factored in to account for, at the end of life of the facility, the costs to decommission the plant and dispose of the residuals and return the site to a 'green field' condition (7).

The list that follows divides the operational aspects into various 'accounts' or functional areas, which are intended to represent known usage of consumables, and expendables. The list is inclusive of service and maintenance needs.

5.19.1 Management and Labor

As shown above (section 5.11), some 72 personnel are full time staff that work within the on a daily basis. An average annual salary and benefit package including insurance, unemployment and training needs to be budgeted for each individual. In addition, there will be perhaps two full time managers outside the facility and at least two QC personnel that work outside the plant at supplier facilities.

5.19.2 Expendable consumables and resources

A. Chemicals and Consumables

Process Consumables (solids)

- LEU-10Mo raw alloy: 7.5 metric tons/yr.
- Zirconium foil: 11,500 lbs./yr.
- Aluminum pre-machined cladding plates: 164,000 lbs./yr.
- Aluminum fuel subassembly end and side pieces and hardware: 100,000 lbs./yr. (est.)
- Grafoil graphite sheeting: 100,000 lbs./yr. (est.)
- Steel rolling cans; 408,400 lbs./yr.
- HIP cans (if applicable)
- Yttria aerosol spray for can coating: 1 gross/yr.
- Electrodes welding electrodes and filler material
- Paper, Plastic cleaning supplies
- Graphite crucible (bottom pour), lids
- Graphite –book molds (various types for different fuels and different sizes)
- KCL salt bath: 50#/yr. (est.)
- LiCl salt bath : 50#/yr. (est.)

Process Consumable (liquids)

- 30% HNO₃ cleaning (U-Mo, AL, Zr sandwich): 6,700 gallons/yr.
- NaOH cleaning (aluminum cladding): 3,200 gallons/yr.
- HF Yttria removal: 24 gallons/yr.
- Ethanol foil cleaning: 480 gallons/yr. (bath)
- Water treatment chemicals for DI water element cleaning

Process Consumables (Gases)

- Argon –, HIP (if applicable): usage is 400 gallons per cycle, assume 100 gallons per cycle use, with the remainder being recycled; 265 cycles per year
- Argon Casting furnace: 15 SCFH: 130,000 ft³/yr, entry/exit Glove Box: 100 ft³/day: 26,500 ft³/yr.
- Bottled Argon for welding: 35 ft³/day: 10,000 ft³/yr.)
- Bottled Helium can leak test: 20,000 ft^3/yr.
- Desiccant for dry instrument air and element drying

Equipment Consumables

- Casting Furnace
 - Glovebox seals
 - Conveyor motor(s)
 - Conveyor rolls
 - o Vacuum seals
 - o Vacuum pump oil
- Finishing Mill(s)
 - o Chucks
 - o Milling bits
 - o Lubricating oils
 - Hydraulic oils

- Machining/Cooling oils
- Friction Stir Welder
 - o Friction stir welding pin (machining tool)
 - o Lubricating oils
 - o Hydraulic oils
 - o Machining/Cooling oils
 - Drive motor (spare)
 - Spare Chucks
 - Spares for recirculating coolant systems
- Hydraulic Shears
 - Shear Blades
 - o Hydraulic oil
- Rolling Mill(s)
 - o Drive Motor (Spare)
 - o Roll refurbishing
 - o Roller bearings
 - o Roller chains
 - Lubricating oils
 - Hydraulic oils
- Roller Leveler
 - Drive motor(spare)
 - o Roll refurbishing
 - o Roller bearings
 - o Roller Chains
 - o Lubricating oils
 - o Hydraulic oils
- Hydraulic Press
 - o Tooling
 - o Hydraulic oil
- HIP
 - o Cooling system
 - Vacuum seals
 - Hydraulic oils
 - Vacuum pump oil
 - HIP recertification (subcontract)
 - o Argon dewar spare valve & gage
- Ultrasonic Tester
 - o Filters (water recirculation)
 - o Probes
- Cleaning Baths
 - o Filters (cleaner liquid recirculation)
 - Spare level probes
- B. Lab Consumables
 - Sample bottles
 - Pipettes, spectrometer specimen vials
 - Equipment Gas
 - o Oxygen
 - o Nitrogen
 - o Argon

- o Helium
- Crucibles (#samples per year)

C. Safety Equipment

- PPE (general)
- Safety toe shoes for machine shop and assembly area
- Gloves; leather, 10 pair/yr, 500 count latex, 500 count cotton
- First Aid kit
- Safety Glasses: 100 /yr
- Lab coats, aprons, hair nets or caps: 100 count
- Biohazard spill cleanup kit
- Cardio/pulmonary resesutation
- Film badges: 50 count
- Swipes, kimwipes
- Hand/Foot Monitor calibration coupons

D. Electronic Media

- Manufacturing Record Storage
- Radiography
- Ultrasonic
- Accountability records
- Copy paper (1 pallet / year)

E. Spare Parts, Maintenance

- Switches
- Transducers
- Encoders
- Measurement accessories
- Tools, Testers
- Compressor oil: 5 gal/yr
- (see also spare-parts material takeoff in estimate, and individual callouts above)

F. Other

- Calibration Standards
- Test Gages
- Signage
- Labels

5.19.3 Maintenance and upkeep of the building and process systems

A. Building Consumables

- Battery backup for alarms (3 year replacement interval)
- Lighting (building and lot)
- Waste Packaging Drums and bottles,
- Sorbant
- Shipping containers for assembled elements (400/yr)
- Janitorial supplies

- Pallets
- Office supplies
- Refrigerant (HVAC system)
- Filters HEPA filters (building): 60/year and prefilters: 60/yr, inlet filters and bags (1 set per year), Local HEPA filters (30/yr), demisters (15/yr), sintered metal filters (3/yr), pre-filters (20/yr)
- Off-gas absorbers

B. Building Upkeep

- Grounds keeping (subcontract)
- Snow removal (subcontract)
- Painting
- Roof upkeep
- Stack maintenance

C. Forklift(s)

- Battery(s) (3 year replacement interval)
- Wheels, Tines, accessories
- Hand Cart (spare)

5.19.4 Packaging and transportation

5.19.5 Utilities and energy use

5.19.6 Contracts or subcontracts provided by suppliers and service providers

- Copy machine: Maintenance Contract
- Laundry contract
- Radiography: Maintenance Contract
- Ultrasonic Tester: Maintenance Contract
- Fluoroscope: Maintenance Contract
- Roll mill roller maintenance contract
- Waste haulage and disposal subcontract

5.19.7 Decommissioning and Disposal

This one time expense might be paid for by adding to an interest bearing account on a yearly basis, with a future value, 40 years after facility commissioning, suitable for paying the cleanup subcontract and disposal cost. No or very little salvage value is expected to be realized, other than as scrap material.

6.0 INITIAL FACILITY HAZARDS EVALUATION

Consistent with the requirements of DOE STD-1189-2008¹, this chapter provides an initial evaluation of the hazards that are expected to be present in the facility based on the current preconceptual stage of development of the design. For those hazards identified in this initial hazards evaluation, potential controls for preventing or mitigating the hazards are also identified. For the purposes of this preliminary hazards evaluation, a "hazard" is "anything that has the potential to cause harm". The two principal "receptors" for hazards at nuclear facilities are the public and facility workers.

Public Consequence Analysis

The consequence (dose) of an accidental release of LEU-Mo material to the "maximally exposed off-site individual" or MEOI is calculated following the standard methodology detailed in DOE STD 3009-94² for identifying safety-class equipment (equipment that protects the public from the determination of safety-class equipment. This dose is the "committed effective dose equivalent (CEDE)" from the inhalation pathway. The CEDE is the total dose equivalent deposited in tissue over the 50 year period following intake of the radionuclide. The DOE defines an evaluation guideline of 25 rem to the MEOI as the threshold for defining safety-class systems, structures and components (SSCs). For the purposes of this analysis, we will assume that an MEOI dose greater than 5 rem (consistent with the guidance in DOE STD 1189 will require additional consideration as potentially requiring safety-class SSCs.

The importance of this "safety-class" designation is primarily one of cost. Safety-class SSCs require significant quality assurance documentation, configuration control, documented surveillance to ensure operability within defined margins, etc. Direct and indirect costs for installation, operating, maintenance, and replacement of safety-class SSCs are substantially higher than for other plant equipment.

The following scenario is assumed for this dose calculation:

A total of 5300 kg of LEU 10%Mo (one year's throughput) is involved in a fire that converts the material to dispersible oxide form (UO $_2$ or U $_3$ O $_8$). It is assumed (consistent with analyses in DOE-HDBK-3010 3 and DOE-STD-1027 4) that 0.1% of this material is entrained in the smoke, and that all of the airborne material is respirable (i.e., has a mean aerodynamic diameter less than 10 microns). The entire amount of airborne material is released from the facility at ground level, consistent with the requirements of DOE-STD-1189-2008. The MEOI is located at the site boundary 100 m downwind from the fire, and that the plume is dispersed in the air in accordance with the assumptions provided in DOE-STD-1189-2008. The CEDE is calculated as follows:

CEDE (rem) = MAR x DR x ARF x RF x LPF x SA x DCF x BR x χ /Q

where:

MAR

material at risk – inventory available in an accident (5300 kg of U-10%Mo = 4.77 x 10^6 grams uranium @ 20% U²³⁵ enrichment)

LEU-Mo Fuel Fabrication Facility

¹ Integration of Safety into the Design Process, DOE-STD-1189-2008, March 2008, 191 pp.

² Preparation Guide for US Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses, DOE-STD-3009-94, Change Notice #3, March 2006, 144 pp.

³ Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities, Volume 1 – Analysis of Experimental Data, DOE-HDBK-3010-94, December 1994, 359 pp.

⁴ Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports, DOE STD-1027-92, Change Notice #1, September 1997, 49 pp.

	DR	damage ratio – fraction of the available inventory affected by the accident (1.0)
	ARF	airborne release fraction – fraction of the material that becomes airborne (1 x 10^{-3})(from DOE HDBK 3010-94, p 4-42)
	RF	respirable fraction – fraction of the airborne material having a mean aerodynamic diameter $\!<\!10~\mu m$ (1.0))(from DOE HDBK 3010-94, p 4-42)
	LPF	leak path factor – fraction of the airborne material that leaves the facility (1.0)
	SA	specific activity – curies/gram for the material (7.12 x 10 ⁻⁷ Ci/g for 20% enriched U)
	DCF	dose conversion factor – rem/curie for the material (1.2 x 10^8 for 20% enriched)(from Federal Guidance Report # 11^5 , Table 2.1)
	BR	breathing rate $-3.5 \times 10^{-4} \text{ m}^3/\text{s}$
	χ/Q	atmospheric dispersion factor based on site-specific conditions (recommended value from DOE STD 1189-2008 on the order of 3.5 x 10^{-3} s/m ³)
-ce	DE = (4.77)	$v = 10^6 \text{ a. v.} = 1.0 \text{ v.} = 0.001 \text{ v.} = 1.0 \text{ v.} = 1.0 \text{ v.}$

CEDE =
$$(4.77 \times 10^6 \text{ g} \times 1.0 \times 0.001 \times 1.0 \times 1.0) \times 7.12 \times 10^{-7} \text{ Ci/g} \times 1.2 \times 10^8 \text{ rem/Ci} \times 3.5 \times 10^{-4} \text{ m}^3/\text{s} \times 3.5 \times 10^{-3} \text{ s/m}^3 = 0.5 rem$$

This result is only one-tenth of the DOE-recommended threshold for challenging the evaluation guideline. None of the other identified hazards has a potential consequence to the public that exceeds this result. Therefore, we can conclude that none of the safety systems will be designated as safety-class. The fact that no safety-class SSCs are required will reduce the QA requirements as well as the costs for the design, procurement, installation, operation and maintenance of equipment and structures for the FFC.

Worker Safety

The remainder of the preliminary hazards evaluation focuses on worker safety issues. As discussed in the requirements section, above, worker safety issues can be categorized as either standard industrial hazards or as radiological hazards. Industrial hazards are typically regulated by OSHA and are covered by the facility industrial hygiene program. Radiological hazards at DOE sites are regulated under 10 CFR 835 and are covered by the facility radiological protection program. Both types of worker hazards must be addressed in the hazards and accident analysis (chapter 3) as well as in the safety management programs (chapters 6-17) of the Documented Safety Analysis. A Hazards Analysis will be performed for the Conceptual Design and a formal Preliminary Documented Safety Analysis (PDSA) will be performed during Preliminary Design.

This preliminary hazards evaluation for the FFC was performed by evaluating the identified process equipment for those radiological and industrial hazards that might be expected to be present for that equipment. For each piece of process equipment, the hazards were evaluated for four phases of the equipment life-cycle: normal operation, maintenance, installation, and removal. The evaluation focused on sources of kinetic and potential energy, including mechanical, thermal, chemical, and radioactive forms. Thus, the equipment evaluation included identification of the chemicals that would be present in the process equipment area. An example of the evaluation sheet used in performing this evaluation is shown in Figure 6-1.

⁵ Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, Federal Guidance Report # 11, EPA-520/1-66-020, September 1988, 224 pp.

Process Equipment ID:	CV 001				
Process Equipment ID: Process Equipment Name:	Mold Feed Con	vevor			
Process Equipment Description:					
Sketch:		asting molu			
Area Code:					
7 1100 0000					
Hazards:	Operation	Maintenance	Installation	Removal	Controls
Thermal - Burns					Insulated Gloves, Tools
Thermal - Cold					Insulated Gloves, Tools
Mechanical - Pressure					Pressure Relief Devices
Mechanical - Pinching		х	х	х	Equipment Guarding
Mechanical - Rotating Equipment		х	х	Х	Equipment Guarding
Mechanical -Falling Objects		Х	Х	Х	
Mechanical - Flying Objects					Eye Protection, Face Shields
Mechanical - Lifting		Х	Х	Х	
Mechanical - Sharp Objects		Х	Х	Х	- · · · · · · · · · · · · · · · · · · ·
Mechanical - Cutting Electrical					Equipment Guarding
Chemical - Corrosive		х	Х	х	Lockout/tagout Eye Protection, Face Shields, Gloves
Chemical - Ignitability					Eye Flotection, Face Shields, Gloves
Chemical - Toxic					Ventilation, Respiratory Protection
Chemical - Reactive					Voltalation, recopilatory recoulon
Chemical - Fumes					Ventilation, Filtration, Respiratory Protection
Non-Ionizing Radiation					, , , , , , , , , , , , , , , , , , , ,
					ALARA Program, Time/Distance/Shielding,
External Ionizing Radiation - Chronic	x	х		х	Dosimetry
					Geometry, Inventory, and Moderator Control,
Nuclear Criticality					Criticality Alarms
Airborne Radioactive Materials					Ventilation, Filtration, Respiratory Protection
					Combustible Control, Fire Detection/
Fire					Suppression/Alarm System
Explosion Spills					
Confined Space					
Air Displacement/Asphyxiation		х		х	
Noise		^			
Ergonomics					
Slips, Trips & Falls					Non-skid Surfaces, Handrails
Chemicals:					
U10Mo acorns, ingots, coupons, foil	х				
U10Mo foil trimmings					
Zr foil					
U10Mo-Zr Clad Plates					
U10Mo-Zr Clad trimmings					
Nb foil					
Nb foil trimmings Al - 6061 metal shapes					
Al - 6061 metal shapes Al - 6061 milling scrap					
Al Clad Plates					
Fuel Assemblies					
steel can					
yttria coating in can					
W welding electrodes					
W friction bonding tool					
paper, plastic cleaning supplies					
Steel Mold (HR-160)					
graphite crucible yttria coating on crucible					
yttila coating on crucible	Х				
KCl salt for salt bath				1	
KCI contaminated/spent salt					
slag from melter					
steel convenience cans					
HNO3 30% cleaning solution					
HF cleaning solution					
NaOH (75 g/lit) cleaning solution					
■ U2O (cooling ota)					
H2O (cooling, etc)			1	İ	I
H2O DI rinse					
H2O DI rinse ethanol					
H2O DI rinse ethanol KCl molten salt/vapors					
H2O DI rinse ethanol KCI molten salt/vapors janitorial supplies					
H2O DI rinse ethanol KCI molten salt/vapors					

FIGURE 6-1 – EXAMPLE EVALUATION SHEET FOR PRELIMINARY HAZARDS ANALYSIS

The presence of U²³⁵ in the FFC introduces radiological hazards associated with fissile radioactive materials (especially nuclear criticality and external ionizing radiation). In addition, this material increases the consequences of other accidents such as fires or explosions because of the airborne radioactive material hazard. Radiological hazards can be subdivided into two categories. The first is worker exposure to ionizing radiation that is largely a chronic condition in the workplace. The second category includes upset conditions that would potentially result in higher doses for short time periods.

To assess the importance of worker chronic exposure to 20% enriched LEU materials, a simple dose rate calculation was performed using the Uranium Radiation Individual Dose Calculator at http://www.wise-uranium.org/rdcu.html. This estimate assumed that a worker receives external exposure from working 2000 hr/year at a distance of 2 m from a 20 kg point source of 20% enriched uranium. These conditions might be expected in the casting area. The annual dose received by the worker is calculated to be 2.8 mSv (280 mrem) which is approximately 14% of the administrative dose for occupational radiation exposure at DOE sites (2 rem/yr). Workers in other areas such as the material storage area would likely receive higher doses from working in the vicinity of larger source terms.

Radiological hazards from upset conditions would include inhalation of airborne radioactive materials, external exposure to inadvertent nuclear criticality events, or external exposure from worker entry into a radiation area, a high-radiation area, or a very-high radiation area such as a radiography cell while the radiography source is exposed. Controls for these hazards are discussed in a later section of this report.

Many of the hazards identified as standard industrial hazards were included in the evaluation even if the equipment is designed to significantly reduce the risk of those hazards. For example, electrically-powered equipment that is designed and built to meet electrical codes and standards typically poses negligible risk from electrical hazards to the workers during normal operation. However, the electrical hazard continues to exist as long as power is supplied to the equipment, even if all the electrical components are contained within the appropriate enclosures. The rationale for identifying these "low-risk" hazards is in defining the importance of the hazard controls (enclosures, operating and maintenance procedures, lock-out/tag-out protocols, etc.). Modifying or removing these controls may increase the risk of the hazard.

In addition to posing industrial-type hazards to workers, process equipment can also serve as initiators of an accident sequences that are unrelated to the function performed by that equipment. For example, electrically-powered equipment could initiate a fire. The fire could suspend and transport radioactive materials (inhalation hazard), and the activation of the fire suppression system could provide moderator for a nuclear criticality event. For this preliminary hazards evaluation, hazards that could be initiated by a piece of equipment were also included as part of the hazards inventory for that equipment.

6.1 Principal Worker Hazards

The principal hazards to the worker identified in the preliminary hazards analysis include standard industrial hazards and hazards related to the presence of radioactive materials. These hazards are not listed in order of importance or of consequence.

Standard Industrial Hazards

- Fire
- Steam explosion (introduction of water or other liquid into molten salt or molten metal)
- Electrical hazards

- Mechanical hazards (falling objects; rotating equipment; pinching, cutting, or crushing hazards; sharp objects; pressure)
- Thermal hazards (burns)
- Non-ionizing radiation (welding)
- Chemical hazards (toxic, reactive, or corrosive chemicals; chemical vapors or fumes)
- Spills of hazardous materials

Radiological Hazards

- Spills of radioactive materials
- Ionizing radiation (radiography, radioactive materials)
- Inadvertent nuclear criticality

6.2 Hazards Control

Prevention and Mitigation of Standard Industrial Hazards

Most of the standard industrial hazards listed above are typical of hazards that would be expected in a machine-shop/foundry environment. Generally, these types of hazards are controlled by equipment design (built-in guarding, shields, and interlocks), operating and maintenance procedures, personal protective equipment (hardhats, face/eye protection, gloves, safety shoes, protective clothing), and personnel training. Additional mitigation for these hazards would result from implementation of nuclear facility safety management/administrative control programs. For example, DOE non-reactor nuclear facilities operate maintenance, change control, and worker safety programs with greater formality than is usual for non-radiological facilities. Application of the increased formality to operation and maintenance (e.g., use of a formal lockout/tagout procedure for equipment maintenance, and use of formal change control processes for equipment modification) should reduce both the likelihood and the severity of standard industrial hazards.

Prevention and Mitigation of Radiological Hazards

The principal controls for radiological hazards include a radiation protection program, an ALARA program, sensors and alarms for upset conditions (continuous air monitors, personnel contamination monitors, nuclear criticality alarms, personal dosimetry), support from radiation control technicians, periodic dose rate and contamination surveys, critically safe geometries for equipment and storage areas, material accumulation limits based on criticality safety evaluations, maintenance and operating procedures, worker training, and management walk-arounds and self-assessments.

Radiation protection program requirements are defined by 10 CFR 835 and are incorporated into the facility Documented Safety Analysis.

In addition to the hazards specifically identified as radiological hazards, several of the standard industrial hazards could act to disperse radioactive materials or could be initiators for other serious accidents involving radioactive materials. The first two items in the list of standard industrial hazards are examples. For example, the consequences of a fire in a machine shop or foundry would be made much worse if the fire acted to disperse nuclear material.

Prevention and Mitigation of Fires

Although the fire hazard is listed above as a standard industrial hazard, a fire in a nuclear facility is a much greater hazard than a general fire due to the potential for nuclear criticality from the

introduction of water into the facility, to increased possibility of dispersal of airborne radioactive material, and to the potential for loss of the safety function of one or more safety systems in a fire. DOE O 420.1B⁶ defines fire protection program requirements for DOE nuclear facilities. DOE STD-1066-97⁷ provides design guidance that supplements the requirements of national consensus fire protection design standards. The increased design requirements for fire protection systems in nuclear facilities, coupled with administrative control programs (such as transient combustible control and housekeeping) are important contributors to the prevention and the mitigation of fires.

6.3 Criticality Controls

In addition to providing fire protection requirements, DOE O 420.1B defines nuclear criticality safety for Hazard Category 2 nuclear facilities. The primary controls for nuclear criticality hazards are preventive controls which are set by the criticality safety program and validated using criticality safety evaluations (CSEs) of specific equipment, processes or conditions. Likely controls that would be used in the FFC include:

Equipment or container geometry

Fissionable material mass limits

Fissionable material concentration limits

Fissionable material spacing limits

Control of moderators and reflectors

Examples of these controls as proposed for implementation in the FFC include:

- The casting crucible diameter is limited to 6 inches which is expected to be a critically safe geometry for the LEU-10%Mo material in the solid and in the molten state (CSE needed). The height of the crucible limits the total mass of LEU-10%Mo alloy, but detailed analysis is required to ensure that this mass is subcritical in any geometry.
- Spills of fissionable material from the casting crucible should be captured in a critically-safe geometry (CSE needed).
- Fissionable material in or spilled from the casting crucible should not be capable of being moderated by spills of induction coil cooling water (CSE needed) (note: Induction coil cooling water system is a limited volume system).
- Fire water from sprinklers that is collected on the process area floor will not exceed 6 inches in depth at any location (CSE needed). This is expected to be a critically safe geometry for all nuclear material configurations. (note: sumps are 18 inches deep)
- Any equipment, structure, or container that could collect water more than 6" in any dimension shall be evaluated to ensure that a criticality event is not credible even if water collection did occur. (CSE needed)
- Floor sumps for collecting water spills on the process area floor have a diameter of 6" or less to provide geometry control (CSE needed).
- Waste water that potentially contains fissionable material in a dissolved or suspended state will be collected in geometrically safe tanks for sampling and analysis before being transferred to uncontrolled geometries (CSEs needed).

-

⁶ Facility Safety, DOE O 420.1B, December 2005, 65 pp.

⁷ Fire Protection Design Criteria, DOE STD-1066-97, March 1997, 85 pp.

- Thickness of stacks of cast materials, rolled materials, clad materials and encapsulated plates will not exceed 1" in thickness in the narrowest dimension. This is expected to be a critically-safe geometry (CSE needed).
- Spacing between containers of fissionable materials will not be less than 8" in any direction (CSE needed). The spacing will be maintained by physical restraints.
- Mass of fissionable material per container will be limited to 11 kg. This is expected to be a critically safe mass for any container geometry (CSE needed).

In addition to these preventive controls, the consequences of a nuclear criticality event are reduced by the use of mitigative controls, including:

Criticality accident alarm systems to alert workers of the presence and location of a criticality event

Public address system to alert and instruct workers about the presence and location of a criticality event

Emergency response program to ensure proper evacuation of the facility, account for personnel, control access during the incident, and plan recovery actions

Personal nuclear accident dosimeters (PNADs) provide estimates of the doses received by exposed personnel to support their medical treatment.

Worker training in nuclear criticality safety and in emergency response procedures are important elements of both preventive and mitigative controls.

Criticality controls that are not considered for FFC include neutron absorbers/poisons and fixed shielding. These controls are not viewed as cost effective for implementation in FFC.

6.4 FFC Facility Categorization

6.4.1 FFC Hazard Categorization

DOE non-reactor nuclear facilities are categorized based on inventory according to DOE-STD-1027-92^{Error! Bookmark not} defined. to determine the rigor of the safety analysis required to support licensing of the facility. Attachment 1 of this standard provides a listing of the threshold quantities for hazard categories 2 and 3 for selected isotopes. A portion of this table is reproduced in Figure 6-2. The second and third columns in this attachment show the threshold (minimum) values for a hazard category 2 facility in curies and grams, respectively, for the isotope shown in the first column. The fourth and fifth columns show the threshold (minimum) values for a hazard category 3 facility in curies and grams, respectively, for that isotope. Because the LEU-10%Mo has the potential for nuclear criticality, the hazard category 2 threshold is given in the note as 700 grams compared to a total facility inventory on the order of 7000 grams. Thus, the FFC is categorized as a hazard category 2 (HC2) facility. This result means that the facility will require a Documented Safety Analysis with Technical Safety Requirements (DSA/TSR) prepared in accordance with DOE-STD-3009-9 to meet the requirements of 10 CFR 830 Subpart B.

		DOE-STD-10 ATTACHME		
Isotope	Category 2	Threshold	Category 3	Threshold
	Curies	Grams	Curies	Grams
U-233	2.2E+02***	2.3E+04***	4.2E+00	4.4E+02
U-234	2.2E+02	3.5E+04	4.2E+00	6.7E+02
U-235 U-238	2.4E+02*** 2.4E+02	1.1E+08*** 7.1E+08	4.2E+00 4.2E+00 4.2E+00	1.9E+06 1.3E+07

^{***} To be used only if segmentation or nature of process precludes potential for criticality. Otherwise, use the criticality lists for U₂₃₃, U₂₃₅ and Pu₂₃₉ of 500, 700, and 450 grams, respectively.

FIGURE 6-2. Extract from DOE-STD-1027-92, Attachment 1 showing isotopes of importance to the FFC.

6.4.2 FFC Security Categorization

The security category for the FFC is determined from the amount and type of SNM in the facility based on the attractiveness level of the material. The DOE categorization scheme from DOE M 470.4-6⁸ is reproduced in Figure 6-3. Uranium that is enriched in U²³⁵ to a level less than 20% is designated as Attractiveness Level "E". Attractiveness Level E material is not readily converted to use in nuclear weapons and is therefore subject to lower levels of physical security. Quantities of Attractiveness Level E material larger than the reportable quantity of 1 gram cause the facility to be categorized as a Security Category IV (SC IV) facility as shown in the red outline in Figure 6-3.

Physical security requirements for SC IV facilities include a perimeter fence, secured material storage areas, and access control to prevent unauthorized entry into the facility. Security features such as armed guards, hardened material (LEU) storage areas, and motion detectors are not required for protection of SC IV material.

6.4.3 FFC Performance Categorization

In addition to other requirements, DOE O 420.1B defines the requirements for DOE nuclear facility design and construction to withstand Natural Phenomena Hazards (NPH)⁹ and to ensure confinement of hazardous materials, protection of occupants and members of the public, continued operation of essential facilities, and protection of government property. DOE STD-1021-93¹⁰ details the process for selecting the performance category for the facility and for safety SSCs consistent with the risks identified for the facility. Initial performance categorization provides a means of identifying, early in the design process, the level of design required consistent with the facility safety basis and the required safety systems. Figure 6-4 shows the guidelines from DOE STD-1021-93 for

_

⁸ DOE M 470.4-6, Chg.1, Nuclear Material Control and Accountability, August 14, 2006, 168 pp.

⁹ NPH include earthquakes, wind and wind-driven missiles, flooding, lightning, etc.

¹⁰ Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components, DOE-STD-1021-93, Change Notice #1, January 1996, 37 pp.

Table I-4. Graded Safeguards

			Pu/U-	233 Cates	zorv				arated Np- 1 and -243	All E
	Attractiveness			(kg)			•	gory (kg		Materials
1	Level	I	II	III	IV^1	I	II	III	IV^1	Category IV
WEAPONS	A	All	N/A	N/A	N/A	All	N/A	N/A	N/A	N/A
Assembled weapons and test devices										
PURE PRODUCTS	В	<u>≥</u> 2	<u>></u> 0.4<	≥0.2<0.4	< 0.2	<u>≥</u> 5	≥1<5	<u>≥</u> 0.4<1	<0.4	N/A
Pits, major components, button ingots,			2							
recastable metal, directly convertible										
materials										
HIGH-GRADE MATERIALS	C	<u>></u> 6	<u>></u> 2<6	<u>></u> 0.4<2	< 0.4	<u>></u> 20	<u>></u> 6<20	<u>></u> 2<6	<2	N/A
Carbides, oxides, nitrates, solutions										
(≥25 g/L) etc.; fuel elements and										
assemblies; alloys and mixtures; UF4 or										
UF ₆ (≥ 50% enriched)										
LOW-GRADE MATERIALS	D	N/A	<u>></u> 16	<u>></u> 3<16	<3	N/A	<u>></u> 50	<u>></u> 8<50	<8	N/A
Solutions (1 to 25 g/L), process										
residues requiring extensive										
reprocessing; moderately irradiated										
material; Pu-238 (except waste); UF ₄ or										
UF ₆ (≥ 20% < 50% enriched)										
ALL OTHER MATERIALS	E	N/A	N/A	N/A	Reportable	N/A	N/A	N/A	Reportable	Reportable
Highly irradiated forms, solutions					Quantities				Quantities	Quantities
(<1 g/L), uranium containing <20% U-										
235 or <10% U-233 ² (any form, any										
quantity)										

FIGURE 6-3. - Table I-4 from DOE M 470.4-6. The red outline indicates the security categorization of the FFC.

performance categorization of SSCs. According to this figure, and recalling that the preliminary hazards evaluation did not identify any safety-class SSCs, we conclude that the FFC performance category is PC2.

The lower limit for Category IV is equal to reportable quantities in this Manual.

The total quantity of U-233 = [Contained U-233 + Contained U-235]. The category is determined by using the Pu/U-233 side of this table.

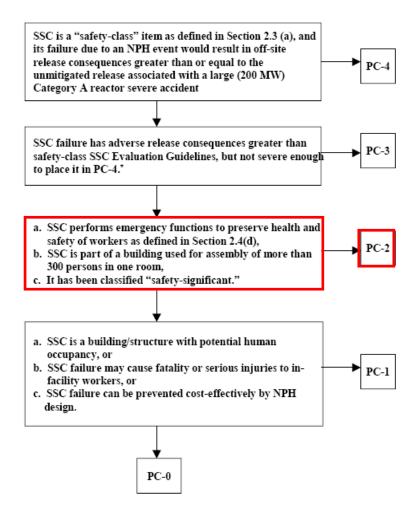


FIGURE 6-4. BASIC GUIDELINES FOR PRELIMINARY NPH PERFORMANCE CATEGORIZATION OF STRUCTURES, SYSTEMS AND COMPONENTS (FIGURE 2-1 FROM DOE STD 1021-93)

7.0 ENVIRONMENTAL STRATEGY

Section 2.2.4 of this report identifies Environmental Protection requirements for the FFC based on Federal environmental protection regulation. This chapter defines the permitting activities that must be completed before the FFC can be constructed and/or operated. In several cases, these permits can take many months and require significant investment to complete. The intent here is to identify those required items that could impact cost and schedule for the FFC.

7.1 NEPA – EIS/EA

This study assumes that the FFC will be regulated and licensed by the NRC. As part of the license application process, the licensee prepares an environmental report (ER) that provides the baseline information required for NRC to prepare an Environmental Impact Statement (EIS) or an Environmental Assessment (EA). The ER includes analysis of environmental impacts of construction and operation of the facility, including availability of water and other utility resources, release of pollutants to the environment, transportation impacts, economic costs and benefits, evaluation of alternatives, cumulative impacts (e.g., consideration of impacts from nearby activities), etc. Preparation of the ER requires both financial resources and time for the licensee staff to prepare the report. The NRC preparation of the EIS or EA does not start until the ER is submitted to the NRC. Similarly, the review of the EIS/EA includes receiving and responding to public comments on the proposed licensing of the facility before the NRC can issue a record of decision (ROD). The ROD is one component of the NRC license to begin construction of the facility. The important point here is that the NEPA process can impose a significant schedule constraint on the overall design and construction timeline.

To preclude significant schedule delays due to the NEPA process, the ER must be prepared as early as possible in the design process. This often means that the ER is based on conceptual designs rather on more detailed designs where the design information is more complete and accurate. ERs prepared based on conceptual-level designs adjust for uncertainty in the design by "bounding" the actual impacts with conservative estimates of the impacts.

One option that might be available to accelerate the NEPA process for the FFC would involve the case where the DOE is the licensee and the FFC would be built on a DOE site having existing NEPA documentation such as a site-wide EIS, a programmatic EIS, or a project-specific EIS that covers fuel fabrication or related activities. In this case, the existing NEPA documentation would be evaluated to see if it covers new activities such as construction and operation of a new facility such as the FFC. If the existing NEPA documentation does, in fact, include such new activities, the DOE could determine that the increased activity of the FFC on the DOE site has no significant additional impact over the impacts already approved. This determination could substantially reduce the time and resources required for NEPA compliance. In addition to reducing the time and cost to produce NEPA documentation, this option also has the potential to reduce impacts from site construction activities if the existing site infrastructure includes facilities that could support the FFC.

This option would require a Memorandum of Understanding (MOU) be developed between the NRC (as licensor) and the DOE (as licensee and as the responsible agency for the NEPA compliance activity) detailing the responsibilities of both agencies regarding the NEPA process. However, interdepartmental MOUs that reapportion responsibilities are not uncommon.

7.2 Other Permits

Air Emissions - NESHAPS

Because of the small number of hazardous chemicals, and the small inventories of those chemicals within the FFC, it is expected that the FFC will have negligible emissions of hazardous air pollutants. However, a dose rate study is needed to ensure that the radioactive content of air emissions from the facility do not exceed the 10 mrem/year standard for a member of the public (10 CFR 61.92). This study requires use of an EPA-approved model (CAP-88PC or AIRDOS-PC) for evaluating the dose from all exposure pathways (inhalation, immersion, ingestion)¹. The results of the analysis will determine what additional air emission monitoring and control technology, if any, would be required to meet the Clean Air Act standards.

Discharge of Water – NPDES Permit

As discussed in Chapter 2, the FFC will require NPDES permits for discharging stormwater runoff from the site during construction and during operation of the facility. The permit for the construction period is called the Construction General Permit, and the forms are available on the EPA website at http://cfpub.epa.gov/npdes/stormwater/const.cfm (note: the EPA is in the process of changing CGP forms). EPA is the permitting authority for the states of MA, NH, NM, ID, and AK, for the District of Columbia and in most Indian Country lands. In other states, the permitting authority has been delegated to the state, but some states do not have permitting authority for federal facilities. Timescales for issuance of CGPs under state authority are typically on the order of one month from submission of the Notice of Intent.

The FFC will require an NPDES permit for discharging stormwater runoff from the site's runoff collection structure. The EPA is the permitting authority for the states of MA, NH, ID, NM, and AK, the District of Columbia, and most Indian Country lands. In other states, the permitting authority has been delegated to the state, but some states do not have permitting authority for federal facilities (CO, DE, VT, and WA). In those cases, the EPA retains permitting authority for federal facilities. Timescales for approval of NPDES stormwater permit applications are on the order of one to three months.

Hazardous and Radioactive Wastes

As a generator of hazardous waste, the FFC will be required to have an EPA identification number (40 CFR 262.12). The FFC will store but not treat or dispose of hazardous, radioactive and mixed wastes. Hazardous and mixed wastes would be stored in a 90 day storage area that does not require a permit. The volumes of hazardous wastes generated at the FFC are small, and the FFC may qualify as a Small Quantity Generator or as a Conditionally Exempt Small Quantity Generator. The requirements and benefits for these designations are presented in Table 7-1.

_

¹ The analysis presented in Chapter 6 included only inhalation and was the cumulative dose over a 50 year period from an acute exposure. The air emissions analysis described here is the annual dose from chronic exposure to low concentrations of radionuclides.

TABLE 7-1. DESCRIPTION OF SMALL QUANTITY GENERATOR AND CONDITIONALLY EXEMPT SMALL QUANTITY GENERATOR DESIGNATIONS

Designation	Description	Requirements
Small Quantity Generator	Generate more than 100 kg but less than 1000 kg of hazardous waste per month	 May accumulate hazardous waste on site for 180 days without a permit (or 270 days if shipping a distance greater than 200 miles). On-site quantity of hazardous waste must never exceed 6000 kg At least one employee always available to respond to an emergency Not required to have detailed, written emergency plans
Conditionally Exempt Small Quantity Generator	Generate 100 kg or less per month of hazardous waste or 1 kg or less per month of acutely hazardous waste	 Must identify all the hazardous waste generated May not accumulate more than 1000 kg of hazardous waste at any time Must ensure that hazardous waste is delivered to a person or facility authorized to manage the waste. Is exempt from various EPA requirements (see 40 CFR 261.5).

Current estimates of hazardous waste volumes suggest that the FFC would qualify as a Conditionally Exempt Small Quantity Generator.

To ship hazardous wastes to a permitted TSD facility, the FFC must use the EPA's Uniform Hazardous Waste Manifest system (http://www.epa.gov/epaoswer/hazwaste/gener/manifest).

Low Level Radioactive wastes will be packaged for storage and for shipment to a commercial or a DOE LLW disposal site, as appropriate.

8.0 LICENSING REQUIREMENTS

The Atomic Energy Act requires the NRC to licenses the following activities:

- Construction, operation and decommissioning of commercial reactors and fuel cycle facilities.
- Possession, use, processing, exporting, importing, and certain aspects of transporting nuclear materials and waste.
- Siting, design, construction, operation, and closure of waste disposal sites.

The NRC regulates fuel cycle facilities that mill and enrich uranium and then fabricate it into fuel for use in nuclear reactors. The NRC also regulates the fabrication of nuclear fuel that is a combination of uranium and other materials. (Exclusive DOE use facilities are not regulated by the NRC. However, the FFC will provide fuel for both NRC and DOE regulated reactors and thus, require a NRC license.)

The NRC licenses fuel that is used in nuclear reactors by reviewing and approving the fuel qualification report. (A given fuel type is deemed acceptable for use in nuclear applications as a result of the review and acceptance of the qualification report. A fuel is licensed for use in a given reactor after the review of safety documentation for that reactor which references information in the qualification report and any additional fuel performance data that is required for the specific application.) NRC has adopted a policy of discouraging the use of HEU fuel. This policy is reflected in 10 CFR 50.64.

This chapter provides the NRC regulatory requirements for the licensing of the LEU-Mo monolithic fuel and the licensing of the Fuel Fabrication Facility.

Although the FFC will be licensed by the NRC, applicable DOE requirements for the design, construction and operation will also be considered.

8.1 Licensing of the LEU-Mo Monolithic Fuel

A fuel is considered "qualified" within a given envelope of operating conditions after the NRC has reviewed and accepted documentation supplied by the fuel developer which summarizes the fuel performance and properties within that specific envelope. Licensing is the action of the regulatory authority i.e. the NRC to approve the use of the fuel in a specific reactor, since the suitability of the fuel is judged with respect to the conditions that the fuel may experience in that reactor. In order to facilitate licensing of a number of reactors to use the same fuel, the NRC has agreed to review a fuel qualification report on a generic basis and issue approval for it's use within an envelope of conditions covered by the qualification tests, similar to the approach the NRC used in issuing it's approval for the U₃Si₂ dispersion fuel: NUREG – 1313 Safety Evaluation Report related to the Evaluation of Low Enriched Uranium Silicide-Aluminum Dispersion Fuel for Use in Non Power Reactors. Such generic approval is not a license to use the fuel; each reactor must show that its intended use fits within the approval envelope. Generic approval of the fuel may be viewed both as the end of fuel qualification and beginning of licensing.

The RERTR program has a well planned fuel qualification program to pursue generic approval of the NRC for the LEU-Mo monolithic fuel. (See Report INL/EXT-05-01017.) The qualification process for the monolithic fuel is based on developing industrial processes and adequate specifications for manufacturing LEU-Mo fuel plates, getting basic data for ex-reactor and in-reactor irradiation tests on miniature and full sized plates, obtaining a comprehensive

understanding of the LEU-Mo fuel performance under reactor operational conditions, developing models to aid in understanding and predicting irradiation behavior, and confirming through the irradiation of full size sub-assemblies that the integrated fuel behavior is consistent with the testing database. The manufacture and irradiation of full sized sub-assemblies is the last stage of the fuel qualification process. During the qualification process one fuel sub-assembly is irradiated to a high burn-up, typically 70-80% average, in order to demonstrate that adequate margins exists beyond the burn-ups normally reached in reactors that will use this fuel. The generic fuel qualification data is submitted to the NRC in a fuel Qualification Report. The NRC reviews the report and issues a Safety Evaluation Report (SER) signifying its approval of the generic fuel deign. Following issuance of the SER by the NRC that describes the generic behavior of the LEU-Mo fuel, specific analysis and testing required to license individual reactors to use the fuel is initiated. Additional tests may be necessary to support utilization in a specific reactor subsequent to the NRC acceptance and review of the fuel qualification report. In these cases Lead Test Assemblies (LTAs) will be fabricated for the given reactor in order to demonstrate satisfactory behavior in the specific configuration and operating conditions.

In addition to qualifying the fuel itself, the fuel fabricator must be qualified. To be qualified, the fabricator must demonstrate its ability to manufacture the LEU-Mo monolithic fuel plate sub-assemblies, which consistently meet specifications developed and demonstrated during the fuel qualification process, and that fuel assembly performance is consistent with the fuel performance database. This is normally accomplished by quality tests and inspections during the hot start-up process. In addition this is also accomplished through the manufacture and irradiation of the full sized sub-assemblies — Lead Use Assemblies (LUA's). The irradiation of the full sized sub-assemblies provide better statistics through the irradiation of many plates and demonstrate the ability of the fuel fabricator to produce acceptable plates and sub-assemblies by an industrial scale process.

8.2 Licensing of Fuel Fabrication

The NRC regulates fuel cycle facilities through a combination of regulatory requirements; licensing; safety oversight, including inspection, assessment of performance, and enforcement; operational experience evaluation; and regulatory support activities. The purpose of the NRC regulations is to ensure adequate protection of the health and safety of workers and members of the public, safeguards and security and the environment for activities performed at the fuel fabrication facilities

NRC's regulations are found in chapter I of Title 10, "Energy" of the Code of Federal Regulations. Chapter I is divided into Parts 1 through 199. The following lists parts relevant to the licensing and operation of the FFC:

- Part 20 Standards for the Protection Against Radiation
- Part 40 Domestic Licensing of Source Materials
- Part 51 Environmental Protection regulations
- Part 70 Domestic Licensing of Special Nuclear Materials
- Part 73 Physical Protection of Plants and Materials
- Part 74 Material Control and Accounting for Special Nuclear Material
- All current rule making

NRC has also issued as guidance Regulatory Guides that are issued in 10 divisions and are intended to aid licensees in addressing regulations. The guides that are most applicable to the design and license of the FFC are:

- Division 3 Fuels and Materials Facilities
- Division 4 Environmental and Siting
- Division 5 Materials and Plant Protection
- Division 8 Occupational health

NRC reviews the application for construction permit and operation license, according to procedures and criteria documented in a Standard Review Plan (SRP). If the application is approved a license is issued. The license contains the amount and type of material that the facility is allowed to posses and any special conditions imposed by the NRC. The fuel cycle materials facilities licenses are typically issued for 10 years. The SRP applicable to the FFC is expected to be:

• Standard Review Plan for the review of a License Application for a Fuel Cycle Facility (NUREG-1520)

In order to obtain a license to build and operate a Fuel Fabrication facility, an applicant must submit an application for approval to the NRC. The contents of the application are specified in the Code of Federal Regulations (CFR) and reflect the requirements set down by Congress in the Atomic Energy Act.

The main regulation that apply to the FFC is Title 10 of the Code of Federal regulations, part 70 (i.e., 10 CFR 70), "Domestic Licensing of Special Nuclear Material". Under the regulation, NRC authorization must be received before construction via a Construction Permit (CP) and an Operating License (OL) before operation of the FFC. In addition the impacts of the construction and operation of the FFC on the quality of the human environment will have to be assessed in either an Environmental Assessment and or an Environmental Impact Statement.

Construction Permit

Under NRC regulations an application for the construction of the FFC must be submitted to the NRC before construction of the facility. To request a Construction Permit (CP), the applicant must provide:

- an Environmental Report (ER)
- a description of the plant site
- a description of the safety assessment of the design of the principal structures, systems and components (ISA), and
- a description of the quality assurance program.

Utilizing the information provided in the Construction Permit (CP) application, the NRC performs the following:

- prepares the Environmental Impact Statement (EIS)
- performs a review of the ISA Report (Integrated Safety Analysis)

- prepares a Safety Evaluation Report (SER)
- conducts public hearings
- issues Construction Permit (CP)

Operations License

To request and Operations License (OL) an applicant has to submit the following documents:

- Environmental Report (ER) supplement
- a final ISA
- technical specifications

Utilizing the information provided in the Operations License (OL) application, the NRC performs the following:

- Prepares an EIS supplement
- Performs review of the final ISA
- Prepares a SER
- Issues Operations License.

A proposed timeline for the NRC licensing process is included in Section 11 – Schedule estimate. The timeline is aggressive, and is based on a well characterized uncontaminated site, and early joint NRC/NNSA agreement of the regulatory frame work of the project for the design, construction and commissioning of the FFC.

9.0 RISK MANAGEMENT

This section provides the high level programmatic and technical risks, and risk management strategies for the Greenfield FFC. This risk assessment is based on the initial scoping evaluation of the process and facility design as well as process hazards evaluations conducted as part of this Greenfield Alternative Study.

The primary objectives of the FFC mission are:

- Provide proliferation resistance fuel for use in US HPRRs In accordance with NNSA's GTRI program directive to meet the US HEU minimization policy
- Convert the 5 US HPRR's that currently use HEU- based dispersion fuel to a new monolithic LEU-Mo fuel by 2014. The ultra high density LEU-Mo fuel provides the proliferation resistance and is appropriate for research reactor use.
- The Fuel Fabrication Capability (FFC) facility to be designed, built and commissioned in time to support fabrication of LUA's and HPRR cores in order to complete conversion of the HPRR's per plan.
- The FFC will be licensed by the NRC; likewise the LEU-Mo fuel will require NRC approval via submittal initially of the generic Fuel Qualification Report followed by the specific data of the performance of the LTA's irradiated in each of the HPRRs.

The above FFC mission goals in conjunction with the initial hazards evaluation (See section 6.0) provide the basis for identifying the high level programmatic and technical risks of the FFC. These risks impact the ability of the FFC to be completed on schedule (1/1/2013) to support the conversion of the HPRRs by 2014, as well as contribute to cost growth. Hence these risks must be managed/mitigated so as to deploy an on-time, cost-effective FFC that meets the mission objectives. The risks identified in this section are specific to the Greenfield Alternative for the LEU-Mo FFC project, and given the quick initial assessment, the risks are preliminary.

9.1 Programmatic Risks

The programmatic risks comprise of those high level risks which require management by the NNSA. These risks involve (1) Performing the FFC alternatives evaluation for the selection of the acquisition strategy, (2) Providing adequate project funding, (3) Establishing high-level project interfaces, (4) Facilitating early involvement of the NRC to establish the licensing strategy for the project, and (5) Timely site selection.

Evaluation of the project schedule indicates that even with the very short performance period for completion of the FFC project, it is still possible to meet the GTRI milestone for reactor conversion. The successful early mitigation of the programmatic risks is essential to establish the framework for the successful deployment of the FFC project and meet the FFC mission goals.

The key programmatic risks are summarized below:

• Acquisition Strategy –The NNSA has a process in place for the selection of either the Commercial alternative or the National Laboratory alternative for the deployment of the FFC. An expeditious selection is key and crucial for the downstream project initiation activities, in- particular the start of the conceptual design in October 2008 leading to the DOE approval of CD-1 by July 2009. This is required in-order to complete the time-critical licensing, design, construction and commissioning of the FFC to support completion of hot operations by 1/1/2013.

To mitigate this risk, a dual path conceptual design of the National Laboratory Alternative and the Commercial Alternative should commence in October 2008, in the event the acquisition strategy decision is not made on time. The project planning level schedule included in Section 8.0, provides an aggressive schedule that is compliant with DOE O 413.3A for the acquisition of the FFC assets. However there is little float in the schedule, and any delay in the critical path design and equipment procurement activities will delay the start of the FFC operations.

- Adequate Project Funding Given the important proliferation resistance mission of the FFC in support of the NNSA, it is necessary that the project be funded fully to allow uninterrupted execution of the planned R&D, design, licensing, construction and commissioning activities. Any funding cuts will cause delays to project completion, and contribute to adding to the cost of the project. The project cost estimate is presented in Section 10.0 of this report.
- Establish High-Level Project Interfaces Early definition of the high-level project interfaces is necessary to establish the firm project scope and requirements from the outset. The interface definition will require either trade studies or programmatic decisions. Examples of interface include (1) casting operations (2) waste treatment and disposal plan (3) Make-buy evaluations for the supply of fabricated materials for the project.
- Early Involvement of the NRC The FFC will be licensed by the NRC. This includes obtaining a Construction Permit in order to commence with the construction and subsequently the Operations License to commence with the operations. Early engagement of the NRC to establish the FFC licensing strategy including establishing the Standard Review Plan Requirements for Licensing documents approval, as well as requirements for plant commissioning would be very beneficial. A stable regulatory process is necessary to avoid rework and delays. It is recommended the NRC involvement and familiarity with the process operations, commence in the conceptual design phase.
- Timely site Selection If the NNSA selects the National Laboratory site for housing the FFC, it is preferred the selected site meet the following requirements to minimize impacts to project cost and schedule: (1) Fuel fabrication activities are currently performed at the site, (2) There is a programmatic EIS at the site that allows new fuel fabrication activities (3) About 15 acres of well characterized uncontaminated land adjoining the national laboratory site is available for siting the FFC (4) utilities, emergency management facilities and facilities for treatment, packaging and disposal of waste are available at the site, and (5) Allows cost effective construction and operations of the facility. Site selection is required to be completed by 4/2009, in order to allow for the start of the preparation of the construction permit application as planned.

Note: if the NEPA process is involved for site selection, it could result in cost and schedule impacts.

It must be mentioned , that the above high level programmatic risks be managed by the NNSA, so as to allow the project to allow the critical path design and licensing activities to commence in October 08 in order to not jeopardize the completion of the hot ops of the FFC by 1/2013

9.2 Technical Risks

The project technical risks involve challenges related primarily to technology development and demonstration as well as the NRC acceptance of the Fuel Qualification report and to a lesser degree technical issues resolution.

A number of technology development topics and demonstration of the fabrication processes have been noted in Section 1.4.2 of this report. The National Labs should in FY-09 and FY-10 complete the on-going development and demonstration of these processes to allow selection of the equipment and processes for the FFC. Key processes to be down-selected based on performance during technology demonstration includes the following:

- Diffusion Barrier material (zirconium or silicon layer)
- Fuel plate bonding equipment/process (Friction Bonding or Hot Isostatic Pressing)
- Non-destructive fuel plate examination process for monolithic fuels

Another key work item for the national labs is the preparation of the Generic Fuel Qualification report to be submitted to the NRC. This includes irradiation testing data of mini plates, full-size plates and a full element required for the qualification of the generic LEU-MO monolithic alloy fuel.

The National Labs engaged in supporting the development and maturity of the FFC processes and equipment designs have to be adequately funded to allow completion of these key development activities of the FFC processes in the near term. The Technology Readiness Levels (TRL) for all processes to be deployed in the FFC at CD-2 should be at 8 or higher.

Key technical risks for the FFC much like other Fuel Fabrication Facilities include the following topical areas:

- Safety
- Safeguards and Security
- Waste Management
- Cost
- Technology

The risks involved with these areas must be addressed from the outset, so as to establish the project requirements and features necessary to handle these risks and gain DOE and NRC authorization for the construction and operations of the FFC. Based on the initial scoping hazards evaluation included in section 6.0 of this report, safety concerns include chemical, fire and criticality hazards along with normal industrial hazards. Our evaluations indicate these risks pose a low risk to the public, most at risks from these hazards are the plant workers, and most of the worker safety risks are non-radiological in nature.

The risks are quantified as High, Medium or low based on a qualitative assessment of the level of likelihood that an event will occur and the level of consequence if that event does occur. The risk level matrix is shown in Figure 9-1

Risk Consequences

		Negligible	Marginal	Significant	Critical	Crisis
ø	Very Likely	Low	Medium	Medium	High	High
s k i n e s	Likely	Low	Low	Medium	High	High
Ri ikel	Unlikely	Low	Low	Medium	Medium	High
Γ	Very Unlikely	Low	Low	Low	Medium	Medium

FIG. 9-1 RISK LEVEL MATRIX

A scoping level assessment of the risks involved in each of the technical areas identified above, and near term actions required to address these risks is identified in Table 9-1.

TABLE 9-1 FFC PRELIMINARY PROJECT TECHNICAL RISKS AND MITIGATION

Item #	Technical Risk Area & Risk level	Risk	Risk Mitigation Strategies
1	Safemards	Key hazards which provide safety risks, include: Criticality, Fire, Natural Phenomena, and Industrial hazards (burns, electrical shocks etc.) NRC licensing requirements for project not established. NRC staffing for review of Project documents is critical to avoid delays	 Perform a preliminary Hazards analysis during conceptual design. Provide engineered safety features to mitigate the risks. Perform fire Hazards and Life Safety evaluations. Provide engineered features to address all fire and life safety code requirements. Prepare criticality hazards calculations to establish criticality control features for the project Integrate safety into design early, follow requirements of DOE STD 1189. NRC/NNSA establish the regulatory framenwork for the project early in the conceptual design Early involvement of the NRC during the developemnt of the design NRC to be adequaltely staffed to support timely review of project licensing dcouemnts
2	Safeguards and security - Low	Concerns over safe and secure transport of nuclear materials and security of the FFC from terrorist attacks.	 Use only low enriched material which has a much lower attractiveness level. Perform vulnerability assessment to provide the appropriate protection of the nuclear materials in the FFC FFC located at a national Laboratory site, which has established security. The LEU-Mo alloy material will be packaged in accordance with 10 CFR 71, security for the material in transit will be in accordance with 10 CFR 73.
3	Waste management - - Low	Concerns over management (treatment and disposal) of hazardous waste	 Perform trade studies to establish path forward relative to utilizing the host site capabilities or including these capabilities in the FFC: Treatment of hazardous liquid waste Characterization, Packaging and shipping the waste to disposal facilities Perform waste minimization studies, with

			emphasis on internal recycling to the maximum extent feasible. Include the selected approach in the facility design basis.
4	Cost - Medium	Concerns over cost growth	 Perform trade studies as identified in Section 1, to optimize the facility layout Avoid any project implementation and site selection delays, so as to accomplish project activities as scheduled. Project escalation costs amount to approx. \$1.8 million a year Freeze project functions and operations requirements during conceptual design, likewise establish the project licensing and permitting strategies approved by the NRC early in the design process, to establish a firm regulatory basis from the outset. This is necessary to avoid rework. Prepare a rigorous Project risk management plan and risk management strategies. Adopt a design-build strategy to realize efficiencies and cost savings. Implement a design-to-cost to manage changes. Utilize the draft NNSA PDRI process to ensure design deliverables provide the required maturity before authorization is provided to advance to the next phase. Perfrom source surveys to selct qualified vendors of process equipment. Seek authorization to procure long lead equipment upon completion of CD-2 doucmentation.
5	Technology – Medium	Uncertainties exist in: Selection of diffusion barrier Selection of the plate bonding process Selection of the non-destructive examination process NRC acceptance of the Generic Fuel Qualification report	 Perform the required demonstration/testing in FY-09 in-order to down-select the processes to be incorporated in the FFC Prepare a technology maturation plan/road map to define the pathway to be used to mature the technologies selected for deployment in the FFC. (Require TRL-5 for CD-1 approval and TRL-7 or better for CD-2 approval) Early involvement of the NRC realtive to the developemnt of the Fuel Qualification test data and perfromance evaluation Complete Fuel Qualification documentation for submittal to the NRC by 12/2010

9.3 Risk Management Plan

A risk management plan will be prepared during the conceptual design phases, so that all FFC project risks are identified and that all events that might adversely impact the performance of the project are addressed by incorporating appropriate efficient and cost effective measures to manage the unacceptable project related risks. The risk management plan will describe the roles and responsibilities of the project personnel in performing risk management functions, and will define reporting and tracking requirements for risk related information. A product of the risk management process is a report on project risks. The report will list the high and moderate level risks and includes the risk handling strategies and project impacts.

The risk management process will include the following:

- Preparing a risk management plan
- Risk identification; risk analysis and reporting
- Project impacts determination Cost and schedule
- Risk tracking, reporting and closure

The risk management process will:

- Assess individual risks and their impact on project and facility performance, cost and schedule.
- Evaluate alternate approaches to manage high risks.
- Develop action plans to handle (i.e., avoid, reduce, transfer, or accept individual risks).
- Interface risks with other projects/ programs.

Secondarily, the project risk management process will:

- Provide risk-informed feedback regarding the setting of project milestones and goals.
- Identify actions that can be taken to help achieve cost, schedule and performance goals.
- Assist in making decisions on funding priorities.
- Assist in monitoring the status of the project as it proceeds.
- Provide evidence of compliance with NNSA project risk management requirements.
- Evaluates TRL's for key process/equipment items, to mange technology related risks.

10.0 COST ESTIMATE

This section provides the estimate basis comprising of assumptions, inclusion/exclusions as well as the basis used for estimating the quantities and prices used in this ROM scoping level cost estimate. The estimate is based on the site, facility and process design and layout drawings prepared for this Greenfield Alternative Study. A detail process and mechanical equipment list was prepared and used to estimate the pricing of the equipment items. Also included are the estimate summaries and details along with a project contingency analysis based on the risk evaluations for the various cost accounts included in the estimate. ROM estimate ranges were prepared for the following:

- Base Case Greenfield Facility using the Friction Bonding process
- Greenfield Facility using the Alternate HIP Process.

A summary level operations cost estimate was also prepared.

10.1 Assumptions.

The following are the assumptions used for the preparation of the ROM type cost estimates.

- All costs are in constant un-escalated CY 2008 dollars.
- FFC is sited at an uncontaminated well characterized site at a US National Laboratory with an on-going fuel fabrication program.
- Cost of land, access roads, utilities (Power, water, sewer) to the site boundary is not included in the estimate
- Adequate annual funding will be provided for un-interrupted progress to completion.
- Owner's costs are not included .This includes costs for project management and control, site security, environmental permits and safety documentation, start-up, testing and acceptance cost.
- Cost for fuel qualification and technology development and demonstration is not included in the estimate.
- Cost of LEU-Mo feed material including transportation from Y-12 is not included.
- Costs of shipping casks and containers are not included in this estimate.
- Costs for the treatment, packaging and disposal of waste are not included.

10.2 Cost Estimate Basis

The construction approach envisions one General Construction Contractor with fully sub-contracted union shop labor. A standard 40 hour work week is assumed @ 5 days 8 hours/day.

10.2.1 Quantity Basis

Quantities for the civil/structural/architectural works were largely based on the site and facility layout drawings included in Appendix A. The equipment quantities and design parameters were based on a detail mechanical and process equipment list included in section 3 of the estimate. All other accounts utilized factored estimates considering building size and historical data for industrial facilities. The quantity basis for each of the construction code of accounts is shown below:

Code of Account	Description	Quantity basis
02	Improvement to site	This account includes site preparation activities comprising of clearing and grubbing, site drainage, installing yard fencing, building parking lot and site roads including asphalt wearing coat. Quantities were estimated using the site layout drawings.
03	Earthwork	This account includes excavation and backfill for the building foundation and slabs on grade, and all earthwork required for the roads and parking lots. Quantities were estimated using the site layout drawings.
04	Concrete	Quantities based on the layout drawings: o 18" thick Slab on Grade in work shop area o 6" thick slab on grade in office area o Continuous footer 4' wide x 2' thick along building column o 6" thick slab on metal deck in the suspended slabs o Concrete walls in the radiography area
05	Structural Steel	Quantities include structural framework to support the cranes and hoists. Quantities were estimated using the site layout drawings.
06	Permanent equipment	This section includes the mechanical and process equipment per the equipment list included in section 3 of this report. All the equipment is identified in the facility layout drawings included in the Appendices of this report.
11	Piping Bulks	The quantities were estimated using a factored approach considering the facility size.
12	Electrical Bulks	The quantities were estimated using a factored approach considering the facility size
13	Instrumentation Bulks	The quantities were estimated using a factored approach considering the facility size.
16	Buildings	This account was based on quantity take off from the facility layout drawings including elevations and sections. The account includes building siding & roofing (insulated metal panels), interior walls and structural steel building framing. Also included is the personnel amenities, as well as standard building HVAC.

10.2.2 Pricing Basis.

The prices for the construction accounts was based upon current project costs such as from the Integrated Waste Treatment Unit Project and other on going URS WD projects. The pricing for the specialty equipment items such as HIP, Electron Beam Welder, milling and rolling machines, friction bonding machine, X-ray and fluoroscopy equipment were based on preliminary vendor data. All other standard off-the shelf items were based on URS WD project data base pricing and or the Means hand book.

- The construction labor rates are "all in" labor rates for union craft labor and includes:
 - O Direct Labor wages: W2's, fringes, legalities, small tools, consumables, safety items/training, construction equipment and maintenance.
 - Site in directs: Site office, mobilization and de-mobilization; indirect craft support such as scaffolding, clean-up, material receiving and storage.
 - o General Construction contractor's overhead and profit.
- A labor factor of 1.2 is applied to account for Quality assurance (NQA-1 for Quality level 2 items) and protocols for work at a federal site
- Construction Management Services includes costs for site construction manager, and personnel for safety, project controls and superintendents for civil/structural, piping/mechanical and electrical/I&C.
- Design/Engineering (Home Office Services) costs are based on a factored percent of the direct field cost for preparing the Preliminary and final design of the project.
- Insurance is calculated at 0.42% of the Total Field Cost and Home Office Services Cost
- Taxes for materials and services have not been included as the FFC is a federal project.
- Freight is applied at 5% on all materials cost.

10.3 Contingency

Contingency Development Approach

Contingency is a specific provision of resources to be included in an estimate for undefined items, which statistical studies of historical data have shown, will likely be required within a defined scope of work. Contingency covers inadequacies in the estimate basis definition (level of completeness of the design) and inadequacies in the estimating methods and data (Quantity and pricing data). The methodology used for estimating the contingency is the Risk Analysis method.

Risk Analysis

The Risk Analysis method for estimating project contingency utilizes the Monte Carlo Simulation Model. The contingency development process follows the following steps:

• Develop the cost of the project. Group the cost into discrete work items (See Risk Analysis work sheet)

- Next identify uncertainties in the various estimate accounts for labor, materials, subcontract etc. as shown in the risk analysis work sheet, by specifying the possible +/- values of the variables in the estimate with probability ranges.
- Discrete values of the uncertainties (Low and high values) were established based on the consensus of the estimator, the INL project team and the project design team. The uncertainty ranges were established by examining for each estimate account the type of work activity, the completeness of the design and the source of the pricing/cost data.
- Analyze the estimate with simulation. The simulation model is run (2000 to 3000) iterations to determine the range and probabilities of all possible outcomes of the model. During each iteration, a value for each variable is selected randomly based on the specified probability distribution.
- The results are presented as overall probability distribution for the simulation. The estimate range is established based on the desired confidence level, which represents the confidence that the estimate will not be exceeded

The estimate range for the FFC is established as follows:

- Confidence Level of 99% for the high end
- Confidence Level of 70% for the low end
- Confidence Level of 80% for the median end

10.4 Estimate Summary

Estimate sheets for the summary and details of the estimate are provided in the Attachment to this section for (a) The base case using the Friction bonding process and (2) The HIP alternate. Capsule summaries are presented below:

10.4.1 Base Case Estimate summary.

The base case (friction bonding) estimate summary is shown in Table 10-2

TABLE 10-2 FFC BASE CASE COST ESTIMATE SUMMARY (ALL COSTS ARE IN MILLIONS OF DOLLARS)

(ALL COSTS ARE IN MILLI	ONS OF DO	=
Cost Elements		_
Yard / Civil Works	\$2.3	
Building (FFC)		
 Foundations 	\$4.6	
o Superstructure	\$6.5	
Equipment	\$12.0	
Utilities		
o HVAC	\$3.9	
o Others	\$9.6	
Other Buildings		
 Warehouse 	\$0.8	
Substation	\$0.5	
Total Direct Field Cost		\$40.2
Professional services		
 Design/engineering 		
services	\$7.2	
 Construction 		
management	\$1.7	
Field & Other Professional		
Service Cost		\$49.1
Other cost		
o Insurance/Freight	\$1.4	
Contingency		
 Median 	\$13.9	
High	\$22.3	
o Low	\$11.6	
Total Project Cost		
o Median		\$64.4
o High		\$72.8
o Low		\$62.1
		:

The Base case (friction bonding) total estimate cost range is \$62 M - 73 M

The segregated costs for the casting area are approximately \$5M.

10.4.2 HIP case (HIP bonding) estimate summary

The HIP case estimate summary is shown in table 10-2

TABLE 10-2 FFC HIP CASE ESTIMATE SUMMARY (ALL COSTS ARE IN MILLION DOLLARS)

(ALL COSTS ARE IN MIL.	LION DOLI	LARS)
Cost Elements		
Yard / Civil Works	\$2.4	
Building (FFC)		
 Foundations 	\$4.8	
 Superstructure 	\$6.8	
Equipment	\$23.6	
Utilities		
o HVAC	\$4.4	
o Others	\$9.7	
Other Buildings		
o Warehouse / ECF	\$0.8	
 Substation 	\$0.5	
Total Direct Field Cost		\$53.0
Professional services		
 Design/engineering 	\$9.0	
services		
 Construction 	\$1.7	
management		
Field & Other Professional		
Service Cost		\$63.9
Other cost		
o Insurance/Freight	\$1.8	
Contingency		
o Median	\$17.7	\$83.4
o High	\$27.3	\$93.0
o Low	\$15.2	\$80.9
Total Project Cost		
o Median		\$83.4
o High		\$93.0
o Low		\$80.9

The HIP case (HIP bonding process) total estimate cost range is \$81M - \$93M. The additional cost range for the HIP option is \$13M - \$20M.

10.5 Operations Cost

The annual operations cost is comprised of the annual labor cots and annual non-labor costs.

The staffing estimate for the FFC is provided in table 5-3 – FFC Shop personnel tally and Table 5-4 FFC Office personnel tally. The staffing estimate includes 55 shop floor personnel and 17 management and administrative personnel for a total FFC head count of 72 personnel.

Based on historical data the annual labor cost estimate for the 72 personnel is: \$8M -- \$10M

The annual non-labor costs include costs for:

- Utilities
- Materials and consumables
- Equipment replacement.

Section 5.19 of this report provides a detail listing of materials and consumables.

Using historical data for industrial facilities, the annual non-labor costs are estimated to be as follows:

- Utilities -- \$ 1M \$ 2M
- Materials & Consumables -- \$ 5M --\$ 6M
- Equipment Replacement --\$ 1M -- \$ 2M

Hence the annual operations cost is estimated to be \$ 15M -- \$ 20M

10.6 Startup & Testing

Startup and Testing costs are included in the owner's cost and based on historical data are anticipated to be \$10M - \$15M.

Estimate Summary

Base Case (Friction Bonding)

Date: Priced By:

9:56

FFC Product Line: Filc Name: Office:

6/20/2008 ADC Denver Gov

Washington Division

GREEN FIELD SITE

FFC

Client: Project: Location: Facility:

Entire Estimate

Green Field Site

Rev No: 0

Job No: 27989-325

\$2,810,172 \$7,407,840 \$413,652 \$15,221,404 TOTAL \$1,758,213 \$1,267,365 \$963,860 \$5,363,725 \$1,715,494 \$7,203,000 20 8 20 \$40,177,734 \$1,715,494 \$1,118,385 \$13,860,281 \$64,324,980 \$41,893,227 \$49,096,227 \$250,087 \$64,324,980 SUBS \$46,150 \$238,220 \$238,220 \$2,654,150 \$492,487 \$3,192,787 \$3,431,007 \$3,431,007.31 MATERIAL \$1,763,044 \$244,090 \$353,652 \$4,056 11,722,390 \$1,329,359 \$22,367,690 \$1,956,697 \$149,881 \$22,367,690 \$4,844,521 \$22,367,690 \$844,864 LABOR \$7,203,000 \$867,563 \$959,804 \$14,617,256 \$1,477,274 \$1,477,274 \$5,644,796 \$1,480,813 0.00% 0.00% \$169,561 \$126,983 \$2,914,541 \$16,094,530 \$23,297,530 % of Sales: WORKHOURS 0.51% 009'89 10,501 11,882 72,070 1,858 9,533 18,485 17,394 37,425 20,984 20,984 270,154 2.28% 27.47% 180,570 201,554 Prov. Rate: TOTAL FIELD, HOME OFFICE AND ENGINEERING Temporary Construction Facilities, Furnishings, Services TOTAL PROJECT COST Basis for FEE INSURANCE CGL & Pkg Policy FREIGHT 5% on Material Costs Constr. Mgt. Staff & Scrvices Craft Labor Related Expenses FEES ON CLIENT COSTS GRAND TOTAL PROJECT INDIRECT FIELD COST PERMITS (EXCLUDED) Structural Steel/Platework WARRANTY RESERVE DIRECT FIELD COST Painting/Coatings/Lincrs Construction Equipment TOTAL FIELD COST BONDS (EXCLUDED) TAXES (EXCLUDED) Instrumentation Bulks Home Office Services Permanent Equipment improvements to Site Concretc/Masonry Start Up Scrvices CONTINGENCY CLIENT COSTS DESCRIPTION Electrical Bulks ESCALATION Piping Bulks Demolition Sparc Parts Earthwork Insulation Buildings G&A ?? Freight FEES ACCT 74.30 74.50 79.50 74.10 74.40 80.10 74.20 100.2 100.1 89.1 90.1 110 31 32 33 41 51 9 16

Grand Total Summary

PROPRIETARY & CONFIDENTIAL
The information contained herein is intended for use solely by Client madder other parties expressly authorized in writing by URS Weahington Division. The information contained herein shall not be disclosed to say third parties without the prior written consent of URS Veahington Division.

Page 1 of 1

Wasnington

FFC Greenfield Site

Expected Value 13,519,601 2,998,630 2,083,164 524,318 2,607,482 0.0% 0.0% PROBABILITY SIMULATION 2,396,003 52,140 1,901,795 8,301,398 %0.0 5,576,846 1,530,312 10,203,192 57,726,416 2,448,143 16,690,968 7,107,158 17,152,387 1,517,087 57,726,416 172,737 17,152,387 1,517,087 High Percentile % 80 8888888 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 Low 5 5 2222222 2222 5 5 99 9 임 9 9 9 9 9 10 % more **4 4 444** 20020 25 25 20 9 0 99 High Value Estimate 0.0% 2,969,053 64,610 3,033,663 0.0% 16,753,072 3,715,810 209,833 2,230,142 10,084,200 2,445,871 615,609 1,779,014 %0.0 7,266,782 1,994,039 21,925,884 21,925,884 12,314,342 72,053,918 72,053,918 20,678,715 9,260,820 3,061,480 COST ESTIMATE RISK ANALYSIS MODE! % less 90 00000 5050 9 9 က်က် -10 -10 (Costs in Current Dollars) Low Value Estimate 45,631,377 1,908,677 41,535 1,950,212 10,769,832 2,388,735 142,387 0 1,129,955 1,761,027 443,238 2,204,266 1,629,719 6,842,850 0.0% 0.0% 0.0% 1,300,048 4,117,843 13,155,530 8,472,569 13,300,954 5,247,798 13,155,530 45,631,377 2,120,752 46,150 2,166,902 11,966,480 2,654,150 149,881 492,487 2,449,184 1,715,494 7,203,000 %00.0 0.00% 0.00% 0 Reference 1,329,359 14,617,256 4,844,521 6,173,880 1,956,697 14,617,256 8,918,494 1,368,472 1,368,472 50,464,699 Target 14,770,511 **Estimate** 50,464,699 Plant Equipment (Non-Firm Priced) - Material Plant Equipment (Non-Firm Priced) - Subcontract Plant Equipment (Firm Priced) - Material Plant Equipment (Firm Priced) - Subcontract Construction Indirects
TOTAL INDIRECT CONST. COSTS
PROFESSIONAL SERVICES COSTS Taxes, Ins., Bonds, L.O.C., etc.
TOTAL OTHER PROJECT COSTS TOTAL PROF. SERVICES COSTS OTHER PROJECT COSTS Non-Manual Local Hires
TOTAL DIRECT LABOR COSTS
INDIRECT CONSTRUCTION COSTS Pipe, Valves & Fittings - Subcontract Insulation & Paint - Material Constr. Management (Field Staff) Contingency (%)
Contingency (\$)
Business Development Rate (%) Pipe, Valves & Fittings - Material Home Office Services - Material Insulation & Paint - Subcontract ESTIMATED PROJECT COST Run @Risk Simulation Instrumentation - Subcontract Home Office Services - Labor TOTAL MECHANICAL Business Development (\$)
TOTAL PROJECT COST Instrumentation - Material Buydowns - Subcontract TOTAL BUYDOWNS LABOR COSTS TOTAL ELECTRICAL Civil Work - Material Civil Work - Subcontract H.O. Overhead Rate (%) F.O. Overhead Rate (%) F.O. Overhead (\$) Electrical - Subcontract TOTAL CIVIL
MECHANICAL WORK Description **ELECTRICAL WORK** TOTAL BURDEN Buydowns - Material Electrical - Material H.O. Overhead (\$) Direct Craft Labor BUYDOWNS Uncertain Tem Em ģ T 2 E 7 9 25 8 9 5 5 78 22 22 8 24

Page 1

File: Ffc Printed: 6/19/08



Washington

CONTINCENCY ANALYSIS RESULTS SUMMARY (Costs in Current Dollars) TTO Greenfield Site

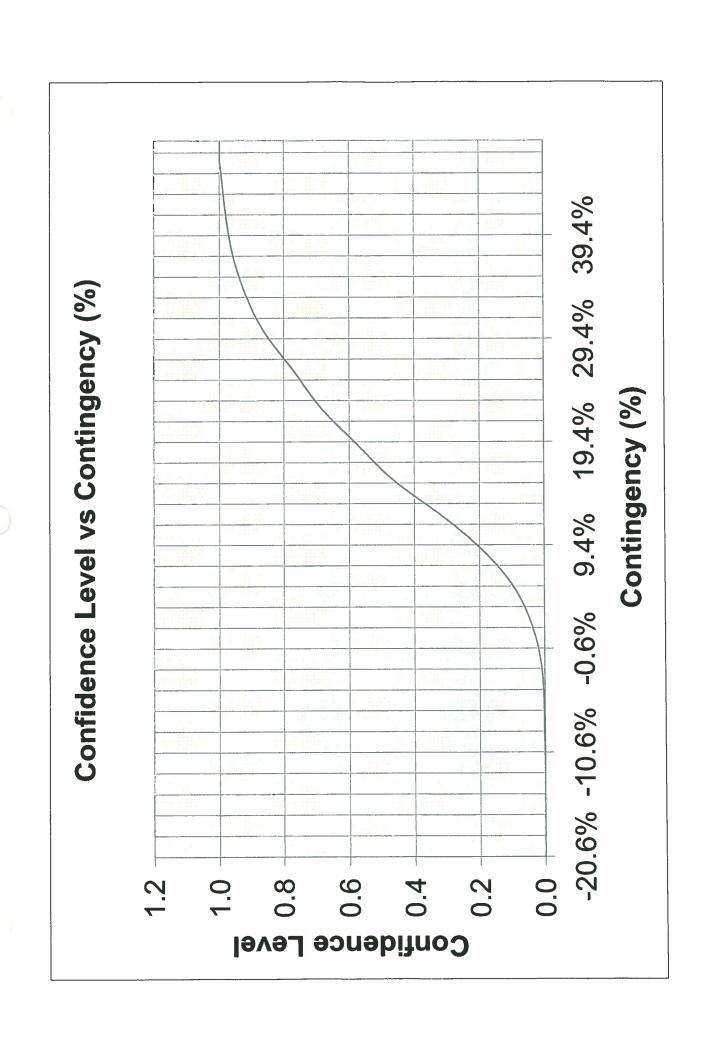
			Estimated	Total
Confidence Level	Contingency	Contingency	Project Cost (\$)	Project Cost (\$)
	(%)	(\$)	(w/o Contingency)	(w/ Contingency)
20%	16.7%	8,435,301	50,464,699	58,900,000
%09	19.8%	10,010,301	50,464,699	60,475,000
%02	23.0%	11,585,301	50,464,699	62,050,000
80%	27.5%	13,860,301	50,464,699	64,325,000
%06	32.3%	16,310,301	50,464,699	000'522'99
82%	36.5%	18,410,301	50,464,699	68,875,000
%66	44.1%	22,260,301	50,464,699	72,725,000



Washington

SULLS SERIOR ANALYSIS RESILLED FFC Greenfield Site

	(Cos	(Costs in Current Dollars)	t Dollars)	
Confidence Level	Contingency (%)	Contingency (\$)	Estimated Project Cost (\$) (w/o Contingency)	Total Project Cost (\$) (w/ Contingency)
%0	-19.0%	-9,589,699	50,464,699	40,875,000
10%	5.3%	2,660,301	50,464,699	53,125,000
20%	9.1%	4,585,301	50,464,699	55,050,000
30%	11.9%	5,985,301	50,464,699	56,450,000
40%	13.9%	7,035,301	50,464,699	57,500,000
20%	16.7%	8,435,301	50,464,699	58,900,000
%09	19.8%	10,010,301	50,464,699	60,475,000
%02	23.0%	11,585,301	50,464,699	62,050,000
%08	27.5%	13,860,301	50,464,699	64,325,000
%06	32.3%	16,310,301	50,464,699	66,775,000
%56	36.5%	18,410,301	50,464,699	68,875,000
%66	44.1%	22,260,301	50,464,699	72,725,000



Estimate Summary

HIP Alternate

9:07.	TOTA	74101	\$1,267,365	\$1,087,040	\$8,016,924	\$434,119	\$1.812.118	\$2,838,498	\$5,122,968		\$5,363,725		000 000	817,177,000	31,/15,494				\$1.715.494	\$54,943,272	028 999 970	\$63,943,242	275 2763	05	8 8	0\$	\$1,507,377	80	\$17,283,858	\$00,000	220,000,000		2 8	2 8	\$83,000,022			
6/20/2008 ADC Denver Gov FFC	STIRS		\$46,150			\$6 939 750					\$492,487		67 470 307	8738730	0.22,00,220				\$238,220	\$7,716,607		\$7,716,607.31		•				•••									-	
Date: Priced By: Office: Product Line: File Name:	MATERIAL		\$353,652	\$4,056	\$1,853,693	\$19,234,532	\$158,279	\$1,339,909	\$4,989,521		\$1,956,697		620 147 542	350,141,043					0\$	\$30,147,543		\$30,147,543																
Washington Division 989-325 Rev No: 0	LABOR		\$867,563	\$1,082,984	\$6,103,231	\$1,110,740	\$1,653,839	\$1,498,589	\$133,447	. .	\$2,914,541		\$15.601.848	\$1.477.274					\$1,477,274	\$17,079,122	\$8,999,970	\$26,079,092								/o of Sures : 0.00 %	%000							
URA Washingto	WORKHOURS		10,501	13,404	1,939	12,533	19,008	17,603	.,493		37,425		192,614	20,984			-		20,984	213,598	85,714	299,312	0.42%				2.36%	7000 70	20.30%	TOTAL TANCE			***					
Client: INL Project: FFC Location: GREEN FIELD SITE HIP Option Facility: Entire Estimate HIP Option	DESCRIPTION	Demolition	Improvements to Site	Concrete/Masonry	Structural Steel/Platework	Permanent Equipment	Piping Bulks	Electrical Bulks Instrumentation Bulks	Painting/Coatings/Liners	Insulation	Buildings	Spare Fans Freight	DIRECT FIELD COST	Constr. Mgt. Staff & Scrvices	Craft Labor Related Expenses	Temporary Construction Facilities, Furnishings, Services	Construction Equipment	Start Up Services	INDIRECT FIELD COST	TOTAL FIELD COST	Home Office Services	TOTAL FIELD, HOME OFFICE AND ENGINEERING	INSURANCE CGL & Pkg Policy	TAXES (EXCLUDED)	BONDS (EXCLUDED)	PERMITS (EXCLUDED)	FREIGHT 5% on Material Costs	CONTINGENCY	G&A 77	TOTAL PROJECT COST Basis for FEE	FEES	WARRANTY RESERVE	CLIENT COSTS	FEES ON CLIENT COSTS	GRAND TOTAL PROJECT			
	ACCT	10	20 20	8 4	90	90	= :	13 [5	14	15	2 19	22		31	32	33	14	21			19		74.10	74.20	74.30	74.40	74.50	05.67	89.1	06	90.1	91	100.1	100.2	110			

Grand Total Summary

PROPRIETARY & CONFIDENTIAL

The information contained herein is intended for use solely by Client and/or other parties expressly authorized in writing by URS Washington Division. The information contained herein shall ont he disclosed to any third parties without the prior written consent of URS Washington Division.

Page 1 of 1

Run @Risk Simulation

FCC with HIP COST ESTIMATE RISK ANALYSIS MODEL (Costs in Current Dollars)

Washington

	7.00.00.00.00.00.00.00.00.00.00.00.00.00								
Š	iondinesa.	larget	Low Value		High Value		Perce	Percentile %	!
		ESUMATE	Estimate	% less	Estimate	% more	Low	High	Expected Value
,	CIVIL WORK								
- 2	Civil Work - Matenal Civil Work - Subcontract	2,211,392	1,990,253	-10	3,095,949	9	10	06	2,498,407
	TOTAL CIVIL	2 257 542	2 024 788	2	04,010	40	10	8	52,140
	MECHANICAL WORK	200,000,0	4,001,100	1	3,100,559	1			2,550,547
က	Plant Equipment (Firm Priced) - Material	19,491,736	17.542.562	2	07 288 430	-	,		
4	Plant Equipment (Firm Priced) - Subcontract	0	5	2 0	004,002,12	€ 0	2 9	3 8	22,021,554
2	Plant Equipment (Non-Firm Priced) - Material	0		0 0	o c	> 0	2 9	S 6	э
9		6.939.750	6 245 775	9 6	0 745 650	> 9	2 9	S (0
7		158.279	150.365	, L	224 504	\$ \$	2 9	G 6	7,840,455
80	Pipe, Valves & Fittings - Subcontract	0	0) "		5 4	2 9	3 8	182,415
6	Insulation & Paint - Material	0		-1	o c	3 6	2 5	8 8	-
9	Insulation & Paint - Subcontract	0	0	0	0	0	2 5	8 8	
	TOTAL MECHANICAL	26,589,774	23,938,711		37.225.680		2	3	30 044 434
	ELECTRICAL WORK								+C+'++O*O
- :	Instrumentation - Material	4,989,521	4,241,093	-15	7,484,282	20	10	6	5 743 765
72	Instrumentation - Subcontract	0	0	0	0	0	2	8 6	
13	Electrical - Material	1,367,206	1,162,125	-15	2.050.809	0.00	2 0	8 8	1 573 880
14	Electrical - Subcontract	0	0	0	0	90	2 0	8 6	000'0 10'1
	TOTAL ELECTRICAL	6,356,727	5.403.218		9.535.091			3	7 247 645
	BUYDOWNS								0+0,110,1
15	Buydowns - Material	2,008,403	1.807.563	-10	2 510 504	25	10	6	2 100 010
16	Buydowns - Subcontract	492,487	443.238	- 0	615.609	3 5	5 5	8 8	2,130,212
	TOTAL BUYDOWNS	2,500,890	2,250,801		3.126.113	3	2	000	2 662 530
	LABOR COSTS								4,004,000
17	Direct Craft Labor	15,724,767	14,152,290	-10	23,587,151	20	2	6	18 451 978
28	Non-Manual Local Hires	0	0	0	0	0	10	8 6	000
	TOTAL DIRECT LABOR COSTS	15,724,767	14,152,290		23,587,151			3	18 451 978
	INDIRECT CONSTRUCTION COSTS								
13	Construction Indirects	0	0	0	0	0	10	8	0
Ī	TOTAL INDIRECT CONST. COSTS	0	0		0				0
	PROFESSIONAL SERVICES COSTS	-							
0	Constr. Management (Field Staff)	1,715,494	1,629,719	Ś	2,230,142	30	10	06	1.901.795
2 2	Home Office Services - Labor	8,999,970	8,549,972	ဟု	12,599,958	9	10	06	10,372,391
N	Home Office Services - Material	0	0	0	0	0	10	8	0
	TOTAL PROF. SERVICES COSTS	10,715,464	10,179,691		14,830,100				12,274,186
	OTHER PROJECT COSTS		-						
23	Taxes, Ins., Bonds, L.O.C., etc.	1,778,802	1,689,862	Ϋ́	2,312,443	30	10	90	1,971,978
	TUTAL OTHER PROJECT COSTS	1,778,802	1,689,862		2,312,443				1,971,978
_	BURDEN								
+7	T.C. Overhead Kate (%)	%00.0	%0:0	0	%0:0	0	10	06	%0.0
	T.O. Overneda (4)	0	-		0				0
9	F.O. Overnead Rate (%)	0.00%	%0.0	0	%0.0 °	0	10	06	%0.0
	TOTAL BURDEN	0	0 0						
	COTHEN DOO INTO COT	2000000	2000				1		0
Ī	COLUMNIED PROJECT COST	998,828,60	59,646,361		93,777,135				75,273,296
	Continue (%)	-	%0:0		%0:0 %				%0.0
26	Business Development Rate (%)	%000	2 0	c	0 %	-	ç		0
	Business Development (\$)	0		>	%0.0 %0.0	5	2	26	%0.0
ľ			-	_	0	_	_	_	_



Washington

GONINGING ANALYSIS RESULES SUMMARY (Costs in Current Dollars)

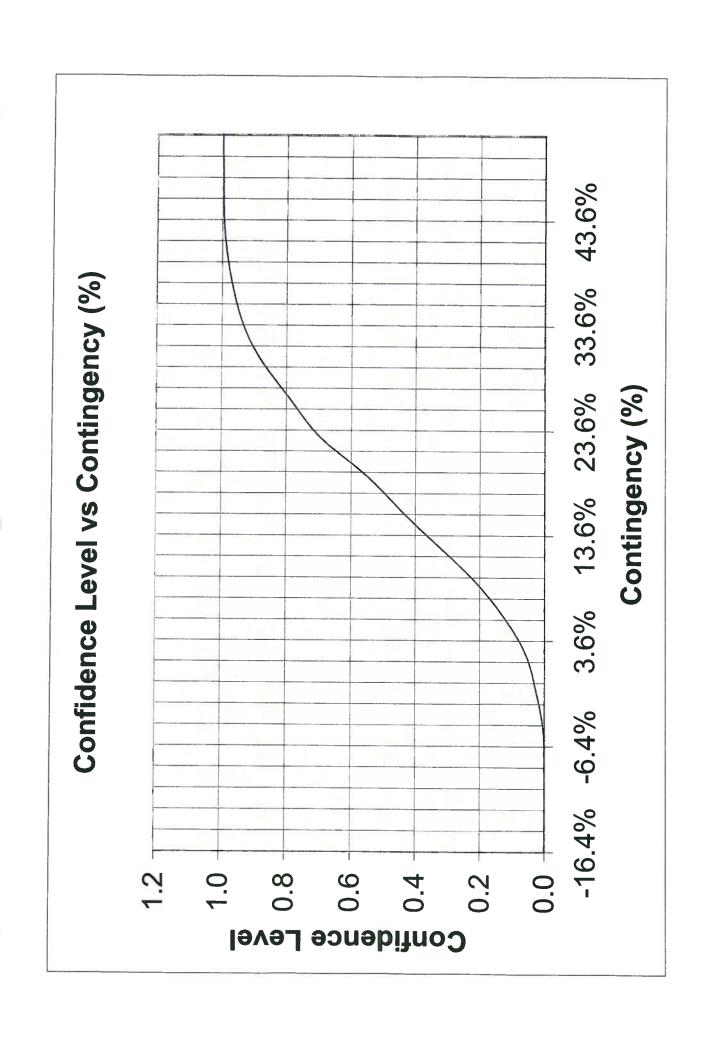
Confidence Level	Contingency	Contingency	Estimated Project Cost (\$)	Total Project Cost (\$)
	(%)	(\$)	(w/o Contingency)	(w/ Contingency)
20%	17.6%	11,576,034	65,923,966	77,500,000
%09	20.3%	13,376,034	65,923,966	79,300,000
%02	23.0%	15,176,034	65,923,966	81,100,000
%08	26.8%	17,651,034	65,923,966	83,575,000
%06	31.2%	20,576,034	65,923,966	86,500,000
%56	35.0%	23,051,034	65,923,966	88,975,000
%66	41.5%	27,326,034	65,923,966	93,250,000



Washington

(Costs in Current Dollars)

			Estimated	Total
Confidence Level	Contingency	Contingency	Project Cost (\$)	Project Cost (\$)
	(%)	(\$)	(w/o Contingency)	(w/ Contingency)
%0	-14.9%	-9,798,966	65,923,966	56,125,000
10%	4.6%	3,026,034	65,923,966	68,950,000
20%	8.7%	5,726,034	65,923,966	71,650,000
30%	11.8%	7,751,034	65,923,966	73,675,000
40%	14.5%	9,551,034	65,923,966	75,475,000
20%	17.6%	11,576,034	65,923,966	77,500,000
%09	20.3%	13,376,034	65,923,966	79,300,000
%02	23.0%	15,176,034	65,923,966	81,100,000
%08	26.8%	17,651,034	65,923,966	83,575,000
%06	31.2%	20,576,034	65,923,966	86,500,000
%36	35.0%	23,051,034	65,923,966	88,975,000
%66	41.5%	27,326,034	65,923,966	93,250,000



11.0 SCHEDULE ESTIMATE

This section provides a scoping level integrated FFC project schedule. The schedule defines key activities and their durations, along with required project approvals necessary to meet the desired FFC hot ops by 12/31/2012 in-order to complete the conversion of the fuel of the 5 HPRR's from HEU to LEU by 10/1/2014.

11.1 Introduction

An integrated summary level project scoping type schedule has been developed for the FFC. The schedule is presented in Fig. 11-1. The schedule covers key activities relative to securing project funding/approvals, NRC licensing, environmental permitting, construction including start-up and commissioning as well as fuel qualification. The schedule conforms to the requirements of DOE O 413.3A – Project Management for the Acquisition of Capital Assets, which mandates compliance with the critical decisions and baseline change control as the fundamental processes for DOE project authorization and change management. The schedule defines the major activities on an annual basis, commencing with the completion of the Greenfield Alternative Study leading to the start of the conceptual design in October of 2008, and ends with the conversion reactor hot ops by 10/1/2014.

The DOE's critical decision process for project authorization/funding requires careful planning and scheduling of work activities to facilitate DOE's review of project performance and approval of key review documents. The critical decision approval process provides the DOE with a structured approach to ascertain that the project is on schedule, within budget and fully capable of meeting the project mission, functions and operations requirements and safety and ES&H standards before approving funds to proceed to the next phase of the project

In this regard it is noteworthy to mention that the NNSA (NA-50 and NA-54) is proposing to utilize the Project Definition Rating Index (PDRI) process as a management tool. The PDRI has been designed by industry and used by the DOE to increase the likelihood of project success by improving project scope definition, and achieving project objectives within established budget and schedule. The NNSA PDRI has five rating areas: Scope/technical, Safety/quality assurance; Cost; Schedule, and Management Planning and Control. Each rating area has a number of subelements, which are evaluated/ rated by a team of subject matter experts to gauge the maturity of the design products to meet established thresholds. This data is utilized by the acquisition executive to authorize appropriate critical decision approval, thus enabling the project to advance to the next phase.

The goal of the NNSA PDRI process is to significantly improve up-front planning in the areas of alternatives evaluation, safety evaluation, and technology maturity as well as nailing down the project requirements and design criteria so as to define the project scope during the conceptual design phase of the project which concludes at CD-1. By CD-2 (completion of preliminary design), the project scope definition must be complete, to allow establishment of a firm technical, cost and schedule performance baseline for the project. This baseline will be independently validated by an external review team per DOE 413.3A. The importance of a well defined project scope at CD-2 is highlighted by the NNSA's firm expectations that the Performance Baseline cost and schedule will not be exceeded.

Greenfield Alternative Study

INL/EXT-08-14577
URS WD PROJECT NO. 17989-325

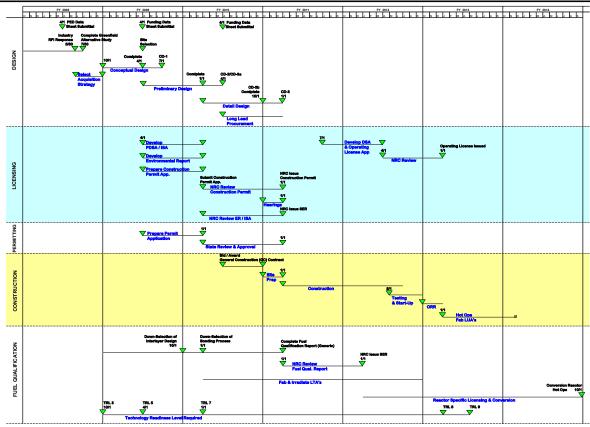


FIGURE 11-1 INTEGRATED FFC SCHEDULE

DOE O 413.3A permits projects to propose partial or phased critical decision approval as well as to propose combined CD reviews. Accordingly in order to facilitate early procurement of Long Lead Equipment (LLE), a combined CD-3a (Authorization to procure Long Lead Equipment) and CD-2 (Approve Performance Baseline) will be secured at the completion of the Preliminary Design (Title I). This will enable the LLE to be procured early in time to allow for the timely installation and integration into the construction process. Likewise early approval for site work (grading and drainage, fencing, parking, temporary utilities, excavation for foundations) will be sought (CD-3b) prior to the completion of detail design and receipt of CD-3 – Approval to begin Construction. Early approval to commence site preparation work is required in order to facilitate start of the permanent plant construction upon approval of the CD-3 authorization.

Actions authorized by the DOE's Critical decision approval process are summarized in Table 11-1.

CD-1 CD-4 CD-0 CD-2 *CD-3* CD-3a *CD-3b* CD-3cProceed with Allow Establish Approve **Approve** Approve Allow start expenditure of Baseline expenditure conceptual expenditure expenditure PED funds for of funds of funds of funds design using budget for operations program funds desian construction to procure for early site LLE items prepration construction **Request PED** Continue construction funding design Request construction funding

TABLE 11-1 ACTIONS AUTHORIZED BY DOE CRITICAL DECISION APPROVAL

11.2 Assumptions and Design Basis

The following provides key assumptions used to develop the integrated project schedule:

- Conceptual design will commence on 10/1/08 and complete 4/1/09 to allow for timely approval of CD-1 by 7/1/09. This is required to complete the Critical Path design activities to allow start of construction by 1/11.
- Site selection will be completed by 4/2009 to allow for the preparation of the required Environmental Report to support the Construction Permit application to the NRC. The site selected will be a well characterized site with no contamination.
- Early interaction (during conceptual design) with the NRC to establish the project licensing basis and requirements.
- On going involvement of the NRC during the development of the preliminary and detail design to allow NRC staff to gain familiarity with the design.
- NRC will provide a NUREG 1313 type SER signifying the approval of the Generic Fuel Qualification Report.
- NRC has sufficient staff, to allow for timely review and approval of Construction Permit,
 Operations license, Fuel Qualification report with 12 months of the submission of these licensing documents

- LTA's fabricated through the INL's lead test assembly plan, will be used for generic fuel qualification. LUA's fabricated at the FFC will be used for the qualification of the fuel fabrication processes.
- Adequate funding required for each of the phases will be provided to allow for uninterrupted execution of the design, permitting, construction and start-up/ commissioning activities. A period of 12 weeks has been allocated at the end of each of the design phases for the approval of the DOE's critical decisions. The approval process will utilize Independent Review Teams and the PDRI. During this 12-week period the design effort will continue un-interrupted.

11.3 Key Activity Durations

Durations of Key Activities is presented in Table 11-2 below:

TABLE 11-2 FFC PROJECT DURATIONS – KEY ACTIVITIES

Activity	Duration
Conceptual Design	6 months
Preliminary Design	9 months
Detail Design	9 months
NRC Construction Permit (Prep, Review)	21 months
NRC Operations License (Prep, Review)	18 months
Construction	18 months
Start-up & Commissioning	8 months

The proposed activity durations are workable and represent the minimum durations consistent with the scope of the project. Although this scoping-level schedule has not been developed using resource loadings, it is believed that the schedule as presented approximately represents the shortest reasonable overall duration possible for the project. Any delays encountered are expected to result in an extension of the completion date.

12.0 REFERENCES

The following INL documents were key reference documents used for the Greenfield Alternative Study:

- Statement of Work for an Engineering Alternative Study for a Greenfield LEU Molybdenum Fuel Fabrication Capability April 208
- Conceptual process description for the Manufacture of Low Enriched Uranium Molybdenum Fuel; Wachs et al; INL/EXT-08-13840; February 2008

Guidance and specific project design basis and requirements was provided by cognizant INL and Y-12 personnel involved with the development of the monolithic LEU-Mo fuel. Notes of meetings and motes of weekly teleconference document the programmatic and technical direction relative to the process and equipment requirements. In addition a 35% complete design review was conducted by the cognizant INL and Y-12 personnel. Comments and directions resulting from the design review were recorded in the Notes of the 35% complete design review meeting.

The directions, comments received from the cognizant INL and Y-12 personnel during the weekly teleconference, as well as at the design review and Kick-off meetings were considered as design basis requirements and incorporated into the facility and process design.

APPENDIX A – DRAWINGS AND DATA

1. SITE LAYOUT

SK-ME-06, Green Field Alternative, FFC Site Plan

Architectural Prospective, 4 Drawings

FACILITY LAYOUT

- SK-ME-01, Green Field Alternative, General Arrangement, Plan
- SK-ME-02, Green Field Alternative, Storage Arrangements, Plan Views
- SK-ME-03, Green Field Alternative, General Arrangement, HIP Layout, Plan
- SK-ME-04, Green Field Alternative, Building Sections
- SK-ME-05, Green Field Alternative, Building Sections and Details
- SK-ME-07, Green Field Alternative, Miscellaneous Building Sections and Details
- SK-ME-08, Green Field Alternative, Miscellaneous Building Sections and Details
- SK-AR-01, Green Field Alternative, FFC Building Elevations with HIP Option

2. BLOCK FLOW DIAGRAMS

BF-1, Overall Block Flow Diagram

3. PROCESS FLOW DIAGRAMS

- SK-1, Flow sheet. Legend and Symbols
- SK-2, Front-End Processing, Process Flow Diagram
- SK-3, Fuel Zr Cladding, Process Flow Diagram
- SK-4, Fuel AL Cladding, Process Flow Diagram
- SK-5, Final Assembly, Process Flow Diagram
- SK-6, Inspection, Process Flow Diagram
- SK-8, Waste Characterization and Packaging, Process Flow Diagram
- SK-9, Shipping, Receiving, and Storage, Process Flow Diagram
- SK-10, Alternate HIP Process, Process Flow Diagram
- SK-11, Argon Purification and DI Waster Supply, Process Flow Diagram
- SK-12, Final Assembly Machining, Process Flow Diagram

4. EQUIPMENT CUT SHEETS

CS-800 Carbon/Sulfur Determinator

PAXcam Digital USB 2.0 Camera System

Pegasus Floor Scale System

Raymond Forklifts

Hass Automation, CNC Turning Centers

Hass VR Series, 5-Axis Contouring VMCs

Elan 9000 ICP-Mass Spectrometer

Olympus GX Series, Metallurgical Microscopes

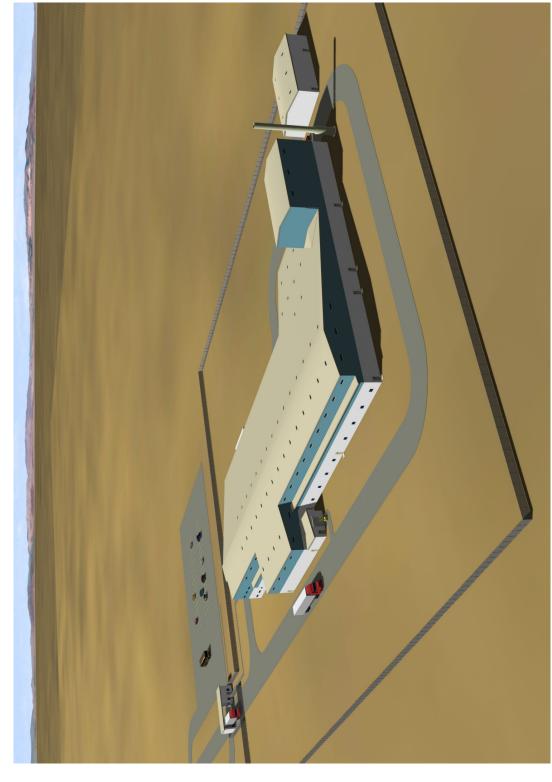
Raymond Walkie Pallet Truck, Model 102XM

Spectrum System 1000, Grinder/Polisher

Pre-Engineered Tarca Crane System

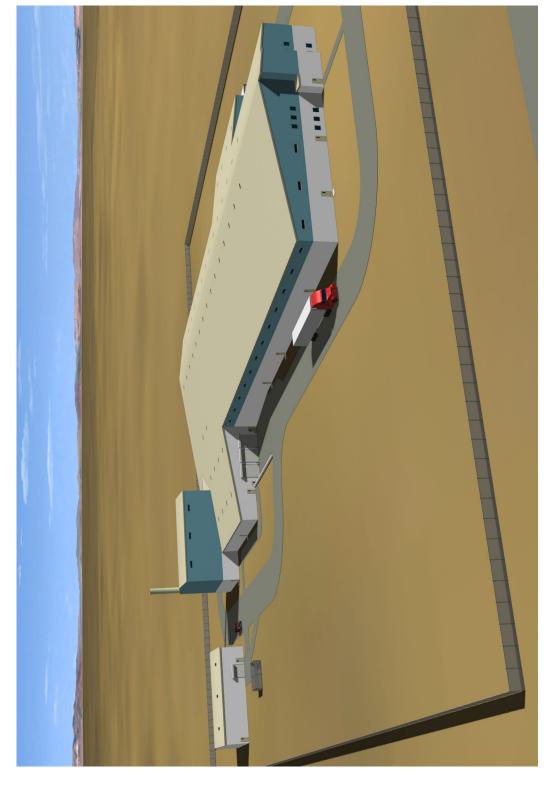
Hot Isostatic Pressing System

SITE LAYOUT



GREEN FIELD ALTERNATIVE FFC







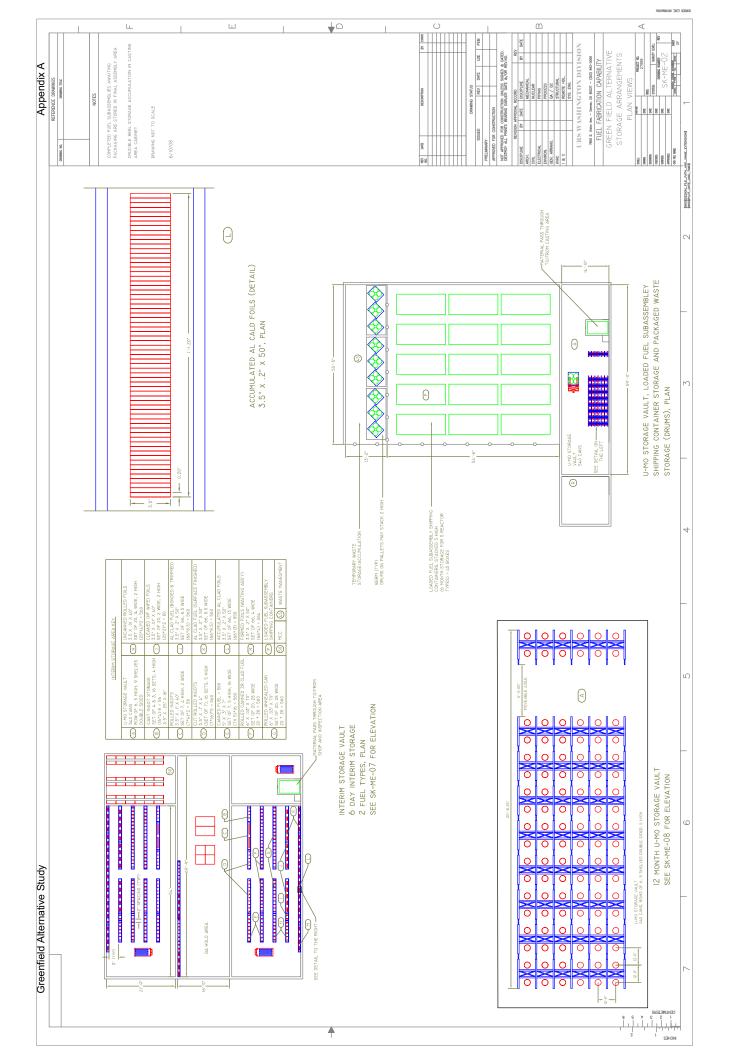
GREEN FIELD ALTERNATIVE FFC



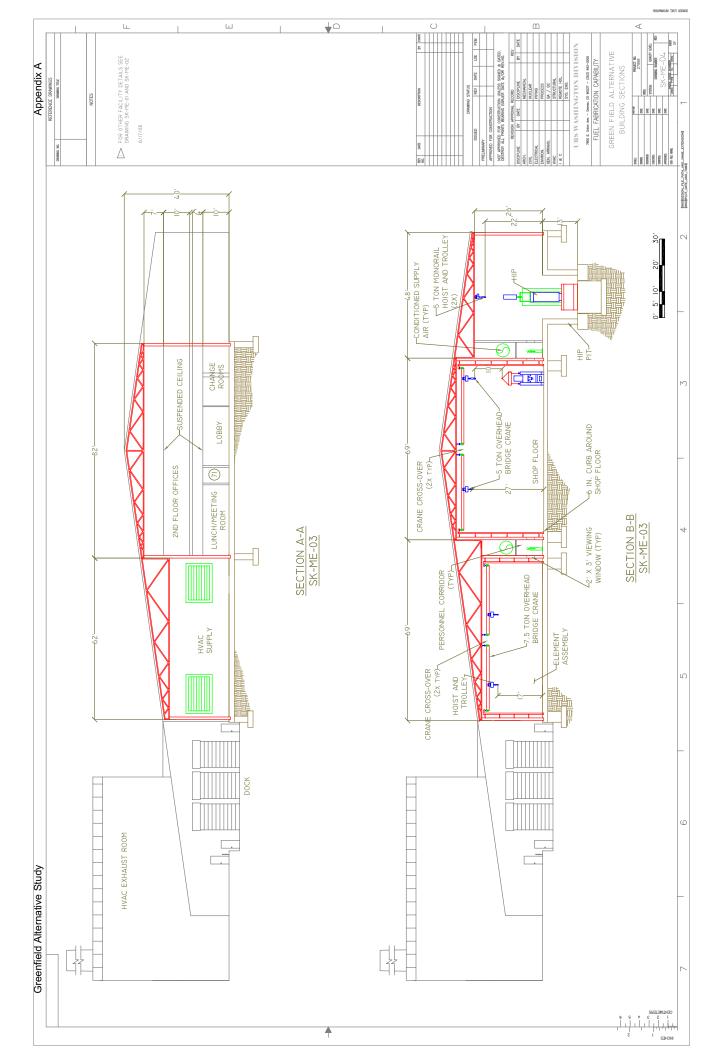


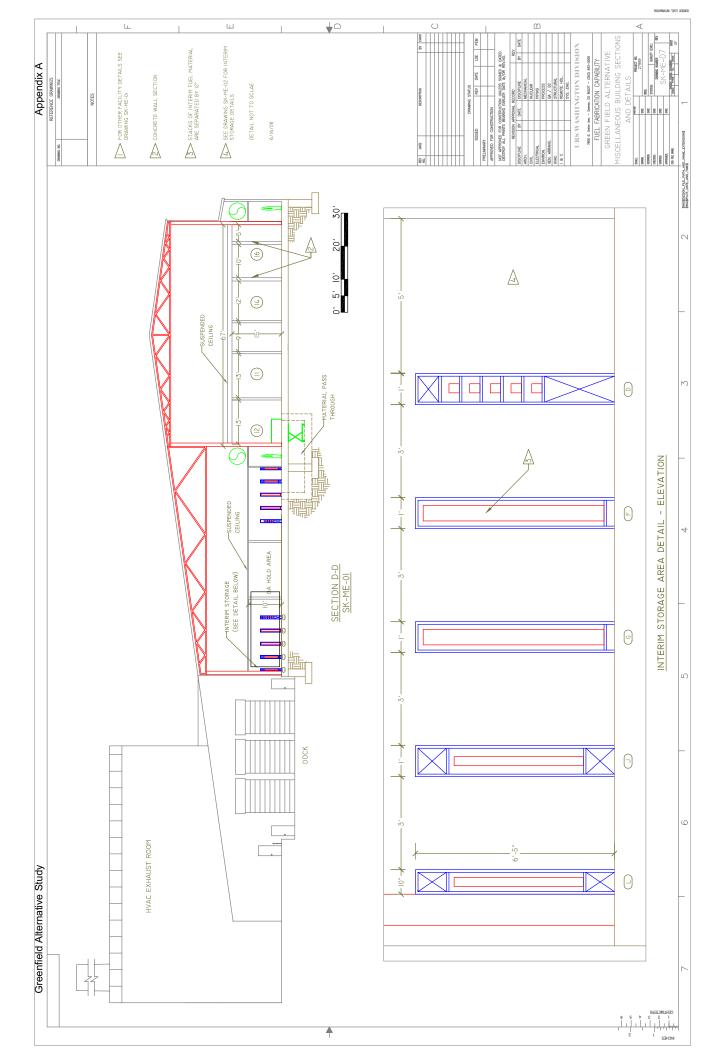
FACILITY LAYOUT

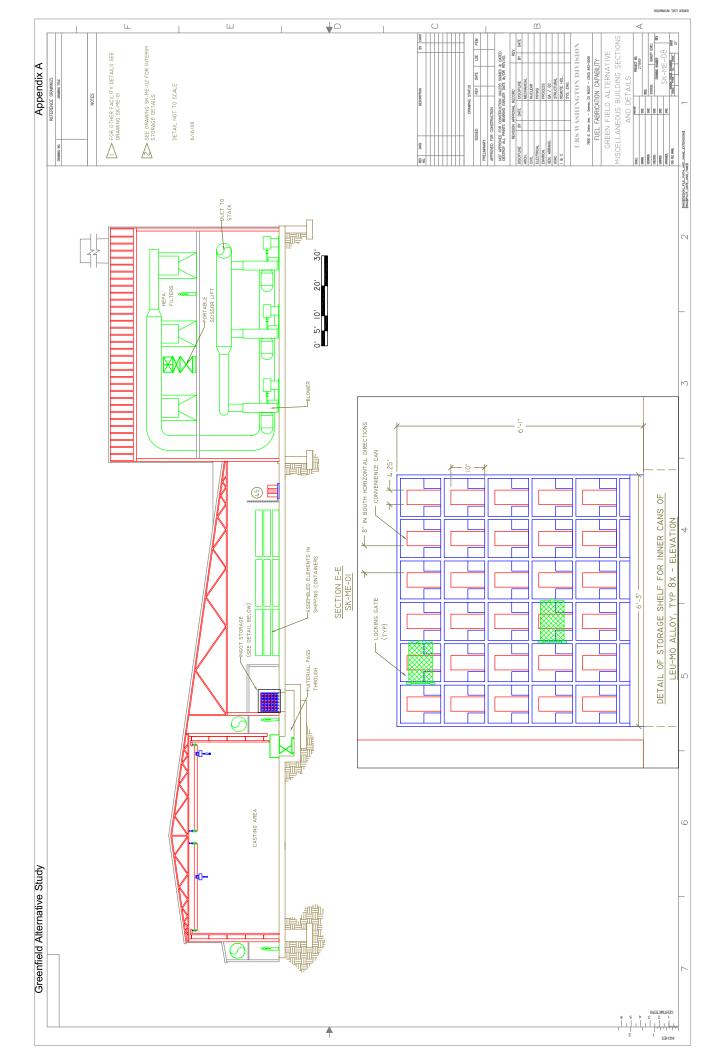




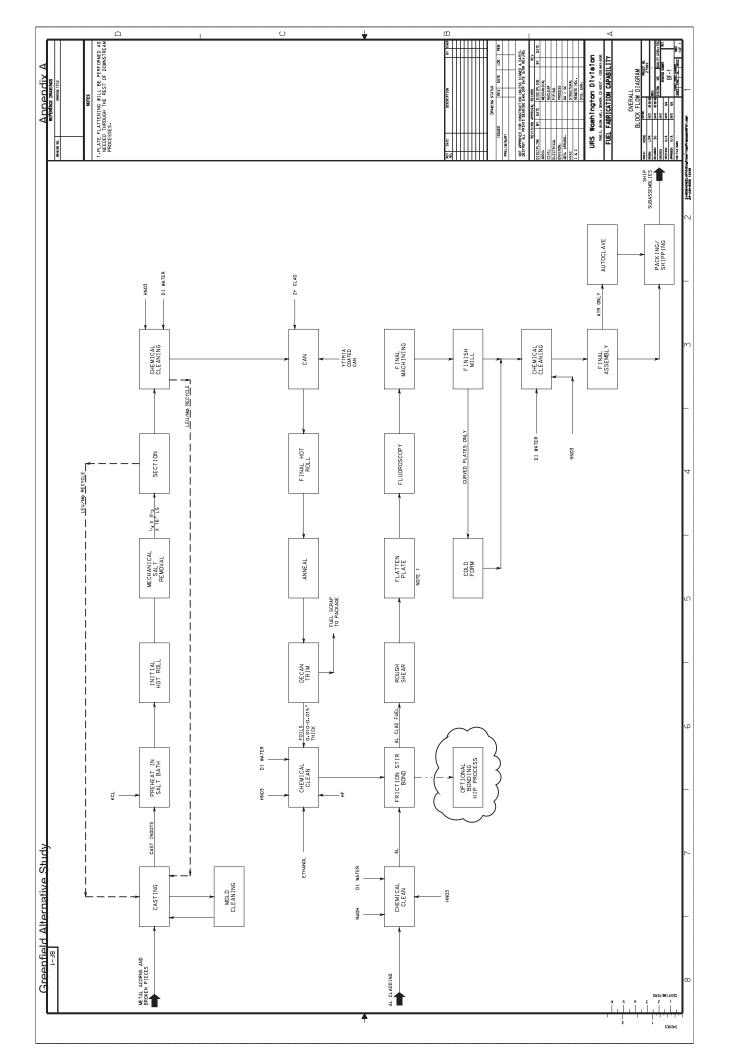




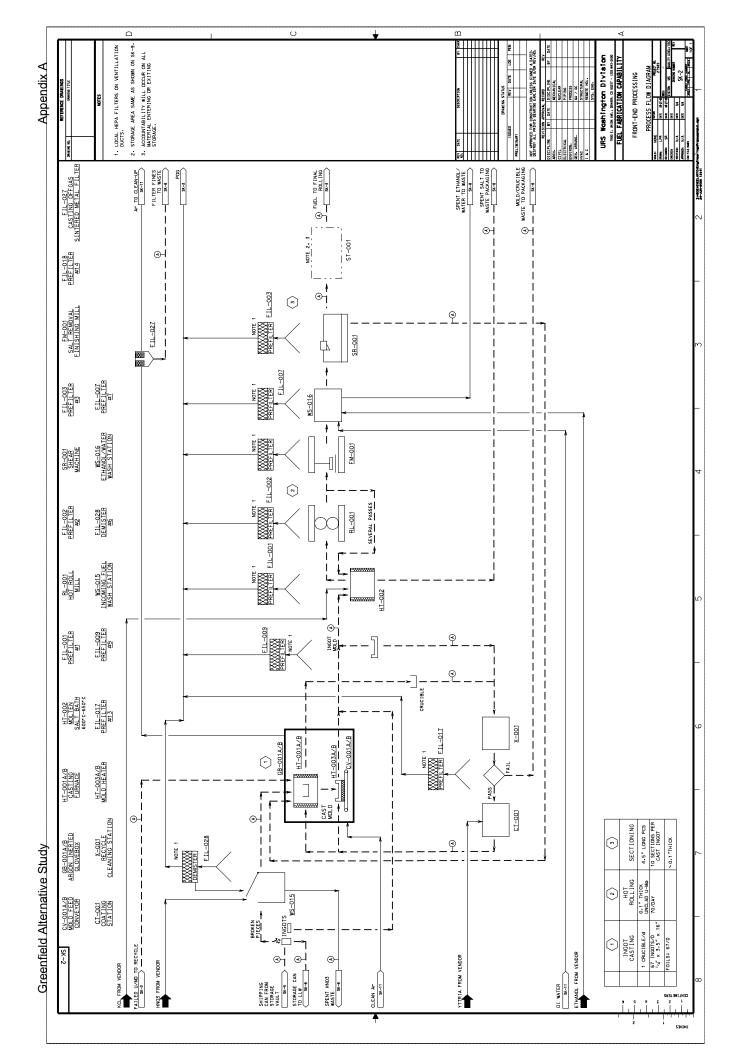


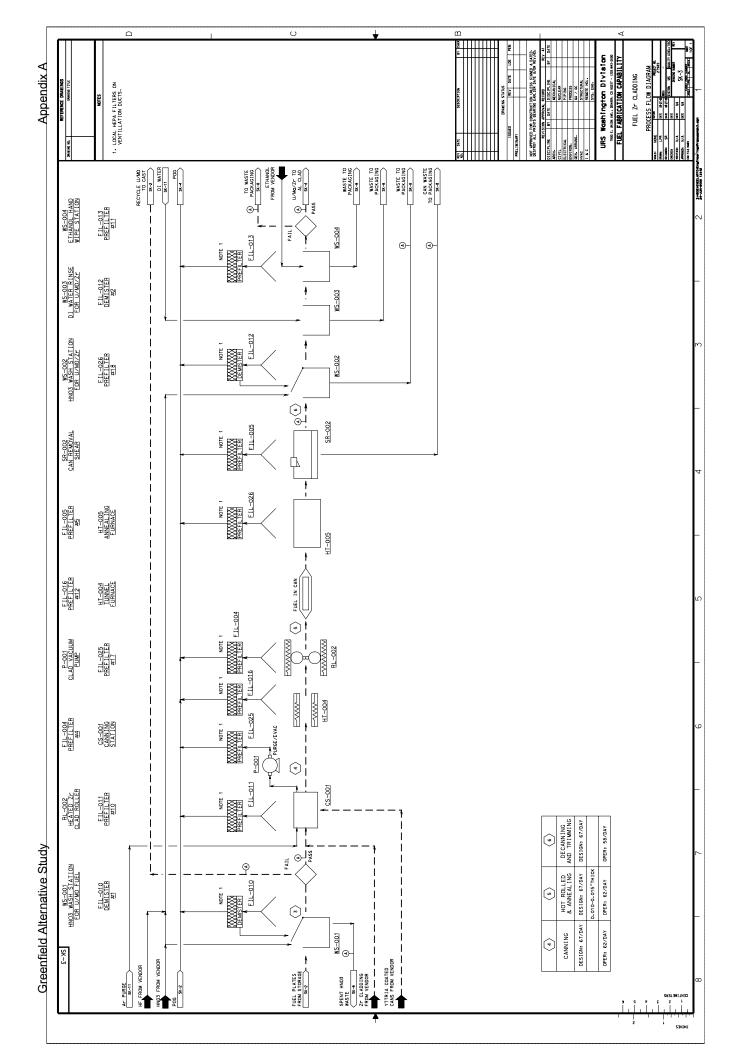


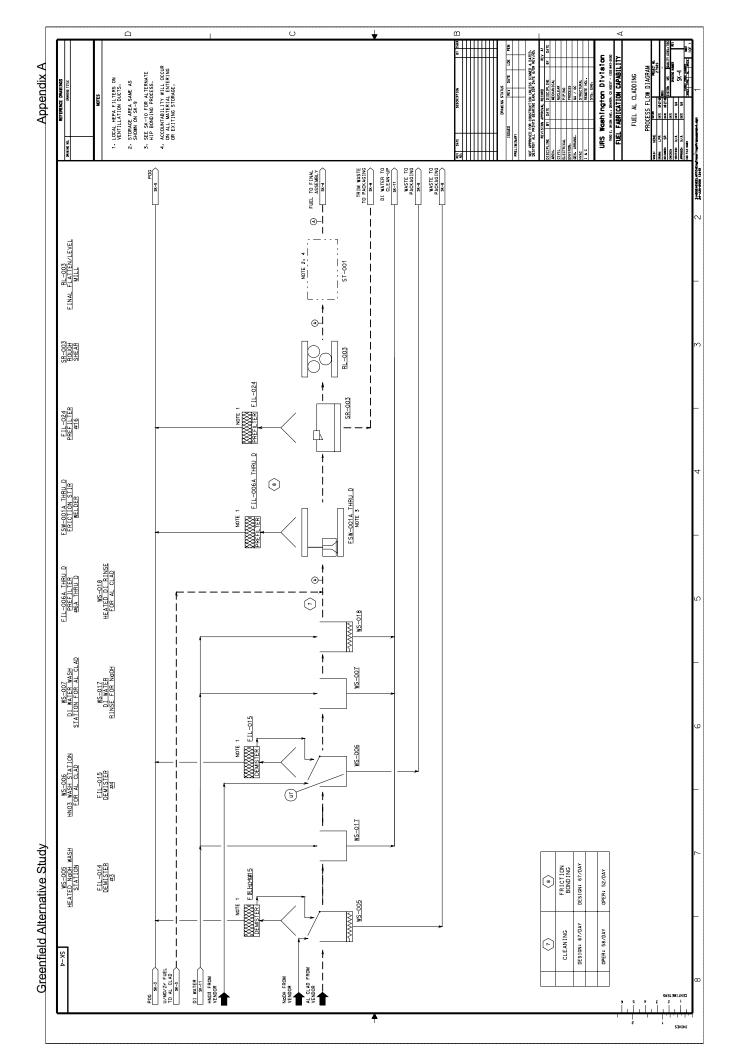
BLOCK FLOW DIAGRAMS

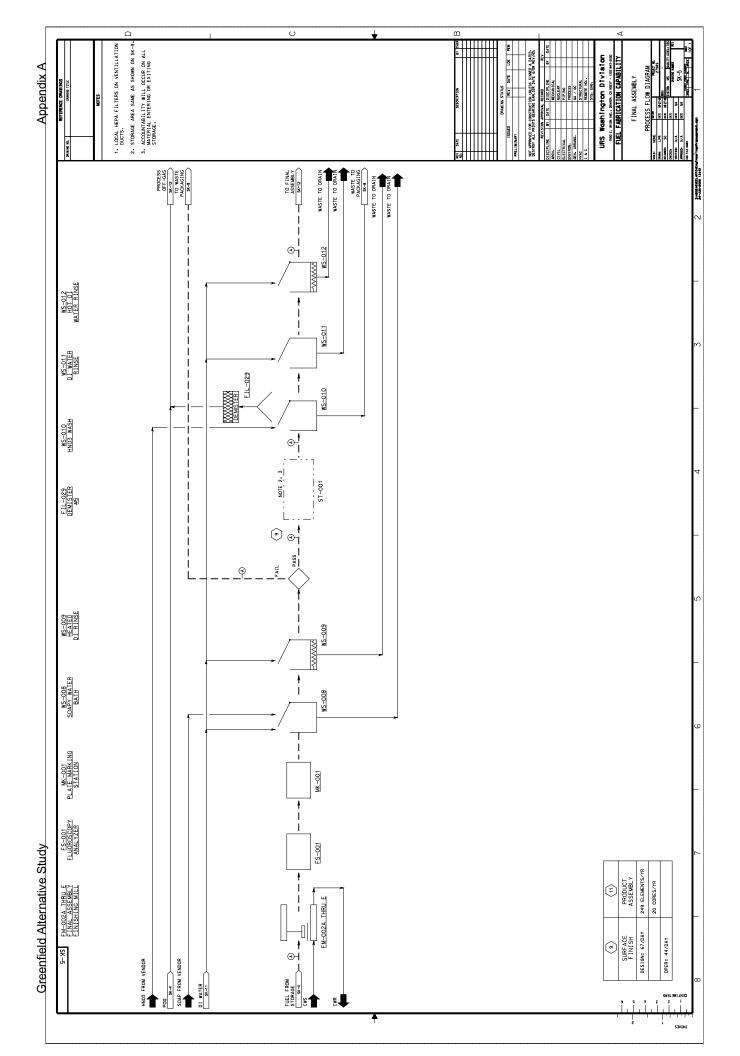


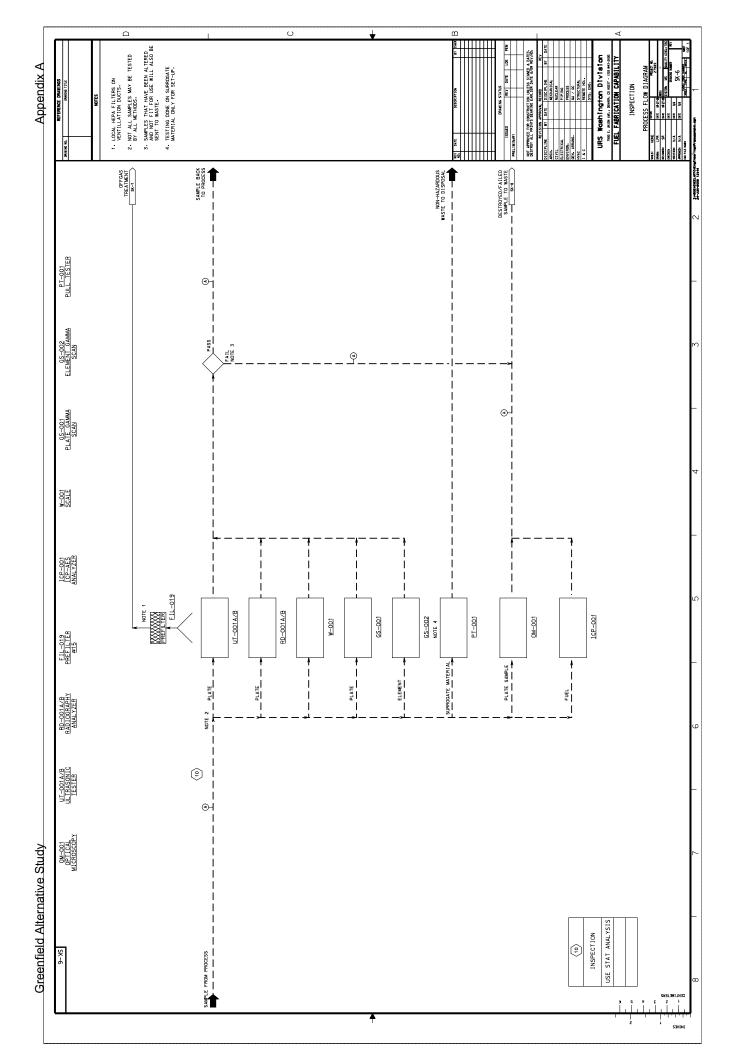
PROCESS FLOW DIAGRAMS

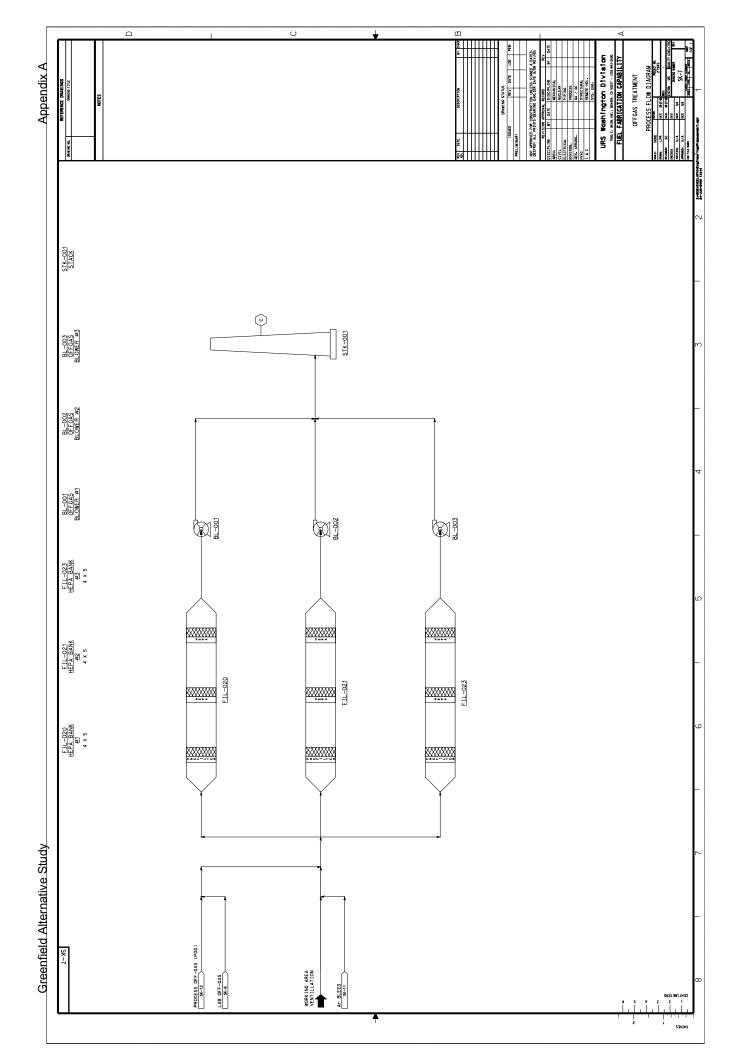


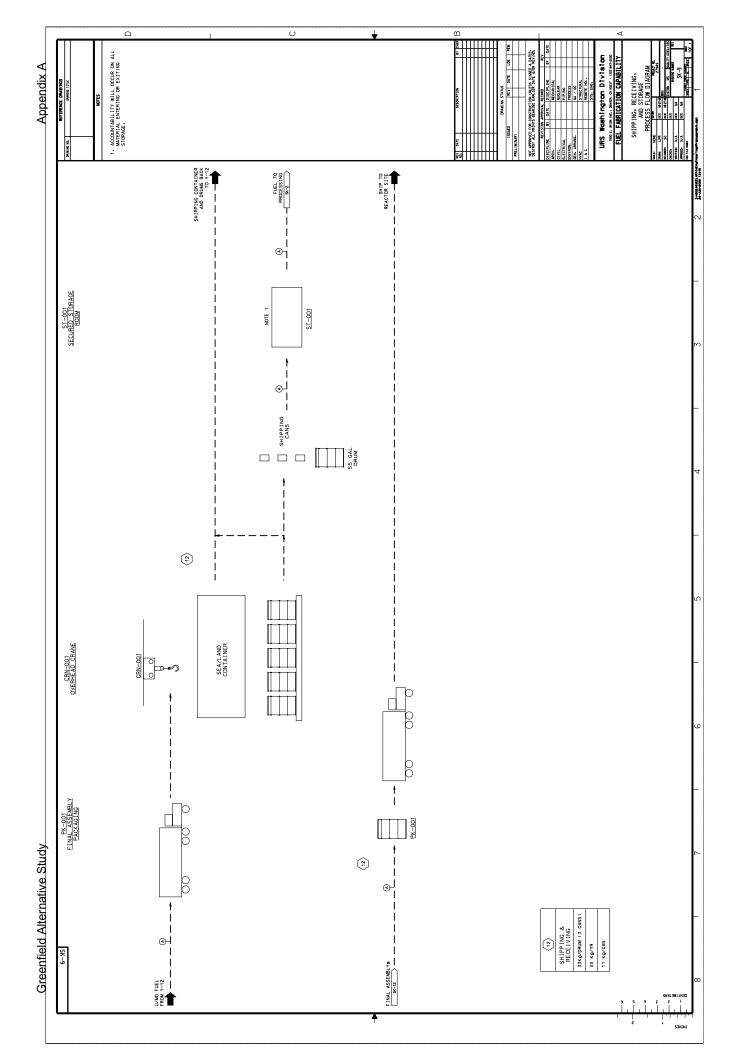


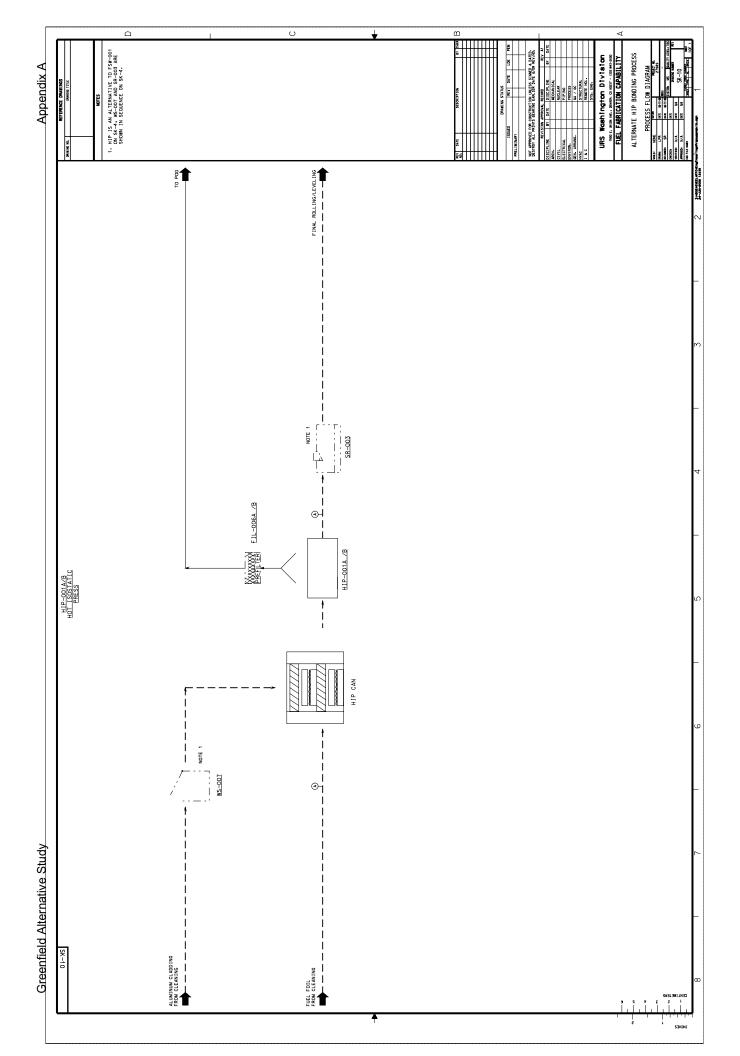


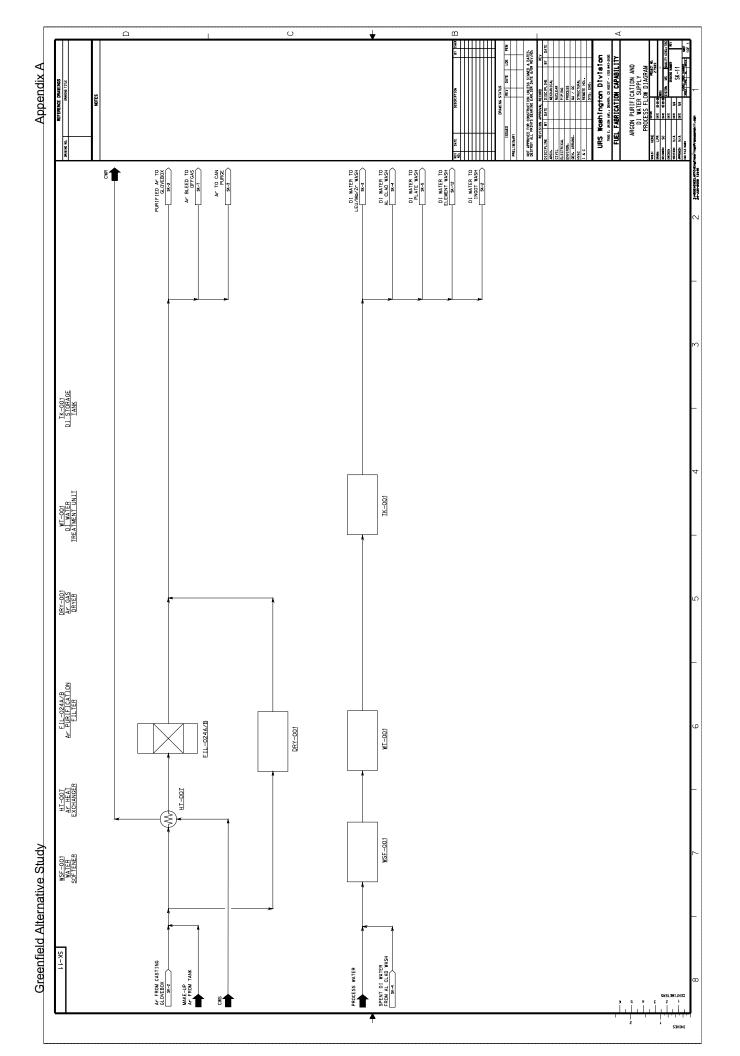


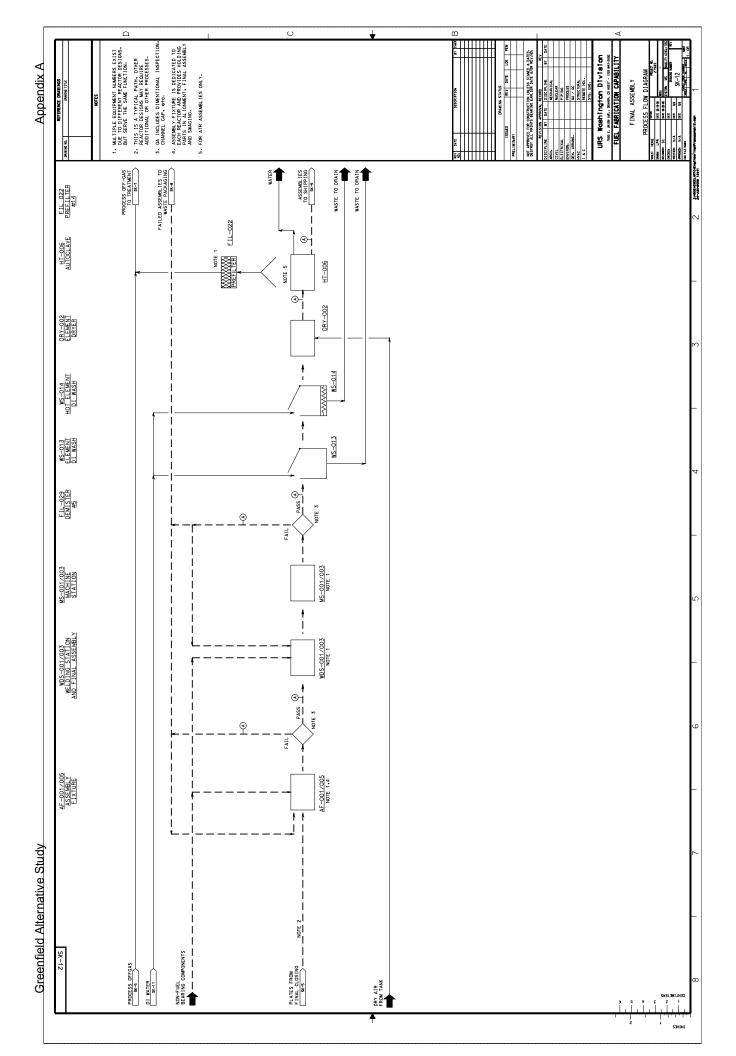












EQUIPMENT CUT SHEETS

Determinator

CS - 800 Double Dual Range Carbon / Sulfur

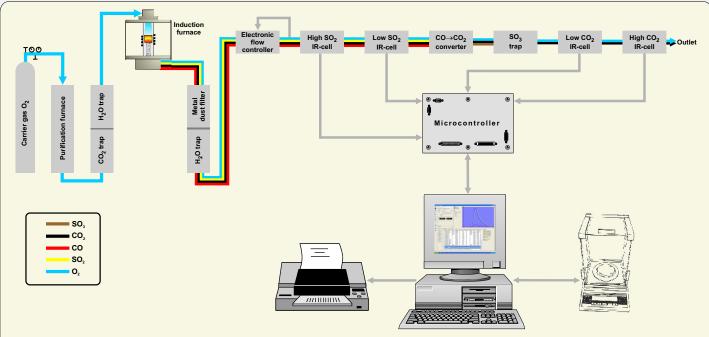




- Four solid state infrared cells
- No halogen trap required
- Automatic furnace cleaning
- Power controlled induction furnace
- PC controlled
- Up to 20 grams of copper samples without accelerators



CS-800 Double Dual Range



System overview

The CS-800 incorporates the latest in combustion technology. It is designed for the rapid, simultaneous determination of carbon and sulfur in steel, cast iron, copper, alloys, ores, cement, ceramics, carbides, minerals, sand, glass, etc.

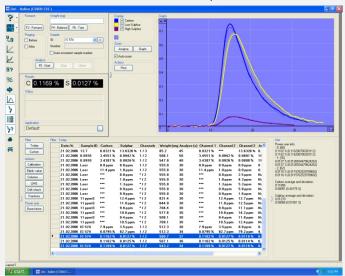
The CS-800 can be supplied with up to four independent infrared cells. The respective cells with the appropriate path length and sensitivity can be individually selected to offer optimum precision for the analysis of high and low levels of both sulfur and carbon. The CS-800 features a microcontroller, induction furnace and solid state infrared detectors with auto zero and auto range control.

Operating technique

Samples are accurately weighed in the ceramic crucible on the interfaced electronic balance. By pressing a key, the sample weight is automatically transferred to the PC. If required, sample weights can also be entered manually. By pressing the start key the analysis cycle begins and the sample enters the furnace. Depending on sample weight and material analysed, the typical analysis time is 50 seconds. During the analysis cycle instructions are displayed to ensure easy and reliable performance. The CS-800 requires minimal maintenance for which access is simple.

PC control with Windows 2000/XP software

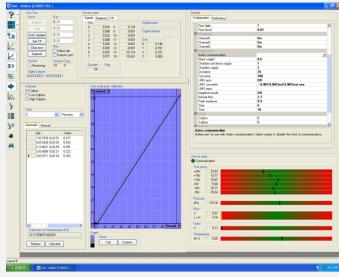
Comprehensive analyser control and easy operation are provided by the PC and software connected to the computer.



The multilingual software provides the user with the following features:

- Optional display layout adjustable screen appearance of the program windows.
- User profiles with multi-level access parameter changes protected by unauthorized acces.

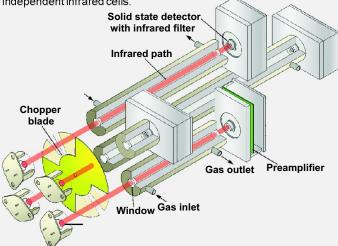
- Sample ID memory supplemented with running analysis number.
- Data base (analysis results storage) all data for each analysis is stored and can be recalled later for review, report creation, statistical calculations or results recalculation with modified parameters.
- Optional data base configuration displays only results meeting specified conditions, for example, certain date/time period, specific sample I.D. etc.
- Visualisation of the results consistency.
- Peak separation calculation procedure for fractional analysis.
- LIMS communication and data export (Notepad, Excel etc.).
- Basic one-point and advanced multi-point calibration.
- Barometric pressure compensation.
- Simultaneous calibration of more than one measuring range.
- Procedure for automatic linearity correction calculation.
- Applications memory and deficiency checks adjustable analysis counters to prompt the changing of reagents, cleaning of filters and other maintenance procedures.
- Hardware diagnostics display and technical report printouts.



Carbon/Sulfur Determinator

Infrared cells

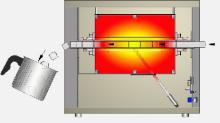
The infrared cells of the CS-800 do not require any manual zero adjustments. The zero and sensitivity adjustments of the infrared cells are permanently and automatically controlled by the electronics. The detectors utilize solid state sensors combined with infrared filters. The sensors are not gas filled, thus eliminating long term problems due to gas leakage. The CS-800 can be equipped with up to four independent infrared cells.



The lengths of all four cells can be individually optimized, to obtain maximum precision for the target analysis levels of each customer. Each of the cells can be installed with infrared absorption lengths ranging between 1mm and 320mm.

Preheating crucibles

The ceramic crucibles for the induction furnace can be preheated in the high temperature furnace HTF-540. The preheating reduces the blank value of the crucibles. This is important for analysis in the very low ppm range.



The crucibles are inserted into the furnace tube and they remain preheated in the tube until needed. Each time a crucible is needed, a new one is inserted into the tube, and a preheated crucible falls out the other end of the furnace tube. The recommended preheating temperature is between 1250°C and 1350°C.

Auto loader

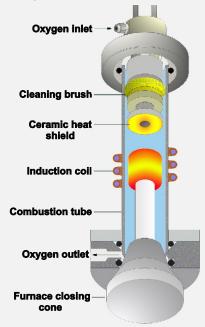
The CS-800 can be supplied with an automatic sample loading system. This loading system may also be retrofitted at a later date. Unlike many other auto loaders the ELTRA system can accommodate 130 samples giving hours of unattended operation. On request, the loader can be delivered for more crucibles. The auto loader, which does not occupy any additional bench space, is mounted above the area where the balance, PC, monitor and consumables are normally situated. The crucibles positions in the loader are easily accessible to the operator even from a sitting position. Three available models for 130, 104 and 36 crucibles. Dispensers for accelerators are available.



Automatic induction furnace cleaning

Users of carbon and sulfur analysers with induction furnaces know that dust accumulates during combustion and forms deposits (mainly of iron and tungsten oxides) in the combustion chamber.

The CS-800 furnace is cleaned automatically after each analysis, thus ensuring repeatable and accurate results without the time consuming and unpleasant task of manual furnace cleaning.



The standard cleaning apparatus is mechanically attached to the furnace open / close system, thus ensuring that it is not possible for the cleaning brush to collide with a hot crucible.

The cleaning brushes won't burn!

The efficient design of the cleaning mechanism rules out any possibility of the cleaning brush catching fire. To confirm this fact, ELTRA offers free replacement of each burned cleaning brush, during the entire working life of the analyser.

Electronic flow controller

An essential part of the gas flow system is the electronic flow controller. This provides a stable gas flow by eliminating the known disadvantages of mechanical controllers.

Up to 20 grams of copper sample without accelerators

The unique design of the induction furnace combined with intelligent power control electronics enables the analysis of copper samples up to a weight of 20 grams without the need of any accelerators. This is very important in case of samples with extremely low C and S contents, like copper and copper alloys. The higher the weight, the higher the amount of C and S present. The elimination of the need for an accelerator is a breakthrough in the analysis of very low C and S. The use of accelerators can badly affect the results when the very low C and S in the sample is similar to the C and S content of the accelerators (blanks). The CS-800 eliminates this problem.

Carrier gas conservation

If an analysis has not been carried out for a period of time, the analyser will automatically switch to "gas conservation mode." This effectively means that the carrier gas flow rate is reduced to a minimum, only allowing a small amount of oxygen to circulate through the IR cells etc. The period of time before the gas conservation is activated, can be modified via the PC software. It is also possible to have carrier gas flow only during combustion. As soon as the next sample is analysed, the carrier gas returns to normal flow rate.



The induction furnace and the auto loader use standard ceramic crucibles, which are 1" or 25mm in diameter.

CS-800 Specifications

AAEACHDINIC DANICES					
MEASURING RANGES					
Low carbon Up to 0.1% C at 500mg sample resp. up to 0.5mg C ¹⁾	Low sulfur Up to 0.3% S at 500mg sample resp. up to 1.5mg S 1)				
High carbon Up to 5% C at 500mg sample resp. up to 25mg C ¹⁾ Indicating range up to 100% C ²⁾	High sulfur 30% S at 150mg sample resp. up to 45mg S ¹⁾ Indicating range up to 100% S ²⁾				
SENSI	TIVITY				
Carbon 0.1ppm C at 500mg sample resp. 0.05μg C	Sulfur 0.1ppm S at 500mg sample resp. 0.05µg S ¹)				
ACCL	IRACY				
Low carbon ¹⁾ ±1ppm C ³⁾ at 1gram sample resp. ±1 µg C or ±0.5% of carbon present	Low sulfur ¹⁾ ±1ppm S at 1gram sample resp. ±1µg S or ±0.5% of sulfur present				
High carbon ¹⁾ ±10ppm C ³⁾ at 500mg sample resp. ±5µg C or ±0.5% of C present	High sulfur ¹⁾ ±10ppm S at 150mg sample resp. ±1.5µg S or ±0.5% of S present				
GENERAL SPE	CIFICATIONS				
Normal sample weight: 0.5g to 1g for steel and cast iron	Normal analysis time 40 to 50 seconds				
Furnace type Induction, 19.5 MHz 2.2 kVA max	Furnace dust cleaning Automatic				
Detection method Solid state infrared absorption for carbon and sulfur	Chemicals CO₂ trap sodium hydroxide H₂O trap magnesium perchlorate Catalyst copper oxide				
Gas required Oxygen 99.5% pure 2 to 4 bar (30 to 60 psi) 3 l/min	Compressed air 4 to 6 bar (60 to 90 psi)				
Interfaces Computer - serial ⁴⁾	Power requirements 230 V AC ±10% 50/60 Hz max 15 Amps 3450 Watts				
Weight analyser: approx. 110 kg	Dimensions Width Height Depth 55 cm (21") 80 cm (31.5") 60 cm (23.5")				
	SORIES				
Balance 0.0001g to	o 60 g ± 0.0001 g ⁵⁾				
Computer PC with HDD, 3.5" drive, CD-ROM, TFT flat screen and keyboard 5)					
Color printer with automatic cut sheet feed, other options on request ⁵⁾ 1) Other ranges on request. 2) Possible by reducing the sample weight. 3) With preheated crucibles and oxygen purification furnace. 4) Balance (serial - RS232)					

¹⁾ Other ranges on request. 2) Possible by reducing the sample weight. 3) With preheated crucibles and oxygen purification furnace. 4) Balance (serial - RS232) and printer (USB, parallel) are connected to the PC. 5) Visit our web pages for further details (http://www.eltragmbh.com/cs800/information.shtml).

Typical results

30.03.01 13:05 Steel/0 30.03.01 13:06 Steel/0 30.03.01 13:08 Steel/0		0.0236 %C 1/0	93.7 ppmS 3/0 050 94.2 ppmS 3/0 050 92.6 ppmS 3/0 050
m	eans: 0.02346 sd: 0.000113	93.5 0.6	
	Cast i		
28.02.01 15:00 Cast iron 38/0			0.1536 %S 3/0 050
28.02.01 15:01 Cast iron 38/0			0.1546 %S 3/0 050
28.02.01 15:03 Cast iron 38/0	15 506.5 mg	2.7947 %C 2/0	0.1535 %S 3/0 050
	means: 2.787	76 0.1539	9
	sd: 0.005	77 0.0014	1
	Copp	er	
28.02.01 14:44 Copper/03			4.3 ppm S 3/1 045
28.02.01 14:49 Copper/03		54.7 ppm 1/0	4.2 ppm S 3/1 047
28.02.01 14:53 Copper/03	•		4.3 ppm S 3/1 046
		54.4 4.3	рр
	sd:	1.7 0.0	
	ou.	1.1 0.0	
	Ore		
31.03.01 09:52 Ore 25C/0		1 0146 %C 1/0	5.3059 %S 2/0 041
31.03.01 09:55 Ore 25C/0		1.0147 %C 1/0	5.1395 %S 2/0 041
		1.0264 %C 1/0	5.3230 %S 2/0 039
	neans: 1.01856		
"	sd: 0.0052		
	30. 0.0032	2 0.01113	
	Cemen	nt.	
31.03.01 09:43 Cement B8/0			0.5446 %S 2/0 050
31.03.01 09:45 Cement B8/0			0.5463 %S 2/0 050
31.03.01 09:49 Cement B8/0			0.5746 %S 2/0 047
51.05.01 05.43 Cement Bo/c	means: 1.0575		
	sd: 0.0139		
			o re subject to change

ELTRA

ELTRA GmbH Mainstr. 85 Block 20 D-41469 Neuss Germany

** +(49) 2137 12822 Fax: +(49) 2137 12513

analysers@eltragmbh.com www.eltragmbh.com

The contents of the catalogue are subject to change without prior notice for further improvement.

01.02.2006



Digital Imaging Workflow for Industrial Applications

The PAXcam Digital USB 2.0 Camera System



- Affordable camera for microscopy, with an easy-to-use interface
- Beautiful, high-resolution images; true color rendition
- Fully integrated package with camera and software
- USB 2.0 interface for the fastest live digital color preview on the market
- Easy-to-use interface for color balance, exposure & contrast control, including focus indicator tool
- Adjustable capture resolution settings (true optical resolution -- no interpolation)
- Auto exposure, auto white balance and manual color adjustment are supported
- Create and apply templates and transparencies over the live image
- Acquire images directly into the PAX-it archive for easy workflow
- Easy one-cable connection to computer; can also be used on a laptop
- Adjustable region of interest means smaller file sizes when capturing images
- PAXcam interface can control multiple cameras from the same computer
- Stored presets may be used to save all camera settings for repeat conditions

Capture Images Directly to PAX-it Image Database Software



PAX-it!

- File & retrieve images in easy-to-use cabinet/folder structure
- Store images, video clips, documents, and other standard digital file types
- Images and other files are in a searchable database that you design!
- Annotate images with circles, arrows, text; add a calibrated scale bar
- Automatically stitch overlapping adjacent images together (mosaic)
- Add written notes & dictated messages to images
- Link to MS Word™ and Excel™ for easy report generation
- Link to MS PowerPoint[™] for easy construction of presentations
- Link to email service for sending images, notes, & data as attachments
- Additional modules for measurement, image analysis, network sharing, web-sharing, tutorial production, CD/DVD Archiving, Extended Security

Special Package Pricing PAXcam USB 2.0 Digital Camera System includes:

- PAX-it Image Database Software / interface
- USB 2.0 digital camera, card and cable
- Free tech support & software updates for one year

PAXcam2 (1600 x 1200)

PAXcam3 (2048 x 1536)

PAXcamARC (Adjustable Resolution to 5120 x 4096)



Semiconductor Material Science

Welding

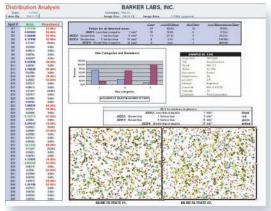
Automotive

Documentation

PAX=it![™] Shared Image Archive



Reports



Created using PAX-it's report generator feature and optional Image Analysis module

and

The PAXcam system also includes:

Email: link to your email service to send images & data as attachments

Videotext Overlays: annotate and edit images with text, shapes, arrows and calibrated scale bar; overlays can be placed on the live preview image for alignment and comparison

Reporting: create powerful, customizable presentations and written reports via link to MS Office™ programs

Image Stitching: automatically stitch overlapping adjacent images into one mosaic image

Image Fusion: fuse multiple images at different focal planes into one focused image, solving problematic depth-of-field issues

PAXcam Minimum System Requirements:

P2 - 400Mhz, Win 2000, Win XP. Must have PCI slot or USB 2.0 port available. For best performance, a 0.5x c-mount coupler is recommended.

LECO Corporation 800-292-6141 www.leco.com

Form No. 203-988-004 5/06

Failure Analysis





PAXcam seamlessly integrates with PAX-it's optional modules:

Networking: share images, reports, presentations and more with a PAX-it site license

Web: PAXnet web-based asset sharing over intranet or internet; no additional software required at remote sites

Basic Measurement: manual point-to-point, fixed area, parallel line, ellipse arc, and angle measurements. Easy to calibrate.

Image Analysis: user-defined area fractioning, porosity, nodularity, grainsizing, plating thickness, flake size classification, ferrite/pearlite, color and grayscale thresholding

CD/DVD Creator: back up, burn partial or entire PAX-it collection to CD or DVD, store images off-line while leaving database information and thumbnails on-line.

Extended Security: increased user/group permission controls, electronic image signature and validation, and logging of audit trails in a network environment



Pegasus Floor Scale Systems

Calibrated Platform Scale with Indicator

- Pre-calibrated— Indicator and floor scale calibrated at the factory prior to shipment
- ♦ Easy Installation— Units can be placed into service with no on-site installation required.
- ◆ Capacity, Size— Match a capacity and size with one of four Salter Brecknell indicators.
- ◆ A/D Conversion Rate— Up to 25 measurements per second.





Pegasus Floor Scale Systems

Capacities & Resolution

Capacity	Dimension-in.	Dimension-cm
5,000 x 1 lb	48 x 48 x 3.1	122 x 122 x 7.9
(2500 x .5 kg)	60 x 60 x 3.1	152 x 152 x 7.9
10,000 x 2 lb	48 x 48 x 3.1	122 x 122 x 7.9
(5000 x 1 kg)	60 x 60 x 3.1	152 x 152 x 7.9

ALL capacities and resolutions shown above are based on 5000d.

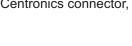
Material Specifications

Platform- Mild steel
J-Box- ABS Plastic

Finish-Powder coat paint

Indicator Interface Cable

Models 750S/200ES— Includes quick disconnect, 25 ft Models 200E/750— 14 pin Centronics connector, 15 ft



Loadcell Specifications

Material – Alloy tool steel potted Rated Output – 3 mv/V Output Resistance – 350 ohm









Model 750 / 750S Indicator

Easy to Read—Large 1" (25 mm) LED display.

Construction—

Model 750: ABS NEMA 12 enclosure

Model 750S: stainless steel NEMA 4X enclosure

Power-

Model 750: 115 VAC ± 10% Model 750S: 115/230 VAC ±10%

Excitation Voltage– ±10 VDC, 8 x 350 ohm loadcells Serial Port– One full duplex RS-223; One simplex RS-232C; One simplex passive 20mA current loop

Digital Calibration– Front panel calibration and configuration

Keyboard– Units, Zero, Net/Gross, Tare, Print **Functions**– Gross/Net/Tare; Print ticket mode with

6-digit ID number, Simple piece counting

Units- Custom unit configuration

Stand- Stainless steel swivel stand included

Display- Up to 50,000 graduations

Certifications – NTEP approved at 10,000 divisions, Class III / IIIL, COC #00-064A1

Model 200E / 200ES Indicator

Easy to Read- 0.6" (15 mm) LED display

Construction-

200E: ABS NEMA 12 enclosure

200ES: NEMA 4X stainless steel enclosure

Power-

200E: 115 VAC ±10% 200ES: 115/230 VAC ±10%

Excitation Voltage- ±10 VDC, 4 x 350 ohm loadcells

Serial Port- One full duplex RS-232.

Digital Calibration – Front panel calibration and

configuration

Keyboard- Units, Zero, Net/Gross, Tare, Print

Functions – Gross/Net/Tare; Print ticket mode; Simple

piece counting

Units- Switch between lb and kg

Stand- Stainless steel swivel stand included

Display– Up to 50,000 graduations

Certifications— NTEP at 5,000 divisions, Class III, COC #00-065A1

Salter Brecknell Weighing Products



a division of Avery Weigh-Tronix 1000 Armstrong Dr. Fairmont, MN 56031 Toll free: 800-637-0529

Tel: 507-238-8702 Fax: 507-238-8271 e-mail: sales@salterbrecknell.com www.salterbrecknell.com





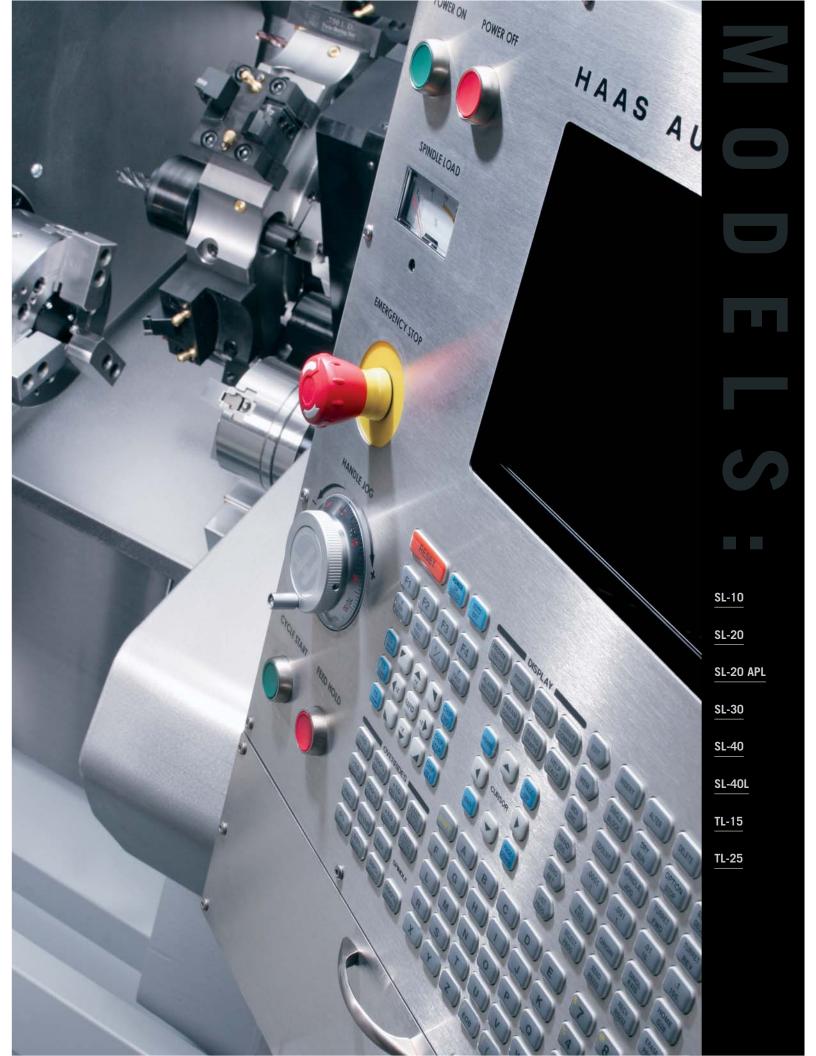
HIGH-PERFORMANCE TURNING CENTERS



Special turret design	5-7
Live/driven tools & C axis	8-9
Rigid foundation	10-11
Main spindle & spindle drive	12-13
Motion control	14-15
Part setup & support	16-17
Part-holding variations	18-19
Chip removal & automated operation	20-23
Operator convenience	24-25
Model variations	26-27
Toolroom lathes	28-29
The Haas control	30-33
Specifications	34-39

aas Automation manufactures a complete line of CNC lathes designed to meet the ever-increasing needs of modern machine shops – both now and long into the future. The SL Series of CNC lathes is the culmination of extensive design and real-world testing aimed at making Haas lathes the finest available. At present, more than 12,000 high-performance Haas turning centers are installed worldwide, proving their capabilities every day in machine shops around the globe. The addition of the Toolroom line opens up new possibilities and provides additional capabilities. With these machines, we have raised CNC turning to new levels of reliability, ease and productivity.

Haas CNC turning centers include such innovations as massive headstock castings with symmetric ribs for rigidity and stability; large tailstock castings with a two-piece design for easy realignment; embedded chip trays for improved sealing and efficient chip removal; increased-volume, roll-out coolant tanks; and double-wall doors riding on precision bearings for smooth, reliable operation.







New, faster hydraulic turret for the SL-40 reduces tool change times by 60%.

Special Turret Design



On-The-Fly Indexing

This standard feature allows tool changes on the fly, while the axes are in motion retracting from the part. This feature, combined with high-speed rapid movements, results in faster tool changes and shorter cycle times by reducing non-cutting time to an absolute minimum.

Improve your cycle times by keeping the machine in constant motion.

THREE TYPES OF TURRET¹



Haas SL Series turning centers come standard with a BOLT-ON TOOL TURRET that provides super-rigid mounting of turning tools and boring bars. This turret accepts tools around the perimeter, and has an equal number of standard radial slots on the face for mounting turning tools in either the right- or left-hand direction.



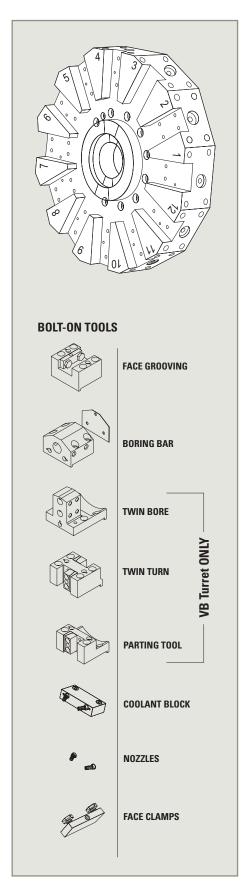
The optional HAAS VDI TURRET accepts standard VDI 40 tools, including axial and radial live tools when combined with the versatile live tooling option.



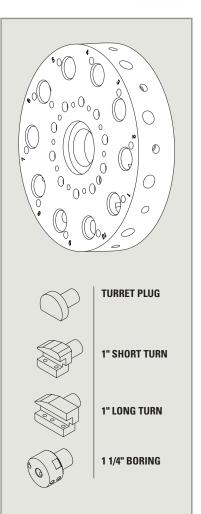
Dual-spindle TL-15 and TL-25 models feature the VB HYBRID TURRET, a 12-station turret that allows the use of VDI 40 tools (including live tools), as well as standard bolt-on tools. The turret has 6 VDI stations and 6 bolt-on stations (both radial slots for turning tools and perimeter stations for ID tools). The VB turret is optional on the SL-20, SL-30 and SL-40.

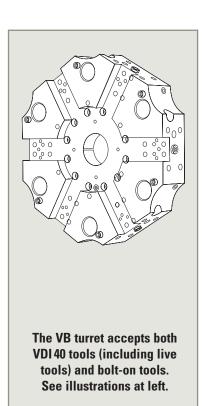
¹ Turret type may affect maximum turning diameter.

Toolholders







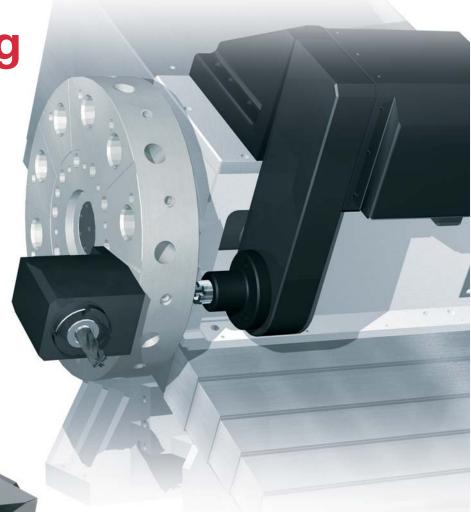


Live Tooling

Live Tooling with C Axis

The live tooling option for Haas lathes allows you to use standard VDI40 axial or radial driven tools to perform secondary operations such as milling, drilling, flatting and tapping – both on the face of the part and around the diameter. This option includes a full C axis, which provides interpolated bidirectional motion at precise speeds and feeds for part positioning and repeatability. A powerful hydraulic brake locks the main spindle during secondary operations, and disengages for turning and indexing.

Live tooling is not available with a standard bolt-on style tool turret. It is only available with the VDI or VB Hybrid turret.



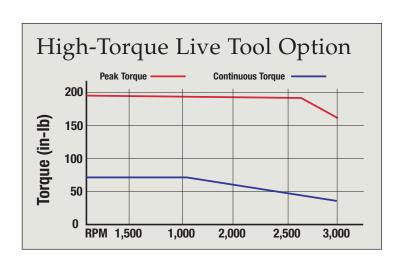
Simple, Modular Live Tool Drive System

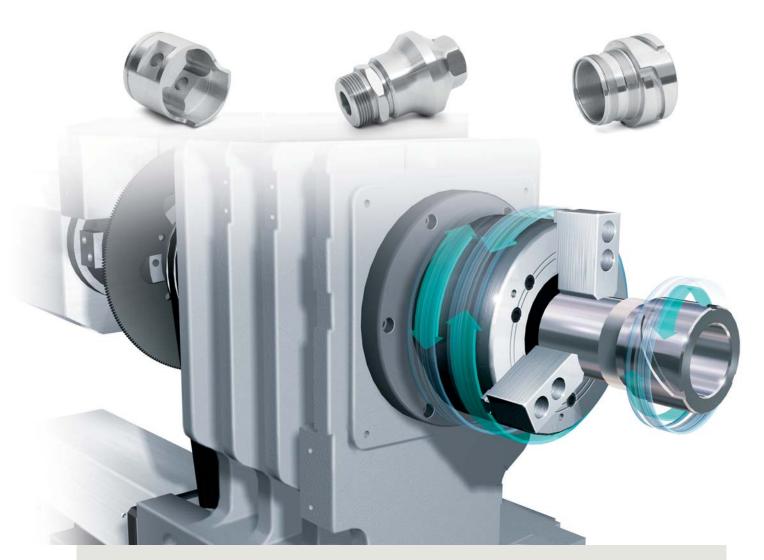
The Haas live tooling drive system features a simple, modular design that places the drive motor outside of the tool changer mechanism. This setup simplifies maintenance and service while providing a robust, reliable drive for secondary operations.



High-Torque Option +50% torque increase over

standard live tools.





C-AXIS MOTION

Eliminate secondary operations and increase your productivity by adding the ability to mill parts on your turning center. The C axis provides high-precision (±0.01 degree) bidirectional spindle motion that is fully interpolated with X and/or Z motion. It is servo driven through a back-gear reduction to provide outstanding torque for precision milling. Speeds are programmable from 0.1 to 60 rpm, and Cartesian-to-polar interpolation

allows programming of face machining operations using traditional X and Y coordinates.

Cartesian-to-polar coordinate programming converts X,Y position commands into rotary C-axis and linear X-axis moves, which greatly reduces the amount of code required to command complex moves. In the polar coordinate system, milling a straight line on the face of the part would require many points to define the path, but in Cartesian, only the end points are necessary.

Spindle Orientation

This option enables orientation of the main spindle for automatically loading nonround bar stock (hex, square, etc.) via a bar feeder. An M19 specified in the part program orients the spindle to within ± 0.1 degree, with a repeatability of ± 0.045 degree.

Spindle orientation is included in the Live Tooling option, and is standard on APL, dual-spindle models and CE machines.



Live Tools

The live tooling option accepts radial and axial driven toolholders. These tools can be used on both the VDI turret and the VB Hybrid turret.

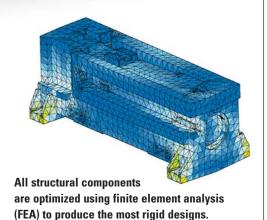
Rigid Foundation



Massive Cast-Iron Construction

Cast iron is more expensive to buy and machine, but it provides up to ten times the damping capacity of steel. That's why Haas uses cast iron for all major components. Castings are internally reinforced with heavy ribs to resist flex and damp vibrations, and each one is thoroughly inspected prior to machining to ensure it is free of flaws.

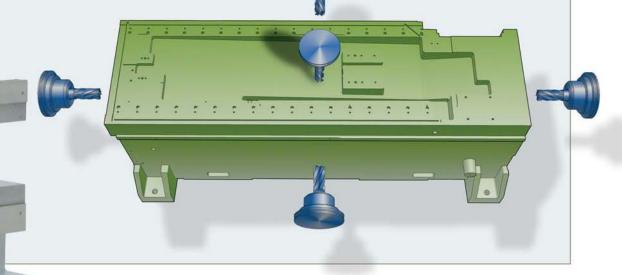
SL Series lathe castings feature heavy symmetric ribs that increase rigidity and improve thermal stability. Massive headstock and tailstock castings further increase rigidity, ensuring high accuracy and precise repeatability.



1 Setup, 5 Sides – surfaced, drilled and tapped

All Haas base castings are machined on state-of-the-art, 5-side CNC machines. Each casting is completely machined, drilled, tapped and inspected in a single setup, which provides higher accuracies and smoother production. Our ability to precisely machine all critical features of each casting eliminates alignment errors in final assembly. High-accuracy in-process inspection

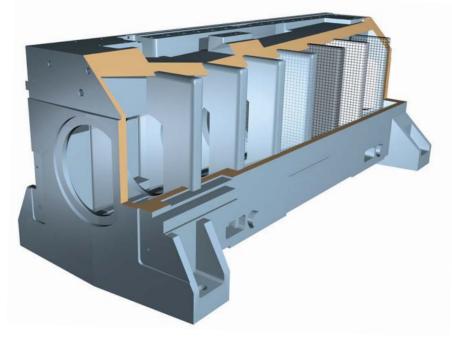
guarantees that every casting meets our stringent quality standards.



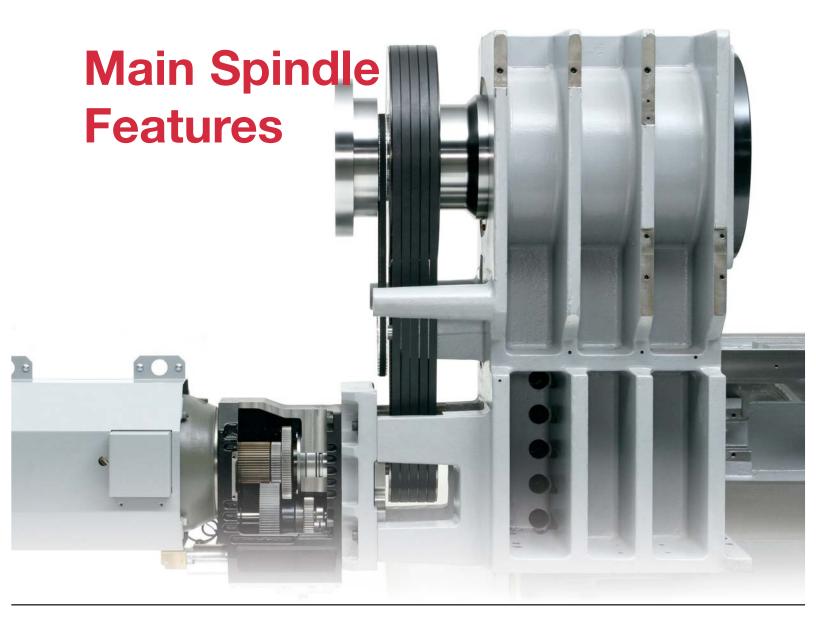
Anti-Flex, Torque-Tube Base Casting*

Our unique, specially designed, Haas torque-tube base casting yields superior rigidity and gives the most anti-flex properties of any base design. It's so stable, in fact, that the machine will cut accurately with one leveling screw removed, and no special foundation is required for installation.

*Except the SL-10, which is built using a heavily-ribbed and reinforced structure that incorporates the coolant tank into the base, and the Toolroom Lathes.

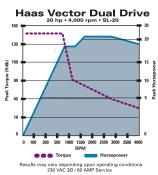


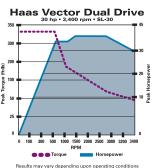
Rigid, Cost-Effective Design Solutions.



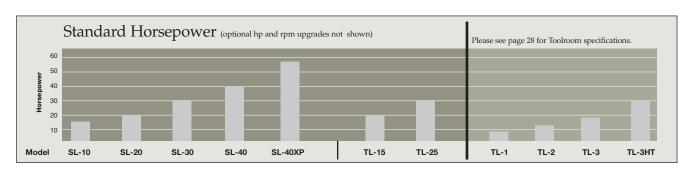
Powerful Vector Spindle Drives

The Haas-designed vector spindle drive uses the same technology as our brushless servo motors to provide peak performance and speed control under heavy cutting loads. This true closed-loop system optimizes the slip angle between the rotor and stator of the spindle motor to double low-speed torque and acceleration, resulting in the most powerful spindle output ever. These drives allow you to push the spindle to 150 percent of the motor's continuous horsepower for 15 minutes, and to 200 percent for 5 minutes.





That's more performance headroom than any other drive on the market.



Built for Extra Torque

This Haas-made gearbox is standard on the SL-40, SL-40L Long Bed, SL-30 Big Bore and TL-25 Big Bore. Designed and built entirely in-house to ensure superior quality and precision, Haas gears are CNC machined and hobbed out of 8620 steel, then heat-treated to 60 Rc and precision ground to AGMA Class 13 quality.

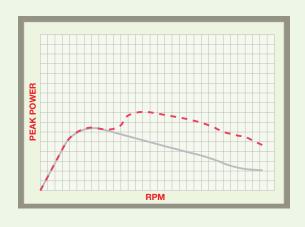
The gearbox yields 1,400 ft-lb of spindle torque at 150 rpm for low-speed, heavy cutting – and it also allows speeds to 2,400 rpm for finish cuts and turning aluminum.

Gearbox shown with cutaway for illustration purposes.



On-The-Fly WYE-DELTA Switching

Most Haas lathes feature the Haas Dual-Drive system, which consists of a dual-winding motor – Wye and Delta – and an electronic switch to change between the two windings. Selecting the best winding for low-rpm cutting and the best winding for high-rpm cutting yields higher torque values over a wider rpm range. In addition, the Haas Dual-Drive system provides constant horsepower over a much wider rpm range. On-the-fly winding change provides the wide power range needed during constant surface speed cuts.



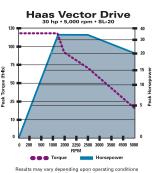
Enhanced power range with on-the-fly Wye-Delta

Typical power curve

Spindle Options

5,000-rpm / 30-hp Spindle

For high-speed turning of smaller parts, the 5,000-rpm/30-hp option for the SL-20 and TL-15 reduces cycle times and provides high surface feedrates. The 30-hp vector drive spindle provides faster acceleration to full speed, and yields more torque at higher rpm.



7,000-rpm / 20-hp Spindle

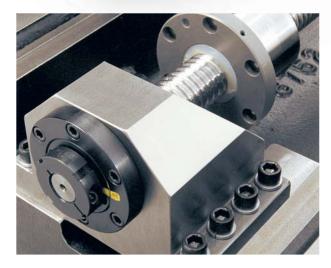
When even higher spindle speeds are needed, a smooth-running 7,000-rpm/20-hp option is available for the SL-20 and TL-15. This 20-hp vector drive spindle has an A2-5 spindle nose, and comes with a 5" chuck with 1.3" bar capacity. It accelerates quickly to top speed, and yields the high surface feedrates needed for excellent finishes on small parts.

55-hp Extra-Performance Option

Available for the SL-40 and SL-40L Long Bed, this option boosts spindle power to 55 hp, with 2,100 ft-lb of torque. It includes a larger servomotor on the Z axis for increased Z-axis thrust of 7,847 lb.

Motion Control



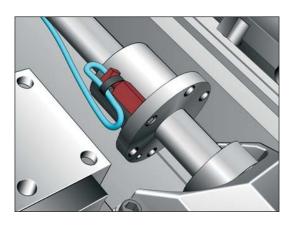


Double-Anchored Ballscrews

Haas uses only premium-quality ballscrews and guides from the world's top manufacturers. Although these suppliers are more expensive than our competitors' sources, their premium quality is the only way to achieve the high accuracy and long life that our customers demand. Our ballscrews are anchored at both ends and inspected for 100% parallelism to the axis guides. Preloaded ball nuts are used to eliminate backlash.

Thermal Stability/ Temp Track

Our temperature-tracking system uses a temperature probe attached to the ballscrew nut combined with electronic modeling to compensate for thermal growth. Temp-Track monitors temperature variations of the ballscrew and uses a sophisticated control algorithm to electronically adjust for thermal expansion, ensuring that the machine maintains accuracy and repeatability throughout the day.

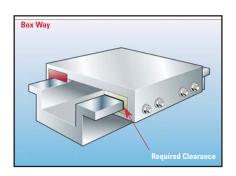


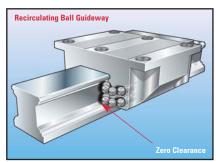
Specifications subject to change without notice. Not responsible for typographical errors.

Recirculating Ball Guideways

Haas uses recirculating ball guideways for each axis of every CNC turning center. These guideways are preloaded for zero clearance, and provide full loadcarrying capacity in all directions. They consume less power, do not require adjustment and are proven to outperform sliding box ways for accuracy and speed. Each guideway is automatically lubricated to guarantee long life.





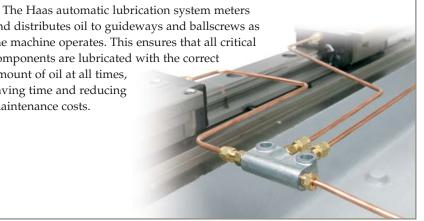


Recirculating Ball Guideways Outperform Box Ways

Recirculating ball guideways are preloaded to provide zero clearance between the moving surfaces. This increases rigidity and stiffness, while providing higher accuracy and reliability. Box ways require clearance between the moving surfaces in order to operate. Recirculating ball guides have a very low coefficient of friction, which allows faster movements without sacrificing repeatability or positioning accuracy. Box ways have a high coefficient of friction, which results in stick-slip effects that can lead to machine errors.

Automatic Lubrication

and distributes oil to guideways and ballscrews as the machine operates. This ensures that all critical components are lubricated with the correct amount of oil at all times, saving time and reducing maintenance costs.



Brushless Servomotors



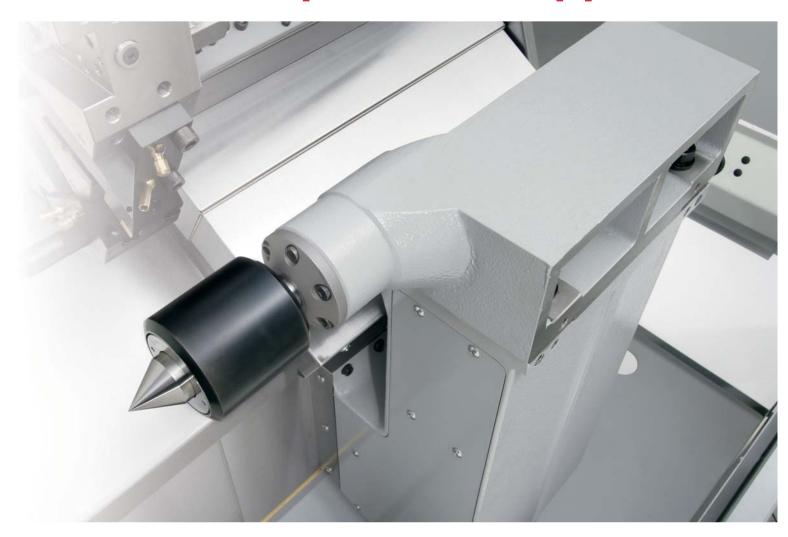
Haas uses state-of-the-art brushless servomotors that offer more torque in a smaller frame than almost any other motor available. These high-performance servos provide more power for heavy cuts, and higher acceleration/deceleration rates to reduce cycle times. With no brushes to wear and generate dust, maintenance is reduced and reliability is substantially increased. These compact motors also run cooler, have a higher duty rating and perform longer than brushtype motors.



Haas Direct-Coupled Servomotors

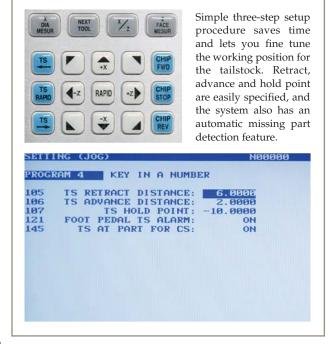
Our servomotors are directly coupled to the ballscrews with steel disc couplings to eliminate windup – even under severe loading. This results in greatly improved positioning accuracy, and more accurate threading and contouring. Unlike belt- or rubber-coupled joints, our couplings don't wear out or lose accuracy over time.

Quick Setup & Part Support



Programmable Hydraulic Tailstock

The Haas fully programmable hydraulic tailstock can be activated via the part program or controlled directly by the operator with the standard foot switch. Closed-loop positioning allows you to stop anywhere along the tailstock's travel. Massive ribbed castings provide superior rigidity, and a two-piece design simplifies realignment if required. (The optional tailstock for the SL-10 features manual coarse adjustment and a hydraulic quill.)



Big-Bore Capacity

The Haas Big Bore option provides larger bar capacity and more power without moving up to a larger machine. For the SL-10, SL-20 and SL-30, this is done by taking the spindle and drive system off the next larger machine and putting it on the smaller platform. The SL-20 Big Bore, for example, gets the SL-30's drive system, and the SL-30 Big Bore gets the SL-40's drive system. The SL-40 Big Bore maintains the same drive system, but with higher ratio gearing, and upgrades to an A2-11 spindle with up to 7.0" bar capacity (6.5" with a draw tube).

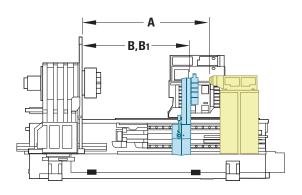
Bar Ca	apacity						
Model	SL-10	SL-20	TL-15	SL-30	TL-25	SL-40	SL-40L
Std Bore	1.75"	2.0"	2.0"	3.0"	3.0"	4.0"	4.0"
	44 mm	51 mm	51 mm	76 mm	76 mm	102 mm	102 mm
Big Bore	2.0"	2.5"	2.5"	4.0"	4.0"	7.0"†	7.0"†
	51 mm	64 mm	64 mm	102 mm	102 mm	178 mm	178 mm

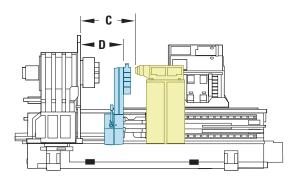
SL-40 Extra-Performance Option

Available for the SL-40 and SL-40L Long Bed, this option boosts spindle power to 55 hp, with 2,100 ft-lb of torque. It includes a larger servomotor on the Z axis for increased Z-axis thrust of 7,847 lb.

Steady Rest Provision

The Haas steady rest platform provides increased support for turning and boring long shafts on SL-30 and SL-40 lathes. It features industry-standard mounting holes to accept a variety of aftermarket automatic hydraulic steady rests. Hydraulic power is provided by the lathe, and the gripper is activated by M code.







Steady Rest and Tailstock Travels

	SL-30	SL-40	SL-40L
A	51.8"	59.4"	94.9"
	1 316 mm	1 509 mm	2 410 mm
B (w/tailstock)	41.5"	52.6"	67.8"
	1 054 mm	1 336 mm	1 722 mm
B ₁ (w/o tailstock)	47.1"	67.8"	67.8"
	1 196 mm	1 722 mm	1 722 mm
C (w/steady rest)	26.6"	33.3"	38.0"
	676 mm	846 mm	965 mm
D	20.9"	26.5"	26.5"
	531 mm	673 mm	673 mm

The steady rest provision does not include the gripper. Minimum and maximum part diameters are dependent on the size and style of gripper unit mounted on the platform. Minimum and maximum travel limits are measured from the spindle bulkhead, and do not include chuck dimensions or other workholding.

Part-Holding Variations



Hydraulic Chuck

Every standard Haas turning center comes with a hydraulic, through-hole chuck. The SL-10 comes equipped with a 6" chuck, the SL-20 comes with an 8" chuck, the SL-30 comes with a 10" chuck and the SL-40 comes with a 15" chuck. Bar capacities range from 1.75" for the standard SL-10 up to a massive 7.0" for the SL-40 with Big Bore.

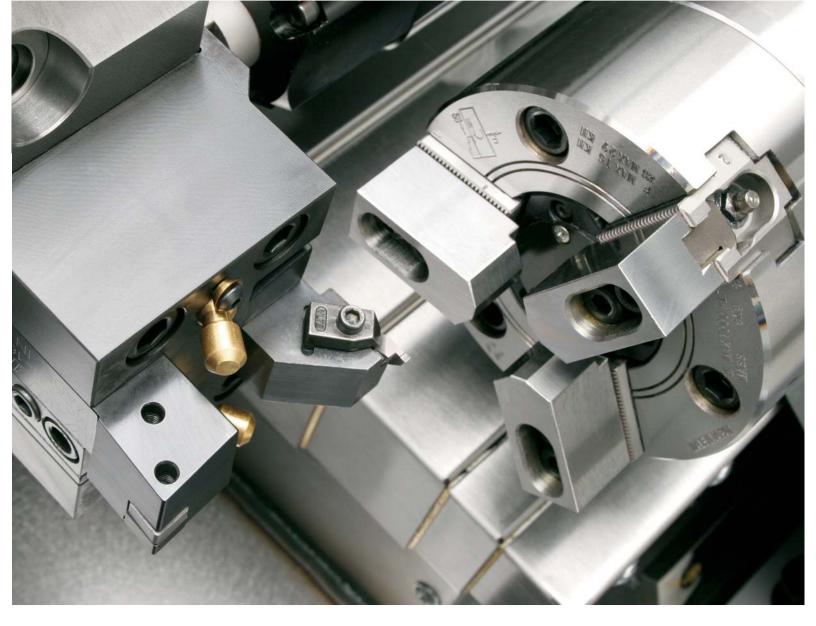
Haas Lathe Workholding

Model	SL-10	SL-20	TL-15	SL-30	TL-25	SL-40	SL-40L
Standard Chuck	6.5" 165 mm	8.3" 210 mm	8.3" 210 mm	10.0" 254 mm	10.0" 254 mm	15.0" 381 mm	15.0" 381 mm
Big Bore Upgrade	8.3" 210 mm	10.0"	10.0"	15.0"	15.0"	Optional †	Optional †

 $[\]dagger$ Chuck, rotating union and draw tube not included; accepts chucks up to 24". Bar capacity 6.5" w/draw tube.

Rear Chuck Options

The SL-40BB and SL-40LBB models are available with optional rear chuck capability for gripping long, tubular parts at both ends of the spindle. Chuck not included.



Sub-Spindle Models

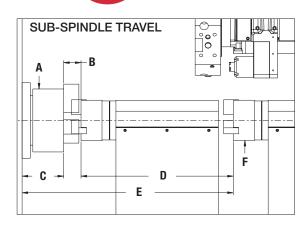
The TL-15 and TL-25 dual-spindle lathes allow turning of double-sided parts in one setup on a single machine. Each model features a powerful vector drive main spindle and a versatile 4,000-rpm sub-spindle. Both machines come standard with a 12-station, hybrid VDI/BOT tool turret. Special twin-bore and twinturn toolholders are included for sub-spindle work. The addition of live tooling and full C-axis to these machines increases their abilities even further.

Sub-Spindle Travel Dimensions

Dim.	TL-15	TL-25
Α	ø8.27" ø210 mm	ø10.00" ø254 mm
В	2.11" 54 mm	2.57" 65 mm_
С	5.48" 139 mm	6.26" 159 mm

Dim.	TL-15	TL-25
D	20.00" 508 mm	33.50" 851 mm
E	27.59" 701 mm	42.33" 1 075 mm
F	ø5.31" ø135 mm	ø5.31" ø135 mm

Part transfer avg. seconds or less

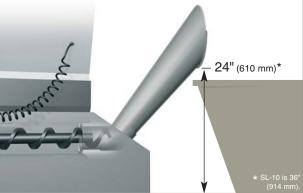


Some items shown in this brochure are optional. Please contact your local distributor for assistance.

Chip Removal

Chip Auger

Most people buy a CNC machine to make money by making parts faster. Yet those same people will spend up to an hour per shift removing chips. Our auger-style chip conveyor automatically removes chips from the machine, while at the same time compressing them and wringing out the coolant. The auger is activated by M code, and for added reliability, the system reverses automatically if a jam occurs.

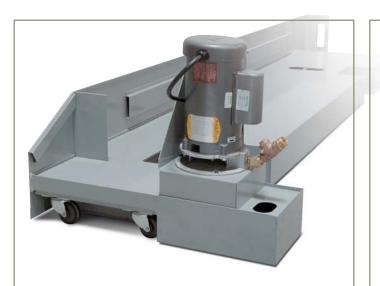


Optional Chip Conveyor

For high-production work using harder materials (such as tool steel or cast iron), a belt-type conveyor is available to clear chips from your machine's interior. Chips may be discharged into a standard 55-gallon (208 liter) drum.



Coolant System Features

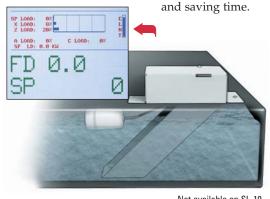


Roll-Out Coolant Tank

Taking a page from our proven VMC design, Haas lathes feature an embedded chip and coolant collection tray for improved sealing. An easy-access, roll-out coolant tank offers increased capacity and easier cleaning, and there's a handy hanger for the coolant pump to ease clean-out. (The SL-10 features a built-in coolant tank.)

Coolant Level Sensor

A mechanical level sensor in the coolant tank allows you to monitor your coolant level directly on the control screen, preventing damaged tools



Not available on SL-10

Auto Jet Blast

An M-code activated air blast clears chips and coolant from the chuck



High-Pressure Coolant

Our high-pressure coolant systems provide up to 300 psi or 1,000 psi of coolant to the cutting edge for deep-hole drilling, heavy cuts, faster feedrates and better surface finishes. The standard HPC option provides up to 300 psi at a flow rate of 1.5 gallons per

> minute, and 250 psi at 4 gpm. The 1,000-psi option (shown at left) has a max flow rate of 6 gpm, and requires separate (customer-supplied) 3-phase power. In both systems, actual pressure will vary with the diameter of the coolant passages in the tool.

Auxiliary Coolant Filter

This 25-micron, #2 bag-type filter system removes contamination and minute particles from the coolant before they can be recirculated through the coolant pump. The filter is mandatory for HPC-equipped machines, but may be used on non-HPC machines as well. It is included with the 1,000 psi coolant option.



Automated Operation



SL-20APL Automatic Parts Loader

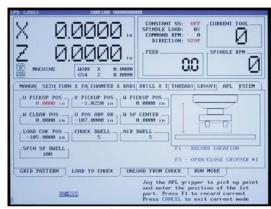
The Haas APL is a fully automatic lathe parts loader with opposing two-jaw grippers. Two gripper configurations come standard: one for shaft work and one stacker system. The APL is programmed directly through the lathe's control, and operates in the background of normal turning operations to deliver near-continuous unattended machining. The APL's double-sided rotating gripper loads and unloads parts with a single trip to the spindle, or flips parts for double-ended turning. The APL is available only with a new SL-20 lathe.

See page 37 for APL specifications.

Increase throughput by 200% or more.

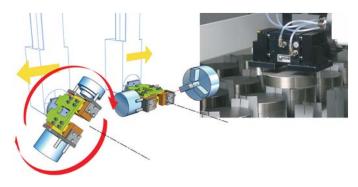
Features

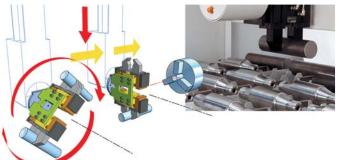
- Allows unattended operation
- Flexible gripper configurations
- Up to 5.0" OD shafts
- Up to 7.0" OD disks
- Easy setup via the Haas control
- Loads/unloads parts in one trip
- Rotates parts for double-ended turning capability*
- * Shaft loader



Simplified Setup

APL setup has been vastly simplified through Haas' Intuitive Programming System, which guides the operator through the steps necessary to quickly program the APL. Answering simple questions, the operator enters basic information into the system by either positioning the part grippers and pushing a single button or entering basic numeric dimensions. All values are calculated automatically by the control, and the APL is ready to go.





Haas Servo Bar 300 Automatic Bar Feeder



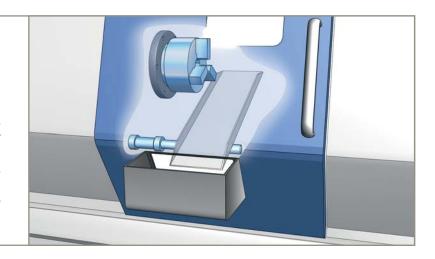
Designed to boost productivity and streamline turning operations, this servo-driven bar feeder is built by Haas exclusively for Haas CNC lathes. It runs directly from the Haas control, making it the only "smart" bar feeder on the market. Unique features make setup and operation simple, like a large access

door for spindle liner change-out and a single adjustment for setting bar diameter. All bar feed parameters are set at the lathe control.

See page 37 for bar feeder specifications.

Parts Catcher

For bar feed applications, or when using a bar puller, the parts catcher rotates into position to catch the finished part and direct it into a bin located on the front door. There's no need to stop the machine and open the door to retrieve parts.



Operator Convenience



Auto Door

This option opens and closes the machine's door automatically via the part program. This reduces operator fatigue during repetitive machining operations, increases operator productivity by up to 25% and allows for unattended operation when used with a robotic loader.

Not available in CE countries.

Door-Activated High-Intensity Lighting

Dual halogen lights provide bright, even illumination of the work area for part inspection, job setup and changeovers. Lights turn on and off automatically when doors open and close, or can be operated via a manual switch.

Convenient Storage Box

This covered box provides convenient storage for toolholders, cutting tools and accessories right at the machine, eliminating the need for a separate tool cart.



Note Pad & Disk Storage

This handy bracket on the side of the control pendant holds a pad of paper for jotting notes, and has slots for holding pencils and storing up to 6 floppy disks.



Storage Area

Another operator-focused feature is this convenient "glove box" below the pendant. The hinged door folds down to form a handy shelf, and closes securely to keep items out of sight.





Tool Presetter

The manual tool-probe arm swings down for fast tool setting. Touch the tool tip to the probe, and offsets are automatically entered.



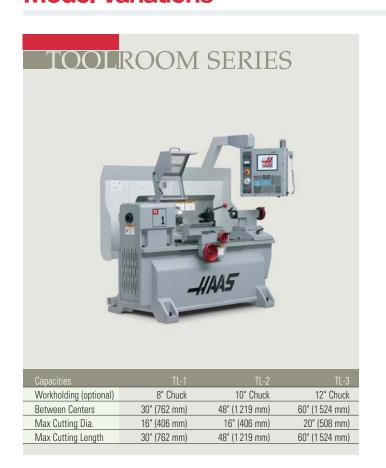
Work Probing

The Haas work probing option incorporates a turret probe, receiver and macros. This option can be used to perform rapid first-off part inspection, inprocess reporting and unattended machining operations. It can also be used to update work offsets to ensure ultimate part accuracy and keep tool wear in check.



Some items shown in this brochure are optional. Please contact your local distributor for assistance.

Model Variations









Model Variations





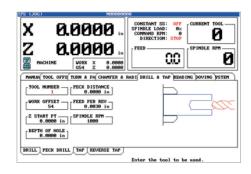






Toolroom Series Lathes from Haas

The Haas Toolroom Lathes combine the full functionality and simplicity of a manual lathe with the power and flexibility of the easy-to-use Haas CNC system. With standard handwheels and high-accuracy DRO, manual machinists will be cutting parts in minutes. And with the new Haas Intuitive Programming System, they'll transition quickly and easily into automatic modes and full CNC. Even novice machinists will find the TL Series lathes very easy to learn and operate.





No G-Code. Use our Intuitive Programming System - see page 32.

Operate Haas Toolroom Lathes in any one of four modes:

In manual mode, standard handwheels move both axes, with accurate digital readout (DRO) of position. In automatic mode, the Toolroom Lathes have built-in cycles for profiling, chamfering, corner radius, grooving, threading, drilling and tapping. In recorder or "Teach" mode, a series of operations can be easily recorded, and then saved and/or edited for running the same part program to duplicate parts in the future. In full CNC mode, Haas Toolroom Lathes are programmed using standard G-code via the Haas control.

Toolrooms and small machine shops have long been bastions of manual machine tools. But to survive in today's competitive market, it is increasingly necessary for these shops to make the move to CNC. The Haas Toolroom Lathes ease the transition from manual machines to CNC – without breaking the bank.

Toolroom Series Specifications

Chindle

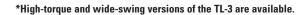
Capacities	TL-1	TL-2	TL-3*
Workholding (optional)	8" Chuck	10" Chuck	12" Chuck
Between Centers	30" (762 mm)	48" (1219 mm)	60" (1524 mm)
Max Cutting Dia.	16" (406 mm)	16" (406 mm)	20" (508 mm)
Max Cutting Length	30" (762 mm)	48" (1219 mm)	60" (1524 mm)

Shinnie			
Max Speed	1,800 rpm	1,800 rpm	1,800 rpm
Max Motor Rating	7.5 hp (5.6 kW)	12 hp (8.9 kW)	18 hp (13.4 kW)
Max Torque	100 ft-lb @ 375 rpm (136 Nm @ 375 rpm)	150 ft-lb @ 150 rpm (203 Nm @ 150 rpm)	204 ft-lb @ 417 rpm (227 Nm @ 417 rpm)
Spindle Nose	A2-5	A2-6	A2-6
Spindle Bore	Ø2.31" (59 mm)	Ø3.00" (76 mm)	Ø3.50" (89 mm)

Swing Diameter			
Over Front Apron	16.00" (406 mm)	16.00" (406 mm)	20.00" (508 mm)
Over Cross Slide	9.50" (241 mm)	11.10" (282 mm)	13.00" (330 mm)

Iravels & Feedrates			
X Axis Travels	8" (203 mm)	8" (203 mm)	12" (305 mm)
Z Axis Travels	30" (762 mm)	48" (1 219 mm)	60" (1 524 mm)
X Axis Max Thrust	3,096 lb (13772 N)	3,096 lb (13772 N)	3,096 lb (13772 N)
Z Axis Max Thrust	1,548 lb (6886 N)	2,340 lb (10409 N)	3,096 lb (13772 N)
X Axis Rapids	75 ipm (1.9 m/min)	75 ipm (1.9 m/min)	75 ipm (1.9 m/min)
Z Axis Rapids	150 ipm (3.8 m/min)	150 ipm (3.8 m/min)	150 ipm (3.8 m/min)

General			
Power	1-Phase – 240V @ 40A 3-Phase – 208V @ 25A	1-Phase – 240V @ 40A 3-Phase – 208V @ 25A	200 – 250VAC 3-Phase, 40A
Machine Weight	4,100 lb (1860 kg)	4,600 lb (2087 kg)	6,500 lb (2 948 kg)
Footprint	83" x 55" (2 108 x 1 397 mm)	101" x 55" (2 565 x 1 397 mm)	118" x 62" (2 997 x 1 575 mm)
Note: Considerations sub	piect to change without notice. M	a har food provision	





Handwheels and precise DRO make manual operation simple, and the heavy-duty cross-slide accepts a wide selection of tool post options.

The optional tailstock, with a manually adjustable quill, provides additional support for long workpieces.



The spindle nose (A2-5 or A2-6) accepts a variety of optional chucks and collets. An integral chip-flow channel prevents chips from building up in the work area and simplifies clean-up.



An optional four-station automatic tool turret (TL-1 and TL-2) eliminates manual tool changes, allowing fully automatic operation to increase productivity and decrease cycle times for longer part runs.

The Haas Control



Common multi-step functions, such as powering up in the morning or setting tool offsets, have been reduced to the push of a single button. Other often used functions, such as setting part zeros, homing the machine, setting the offset to centerline and resetting the tool turret, are also one-button commands.

Dedicated Closed System

Our focus is to provide Haas users with a robust, dependable control that is seamlessly integrated with the machine. Our closed system is not reliant on PC-based controls or third-party NC suppliers. When you call Haas, you get a company that takes full responsibility for the entire machine.

LED Beacon Light

The Haas-designed beacon light features ultra-bright LEDS that can easily be seen from anywhere in the shop. The LEDs generate very little heat and have a life expectancy of more than 10 years.

Color LCD Screen

Our full-color TFT LCD display is designed to work in the machine shop environment. The high-intensity, high-contrast LCD features a very wide viewing angle, and will not fade out in bright light. The panel is mounted behind anti-glare tempered glass for protection and easy viewing.

Multi-Function Jog Handle

Most machines use the jog handle only to move the axes around. On Haas machines, the jog handle can also be used in other modes to cursor through the program for faster editing, override spindle speeds and feedrates, or scan through offsets, parameters, etc.

Advanced Program Editing

A unique feature of the Haas control is an advanced program editor that allows the operator to edit programs in a dual-window format.

Dedicated Keypad

The Haas keypad has 131 keys. All common functions, including a full alphanumeric keypad, are clearly labeled for operator ease. If you have ever fumbled with hot keys, or had to page through screens looking for a specific function, then you will appreciate the simplicity of the Haas control. There are no encrypted codes to memorize, and many functions can be performed simply with the push of a single button.

Stainless Steel Bezel*

Constructed of heavy-gauge T304 stainless steel with a fine-grained finish, the bezel of the Haas control not only looks great, it's also easy to clean, resists wear and will not corrode.

*Not available on all machines.

Control Features
User friendly
 Advanced program editor
 Brushless AC servo drives
■ Triple 32-bit processors
Executes up to 1,000 blocks/second
■ ISO standard G-code compatibility
■ 1 MB standard program memory
Haas one-button power-up
 Haas one-button tool offset entry
■ 50 tool-geometry offsets
■ Tool load monitoring
Advanced tool life management
Background editing
Split screen program review
■ Trig calculator
Speeds and feeds calculator
Arc calculator
RS-232 / DNC link / opt. Ethernet + USB
■ Mid-program restart
■ Inch or metric programming
Message page
Selectable languages
Fully descriptive alarms
Self-diagnostics
Graphic dry run
■ 5 spare M functions†
Electronic thermal compensation
One-year parts and labor warranty
■ Made in the USA

eneral		
Microprocessor		Triple high-speed 32-bit
Program execution speed		1,000 blocks/sec standard
Axis control		2 axes linear, C axis optional
nterpolation		G01, G02, G03
Min. input increment	inch modemetric mode	0.0001" 0.001 mm
Min. output resolution		0.0000072" (0.00018 mm)
Feed Functions		
Rapid Traverse Override		5%, 25%, 50%, 100%
Feedrate Override		0% to 200% in 1% increments
Jog Handle Resolution	inch modemetric mode	0.0001"/0.001"/0.01"/0.1" per handle division 0.001/0.01/0.1/1.0 mm per handle division
Jog Feeds	inch modemetric mode	0.1/1.0/10.0/100.0 ipm 1.0/10/100/1000 mm/min
Zero Return		One key (G28)
Spindle Functions		
Speed Command		S=1 to 7,000 (max determined by model)
Override		0% to 200% in 1% increments
Tool Functions		
ength Compensation		50 sets, geometry & wear
Diameter/Radius Compen	sation	50 sets, geometry & wear
Length Measurement		Automatic length storage
Life Management		10 or 12 tools
Selection		Txx command
Programming		
Compatibility		ISO standard G code
Positioning		X, Z absolute and U, W incremental
Canned Cycles		17 functions, standard
nch/Metric		Switchable
Work Coordinates		105 sets
Part Zero Set		Automatic input and storage
M Functions		5 spare [†]
Cutter Compensation		G40, G41, G42
Data Input/Output		
Communications Port		RS-232
Data Rate		To 115,200 bits/second ‡
Memory Capacity		
Standard		1 MB; up to 16 MB optional
Number of Programs		500

Intuitive Programming System

Simple, intuitive and more powerful than ever . . .

It's getting more and more difficult to find machine operators who are experts in G-code programming. In fact, it's often impossible. Now, thanks to Haas' Intuitive Programming System (IPS), it's no longer necessary for a machine operator to know G-code for basic turning operations. The IPS software is available for our complete line of turning centers. It is standard on our Toolroom machines, and optional on our SL Series machines.

The Haas Intuitive Programming System is a proprietary conversational operating system that makes cutting parts and creating part programs nearly effortless. Using an easy-to-read format with full-color graphics, the IPS guides the operator through the steps necessary to machine a part. The operator simply chooses an operation, touches off the X and Z surfaces, and then enters basic dimension information. Default values for feed per revolution, spindle speed and depth of cut are entered automatically by the control, but can be modified by the operator. Once all necessary information is entered, pushing Cycle Start performs the operation. A Recorder function allows multiple operations to be recorded and saved, so that the information can be played back to duplicate the part. Operations that would be difficult or impossible on a manual machine - radii, tapers, profiles, grooving, threading, rigid tapping - are all possible on Haas

lathes without knowledge of G-code programming. Help menus are available directly on-screen, and a dry-run graphics feature allows operators to check their work before running a part.

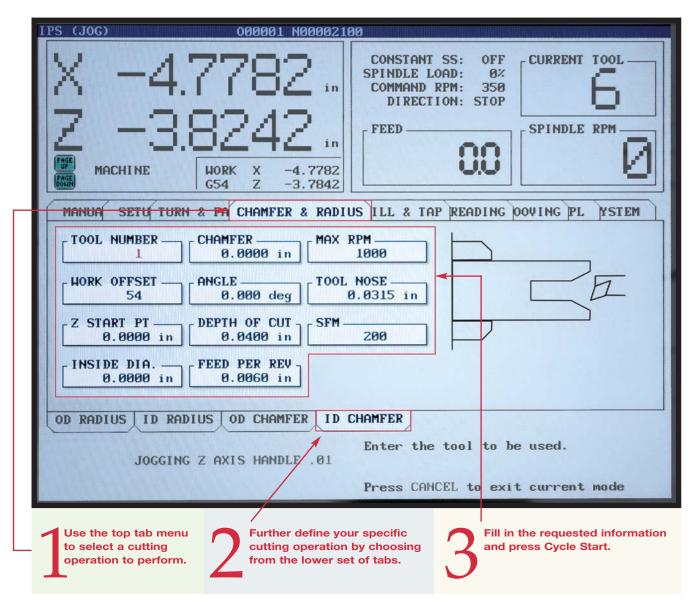
Powerful new features:

- Programmed from the centerline using tool offsets.
- Allows programs created in the Intuitive Programming System to be saved and rerun at a later date, or transferred to a Haas SL series production turning center as standard G-code.
- IPS upgraded threading features:
 - Machine tapered threads based on the amount of taper per foot.
 - Choose right- or left-hand threads.
 - Chamfer out or straight pull-out at thread's end.
 - Thread repair operations for straight, tapered, right-hand or left-hand, inside or outside diameter threads, without the need to orient the spindle to a known position.



Hard Drive & Ethernet Interface with USB Support

Store and transfer data between your Haas and a network or PC with the Ethernet connection. Program files are easily transferred to and from memory or the hard drive, and large files can be accessed by multiple machines. High-speed data transfers allow DNC of large files at up to 1,000 blocks per second. USB support allows the use of customer-supplied ZipTM drives or flash memory devices. Compatible with Windows 95, 98, ME, 2000 and XP. Also works with server versions NT 4.0, 2000 and 2003. IPX/SPX or TCP/IP protocol. Easy setup from the control screen.



Using plain language, simple graphics and easy-to-follow steps, the Haas Intuitive Programming System guides the operator through the steps necessary to machine a part.

PC-Compatible 1.44 MB/3.5" Floppy Drive

Conveniently located on the side of the control pendant, this drive uses standard PC floppies to easily upload programs for machining, download for storage off the machine or DNC directly off the disk.

8 M Functions

Adds 8 additional M functions for a total of up to 13 user interfaces. Use these to activate probes, auxiliary pumps, clamping devices, part loaders, etc.

Memory Upgrade – 16 MB

Allows loading of large programs directly into the machine, rather than from DNC, for faster feedrates. Battery-powered, high-speed static RAM is faster than dynamic RAM and retains data even when the power is turned off.

Memory Lock Keyswitch

Locks memory to prevent program editing by unauthorized personnel. It can also be used to lock settings, parameters, offsets and macro variables.

Machine Specifications (Standard)

		SL-10	SL-20	TL-15*	SL-30	TL-25*	SL-40	SL-40L
Swing Diameter	Over Front Apron	16.25" 413 mm	23.0" 584 mm	23.0" 584 mm	30.0" 762 mm	30.0" 762 mm	40.0" 1 016 mm	40.0" 1 016 mm
	Over Cross Slide	8" 203 mm	9.5" 241 mm	9.5" 241 mm	14.5" 368 mm	14.5" 368 mm	25.0" 635 mm	25.0" 635 mm
	Chuck Size	6.5" 165 mm	8.3" 210 mm	8.3" 210 mm	10.0" 254 mm	10.0" 254 mm	15.0" 381 mm	15.0" 381 mm
	Standard Bar Capacity	1.75" 44 mm	2.0" 51 mm	2.0" 51 mm	3.0" 76 mm	3.0" 76 mm	4.0" 102 mm	4.0" 102 mm
Capacities	Between Centers	16.5" 419 mm	24.0" 610 mm	12.7" 323 mm	39.0" 991 mm	39.0" 991 mm	51.0" 1 295 mm	80.0" 2 032 mm
oupuonics	Max Cutting Diameter ¹	11.0" 279 mm	10.3" 262 mm	8.2" 208 mm	17.0" 432 mm	16.0" 406 mm	25.5" 648 mm	25.5" 648 mm
	Max Cutting Length	14.0" 356 mm	20.0" 508 mm	17.5" 445 mm	34.0" 864 mm	34.0" 864 mm	44.0" 1118 mm	80.0" 2 032 mm
	Max Cutting Length w/Standard Workholding	13.0" 330 mm	19.0" 483 mm	16.3" 414 mm	32.0" 813 mm	32.0" 813 mm	42.5" 1 080 mm	77.25" 1 962 mm
	Max Speed	6,000 rpm	4,000 rpm	4,000 rpm	3,400 rpm	3,400 rpm	2,400 rpm	2,400 rpm
	Torque (ft-lb @ rpm) (Nm @ rpm)	75 @ 1,300 102 @ 1 300	154 @ 650 209 @ 650	154 @ 650 209 @ 650	300 @ 700 407 @ 700	300 @ 700 407 @ 700	1,400 @ 150 1 898 @ 150	1,400 @ 150 1 898 @ 150
	Torque w/Optional Transmiss	ion N/A	N/A	N/A	850 @ 250 1 152 @ 250	850 @ 250 1 152 @ 250	Standard	Standard
Spindle	Max Power Rating	15 hp 11.2 kW	20 hp 15 kW	20 hp 15 kW	30 hp 22 kW	30 hp 22 kW	40 hp 30 kW	40 hp 30 kW
	Spindle Nose	A2-5	A2-6	A2-6	A2-6	A2-6	A2-8	A2-8
	Spindle Bore	Ø 2.31" Ø 59.0 mm	Ø 3.00" Ø 76.2 mm	Ø 3.00" Ø 76.2 mm	Ø 3.50" Ø 88.9 mm	Ø 3.50" Ø 88.9 mm	Ø 4.62" Ø 117.3 mm	Ø 4.62" Ø 117.3 mm
	Draw Tube Bore	Ø 1.81" Ø 46.0 mm	Ø 2.06" Ø 52.3 mm	Ø 2.06" Ø 52.3 mm	Ø 3.03" Ø 77.0 mm	Ø 3.03" Ø 77.0 mm	Ø 4.06" Ø 103.1 mm	Ø 4.06" Ø 103.1 mm
	X Axis Travels	6.25" 159 mm	8.45" 215 mm	7.50" 191 mm	11.30" 287 mm	11.30" 287 mm	17.00" 432 mm	17.00" 432 mm
	Z Axis Travels	14.00" 356 mm	20.00" 508 mm	17.50" 445 mm	34.00" 864 mm	34.00" 864 mm	44.00" 1 118 mm	80.00" 2 032 mm
Travels & Feedrates	X Axis Max Thrust	2,400 lb 10 675 N	2,400 lb 10 675 N	2,400 lb 10 675 N	4,000 lb 17 793 N	4,000 lb 17 793 N	4,000 lb 17 793 N	4,000 lb 17 793 N
	Z Axis Max Thrust	3,700 lb 16 458 N	3,700 lb 16 458 N	3,700 lb 16 458 N	6,200 lb 27 579 N	6,200 lb 27 579 N	6,200 lb 27 579 N	6,200 lb 27 579 N
	Rapids	1,200 ipm 30.5 m/min	1,200 ipm 30.5 m/min	1,200 ipm 30.5 m/min	710 ipm 18.0 m/min	710 ipm 18.0 m/min	710 ipm 18.0 m/min	X=710 ipm, Z=320 ipm 18.0 m/min, 8.1 m/m
	Number of Tools	12	10	12	12	12	10	10
	OD vs ID Tools	Any combo	Any combo	6 VDI / 6 BOT	Any combo	6 VDI / 6 BOT	Any combo	Any combo
Turret	Tool Size (OD turning)	0.75"	1.0"	1.0"	1.0"	1.0"	1.25"	1.25"
	Boring Bar Rear Clearance	4.13"	4.37"	4.37"	4.50"	4.50"	4.63"	4.63"
	(from turret face) Index Time (one tool)	105 mm 1 second	111 mm 1 second	111 mm 1 second	114 mm 1 second	114 mm 1 second	118 mm 1 second	118 mm 1 second
	Positioning	±0.0002"	±0.0002"	±0.0002"	±0.0002"	±0.0002"	±0.0002"	±0.0002"
Accuracy	Repeatability	±0.005 mm ±0.0001"	±0.005 mm ±0.0001"	±0.005 mm ±0.0001"	±0.005 mm ±0.0001"	±0.005 mm ±0.0001"	±0.005 mm ±0.0001"	±0.005 mm ±0.0001"
	Weight	±0.003 mm	±0.003 mm 9,000 lb	±0.003 mm 9,000 lb	±0.003 mm	±0.003 mm	±0.003 mm	±0.003 mm 31,000 lb
		2 495 kg	4 082 kg	4 082 kg	7 258 kg	7 258 kg	11 340 kg	14 062 kg
Miscellaneous	Power Requirement Volts / Phase	14 kVA	14 kVA	14 kVA	28 kVA	28 kVA	28 kVA	28 kVA
	Coolant		0-250 VAC @ 50A, 3 40 gal	-pnase 60 Hz 40 gal	50 gal	200-250 VAC @ 50 gal	100A, 3-phase 60 Hz 77 gal	77 gal
		15 gal 57 l	151	151	189	189 l	291 l	291 l
	Air Requirement All machines: 4 scfm @ 100 psi 113 lpm @ 6.9 bar							

¹ Maximum turning diameter may be affected by machine options.

Machine Specifications (With Options)

	SL-10	SL-20	TL-15*	SL-30	TL-25*	SL-40	SL-40L
	Chuck Size 8.3" 210 mm	10.0" 254 mm	10.0" 254 mm	15.0" 381 mm	15.0" 381 mm	† optional	† optional
	Maximum Bar Capacity 2.0" 51 mm	2.5" 64 mm	2.5" 64 mm	4.0" 102 mm	4.0" 102 mm	7.0"† 178 mm	7.0"† 178 mm
Big Bore Option	Between Centers 16.5" 419 mm	24.0" 610 mm	12.7" 323 mm	39.0" 991 mm	39.0" 991 mm	51.0" 1 295 mm	89.0" 2 261 mm
Capacities	Maximum Cutting Diameter 11.0" 279 mm	10.3" 262 mm	8.2" 208 mm	16.0" 406 mm	16.0" 406 mm	25.5" 648 mm	25.5" 648 mm
	Maximum Cutting Length 14.0" 356 mm	20.0" 508 mm	17.5" 445 mm	34.0" 864 mm	34.0" 864 mm	44.0" 1 118 mm	80.0" 2 032 mm
	Max Cutting Length 12.0" w/Standard Workholding 305 mm	17.5" 444 mm	15.0" 381 mm	31.0" 787 mm	29.0" 737 mm	42.5" 1 080 mm	77.25" 1 962 mm
	Maximum Speed 4,000 rpm	3,400 rpm	3,400 rpm	2,400 rpm	2,400 rpm	1,400 rpm	1,400 rpm
	Torque 154 ft-lb @ 650 rpm 209 Nm @ 650 rpm		b @ 700 rpm n @ 700 rpm			lb @ 150 rpm m @ 150 rpm	
	Transmission N/A	N/A	N/A	Standard	Standard	Standard	Standard
Big Bore Option	Max Power Rating 20 hp 15 kW	30 hp 22 kW	30 hp 22 kW	40 hp 30 kW	40 hp 30 kW	40 hp 30 kW	40 hp 30 kW
Spindle	Spindle Nose A2-6	A2-6	A2-6	A2-8	A2-8	A2-11	A2-11
	Spindle Bore Ø 3.00" 76.2 mm	Ø 3.00" 76.2 mm	Ø 3.00" 76.2 mm	Ø 4.62" 117.3 mm	Ø 4.62" 117.3 mm	Ø 7.08" 180 mm	Ø 7.08" 180 mm
	Draw Tube Bore Ø 2.06" Ø 52.3 mm	Ø 2.56" Ø 65.0 mm	Ø 2.56" Ø 65.0 mm	Ø 4.06" Ø 103.1 mm	Ø 4.06" Ø 103.1 mm	Ø 6.5" Ø 165 mm	Ø 6.5" Ø 165 mm
	Power Requirement 14 kVA	28 kVA	28 kVA	28 kVA	28 kVA	28 kVA	28 kVA
	Taper MT3	MT4	_	MT4 (MT5 opt)	_	MT5	MT5
Tailstock Option	Travels 9.75" manual 4.0" hydraulic 248 mm 102 mm	20.0" 508 mm	-	33.5" 851 mm	_	44.0" 1 118 mm	80.0" 2 032 mm
	Thrust 225 - 900 lb 1 001 - 4 003 N	300 - 1,500 lb 1 334 - 6 672 N	_	300 - 1,500 lb 1334 - 6672 N	_	300 - 1,500 lb 1 334 - 6 672 N	300 - 4,500 lb 1 334 - 20 017 N
	w/ 5,000-rpm / 30-hp						
Spindle Options	Torque –	120 ft-lb @ 163 Nm @		-	-	-	-
	w/ 7,000-rpm / 20-hp						
	Torque –	80 ft-lb @ 108 Nm @		-	-	-	-
	Speed -	0-3,000 rpm	0-3,000 rpm	0-3,000 rpm	0-3,000 rpm	0-3,000 rpm	0-3,000 rpm
	Peak Torque Standard –	132 in-lb	132 in-lb	132 in-lb	132 in-lb	132 in-lb	132 in-lb
Live Tooling	Peak Torque w/HT option –	14.9 Nm 195 in-lb 22.0 Nm	14.9 Nm 195 in-lb 22.0 Nm	14.9 Nm 195 in-lb 22.0 Nm	14.9 Nm 195 in-lb 22.0 Nm	14.9 Nm 195 in-lb 22.0 Nm	14.9 Nm 195 in-lb 22.0 Nm
	Drive Ratio –	1:1	1:1	1:1	1:1	1:1	1:1
	Brake Diameter –	13.25" 337 mm	13.25" 337 mm	‡13.25" 337 mm	‡13.25" 337 mm	21.5" 546 mm	21.5" 546 mm
	Brake Clamp Force –	1,000 lb 4 448 N	1,000 lb 4 448 N	1,000 lb 4 448 N	1,000 lb 4 448 N	1,000 lb 4 448 N	1,000 lb 4 448 N
	Tooling –	7 770 11		chines: Standard VI		4 440 IV	4 440 IV

^{*} See page 36 for specifications on the TL-15 & TL-25 sub-spindle.
† Chuck, rotating union and draw tube not included; accepts chucks up to 24". Bar capacity 6.5" w/ draw tube.
‡ SL-30 and TL-25 Big Bore have 21.5" brake disc.

Sub-Spindle Machines





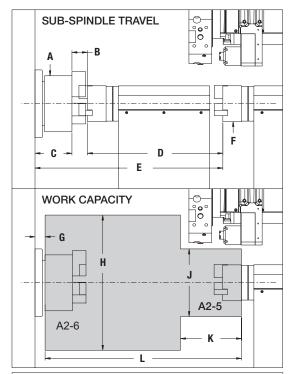
Specs	TL-15	TL-25
Chuck Size	8.3" 210 mm	10" 254 mm
Spindle Rating (peak)	20 hp 14.9 kW	30 hp 22.4 kW
Spindle Speeds	50-4,000 rpm	50-3,400 rpm
Standard Bar Capacity	2" 51 mm	3" 76 mm
Between Centers	12.7" 323 mm	39" 991 mm
Max Cutting Diameter	8.2" 208 mm	16" 406 mm
Max Cutting Length	17.5" 445 mm	34" 864 mm
Tool Turret	Hybri 6 VDI-40, 6	
Sub-Spindle		
Chuck Size	5.3" 135 mm	5.3" 135 mm
Bar Capacity	1.18" 30 mm	1.18" 30 mm
Spindle Rating (peak)	8 hp 6 kW	8 hp 6 kW
Spindle Speeds	0-4,000	rpm

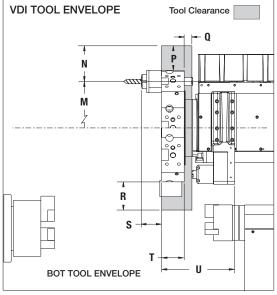
Working Dimensions

TL-15	TL-25
ø8.27"	ø10.00"
ø210 mm	ø254 mm
2.11"	2.57"
54 mm	65 mm
5.48"	6.26"
139 mm	159 mm
20.00"	33.50"
508 mm	851 mm
27.59"	42.33"
701 mm	1075 mm
ø5.31"	ø5.31"
ø135 mm	ø135 mm
1.38"	1.42"
35 mm	36 mm
ø23.00"	ø29.50"
ø584 mm	ø749 mm
ø10.50"	ø14.50"
ø267 mm	ø368 mm
8.25"	5.82"
210 mm	148 mm
	Ø8.27" Ø210 mm 2.11" 54 mm 5.48" 139 mm 20.00" 508 mm 27.59" 701 mm Ø5.31" Ø135 mm 1.38" 35 mm Ø23.00" Ø584 mm Ø10.50" Ø267 mm 8.25"

Dim.	TL-15	TL-25
L	29.00" 737 mm	43.67" 1109 mm
М	ø13.72" 348 mm	ø13.72" 348 mm
N	5.00" 127 mm	7.49" 190 mm
Р	3.40" 86 mm	5.85" 149 mm
Q	1.00" 25 mm	1.00" 25 mm
R	3.40" 86 mm	6.39" 162 mm
S	2.96" 75 mm	2.96" 75 mm
T	3.35" 85 mm	3.35" 85 mm
U	10.08" 256 mm	10.08" 256 mm







Warning: There are numerous work envelope restrictions on the TL-15 & TL-25, depending upon the tooling being used. A complete set of work envelope drawings is available from Haas or your local Haas Factory Outlet.

Automated Operation

SL-20 with APL



Feedrates (Part Loader)*	
U-Axis Rapid V-Axis Rapid W-Axis Rapid Change Time	1,300 ipm (33.0 m/min) 750 ipm (19.1 m/min) 1,880 ipm (47.8 m/min) 30 sec (chip-to-chip†)
APL	
Table Size Table Load Capacity	48" x 24" (1219 x 610 mn 1,000 lb (453.6 kg)
Double Gripper / Double Part	
Part Weight Combined Weight Max Part Diameter Max Part Length	15 lb max (6.8 kg) 30 lb max (13.6 kg) 5" (127 mm) 16" (406 mm)
Disc Gripper	
Part Weight Max Part Diameter	15 lb max (6.8 kg) 7" (178 mm)
Grippers convert to OD or ID. Part configuration determines stacking height.	
Dimensions	
Width Depth Height	179" (4547 mm) 84" (2134 mm) 146" (3708 mm)

Automatic Bar Feeder

Servo Bar featured on page 23. Servo Bar available with SL-10, -20, -30 and -40.

Servo Bar Specifications

Capacity	3/8" to $31/8$ " dia., up to 60" length 9.53 mm to 79.38 mm, up to 1524 mm		
Control	Via the Haas CNC control		
Pushers	Standard 3/8" and 3/4"		
Tray capacity	1" (25 mm) dia. bars x 30 pcs.		
Spindle liner	Most sizes available; depends on lathe model.		
Weight	900 lb (408 kg)		

Note: Specifications subject to change.

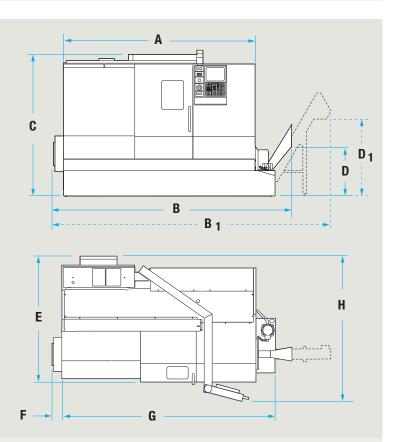
Maximum bar diameter and length determined by lathe model.

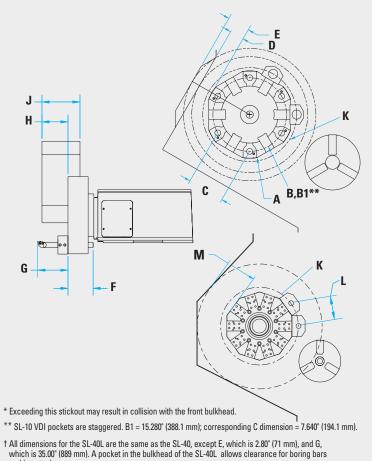


Installation Dimensions

Dim.	SL-10	SL-20/TL-15	SL-30/TL-25	SL-40	SL-40L
А	70"	96"	119"	150"	209"
	1 778 mm	2 438 mm	3 023 mm	3 810 mm	5 309 mm
В	102"	126.5"	*149.5"	189.5"	234"
	2 591 mm	3 505 mm	3 797 mm	4813 mm	5 944 mm
B1	121"	138"	161.5"	192.5"	252"
	3 073 mm	3 505 mm	4102 mm	4889 mm	6 401 mm
С	69"	72"	74"	86"	86"
	1 753 mm	1 829 mm	1 880 mm	2 184 mm	2 184 mn
D	36.34"	24"	24"	24"	24"
	923 mm	610 mm	610 mm	610 mm	610 mm
D1	43"	48"	50"	50"	50"
	1 092 mm	1 219 mm	1 270 mm	1 270 mm	1 270 mn
Е	55"	62"	73"	92"	95"
	1 397 mm	1 575 mm	1 854 mm	2337 mm	2 413 mn
F	14.5" 368 mm	8.0" 203 mm	*8.0" 203 mm	14.5" 368 mm	-
G	76"	106"	128"	160"	219"
	1 930 mm	2 692 mm	3 251 mm	4 064 mm	5 563 mn
Н	55"	74"	77"	98"	107"
	1 397 mm	1 880 mm	1 956 mm	2 489 mm	2718 mn

^{*} With optional two-speed gearbox add 8". With Big Bore option add 14" B1, D1 = With optional chip conveyor

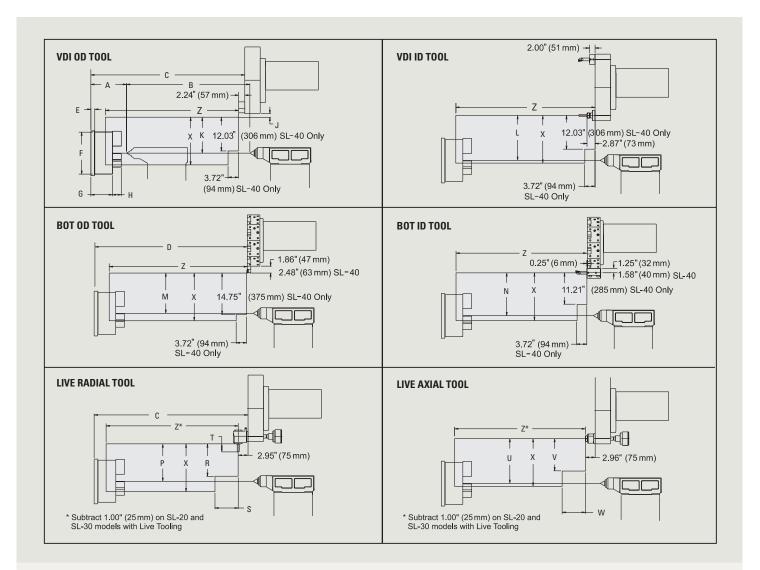




Dim.	SL-10	SL-20	SL-30	SL-40†
A – Turret Dia	7.937"	15.374"	19.000"	23.750"
VDI	201.6 mm	390.5 mm	482.6 mm	603.3 mm
B – Pocket Dia	**12.000"	12.000"	15.280"	20.000"
VDI	304.8 mm	304.8 mm	388.1 mm	508.0 mm
VB	-	13.720" 348.5 mm	13.720" 348.5 mm	20.000" 508 mm
C – Pocket Spacing	**6.000"	3.669"	3.955"	6.180"
VDI	152.4 mm	93.2 mm	100.5 mm	156.9 mm
VB	-	6.860" 174.2 mm	6.860" 174.2 mm	10.000" 254 mm
D – TC Clearance	0.000	3.79"	4.90"	3.66"
VDI		96 mm	124 mm	93 mm
E – TC Clearance (LT)	-	-	-	5.70"† 145 mm
F – Max Tool Stickout,	4.13"	4.37"	4.50"	4.63"
Rear	105 mm	111 mm	114 mm	118 mm
G – Max Tool Stickout,*	4.96"	5.73"	5.90"	10.91"†
Front (full Z travel)	126 mm	146 mm	150 mm	277 mm
H – Live Tool Stickout	-	-	-	5.50" 140 mm
J – Live Tool Pocket Width	-	-	-	8.00" 203 mm
K – BOT ID Tool Pocket Dia	15.28"	15.28"	18.56"	21.42"
	388 mm	388 mm	471 mm	544 mm
VB	-	18.42" 467.9 mm	18.42" 467.9 mm	25.52" 648.2 mm
L – BOT Pocket Spacing	3.95"	4.72"	4.80"	6.62"
	100 mm	120 mm	122 mm	168 mm
VB	-	9.21" 234 mm	9.21" 234 mm	12.76" 324 mm
M – BOT TC Clearance	2.47"	5.00"	6.40"	6.40"
	63 mm	127 mm	163 mm	163 mm

Specifications subject to change without notice. Not responsible for typographical errors. Note: Overall shipping dimensions vary; contact Haas for details.

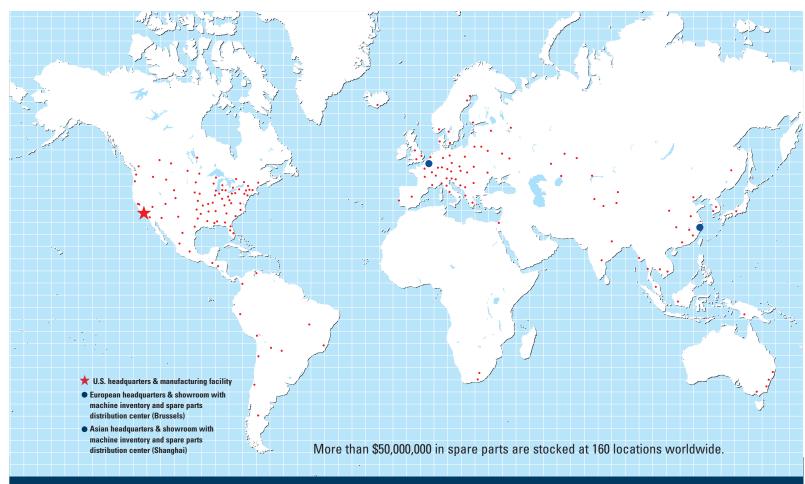
Work Envelope



Dimensions	SL-10	SL-20	SL-30	SL-40	SL-40L
A – Tailstock at Full Travel	9.35"	10.96"	12.03"	12.72"	31.36"
	237 mm	278 mm	306 mm	323 mm	797 mm
B – Tailstock Travel	13.55"	20.00"	34.00"	44.00"	62.00"
	344 mm	508 mm	867 mm	1 118 mm	1 575 mm
C – Turret Home VDI	18.96"	25.73"	39.90"	54.91"	90.21"
	482 mm	654 mm	1 013 mm	1 395 mm	2 291 mm
D – Turret Home BOT	18.96"	25.73"	39.90"	54.64"	89.94"
	482 mm	654 mm	1 013 mm	1 388 mm	2 284 mm
E – Spindle Face	2.12"	1.39"	1.39"	1.40"	1.40"
	54 mm	35 mm	35 mm	36 mm	36 mm
F – Chuck Diameter	6.50"	8.27"	10.00"	15.00"	15.00"
	165 mm	210 mm	254 mm	381 mm	381 mm
G – Chuck Face	5.66"	5.45"	6.12"	7.70"	7.70"
	144 mm	139 mm	155 mm	196 mm	196 mm
H – Chuck Jaws	1.26"	2.00"	1.81"	3.14"	3.14"
	32 mm	51 mm	46 mm	80 mm	80 mm
J – VDI OD Tool Stickout	1.00"	1.26"	1.15"	1.33"	1.33"
	25 mm	32 mm	29 mm	34 mm	34 mm
K – VDI OD Tool Home	9.93"	4.44"	7.29"	12.79"	12.79"
	252 mm	113 mm	185 mm	325 mm	325 mm
L – VDI ID Tool Home	7.44"	7.45"	10.30"	16.00"	16.00"
	189 mm	190 mm	262 mm	406 mm	406 mm

	SL-10	SL-20	SL-30	SL-40	SL-40L
M – BOT OD Tool Home	5.55" 141 mm	5.14" 131 mm	8.50" 216 mm	14.37" 365 mm	14.37" 365 mm
N – BOT ID Tool Home	5.80" 147 mm	5.75" 146 mm	8.66" 220 mm	15.28" 388 mm	15.28" 388 mm
P – Radial Live Tool Home	-	4.74" 120 mm	7.59" 193 mm	13.29" 338 mm	13.29" 338 mm
R – Radial Live Tool X T/S Zon	e –	3.52" 89 mm	5.83" 148 mm	11.53" 293 mm	11.53" 293 mm
S – Radial Live Tool Z T/S Zon	e –	4.40" 112 mm	4.01" 102 mm	8.32" 211 mm	8.32" 211 mm
T – Radial Live Tool Stickout	-	2.83" 72 mm	4.12" 105 mm	4.86" 123 mm	4.86" 123 mm
U – Axial Live Tool Home	-	7.45" 189 mm	10.30" 262 mm	16.00" 406 mm	16.00" 406 mm
V – Axial Live Tool X T/S Zone	-	3.52" 89 mm	5.83" 148 mm	11.53" 293 mm	11.53" 293 mm
W – Axial Live Tool Z T/S Zone	. –	4.40" 112 mm	4.01" 102 mm	8.32" 211 mm	7.32" 186 mm
X – X-Axis Travel	6.25" 159 mm	8.45" 215 mm	11.30" 287 mm	17.00" 432 mm	17.00" 432 mm
Z – Z-Axis Travel	14.00" 356 mm	20.00" 508 mm	34.00" 864 mm	44.00" 1 118 mm	80.00" 2 032 mm

Worldwide Support



Head Office, California, USA



European Headquarters, Brussels, Belgium



Asian Headquarters, Shanghai, China



Our network of dedicated Haas Factory Outlets provides local attention to detail, fully stocked service vans, and the training and backing of an international organization. In total, more than \$50,000,000 in spare parts are stocked at 160 locations worldwide. Local parts inventories are supported by overnight availability from main headquarters.

Haas Automation, Inc.

2800 Sturgis Road, Oxnard, California 93030 Toll Free: 800-331-6746 Fax: 805-278-8540

www.HaasCNC.com

Haas Automation, Europe

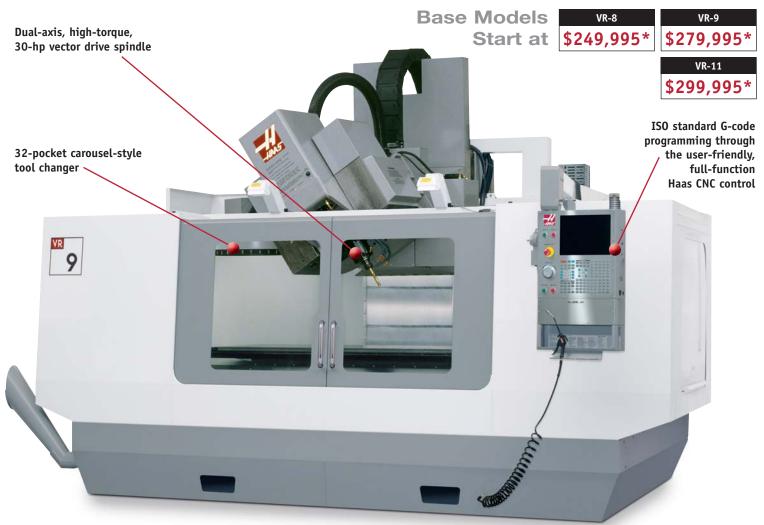
Mercuriusstraat 28, B-1930 Zaventem, Belgium • Tel: 011-32 2 522 99 05 Fax: 011-32 2 523 08 55

Haas Automation, Asia

Sec A, 1F, Bldg #26, Plot FW6-819, District F, No 500 East Fu Te Er Road, Shanghai Waigaoqiao F.T.Z. 200131 P.R.C. • Tel: 011-86 21 5046 2202 Fax: 011-86 21 5046 2232

Haas VR Series

The 5-Axis Contouring VMCs



Warranty: 1 Year Parts and Labor

[Standard Features]

- High-Torque 30-hp Vector Drive Spindle
- 32-Pocket Automatic Tool Changer
- Programmable Coolant Nozzle
- Chip Auger System
- 16 MB Program Memory
- Remote Jog Handle
- Visual Quick Code Programming
- Rigid Tapping
- 15" Color LCD Monitor w/USB Port
- High-Speed Machining w/Look-Ahead
- User-Defined 2nd Home Button
- Anchor Kit

[Options] partial list

- 15,000-rpm Spindle
- 10,000-rpm Spindle
- Through-Spindle Coolant
- Linear Scales (X,Y and Z axes)
- Hard Disk Drive with Ethernet Interface
- User-Definable Macros
- Spindle Orientation
- Coordinate Rotation and Scaling
- Memory Lock Keyswitch



Haas Automation, Inc. | www.HaasCNC.com | 800-331-6746 | Made in U.S.A.

Haas VR Series

The 5-Axis Contouring VMCs



The Haas VR Series five-axis contouring VMCs provide a cost-effective solution for large 5-axis machining operations. With travels ranging from $64" \times 40" \times 30"$ for the VR-8 to $120" \times 40 \times 30"$ for the VR-11, these machines can handle the demands of producing large, complicated parts. Each VR is equipped with a unique dual-axis spindle that features a fully enclosed gimbal design to protect gears from chips and coolant. The VR head provides ± 32 degrees of travel on the A and B axes for machining complex geometries and undercuts.

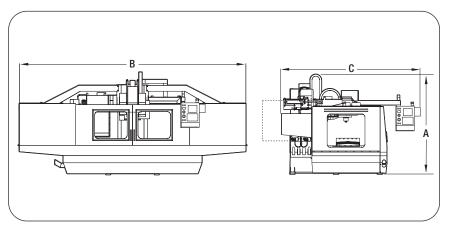
Each VR features a 32-pocket automatic tool changer that swings out of the enclosure for unobstructed machining, and a 30-hp, high-torque spindle that features a vector drive for the absolute best performance throughout the entire rpm range.











Operating Dimensions	VR-8	VR-9	VR-11
A. Max Operating Height	131" 3327 mm	131" 3 327 mm	131" 3327 mm
B. Max Operating Width	178" 4521 mm	192" 4877 mm	257" 6 528 mm
C. Max Operating Depth [†]	160" 4064 mm	160" 4 064 mm	160" 4064 mm
† Requires additional 36" (914 mm) to open rear service panel.			





Prices and specifications subject to change without notice. Not responsible for typographical errors. Machines shown with optional equipment. *Base price in US dollars.

Mar 2008

[Specifications]

ravels	VR-8	VR-9	VR-11
Х	64"	84"	120"
	1626 mm	2 134 mm	3 048 mm
Υ	40"	40"	40"
	1 016 mm	1 016 mm	1016 mm
Z	30"	30"	30"
	762 mm	762 mm	762 mm
A, B	±32°	±32°	±32°
Spindle Nose to Table	4" - 34"	4" - 34"	4" - 34"
(approximate)	102-864 mm	102 -864 mm	102 -864 mm
Table			
Length	64"	84"	120"
	1 626 mm	2 134 mm	3 048 mm
Width	36"	36"	28"
NA NA/ : 1 / T 1	914 mm	914 mm	711 mm
Max Weight on Table	4,000 lb 1814 kg	4,000 lb 1814 kg	4,000 lb 1814 kg
Slots	TOTTING	TOTTING	TOTTKG
Width		5/8" 16 mm	<u> </u>
Center Distance		4.92" 125.0 m	
Genter Distance		4.02 120.011	1111
Spindle			
Taper Size		#40 Taper	
Speed		7,500 rpm	
Max Torque	75 ft-lb @ 1,	000 rpm 102 N	Vm @ 1 000 rpn
Motors			
Spindle Max Rating		30 hp 22.4 k	W
Axis Max Thrust Rating	;	3,400 lb 1512	4 N
Feedrates			
Rapids			

		360 ipm 9.1 m/min
600 ipm 15.2 m/min	600 ipm 15.2 m/min	600 ipm 15.2 m/min
	1,900°/min	
500 ipm 12.7 m/min	500 ipm 12.7 m/min	360 ipm 9.1 m/min
	600°/min	
	13.7 m/min 600 ipm 15.2 m/min 500 ipm	13.7 m/min 15.2 m/min 600 ipm 15.2 m/min 15.2 m/min 1,900°/min 500 ipm 12.7 m/min 12.7 m/min

Tool Changer	
Capacity	32
Туре	CT 40 (BT 40 optional)

General			
Door Open Width	69"	85"	120"
	1753 mm	2 159 mm	3 048 mm
Machine Weight	27,100 lb	28,100 lb	32,500 lb
	12 293 kg	12 746 kg	14 742 kg
Air Required	9 scfm @ 11	00 psi <mark>255 Lp</mark> ı	m @ 6.9 bar
Power Required (min)		28 kVA;	
	200 - 250 VAC or		
		380 - 480 VAC	,

Preparing Your Laboratory for the

ELAN 9000 ICP-Mass Spectrometer

PerkinElmer SCIEX ICP-MS instruments are complete systems with the exception of the following items which must be provided by the customer: electrical power, exhaust vents, argon gas supplies with approved regulator, and coolant system. The items shown in the following checklist need to be considered when preparing the laboratory for the instrument.

- Environmental conditions
- Electrical requirements
- Space requirements
- Exhaust ventilation
- Coolant requirements
- Gases

www.perkinelmer.com/instruments

Computer and printer table

ICP-MS. Maximum dust levels can not exceed 1,000,000 particles (0.5 micron or larger) per cubic foot of air (Class 1,000,000). A normal office environment would be 500,000 to 1,000,000 particles per cubic foot.

If the ELAN 9000 is going to be used to carry out ultra-trace determinations, such as in the semiconductor industry, it is advised that the instrument be installed in at least a Class 1000 clean room.

In addition, the instrument should be located in an area that is:

- Free of smoke and corrosive fumes
- Not prone to excessive vibration
- Out of direct sunlight
- Away from heat radiators

PerkinElmer SCIEX ICP-MS instruments have been designed for indoor use. The ELAN 9000 can be installed into a mobile laboratory if the instrument is isolated from vibrations.

WARNING:

Do not use the instrument in an area where explosion hazards may exist.

Environmental Conditions

The environment in which the instrument is installed should meet the following conditions.

- The room temperature should be between 15 and 30°C (59-86°F) with a maximum rate of change of 2.8°C (5°F) per hour.
- The relative humidity should be between 20 and 80%, noncondensing. For optimum performance, the room temperature should be controlled at 20 ± 2°C (68 ± 3.6°F) and the relative humidity should be between 35 and 50%.

In order to minimize contamination problems, a relatively dust-free environment is necessary. This is especially important when working with ultra-trace techniques, such as

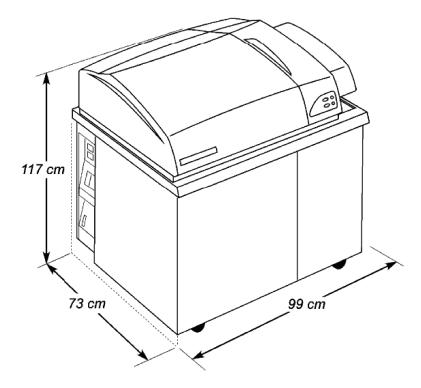


Figure 1. Dimensions of the ELAN 9000 ICP-MS.



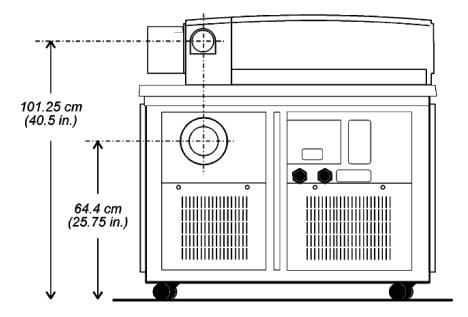


Figure 2. Vent locations, rear of the ELAN 9000 ICP-MS.

- Equip the outlet end of the system with a backdraft damper. Keep the exhaust outlet away from open windows or inlet vents and to extend it above the roof of the building for proper dispersal of the exhaust.
- Equip the exhaust end of the system with an exhaust stack to improve the overall efficiency of the system.
- For best efficiency, make sure the length of the duct that enters into the blower is a straight length at least ten times the duct diameter. An elbow entrance into the blower inlet causes a loss in efficiency.
- Provide make-up air in the same quantity as is exhausted by the system. An "airtight" lab will cause an efficiency loss in the exhaust system.
- Ensure that the system is drawing properly by placing a piece of cardboard over the mouth of the vent.
- Equip the blower with an indicator light located near the instrument to indicate to the operator when the blower is on.

Cleaning the Instrument

Before using any cleaning or decontamination methods, except those specified by the manufacturer, users should check with the manufacturer that the proposed method will not damage the equipment.

Cleaning procedures for the ELAN 9000 can be found in the ELAN 9000 Hardware Guide.

Coolant Requirements

The ELAN 9000 system requires a regulated source of filtered coolant for the purpose of cooling. The coolant supply should be filtered (free of sediment) and have a pH between 6.5 and 8.5. It should be hardness-free with <1ppm of heavy minerals. The recirculator operating pressure should be 344 ± 13 kPa (50 \pm 2 psi). A coolant flow of at least 3.8 L/min (1.0 gpm) is required.

A recirculating system containing a corrosion inhibitor is specified to protect the aluminum components of the cooling system and the interface. Sufficient pre-mixed coolant (Part No. WE01-6558) is supplied for the Heat Exchanger or Refrigerated chiller.

If laboratory temperatures do not exceed 30°C (86°F), the heat exchanger can be used in place of a refrigerated chiller. For laboratories where the temperature can exceed 30°C (86°F), a refrigerated chiller is required. The heat exchanger must be located in a well ventilated area where the air temperature will not exceed 30°C (86°F).

Argon Gas Requirements

Argon is used as the ICP torch gas with the ELAN 9000. The quality criteria for argon is listed below.

Purity	≥ 99.996%
Oxygen	< 5 ppm
Hydrogen	< 1 ppm
Nitrogen	< 20 ppm
Water	< 4 ppm

Either liquid or gaseous argon can be used with an ICP-MS system. The choice of liquid argon or gaseous argon tanks is determined primarily by the availability of each and the usage rate. Liquid argon is usually less expensive per unit volume to purchase, but cannot be stored for extended periods. If liquid argon is used, the tank should be fitted with an over-pressure regulator which will vent the tank as necessary in order to prevent the tank from becoming a safety hazard.

Gaseous argon tanks do not require venting and consequently can be stored for extended periods without loss. A tank of liquid argon containing 4300 cubic feet will last for approximately 100 hours of continuous ICP running time. A tank of gaseous argon will last 5 to 6 hours of ICP running time. The normal argon gas usage is 14-20 L/min.

A cylinder regulator (Part No. 0303-0284) which can be used with argon is available from PerkinElmer. The regulator can be used with CGA 580 or CGA 590 fittings and includes a color-coded hose with 1/4-inch Swagelok fittings to permit direct connection to the regulator and to the instrument gas controls. Liquid argon may be purchased from your gas supplier.

Exhaust Vents

The ELAN 9000 ICP-MS requires two separate vents, one for the ICP Power Supply/Roughing Pump exhaust and another vent for the Torch Box exhaust. The main venting system is required to remove combustion fumes and vapors from the torch housing. Exhaust venting is important for the following reasons:

- It protects laboratory personnel from toxic vapors that may be produced by some samples.
- It will minimize the effects of room drafts and the laboratory atmosphere on ICP torch stability.
- It will help protect the instrument from corrosive vapors which may originate from the samples.
- It will remove dissipated heat which is produced by the ICP torch, RF power supply, and the pump motors.

WARNING:

The use of ICP-MS instruments without adequate ventilation to outside air may constitute a health hazard. For example, the combustion of halogenated hydrocarbons produces toxic vapors. Extreme care should be taken that exhaust gases are vented properly.

The main 100 mm (4 inch) venting system must provide a flow rate of approximately 70 liters/sec \pm 10% (150 cubic feet/min). The 150 mm (6 inch) venting system must provide a flow rate of approximately 210 liters/sec \pm 10% (450 cubic feet/min). Both of the exhaust ports should be connected directly to flexible exhaust hoses.

The main torch box must be installed, but there is an option for the coaxial RF generator and roughing pump exhaust. If a 150-mm (6-in.) duct is not available, a 100-mm (4-in., 150 ft³/min) duct can be connected to the inner duct. Only the RF generator is exhausted in this case. The heat from the roughing pumps is released into the laboratory.

We recommend a 100 mm (4 inch) ID torch box exhaust hose and a 150 mm (6 inch) ID ICP Power Supply/ Roughing Pump air exhaust hose. The ELAN 9000 is supplied with 3 m (10 ft.) of 100 mm (4 inch) and 3 m (10 ft.) of 150 mm (6 inch) flexible tubing. This tubing permits the movement of the instrument without disconnecting the vents from the laboratory system. See Tables VI and VII for vent specifications.

Table VI. Flow Rates and Anemometer Readings

Hose Diameter	Flow Rate	Anemometer Reading
100 mm (4 in.)	70 L/s (150 ft ³ /min)	9 m/s (1695 fpm)
150 mm (6 in.)	210 L/s (450 ft ³ /min)	11.5 m/s (2250 fpm)

Table VII. Hose Diameter and Venting Capabilities

Hose	Hose Diameter	Vented Outside Lab Watts (BTU/hr)
Torch Box Exhaust	100 mm (4 in.)	200 (680)
ICP Power Supply/Roughing Pump	150 mm (6 in.)*	2800 (9400)
ICP Power Supply Only	100 mm (4 in.)	1400 (4700)

^{*}If only the 100-mm (4-in.) ID ICP power supply exhaust hose is used, approximately 1400 W (4700 BTU/hr) of heat is vented into the lab. An independent room air conditioner [3000 W (10 000 BTU/hr)] is recommended to remove this additional heat.

Vent Positions

Both of the ELAN 9000 vents are located on the back of the instrument. See Figure 2. The Torch Box exhaust vent is 23.75 cm (9.5 in) from the left side of the instrument when viewed from the rear and 101.25 cm (40.5 in) above the floor. The ICP Power Supply/Roughing pump exhaust vent is 23.75 cm (9.5 in) from the left side of the instrument (rear view) and 64.4 cm (25.75 in) above the floor.

Venting System Recommendations

The exhaust flow rate at the instrument (the ability to vent the system) is dependent on customer provided blower, the duct length, material and the number of elbows or bends used. If an excessively long duct system or a system with many bends is used, a stronger blower may be necessary to provide sufficient exhaust volume at the instrument. Smooth stainless steel tubing should be used instead of flexible stainless steel tubing where flexibility is not required to reduce system friction loss or "drag." A length of smooth stainless steel ducting has 20-30% less friction loss than a comparable length of flexible ducting. When smooth stainless steel tubing is used, elbows must be used to turn corners. These elbows should turn at no more than 45 degrees between straight sections to reduce friction losses, and the number of elbows should be minimized.

Additional recommendations on the venting system include:

- The duct casing and venting system should be made of materials suitable for temperatures as high as 70°C (160°F) and be installed to meet local building code requirements.
- Locate the blower as close to the discharge outlet as possible. All joints on the discharge side should be airtight, especially if toxic vapors are being carried.

- When storing cylinders external to a building, the cylinders should be stored so that they are protected against temperature extremes (including the direct rays of the sun) and should be stored above ground on a suitable floor.
- Mark gas cylinders clearly to identify the contents and status (full, empty, etc.).
- Do not attempt to refill gas cylinders yourself.
- Use only approved regulators and hose connectors. Left-hand thread fittings are used for fuel gas tank connections whereas right-hand fittings are used for oxidant and support gas connections.
- Arrange gas hoses where they will not be damaged or stepped on and where things will not be dropped on them.
- Perform periodic gas leak tests by applying a soap solution to all joints and seals.

Facilities Requirements

Table III provides information on the gas and liquid services required for the ELAN 9000. Tables IV and V show the electrical supply requirements and approximate power consumption of the ELAN 9000 and its major accessories.

Electrical Requirements

Power to the ELAN 9000 is to be delivered from two 30A single-phase 200-240V dedicated electrical branch circuits according to the power specifications in Table IV. Table V provides the electrical supply requirements and approximate power consumption of the major accessories and options. If the power line is unstable, fluctuates or is subject to surges, additional control of the incoming power may be required. A means of electrically grounding the instrument must be available.

60-Hertz-Operation Connections

The instrument is shipped with two 400 cm line cord cables. The installation kit includes two Hubbell No. 2621 plugs and two Hubbell No. 2620 receptacles for use with two 60 Hz single phase outlets. The instrument is wired for power at the time of installation.

50-Hertz-Operation Connections

The instrument is shipped with two 400 cm line cord cables. It is up to the service person installing the instrument to wire it according to the power available at the lab. The single phase connectors must be supplied by either the customer or the local PerkinElmer office. For 50 Hz operation, Hubbell Number 2351 plugs and

Hubbell No. 2350 receptacles are recommended. Note that the installation kit includes 2 Hubbell No. 2621 plugs and a No. 6 AWG ground wire. A means of electrically grounding the instrument must be available.

Three-Phase-Operation Connections

If a three phase connection is required (by local electrical code), the instrument can be connected via a single line cord to two of the three sides of the three phase line. The three-phase line cord and connectors must be supplied by either the customer or the local PerkinElmer office. A means of electrically grounding the instrument must be available. Four meters of grounding wire are provided with the instrument.

Table III. Services Required for the ELAN 9000

Gases	Argon, 350 \pm 7 kPa (51 \pm 1 psi) at 20 L/min flow
Cooling	Coolant circulation of at least 3.8 L/min (1.0 gpm) at an operating pressure of 344 \pm 14 kPa (50 \pm 2 psi)

Table IV. ELAN 9000 Power Specifications

Power Consumption	
Maximum Volt Amperes (total, both circuits)	6000 VA
Maximum Continuous Current (per circuit)	20 A
Voltage Amplitude Specification	
Operating Voltage	200 - 240 V
Maximum Allowable Percent Sag	5%
Maximum Allowable Percent Swell	5%
Phase (single or three)	Single phase or three phase
Frequency Specification	
Operating Frequency	50 or 60 Hz
Allowable Frequency Variance	± 1 Hz
Waveform Specification	
Maximum Supply Voltage Total Distortion	5%
Maximum Supply Voltage Distortion by Single Ha	rmonic 3%

Table V. Electrical Requirements of ELAN Accessories

Equipment	Voltage (AC)	Power
Computer	Depends on Model	Depends on Model
Printer: HP LaserJet 4100	100-127 V/220-240 V, 50/60 Hz	330 W
Cooling System:		
Heat Exchanger (PolyScience 3370)	208-240 V, 50/60 Hz	800 W
Refrigerated Chiller (PolyScience 6105PE)	208-230 V, 60 Hz, 8 A 240 V, 50 Hz, 8.5 A	2000 W
FIAS 400MS	110/220 V	600 W

Space Requirements

The system should be located near the required electrical and gas supplies. The spectrometer also requires liquid cooling. A suitable cooling system can be purchased from PerkinElmer.

The ELAN 9000 is on wheels and can be moved for service and preventative maintenance. However, a space of at least 30 cm (12 in.) behind the instrument is recommended. This space behind the instrument provides clearance for the vent hoses. Access for most service procedures will be through the front of the instrument. Allow space on the right side of the instrument for an accessory cart or table.

System Layout

The ICP-MS consists of the main instrument, the computer controller assembly and a printer, the dimensions of which are given in Figure 1 and Table I.

The ELAN 9000 ICP-MS can be positioned in either a linear or an L-shaped configuration. In the L-shaped configuration, the computer and printer are positioned on one leg of the L. The instrument and an accessory table make up the other leg.

There should be sufficient space near the spectrometer for the various accessories (autosampler, FIAS, electrothermal vaporizer, laser sampler, ultrasonic nebulizer, etc). It is recommended that the accessories be placed on a movable cart or table to allow for easy servicing access. Table II lists the dimensions of the accessories.

The system computer may be placed on a bench or a separate computer table. A suitable computer worktable is available from PerkinElmer (Part No. N058-1451).

Drain Vessels

A 15-liter drain vessel is supplied with the ELAN 9000 ICP-MS. The vessel is made of HDPE (high density polyethylene) and is used to collect the effluent from the ICP sample introduction system.

The drain vessel should be placed to the right of the instrument. The drain vessel should NOT be stored in an enclosed storage area. The drain system should be checked regularly and replaced when necessary. Should it become necessary to replace the drain vessel, it should be made from a material not likely to be attacked by samples being analyzed. Glass or other brittle materials must not be used.

Liquid waste should always be segregated and clearly labeled. Never mix organic and inorganic liquids in the same drain vessel. Organic and inorganic drain vessels should never be stored in the same area.

Safe Handling of Gas Cylinders

Notice: The permanent installation of gas supplies is the responsibility of the user and should conform to local safety and building codes.

- Fasten all gas cylinders securely to an immovable bulkhead or a permanent wall.
- When gas cylinders are stored in confined areas, such as a room, ventilation should be adequate to prevent toxic or explosive accumulations. Move or store gas cylinders only in a vertical position with the valve cap in place.
- Locate gas cylinders away from heat or ignition sources, including heat lamps. Cylinders have a pressure-relief device that will release the contents of the cylinder if the temperature exceeds 52°C (125°F).

Table I. Dimensions of the Instrument and Computer

Instrument	Width cm (in.)	Height cm (in.)	Depth cm (in.)	Weight kg (lb.)
ELAN 9000 Work Surface Height	99 (39)	117 (46) 87 (34)	73 (29)	295 (650)
DELL Computer	Dime	ensions will vary by	model	
DELL Monitor	Dime	ensions will vary by	model	
HP LaserJet 4100	39 (15.3)	34.6 (13.6)	50.7 (19.9)	17 (37.5)

Table II. Dimensions of the Accessories

Accessory	Width cm (in.)	Height cm (in.)	Depth cm (in.)	Weight kg (lb.)
Cooling System: Heat Exchanger				
(PolyScience 3370) Refrigerated Chiller	38 (15)	63.5 (25)	38 (15)	31.3 (69)
(PolyScience 6105PE)	38 (15)	63.5 (25)	67.3 (26.5)	81 (178)
FIAS 400MS	41.5 (16)	18.4 (7)	41 (16)	11 (24)
AS 93plus Autosampler	44 (17)	37 (15)	34 (14)	4 (9)

PerkinElmer SCIEX ICP-MS instruments include the hoses necessary for connecting the argon to the instrument.

Suggested Safety Practices

This advice is intended to supplement, not supersede, the normal safety codes in the user's country. The information provided here does not cover every safety procedure that should be practiced. Ultimately, maintenance of a safe laboratory environment is the responsibility of the analyst and the analyst's organization.

General

- Never view the ICP discharge directly without protective eye wear. Potentially hazardous ultraviolet radiation may be emitted. Ordinary safety glasses will in general provide sufficient protection, but additional side shields will insure a further margin of safety. Safety glasses will also provide mechanical protection for the eyes.
- ICP-MS instruments generate high amounts of radio frequency energy in their RF power supply and torch boxes, which is potentially hazardous if allowed

- to escape. Safety devices and screening interlocks should not be bypassed or disconnected.
- The power supply of an ICP-MS is capable of generating potentially lethal voltages. No maintenance should be performed by anyone other than a PerkinElmer Service Specialist or the customer's own PerkinElmer trained maintenance personnel.
- Coolant lines should be located away from electrical connections.
 Condensation and possible leaks may create an unsafe situation if in proximity to electrical connections.

PerkinElmer Instruments 710 Bridgeport Avenue Shelton, CT 06484-4794 USA Phone: (800) 762-4000 or (+1) 203-925-4600 www.perkinelmer.com/instruments









GX SERIES





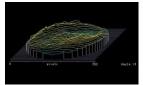
INVERTED METALLURGICAL MICROSCOPES





Images of the world's highest order created with UIS2 wavefront aberration control

A new standard of the objective performance, using wavefront aberration control
The Olympus USIS2 objectives set a new standard, with wavefront aberration control in addition to common performance standards of N.A. and W.D.
Olympus challenges farther highest order optics which has not been fulfilled by the conventional standards. We offer excellent performance objectives by minimizing the aberrations that lower resolution.



Natural color reproduction faithful to the

Natural color reproduction faithful to the specimen.
UIS2 objectives realize natural color reproduction without any chromatic shifts using stringently selected high transmittance glass and advanced coating technology that provides high transmittance which is flat over an ultra-wide band wavelength. In addition, since the total optical system, including the tube lens is designed to reproduce a natural color, clear images faithful to the specimen are obtained even with digital imaging.



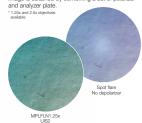
■Color temperature comparison

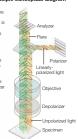




Removes spot flare during ultra low magnification observation.
When a low reflection specimen is observed in ultra low power magnification, spot flare may hinder precise observation. In US2 ultra low magnification observation, a depolarizer built into the objective end removes spot flare and, a clear, high contrast image is obtained by combining a set of polarizer and analyzer plate.

17.5% and 26.06 kpdfwlee





Promotes environmentally-friendly ecologization and weight reduction (Oympus was the first to consider the environment and to tackle ecologization of microscopes. As part of this, on introduction of UISE optical system, eco-friendly glass free of lead and arsenic is used in the objectives and the major semi-apochromatic UIS2 objectives are lightened by approximately 2/3. This contributes to prevention of environmental pollution, improvement of operability of objectives replacement, etc.

**Some UISE objectives are the same weight as conventional objectives.

High-performance research and quality control are enhanced by automated modules

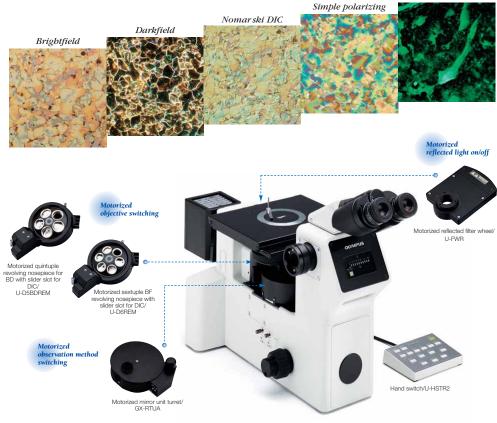
Operations that you want to save — various powered modules fulfill your requirements. Thanks to various motorized modules, speedy magnification change, easy observation mode selection from brightfield to simple polarizing and illumination filter switching are performed through hand control panel or PC. Automation allows the operator to focus on the crisp USI2 images. You only need to add the automation you need without adding any extras.

Independent receiving respective DURBIN UP SERDIN and motorized filter whether any object to the CRIST Control from a PC. **Independent for the CRIST. **Inage analysis software analysis PRIST in recessary for control from a PC. **

Getting the optimized image with any observation method
The UIS2 infinity-corrected optical system was developed with Olympus unique knowledge—and the GX series is designed to maximize its performance in the context of inverted metallurgical microscopes. The results are sharp, detailed images with excellent contrast and consistently high clarity with any and all observation methods. Equipped with 100W halogen lamp and newly improved efficiency, the GX series microscopes provide the intense and even illumination.

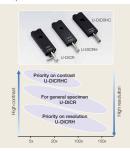
The brightest Darkfield images than ever The UIS2 contrast has improved brightness and delivers better sensitivities for holes or flaws on metallographic structure.





Fluorescence

Nomarski DIC system provides an optimum image suited to the sample
Olympus Nomarski DIC observation uses a simple observation switching silder type single prism system. Three different DIC prisms are provided: the U-DICR red all imaging applications, high resolution U-DICRH, and high contrast U-DICRHs to shat the best resolution and contrast matched to the state of the sample are obtained. Since the exit pupil position of the objective is standardized by the series, the position of the DIC prism does not have to be switched when the magnification was changed by switching the objective.



Polarized light: optimizing contrast in the observation of metallographic and crystal structures. The combination of three key components enables high-contrast reflected light polarized observation with a sensitive tim: the rotating stage CX-SRG for CX, the polarized silder CX-POTP with wavelength pite, and an enalyzer silder, CX-ANX9G or CX-ANI. In addition, use of the binocular tube U-BISOCT (with CXST only) makes it possible to observe an anisotropy on the specimen surface caused by reflection (also known as conoccopic image observation). The rotating stage CX-SRG also provides an unresthicted choice of framing angles when taking in photomicrography.



Digital micro imaging solutions for obtaining high quality microscopic images



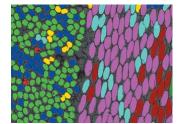
Making the best use of microscope digital imaging, the more freedom, the more comfort

Seamless operation for image acquisition, measurement, advanced documentation and analytical solutions. The image analysis software analysis FIVE has made possible seamless operation from image processing, measurement, and analysis to database and report generation. The analysis FIVE comes in 3 types: "imager," 'cbcu', and "auto", according to the difference of the functions incorporated. The type can be chosen according to the application. The "auto" type has all functions, including particle analysis, etc. Customizing to more pleasant software is possible by freely adding the desired functions.



Particle Analysis

Automatic separation of particles within a given image is possible using the integrated separator function. Users can set a specific "detection area" or ROI (region of interest). Many other parameters can be used to measure all particles automatically, or carry out statistical data processing.





Stitching Images

Multiple adjacent images can be stitched together into one, in a natural way that doesn't show abrupt joints. This function is especially useful for observing large areas which cannot be captured in a single image.



■ analySIS FIVE function

imager

NOTE: Olympus IA software as shown is not available in the U.S.A. Contact LECO for more information on Image Analysis Systems.

- Camera and Microscope Control Measurement
- Database

docu

- Camera and Microscope Control Measurement
- Stitching Images

 Extended Focal image
- â 3D Image
- Database

auto

- Camera and Microscope Control
 Measurement
- Stitching Images Extended Focal image
- 3D Image
 Particle Analysis
- Database
- Database

 Report



Camera and Microscope Control

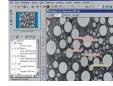
This allows digital camera and microscope* operations to be controlled from the softwa A complete series of processes, from initial observation to final report creation, can be completed on your PC.







Measurement



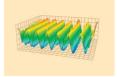


Multiple images of the same area, each focused at a different position, can be combined to produce a single, wholly-focused image. This function allows clear imaging of samples with different height levels on the surface, which cannot be observed all together at the same time conventionally.





By adding height/texture information to multi-focused images obtained with the "Extended Focal Image" (see above), you can create realistic 3D views.





The software systematically stores all your images, analysis results, datasheets, graphs, and other acquired data. This makes it easy to grasp the complete picture, and to search for whatever data you need.





Report

Images can be freely laid out and edited. Some example documentation templates are provided, or you can create original formats, producing professionally-finished reports and documents in whatever styles you choose.





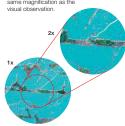
Manufacturer Soft Imaging System



Top-notch performance for today's leading-edge research



Zoom function for easy framing
The 1x-2x zoom facility acts on all ports,
shows critical specimen detail more clearly
and makes accurate framing especially easy
as well as allowing image capture at the
same magnification as the
visual observation.



Truthful reproduction of specimen in image forming and acquisition Viewing images are not reversal, the exact reproduction of specimen in vertical/ horizontal directions. The true reproduction makes it easier to compare the images with dioital photos. digital photos



Ideal for every observation method from brightfield to fluorescence Simply by changing the position of the GX71's mirror unit turret, it is quick and easy to alternate between brightfield, darkfield, Nomarski DIC, simple polarized light and fluorescence observation. The Olympus universal objectives accommodate all observation methods. There is no need to change the objective type seach time the observation method is changed.

The GX71 also employs super widefield eyepieces (F.N.26.5), for an efficient orientation and observation process.





Superb performance and reliability for all kinds of routine observation and documentation



Single lever switchover for brightfield/darkfield observation. The versatile CM51 performs brightfield, darkfield, Nomarski DIC and simple polarized light observations. Switching between brightfield and darkfield observation is done with a single lever, located close to the operator's hand. Changing to Nomarski DIC observation is a simple matter of inserting observation is a simple matter of inserting the DIC-slider.



Expandable functionality
A wide variety of optional units can be easily attached to the GX51, allowing such system upgrades as linking to a digital or video camera via an intermediate tube (GX-SPU).



Designed for ease to use and efficiency. Good working efficiency is the top design priority of the CAST, which was specially developed for handling routine inspection tasks. Its most frequently used operating features are located at the front, while incorporation of the tilting tube U-TBIBO (elevation angle 36-36 degree) allows the operator to work in an easy, natural posture and conduct observations comfortably in a standing position.



GX71/GX51 ACCESSORIES

Compatible with transmitted light polarized observation





Transmitted light polarized observation combination

Transmitted light polarized observation, which is ideal for transparent specimens or fine powders, can be performed by combining illumination pillar IX2-ILL100.



1)GX-SRG 2)PMG3-LWCD 3)IX2-ILL100 4)U-POT 5GX-AN360 6GX-POTP 7U-P4RE



GX71 observation tubes

The super widefield binocular observation tube (U-SWBI30) and super widefield trinocular observation tube (U-SWTR-3) are provided for the GX71.





GX51

U-LH100HC

U-I H100-3

GX51 observation tube

Besides trinocular tube U-TR30H, the lineup includes binocular tube U-BI90, for use in combination with an eyepoint adjuster, and tilting tube U-TBI90, which allows observations to be made in whatever posture suits the individual user.



U-BI90CT

U-TBI90

U-TR30H



Intermediate tubes

Other high-performance accessories are available to meet a variety of applications. Included are an intermediate tube (IX-ATU). which allows attachment of a trinocular observation tube, a side port intermediate tube (GX-SPU) and an eyepoint adjuster (IX-EPA).



Scales

In addition to the calibration scales for each objective, grain size reticules and square scales can also be recorded. Up to 3 scales can be freely combined in a single slider.

Compatible with macro observation and photographing

GX71

Drawing attachment / U-DA

As well as its conventional use as drawing attachment, this accessory also provides a macro observation function. When combined with a trinocular observation tube, the macro images are stored as photomicrographs or retained in the digital camera. *Use in combination with 10x lens for drawing attachment U-DAL10x.



U-LH75XEAPO





Lamp housing

A variety of light sources to accomplish bright and even illumination are provided, according to your purpose.







Revolving nosepieces

Sextuple revolving nosepieces and quintuple revolving nosepieces with DIC slider compatibility are also provided.







The GX series comes with a select range of filters, including neutral density, color temperature conversion and green filters. Two slider slots are provided, each allowing introduction of up to three filters.



GX series specifications

		GX71	GX51	
Optics		UIS2 optical system	ı (infinity-corrected)	
Microscope body	Intermediate magnification	Zoom incorporated (1x - 2x) Clicks in the two intermediate positions (can be released)	_	
Imprinting of scale		All ports Reversed positions (up/down/left/right) from observation positions seen through the eyepiece	All ports Reversed positions (up/down) from observation positions seen through the eyepiece	
	Power source	Power source for illuminator (1	2V100 halogen) incorporated	
	Focusing	Manual, Coarse and Fine coaxial handle. Focus stroke	9mm (2mm above and 7mm below the stage surface)	
	Output port	Front port — Video and DP system (rever	sed image, special video adapter for GX)	
	Side port — Video, DP system (reversed image)	Side port (option) — Video, DP system (upright image)		
Observation tube Super widefield (F.N. 26.5)		U-SWBI30, U-SWTR-3	_	
	Widefield (F.N. 22)	_	U-BI90, U-TR30H	
Illuminator	Observation method	Brightfield, darkfield, simple polarized light, DIC, fluorescence	Brightfield, darkfield, simple polarized light, DIC	
	Illuminator diaphragm	FS/AS manually controlled, with centering adjustment		
	Light source	100W halogen (standard), 100V	V mercury, 75W xenon (option)	
Revolving nosepiece	Manual operation	Sextuple for BF/DIC, quintuple for BF/DF, quintuple	e for BF/DF/DIC, Quadruple for BF with centering	
	Motorized operation	Sextuple for BF/DIC, qu	uintuple for BF/DF/DIC	
Stage	Standard type	Right handle stage for G	(X/Y stroke: 50x50mm)	
	Option		t handle stage (each X/Y stroke: 50 x 50mm) atable stage for GX	
	Stage insert plate	A set of teardrop a	nd long hole types	
mage recording	Digital camera, video camera	OLYMPUS DP series etc, attach	able using appropriate adapters	
Combined weight		Approx. 39kg (BF, DF and DIC observations, combined with DP71)	Approx. 28kg (BF, DF and DIC observations, combined with DP20)	
Power consumption		170VA,	140 W	

UIS2 objective specifications

Objectives	Magnifications	N.A.	W.D. (mm)	Cover Glass Thickness (mm)	Resolution*2 (µm)
MPLFLN	1.25x*3*4*5 2.5x*4*5 5x 10x 20x 50x 100x	0.04 0.08 0.15 0.30 0.45 0.80 0.90	3.5 10.7 20.0 11.0 3.1 1.0		8.39 4.19 2.24 1.12 0.75 0.42 0.37
MPLFLN-BD	5x 10x 20x 50x 100x 150x	0.15 0.30 0.45 0.80 0.90 0.90	12.0 6.5 3.0 1.0 1.0	 0 0 0	2.24 1.12 0.75 0.42 0.37 0.37
MPLFLN-BDP	5x 10x 20x 50x 100x	0.15 0.25 0.40 0.75 0.90	12.0 6.5 3.0 1.0 1.0	 0 0 0	2.24 1.34 0.84 0.45 0.37
LMPLFLN	5x 10x 20x 50x 100x	0.13 0.25 0.40 0.50 0.80	22.5 21.0 12.0 10.6 3.4	— 0 0 0	2.58 1.34 0.84 0.67 0.42
LMPLFLN-BD	5x 10x 20x 50x 100x	0.13 0.25 0.40 0.50 0.80	15.0 10.0 12.0 10.6 3.3	 0 0 0	2.58 1.34 0.84 0.67 0.42
MPLN*3	5x 10x 20x 50x 100x	0.10 0.25 0.40 0.75 0.90	20.0 10.6 1.3 0.38 0.21	 0 0 0	3.36 1.34 0.84 0.45 0.37

Objectives	Magnifications	N.A.	W.D. (mm)	Cover Glass Thickness (mm)	Resolution*2 (µm)
MPLN-BD*1*3	5x 10x 20x 50x 100x	0.10 0.25 0.40 0.75 0.90	12.0 6.5 1.3 0.38 0.21	 0 0 0	3.36 1.34 0.84 0.45 0.37
LCPLFLN-LCD*5	20x 50x 100x	0.45 0.70 0.85	8.3~7.4 3.0~2.2 1.2~0.9	0~1.2 0~1.2 0~0.7	0.75 0.48 0.39

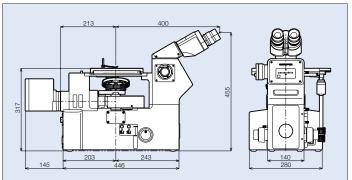
US objective specifications

Objectives	Magnifications	N.A.	W.D. (mm)	Cover Glass Thickness (mm)	Resolution*2 (µm)
MPlanApo	20x 50x 100x 100xOil	0.60 0.95 0.95 1.40	0.9 0.3 0.35 0.1	0 0 0	0.56 0.35 0.35 0.24
MPlanApo-BD	100x	0.90	0.31	0	0.37
SLMPlan	20x 50x	0.35 0.45	21.0 15.0	0	0.96 0.75
LMPlan-IR	5x 10x 20x 50x 100x	0.10 0.25 0.40 0.55 0.80	20.0 18.5 8.1 6.0 3.4	_ _ _ _	
MPlan-IR*3	100x	0.95	0.3	_	_

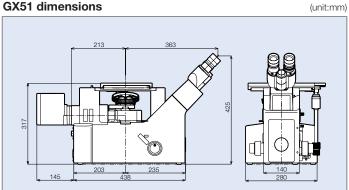
"BD" refers to brightfield and darkfield objectives

- *1 Slight vignetting may occur in the periphery of the field when MPLN-BD series objectives are used with high-intensity light sources such as mercury and xenon for darkfield observation.
- *2 Resolution values are calculated with the aperture diaphragm fully opened.
- *3 Field numbers are limited (up to F.N.22). Not compatible with F.N.26.5.
- *4 Analyzer and polarizer are recommended to the usage with MPLFLN1.25x or 2.5x.
- *5 Available in the beginning of 2007.

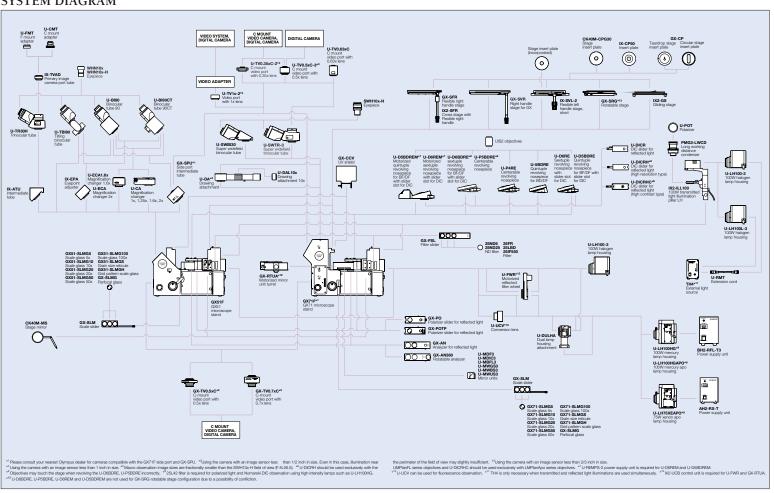
(unit:mm) **GX71 dimensions**



GX51 dimensions



SYSTEM DIAGRAM



5

LECO Corporation 3000 Lakeview Avenue St. Joseph, MI 49085-2396 U.S.A. 800-292-6141 • Fax: 269-982-8977 www.leco.com • info@leco.com Form No. 209-127 5/07

OLYMPUS CORPORATION has obtained the ISO9001/ISO14001.

Specifications are subject to change without any obligation on the part of the manufacturer.



OLYMPUS CORPORATION
Shinjuku Monolith, 3-1, Nishi Shinjuku 2-chome, Shinjuku-ku, Tokyo, Japan
OLYMPUS LIFE AND MATERIAL SCIENCE EUROPA GMBH
Postfach 10 49 08, 20034, Hamburg, Germany
OLYMPUS SURGICAL & INDUSTRIAL AMERICA INC.
One Corporate Drive, Orangeburg, NY 10962, U.S.A.
OLYMPUS UK LTD.
2-8 Honduras Street, London EC1Y OTX, United Kingdom.

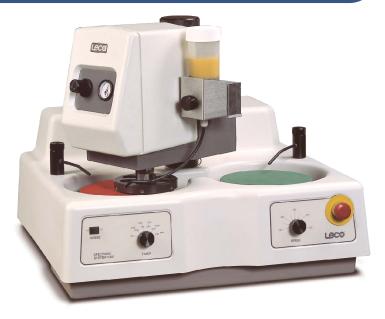
OLYMPUS AUSTRALIA PTY. LTD. 31 Giliby Road, Mt. Waverley, VIC 3149, Melbourne, Australia. OLYMPUS LATIN AMERICA, INC. 5301 Blue Lagoon Drive, Suite 290 Miami, FL 33126, U.S.A.

Spectrum System 1000®

Grinder/Polisher

For your low- to medium-volume laboratory, choose the Spectrum System 1000 (SS-1000) Grinder/Polisher. This system features a dual 8-inch design that can be purchased as a manual stand-alone base unit or with a grinding/polishing head for semi-automatic sample preparation. A rugged 3/4 HP motor drives the simultaneous operation of both 8-inch wheels. Add the head assembly and an optional dispenser to maximize efficiency.

- Built-in timer
- Variable-speed base
- Adjustable water faucet for each wheel
- Compact, durable design



Dispenser

The optional automatic dispenser unit gives you even more freedom to walk away from the unit during sample preparation—allowing more time for other tasks. The dispenser bottle refills quickly and easily from the top, and dispenses colloidal silica without clogging. The gravity-drip design and flexible applicator provide even diamond suspension distribution anywhere on the wheel. Manual application of the suspension or solution to the wheel allows you to accurately control the duration and frequency.





Timer

The variable-speed SS-1000 includes an integrated timer for monitoring grinding and polishing times, eliminating the worries and expense of overgrinding or over-polishing. You can confidently walk away from operation and return to properly ground and polished samples.

The SS-1000 provides simple one-button operation for low-to-high range operation. Low range covers timed procedures from 30 seconds to three minutes; high range settings apply to steps longer than four minutes.



Specifications

Base Unit		Part Numbe	ers	
Weight	90 lb. (41 kg)	SS-1000BD	SS-1000 Base Unit; 120V~, 60 Hz,	
Height	12.5 in. (32 cm)		single phase	
Width	27 in. (69 cm)	SS-1000HD	SS-1000 8-inch Semi-Automatic Polishing Head; 120V~, 60 Hz, single phase	
Depth	24 in. (61 cm)	SS-1000BHD	SS-1000 Semi-Automatic	
Voltage Input	120/220V~, 50/60 Hz, single phase		Grinder/Polisher System; 120V~, 60 Hz, single phase	
Operating Conditions	50° to 104°F (10° to 40°C)	• •		
Motor Output	3/4 HP	Options		
Wheel Size	Dual, 8-inch, belt driven	804-085	Specimen Holder Kit for eight 1-inch diameter samples	
Rotational Speed	0 to 500 RPM	804-088	Specimen Holder Kit for six 1.25-inch diameter samples	
Rotational Direction	CCW	804-091	Specimen Holder Kit for four 1.5-inch	
Timer	00:30, 1:00, 1:30, 2:00,	00.07.	diameter samples	
	3:00, 4:00, 6:00, 8:00, 10:00; continuous operation,	806-793	Specimen Holder Kit for two 2-inch diameter samples	
	microprocessor controlled	806-796	Specimen Leveler	
Water Supply	20 to 80 psi	801-424	8-inch Cloth Clamp	
Grinder/Polisher Discs	8-inch	800-458	8-inch Paper Retainer	
		803-795	8-inch Aluminum Wheel	
Sami Automatia Crin	dor/Polishor Hond Unit	808-655	Gravity Feed Dispenser (250 ml capacity)	
Semi-Automatic Grinder/Polisher Head Unit		810-217-PRM	Abrasive Paper Disc, 60 grit (100/box)	
Weight	30 lb. (13.5 kg)	810-219-PRM	Abrasive Paper Disc, 120 grit (100/box)	
Height	13 in. (33 cm)	810-221-PRM	Abrasive Paper Disc, 180 grit (100/box)	
Width	10.5 in. (27 cm)	810-223-PRM	Abrasive Paper Disc, 240 grit (100/box)	
Depth	15 in. (38 cm)	810-225-PRM	Abrasive Paper Disc, 320 grit (100/box)	
Voltage Input	120/220V~, 50/60 Hz, single phase	810-227-PRM 810-229-PRM	Abrasive Paper Disc, 400 grit (100/box) Abrasive Paper Disc, 600 grit (100/box)	

To see a complete listing of all the high-quality consumables and supplies LECO offers, request our Met Supplies Catalog (form no. 203-826)

V~ denotes VAC.

Specifications and part numbers may change.

Consult LECO for latest information.

Operating Conditions

Motor Output

Rotational Speed

Pneumatic Supply

Sample Loading

Liquid Dispenser

(optional)

Rotational Direction



50° to 104°F (10° to 40°C)

40 to 100 psi, regulated

free of oil and water

1 to 50 lb. (force)

Manual control

1/6 HP

24 RPM constant





PRE-ENGINEERED TARCA™ CRANE SYSTEMS

STYLE CAPACITIES SPANS TRACKS FREE STANDING & CEILING MOUNTED 2 TONS AND UP UP TO 60'
TARCA™ PATENTED TRACK

GORBEL PRE-ENGINEERED TARCA™ CRANE SYSTEMS

A Name Built on Quality

Since 1977, Gorbel Inc. has specialized in overhead material handling solutions, providing the highest quality and highest performance products on the market today. We are the leading supplier of Work Station Crane systems, offering near perfect on-time delivery, a focus on customer service and the industry's best warranty.

Why Choose a Pre-Engineered Tarca[™] Crane System?

Industry's Best Warranty 2 Years on all Crane systems.

Design Responsibility

Gorbel Crane Systems specify which beam to use for each application. We do not "Suggest" or "Recommend" any materials be used.

Ease of Installation

All components are built and assembled with jigs and fixtures which ensure easy installation.

Improved Performance

Tarca™ Systems are designed to be superior to I-beam cranes in strength, durability, and consistency.

Local Representation

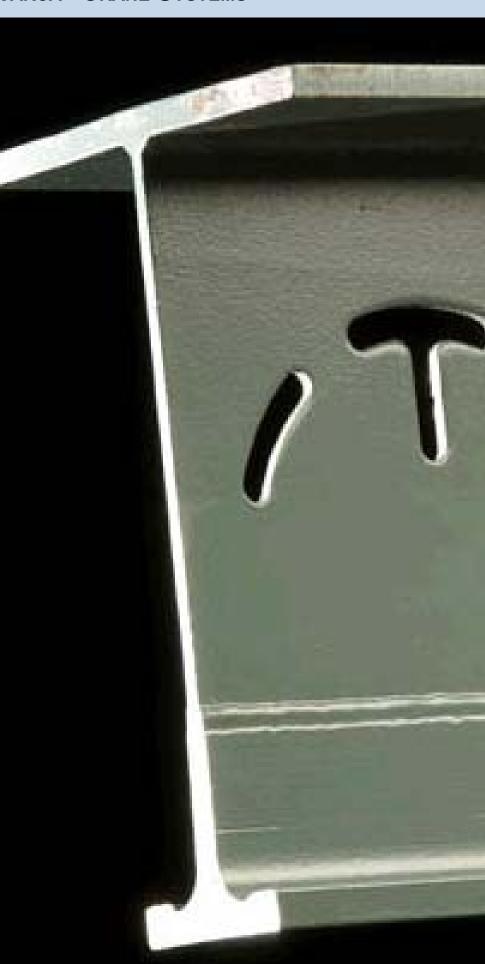
Gorbel cranes are sold and serviced by a nationwide network of material handling specialists that provide solutions suited to your needs and your budget.

Versatility

Gorbel makes a complete line of cranes to meet your individual needs

Safety

All cranes are pre-engineered for powered hoist operation with an impact factor of 15%.





Tarca™ Track For Durability and Strength

Gorbel's pre-engineered crane systems are built using our unique patented Tarca™ Track, which continues to be the benchmark of the overhead material handling industry.

Its three piece welded construction is a compound section of a mild steel top flange and web and a specially rolled high-carbon steel lower rail. Tarca™ systems are characterized by consistently straight rail sections and durable, high quality Tarca™ components. Our Tarca™ systems offer unmatched versatility, durability and ease of installation.

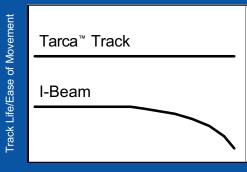
Why Tarca™ Track Over Structural Steel Track?

A structural I-beam is rolled from soft, mild steel according to fairly loose steel mill tolerances. Its beveled flange prevents wheels from making balanced contact, causing uneven wear and a shortened track life.

Gorbel's unique Tarca™ Track, with its special raised tread and high carbon track, is superior to I-beams in strength, durability and consistency. Our exclusive rails permit the use of:

- Underhung carriers operating on a single straight, curved or inclined track
- Underhung cranes operating on two or more straight track runways.

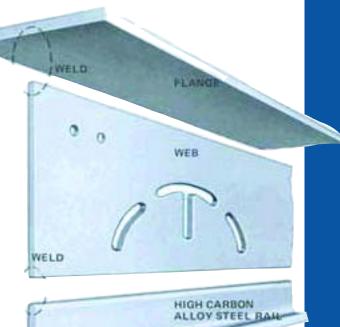
Tarca™ Outlasts and Outperforms I-Beams Over Time—Every Time!



Time

Why choose Gorbel Pre-Engineered Tarca™ Track Systems for extended capacities?

- Tarca[™] Track & components stand the test of time
- · Lower installation costs
- High quality designs mean reduced maintenance costs



Tarca™ Track has a mild steel top flange and web and a high carbon steel lower rail with raised tread to resist peening.

Continuous welding adds rigidity needed to cope with bending and twisting stresses of the most demanding applications.

The web and flange dimensions of each size are proportioned for maximum strength and spanning efficiency.

TARCA™ TRACK: ENGINEERED FOR CRANE APPLICATIONS



Peening caused the mild steel flange on this I-beam (on right) to bend, making it completely unsafe for crane travel.

Strong, Durable Rail

Tarca™ vs. I-beam

High carbon flange means longer track life

A common source of track wear is a process known as peening. Peening is the gradual movement of metal over time, caused by the rolling action of wheels. Because of I-beam's mild steel construction, peening tends to occur unevenly, weakening the beam flange and restricting smooth easy travel.

Tarca™ Track's raised tread design and extra hard alloy steel construction slow down the peening process. The full width of the raised tread wears evenly, extending track life well beyond that of I-beams.

Our raised tread provides durability and superior safety

The raised tread on Tarca™ Track is 20 - 25% of the Tarca™ rail thickness. And though this does add some strength, our stress calculations do not include the strength added by the raised wearing tread. That means you get even more strength and dependability because the rated capacity of the track is not affected by wear.

Since I-beams have virtually no raised tread, their initial load carrying capacity is in the total cross section. As a result, capacity and safety are greatly reduced as soon as the tread begins to wear.

100% weld penetration ensures quality

Tarca™ Track is manufactured using stringent quality assurance procedures. This is the basis for certifying 100% weld penetration for maximum strength, safety and rigidity. Extreme care is taken during track fabrication to maintain dimensional tolerances. Our tracks are straight and true with minimum distortion, so:

- Installs are quick and easy
- Load distribution is uniform
- · Tracks and components last longer

Stop Throwing Away Your Installation Dollars!

Our stringent quality standards in manufacturing guarantee consistently straight, high quality beams. Plate is cut to size and leveled by precision machinery. Special equipment uses continuous welds to insure absolutely straight, uniform track. Standard mill practice dimensions for I-beams have tolerances more than twice those for Tarca^{TI} rail. For example, allowable sweep per 10' of structural beam may be as high as 1/4" while Tarca^{TI} rail is less than half that at 3/32".

Is It Really Cheaper to Use an I-Beam?

Consider the time and money you're throwing away during installation: redrilling holes and cutting, fitting, and shimming rails in order to align I-beams that aren't straight. Our consistently straight rails result in easy, predictable, cost effective installations.

Straight Rails Make System Expansions Easy

These tight quality standards even make system expansion and reorganization easier and more cost effective. Consistently straight beams will reduce labor costs when you want to expand a crane system or rearrange a work area.

Our Weight Is In All the Right Places

Efficient Design for Spanning

The thickness and width of Tarca[™]'s web and flange for each size have been carefully engineered to maximize strength and loading capability while minimizing weight. Tarca[™]'s three piece welded construction:

- Delivers maximum load carrying capacity to dead weight ratios
- Provides ability to cost effectively span longer distances
- Eliminates costly additional supporting structures
- Reduces drag in a manual system

I-beam simply can not match Tarca™'s carrying capacity to dead weight ratio. Structural I-Beams are manufactured for a purpose other than overhead material handling. Because of this, they are manufactured to much looser mill tolerances than many crane and monorail applications require.

Standardized Lower Flange

Standardized lower flange provides compatibility

Tarca[™] track features the same 3-1/4" wide lower flange regardless of rail height or load carrying capacity.

- Allows systems to be easily expanded or rearranged
- Ensures compatibility of components
- Lower costs when suspension points vary

The lower flange of an I-beam increases in width and thickness as its depth increases. Beams of different sizes are therefore not compatible. The result? I-beam crane systems are costly and difficult to expand or relocate.

Rugged, Long Lasting Components

Hardened wheels to ride on high carbon track

Our forged, heat-treated wheels are built to last. They provide years of smooth, easy movement and reliable service. They have been:

- Designed to roll with minimal resistance (2 times easier than I-beam)
- Machined to meet the surface of the track for consistent, full contact and longer life
- Engineered to avoid flat spots for smooth, uniform rolling

Rugged end trucks and carriers

Gorbel end trucks have been carefully engineered to provide the finest performance with little or no maintenance.

Extended drive life

All gears and shafts in Gorbel drives are made with a remarkable alloy-steel that was chosen after long, grueling tests. This special alloy allows the drives to hold up to the wear and tear of constant service. This adds many years of reliable service to the motor head.

Flexible Suspensions

Flexible suspensions provide longer system performance and lower maintenance costs

Tarca™ Track is suspended using ball and socket connections, permitting the track to float in all directions. This means it can compensate for structural movement by allowing tracks to move and adjust to crane wheel centers. This:

- Prevents damaging stress
- · Dampens shock loads
- · Allows for smoother operation

In other words, Tarca™ rails can adjust to loads as they move, enabling carrier wheels to maintain consistent contact. This "load balance" of the wheels and components allows for longer life with less maintenance.



Our Tarca™ Track's standardized lower flange provides compatibility.

Case Study: Tarca™: A Better Solution than I-Beam

Gorbel Keeps Paper Industry Moving

Seven Gorbel crane systems are the key to moving product around a Pittsburgh manufacturing plant. This plant manufactures fabric that is used in the paper industry to drain water out of the pulp mixture. On one end of the facility, the fabric is woven on looms using fishing wire. These pieces of woven wire are then seamed together in widths up to 40', taken off the loom and draped onto aluminum rolls.

These rolls weigh hundreds of pounds and their width makes them quite awkward to manipulate. It is vital to the quality of the paper that this fabric is free from impurities, so extreme care must be taken when handling these rolls.

Why was Gorbel the best choice for this application?

Capacity

3-ton double girder cranes

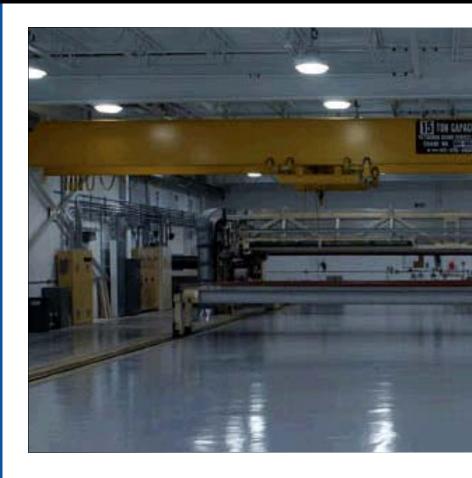
Durability

I-beam wears too quickly for a high duty cycle application like this where cranes are lifting and positioning rolls at a rate of 15 to 20 lifts per shift.

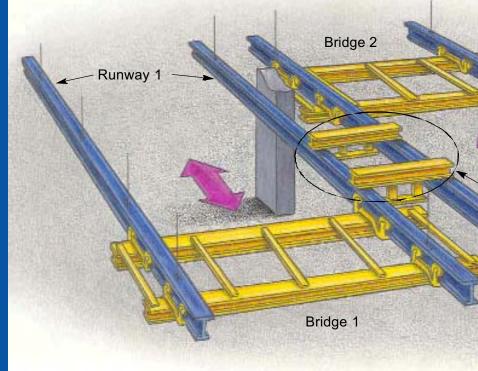
Building Design Interlocks were needed to move the fabric rolls around building columns between the two systems. Gorbel interlocks are so safe and simple to operate that transferring loads from one system to another is quick and easy.

Headroom Constraints

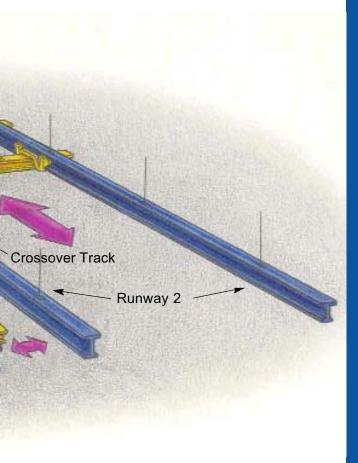
The design of the building created headroom constraints. The size of I-beam needed for these loads would not have fit within the constraints of the building.



Our interlocks let you move your loads around anything—even building columns.







How do our interlocks operate?



 Both bridge girders approach the crossover track. The operator pushes a button powering a gear motor that activates a pair of rollers.



2. The bridges line up with the crossover track. The rollers move from the interlocking beam toward a wedge type engaging mechanism on the crossover track (see Photo 2).



- 3. The rollers make contact with the wedge and selfalign within 1-1/4" horizontal range.

 As both beams are interlocked, forks on powered and nonpowered beams are raised for free passage of carrier (see Photo 3).
- 4. To disengage the interlock, the operator pushes a second button. Motor driven rollers move back and away from wedge, allowing forks to drop and make contact with rail tread. This prevents the carrier from travelling off the open end of the beam.

Gorbel Bridge Components



Tarca™ Rail

Tarca™ Track features specially rolled high-carbon alloy steel rail with raised treads welded to a steel flange and web.

Tarca™ is designed to provide maximum spanning capability for heavy loads while minimizing the weight of required material. Its material properties resist peening and assure a longer operating life than ordinary track designs.



Photo shows carrier with drive and SAFPOWRBAR™

Carriers (Trolleys)

Gorbel carriers provide the connection between the lifting device and the bridge. Our carriers are designed for years of peak performance:

- The wheel base is proportioned for smooth, vibration-free carrier operation.
- Swiveling yoke provides unmatched performance through curves and switches on monorail systems, contributing to longer track life.
- Precision manufacturing and specially designed wheels assure consistent wheel to rail contact.
- The extensive variety of our carriers provides endless flexibility to tackle any application
- Manually driven carriers are also available



Belt-driven model show here.

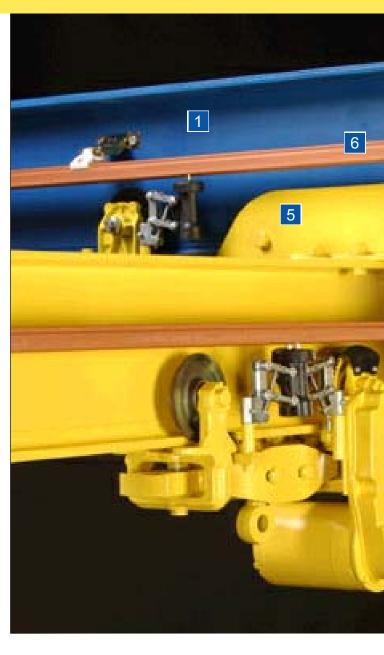
Motorized Drives

Gorbel's drives motorize the travel of carriers and end trucks. We offer:

- A gear driven drive, the best choice for most applications
- A belt driven drive designed to be a lower cost alternative to the gear driven drive
- A tractor driven drive for specialty systems, such as pulling loads up a slope or for use in wet conditions.

Our drives were specially designed to make them long wearing and easy to service.

- Guide rollers equipped with antifriction bearings align wheels on track for easy movement
- Split frame construction for easy removal and reinstallation





Hanger Assemblies

Our hanger assemblies provide a connection between the Tarca™ track and structural support.

Ceiling Mount (shown)

- Ball and socket design compensates for structural shift
- Teflon™ coated chair washers provide durable, long lasting performance

Free Standing Mount (not shown)

- Rigid mounted, bolted connection between the header and Tarca™ rail
- Easy to install
- Maximizes headroom





Motorized end truck shown here.

6

The photo at left shows a system with SAFPOWRBAR™ electrification.



You can also choose Insul-8 Safe-Lec 2[™] conductor bar for your runway electrification.

Electrification Options

(Brackets, Collector Shoe and Bar)
Gorbel SAFPOWRBAR™ Electrification
is used to deliver electric power to
drives and hoists. This rugged, durable
system is made to
perform in the most demanding
applications and environments.

- Inverted U-shaped conductor bars enclosed by flame resistant insulated covers
- Fiberglass molded insulators for double insulation, making them safer and more efficient
- Sliding current collector shoes inside the bars make positive, continuous contact with three surfaces of the bar for longer life and easier maintenance.



End Stop

End stops are required and must be provided at the ends of the carrier or trolley travel and at the end of crane travel on runways.

Our end stops are unique in that they strike the end of the load bar, rather than the wheels. This prevents the wheels from absorbing the force of the load and reduces the areas of wear.

We offer standard wheel end stops for lighter applications and rubber, spring or hydraulic bumpers for higher speed conditions.

End Trucks

End truck with drive for motorized travel on runway

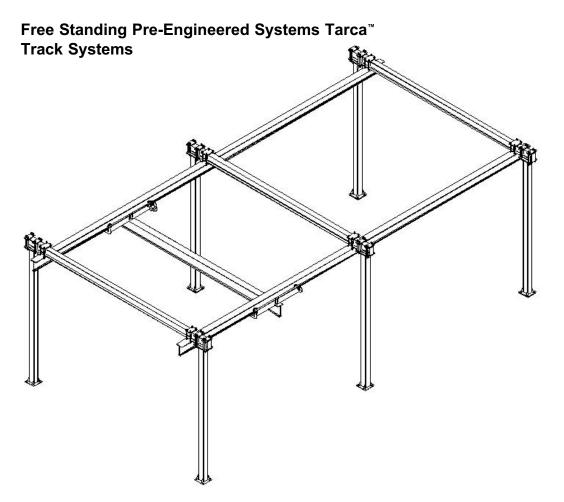
Gorbel end trucks provide the connection between the bridge and runway. These rugged end trucks give you smooth, easy travel with little or no maintenance.

One advantage of our end trucks are their wheels. While other manufacturers have fixed wheels on their end trucks, our articulating wheels allow for irregularities in track and runways. End trucks can also be manually driven.

Designed to be Low Maintenance!

"We've experienced less maintenance with the Gorbel installation in one year's operation than had been required in a single week of operation with the I-beam runway just prior to its replacement."

Plant Manager Babcock & Wilcox unit of J. Ray McDermott & Co.



SYSTEMS SPECIFICATIONS

Capacities
Up to 5 ton'
Spans
Up to 60'
Height Under Bridge
Runway Support Centers
Up to 5 ton'
Up to 60'
20' - 20'
20' - 60' in increments''

- * Consult factory for higher capacities
- ** Custom support centers available at no extra charge

Free Standing System available in Braced designs or completely Free Standing designs:

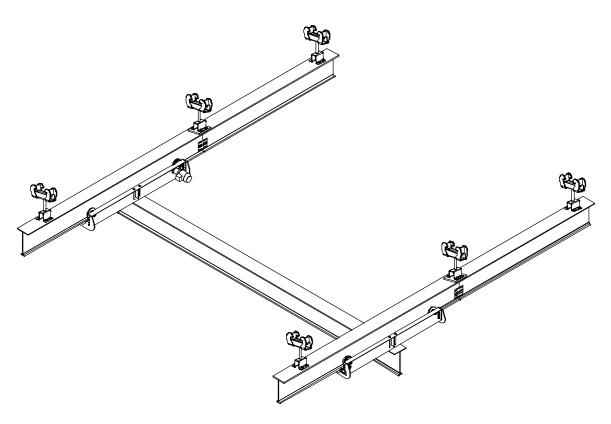
Free Standing Braced Systems

- Require the crane support steel to be tied back to another structure (ie building columns) capable of resisting lateral and longitudinal forces.
- Braced systems tend to be less expensive than completely Free Standing systems.

Completely Free Standing Systems

- · Completely independent of other systems
- Ideal for applications where there is no adequate support steel

Ceiling Mounted Pre-Engineered Systems for Extended Capacities



SYSTEMS SPECIFICATIONS

Capacities Up to 5 ton Up to 60'
Height Under Bridge 10' - 20'

Runway Support Centers 20' - 60' in increments"

- * Consult factory for higher capacities
- ** Custom support centers available at no extra charge

Both Free Standing and Ceiling Mounted Systems Include:

- Runways, Bridge(s), End Trucks, Hanger Assemblies, runway electrification, bridge festooning, crane drives, and controls.
- Free Standing systems also include free standing structure
- · Bracing and hoists by others.

Your authorized Gorbel dealer can give you more information on what makes Gorbel's Ergonomic Work Station Cranes and other material handling products "A Class Above."

> Bridge Cranes (Enclosed Track)

Jib and Gantry Cranes

Specialty Products (Enclosed Track)

Intelligent Assist Devices







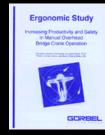
Capabilities



Free Standing



Ceiling Mounted



Productivity & Safety



Jib and Gantry Cranes



Work Station



Articulating



Seismic Zone IV



Telescoping



Tractor Drives



Interlock/Transfer



G-Force

600 Fishers Run P.O. Box 593 Fishers, NY 14453-0593 USA Phone: 585-924-6262

Toll Free: (800) 821-0086
Toll Free Fax (800) 828-1808

www.gorbel.com



PROPOSAL FOR

 \boldsymbol{A}

Hot Isostatic Pressing System

PREPARED FOR

Idaho National Laboratory

2008-53-13

PREPARED BY



ENGINEERED PRESSURE SYSTEMS, INC.

165 Ferry Road Haverhill, MA 01835

Tel: 978-469-8280 Fax: 978-373-5628

March 27, 2008

Tel: 978-469-8280

Fax: 978-373-5628

epsi@epsi-highpressure.com www.epsi-highpressure.com



Pressure Systems, Inc. HIP Summary of Quotation 2008-53-13

Basic Hip System Configuration

Pressure Vessel	_Plate Yoke Vessel Assembly
Design Basis	ASME Section VIII, Div. 3; U3 stamped
Material	SA 723,
Maximum Operating Pressure	15,000 psi
Design Pressure	16,500 psi
Hydrotest Pressure	_20,625 psi
Vessel Design Temperature	$-600^{0} \mathrm{F}$
Calculated Cycle Fatigue Life	_15,000 per
Furnace/Heatsheild	
Workload diameter	
Workload length	60" Clear & Obstructed
Workload weight	
Parts per Cycle	
Process Gas	
Cooling system	
Control System	Fully Automatic PLC Controls
Vacuum System	
Commercial	
Price:	_10"X 60"@ 15,000 psi HIP System \$1,300,000
Payment Terms:	_See Page 48
Delivery:	_12 To 14 Months Ready for Shipment. Deliveries
	are subject to allocation of melting capacity.
	Deliveries to be adjusted after meeting melting
	commitment are secured.
Fob:	_EPSI, Haverhill, MA
Installation Included:	_Supervision, of Start-up and Training
Warranty:	_One Year
Validity:	
Utilities:	See page 43
System Acceptance:	System Functional Testing Only

Vessel Inspections should be conducted periodically.



Pressure Systems, Inc.
Engineered Pressure Systems, Inc. is pleased to provide the following proposal for your Hot Isostatic Pressing (HIP) System. Specifically, we propose the following:

1	Intro	oduction	5	
	1.1			
	1.2			
2	Plate	Plate Yoke HIP Pressure Vessel Assembly		
	2.1	Pressure vessel Assembly	9	
	2.2			
	2.3	Top & Bottom Closures		
	2.4	Top & Bottom Seal plates		
	2.5	Pressure Vessel Support Stand		
	2.6	User Design Specification		
	2.7	Safety Rupture Disc Assembly	14	
3	Top	Top Closure Hoist Assembly		
	3.1	Top Closure Hoist	15	
	3.2	Load Insertion Tooling	16	
4	Furr	nace & Heat shield Assembly		
	4.1	Moly Furnace Assembly	21	
	4.2		23	
		4.2.1. Furness Shells	23	
		4.2.2 Heating Elements	23	
		4.2.3 Furnace Ceramics	23	
		4.2.4 Furnace Thermocouples	23	
		4.2.5 Furnace Side Shield Insulation Package	23	
		4.2.6 Furnace Plug-In Components		
	4.3	High Performance Clopen Top Mantel		
		4.3.1 Mantle High Performance Clopen Top Design		
		4.3.2 Mantle Insulation Package		
		4.3.3 Furnace/Mantle Lifting Fixture	25	
		4.3.4 Gas Purity	25	
	4.4	Plug-In Bottom Zone Heater	25	
		4.4.1 Bottom Zone Heater (BZH)	25	
		4.4.2 Load Thermocouples	26	
		4.4.3 BZH (Bottom Zone Heaters) Ceramics	26	
	4.5	BZH/Tooling Lifting Fixture	26	
		4.5.1 BZH/Tooling Lift Fixture	26	
		4.5.2 BZH Tooling Support Plate	26	
		4.5.3 Optional BZH Support Plate		
	4.6	Seal Plate	27	
		4.6.1 EPSI Supplied Bottom Seal Plate	27	
		4.6.2 Plug-In Design Seal Plate with Components		
	4.7	Electrical Power Distribution		



5	Cooli	Cooling System & Vacuum System			
	5.1	Cooling	29		
	5.2	Vacuum System	29		
6	Argo	n Delivery System			
	6.1		30		
	6.2	High Pressure Piping, valves and Low Pressure Piping	31		
7	Proce	Process Controls			
	7.1	PLC Controls	31		
	7.2	Control Process	31		
	7.3	The process steps will include	38		
8	Insta	llation			
	8.1	Supervision of Installation	38		
		8.1.1 Optional Turn Key Installation			
	8.2	Acceptance Cycles	39		
	8.3	Training	41		
9	Misco	ellaneous			
	9.1	Documentation	43		
	9.2	Utilities	43		
	9.3	References	43		
	9.4	Vessel Inspection	46		
10	Gene	ral Conditions of Sale			
	10.1	Price	47		
	10.2	Delivery	47		
	10.3	Validity of the offer	47		
	10.4	Payment Terms	48		
	10.5	Warranty			
	10.6	Conditions of Sale	48		



INTRODUCTION

EPSI is pleased to present Idaho National Laboratory with this proposal for a Hot Isostatic Pressing System .

This system is configured in accordance with the Idaho National Laboratory Performance Specification for Hot Isostatic Press. Please note EPSI is offering a 10 inch diameter by 60 inch void length work zone to utilize the productivity of a HIP system. We are also offering 14" and 12" HIP systems as options.

Our proposal is divided into several sections relative to describing scope of supply, configuration, operating considerations, and technical features of the major sub assemblies and subsystems. Other sections of interest are a listing of our references for similar presses.

Please note that our review of your technical specifications indicates that the design, safety and performance requirements for the proposed system are similar to the ones we have manufactured for GE groups and Los Alamos National Laboratory. Based on the fact that these presses have proven to be operationally reliable, it is our intentions to supply Idaho National Laboratory essentially with the same equipment to meet your production and safety requirements.

We appreciate this opportunity to submit our proposal for your consideration. Please note that we have prepared it in a comprehensive manner to provide you with the information necessary to conduct your evaluation of the system we intend to supply. However, if you need additional data, or if you have any questions, please do not hesitate to contact EPSI.

Engineered Pressure Systems, Inc. will design, assemble, install and test a complete Hot Isostatic Pressing (HIP) system. The HIP system will consist of the following major components.

- Pressure Vessel Assembly
- Furnace & Heatshield Assembly
- Part Support Tooling
- Control System
- Process Gas Handling & Compression System
- Vacuum System
- Electrical Power Distribution System



The proposed HIP System comprises several modules, which are interconnected with electrical wiring and piping to form the Hot Isostatic Pressing System. The modular design simplifies system installation in your facility. EPSI will supervise the installation the HIP equipment components.

EPSI will furnish facility layout drawings to be mutually agreed upon.

1.1 HIP System Safety Items

HIP Vessel Equipment Safety

EPSI believes we provided the safest highpressure equipment in the world, but no matter how safe our equipment is the ultimate responsibility is of the end user.

Our vessel assembly and yoke plates are designed to be properly NDT inspectable. What this means is that our vessel, yoke plates and pressure components can be inspected by means of ultrasonic testing, MAG practical testing, die penetrant and acoustic emission testing.

We recommend the pressure vessel assembly have a valid inspection every year. The vessel inspection is the responsibility of the end user. We have included a budget price and description to do a vessel assembly inspection one year after the system has been in service.

EPSI has some unique features in our vessel design, which include 99% inspect ability of all cooling water passages and 100% of all high stress areas.

There are some drill throughs that can only be visually inspected for corrosion. Corrosion is a concern that all HIP operators should be aware of and should be eliminated. The vessel cooling water never comes in contact with the vessel. We do this by using stainless steel jackets around the OD of the vessel.

We have yoke locating guide cylinders with limit switches to confirm the yoke is properly centered over the vessel before pressurization occurs. This is a feature we have included in every one of our yoke vessel assembly's.

In our controls we have incorporated safety interlock and warning notifications and logs to the operators. Proper training is crucial to the safety of operating HIP equipment.

Over the past few years EPSI has been awarded contracts over other suppliers because of our vessel design and long-standing safety record with them. Los Alamos National Laboratory placed in order with EPSI for a warm isostatic press to press high explosives. DuPont recently ordered a cold isostatic press from EPSI strictly based on our vessel design versus our competitors.



Facility

There are several safety areas to be considered when operating a HIP facility. As a minimum we bring to your attention the following:

- We recommend that the Pressure Vessel be placed in a pit or a barricaded area that is well vented to confine high-pressure gas in the event of a leak. Placing the majority of the Vessel below floor level also facilitates loading and unloading of the load chamber.
- Argon is heavier than air, and therefore a suffocation hazard is more prevalent in a pit versus a barricaded well ventilated area. All enclosed areas, and the vessel pit, must contain oxygen monitors that give both an audible and visual alarm when oxygen is below safe levels. Additionally, all operators and maintenance personnel will need comprehensive training by our experts concerning this potential hazard. Should you wish EPSI to supply oxygen monitors or additional provisions within the controls to monitor these alarms we will offer this equipment at additional cost.
- All enclosed areas and the vessel pit will need exhaust fans that exhaust the pits of potentially suffocating gasses.
- Recommendations will be made concerning the location of system components relative to one another. This will permit safe access only to certain components while the unit is operational.
- The control panel should be located in an area away from high-pressure equipment.
- Appropriate electrical interlocks will be utilized to prevent operators and maintenance personnel from working on the unit while in operation.



1.2 HIP System Operation

The following paragraphs provide a fundamental description of an operating cycle for the proposed HIP System. This description is presented as a sequence of events listed in chronological order. The HIP System we are proposing is a top loaded unit. This means that the materials to be processed are placed in the vessel from the top using a customer supplied overhead crane. Assuming the pressure vessel is open and ready for loading, the steps for a typical processing cycle are:

- 1. The product to be HIP'ed is placed in a EPSI supplied load tray set and it is in turn placed into the vessel while attached to the bottom zone, plug in heater (EPSI will supply one load can and IDAHO NATIONAL LABORATORY will provide 1,000 pound load or parts for test purposes).
- 2. The heat shield and furnace assembly is installed over the load and the vessel is closed in preparation for evacuation and pressurization.
- 3. The vacuum system is activated to evacuate the pressure vessel to a predetermined level. Vacuum level is indicated at the control console screen by a vacuum transducer gauge. Better cleanliness can be achieved by argon purging and re-evacuating.
- 4. Once the required vacuum level is reached, the vacuum system is turned off. Next, argon flows from Idaho National Laboratory storage to the pressure vessel through appropriate valves and piping. This flow will continue until storage and vessel pressures are nearly equal or liquid pump in turned on depending on pressurization system.
- 5. After equalization, the high-pressure gas compressors or liquid pump and furnace are turned on. Argon flows from storage to the argon compressor, which in turn fills the vessel. When the desired vessel pressure is reached, the pump is switched off automatically. Pressure & temperature is reached at about the same time.
- 6. As soon as a positive pressure is sensed in the vessel, the furnace may be turned on. Power is applied to the furnace heating zones in a controlled manner to elevate the work zone temperature to a specified value. As the work zone temperatures increase, the argon within the vessel expands and consequently increases vessel pressure. Our controls are designed to work with step 5 to save time and energy.
- 7. The system is held at the required temperature and pressure for a specific dwell time (IDAHO NATIONAL LABORATORY specified 4 hours). The work zone temperature and pressure is automatically maintained at set point by the control system, which regulates power to the heating zones.
- 8. After the dwell period is over, furnace power is switched off, and the workload is cooled normally or thru EPSI's clopen top enhanced cooling mantle and valves.



9. When the furnace and work zone have reached a specified temperature, argon is removed from the vessel by venting to atmosphere.

NOTE: Gas recovery can be offered as an option, but would add about \$100,000.

- 10. Subsequently, the vessel reaches atmospheric pressure, and it is opened.
- 11. The mantle and furnace assembly are removed, and the load can is lifted from the vessel.

2 Plate Yoke HIP Pressure Vessel Assembly

2.1 Plate Yoke Pressure Vessel Assembly ASME Section VIII, Division 3

Pressure Vessel

The pressure vessel will be designed as a double ended, cylindrical monobloc vessel. The internal dimensions and basic design considerations for the pressure vessel load are:

10 inch ID by 60 inch IL load Clear and Unobstructed Vessel and Yoke Assembly Weight is approximately 25,000 lbs

The vessel and closures will be manufactured from SA-723, Class 2 material. This material will be melted, forged, machined, and tested to EPSI's specifications to ensure the highest level of quality control.

Yoke Assembly

The Yoke Assembly with out any welding is a rigid structure that withstands the full thrust of both end Closures during pressure cycling with minimal movement.

Yoke Pressure Vessel Assembly

Basic design guidelines, which assume 2,100°F furnace operation temperature, are:

ASME Code Stamped, Section VIII, Division 3

Operating Pressure: 15,000 psi
Design Pressure: 16,500 psi
Hydrotest Pressure: 20,625 psi
Design Temperature: 40°F to 600°F

Where feasible, the analytical methods and safety factors incorporated in Section VIII, Division 3 of the ASME Boiler and Pressure Vessel Code are used.

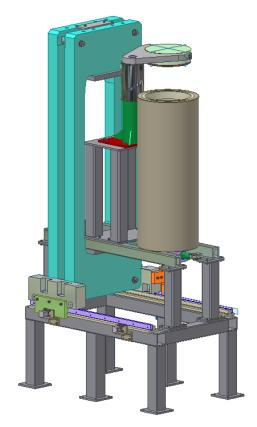


EPSI is offering an ASME, Div. 3, Vessel and Yoke. The following materials will be employed:

Vessel and Closures: SA 723

Vessel Yoke Plates and closures: SA543, or SA 516-70

Upon completion of all manufacturing steps, the vessel and closures will be assembled and hydrostatically tested to the value noted above. Of course, you are also invited to witness this test.



2.2 Pressure Vessel

The pressure vessel will be a double ended, monobloc cylinder.

Dimensions: I.D. – 20" V.L. – 90"

The pressure vessel will be designed, manufactured, tested and inspected. The material of construction for the vessel body, and end closures will be SA-723 steel.

The pressure bearing seal plate assemblies at the top and bottom closures are easily split and will be 99% inspectable to prevent any corrosion of these water-



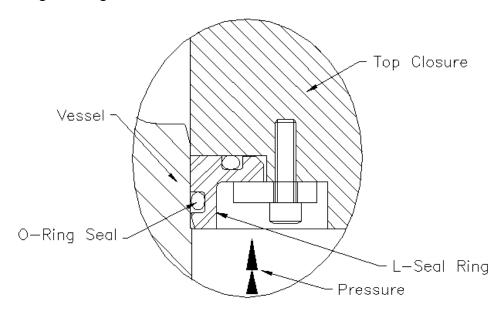
cooled components in the future and 100% of the highly stresses areas will be inspectable. Chemical and mechanical property evaluations, hydrostatic testing, and non-destructive examinations will be performed. Naturally, all data will be supplied to Idaho National Laboratory.

Vessel Inspections should be conducted periodically

2.3 Top & Bottom End Closures

The bottom closure of the vessel is an end plug that bolts into the vessel body from the lower side.

The bottom closure to vessel body seal is accomplished using our standard "L" shaped seal ring. Each leg of the "L" contains an "O" ring in a properly sized groove. One "O" ring seals against the top surface of the bottom seal plate, and the other against the vessel bore. The seal is clamped to the bottom seal plate using retaining washers.



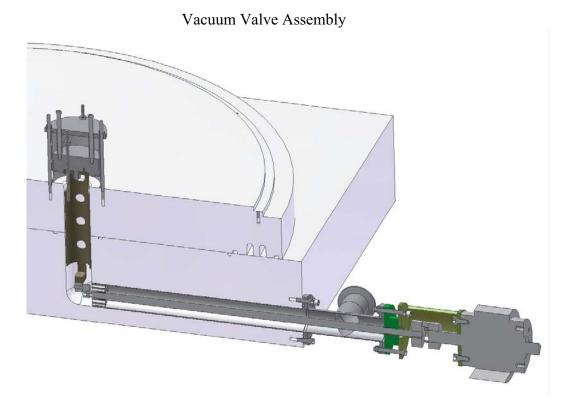
The bottom closure seal plate assembly contains the electrical power and thermocouple circuit feed throughs necessary for the HIP furnace assembly. Automatic plug-in components connect the furnace with the feed throughs when the furnace is installed in the vessel.

On the external side of the bottom seal plate, power cables and thermocouple wiring are permanently connected to the individual feed throughs as required. The bottom seal plate is cooled in the region of the "O" ring seals.



The bottom closure also has the penetrations required to evacuate and route argon into and out of the vessel. Gas flow penetrations are simply drill throughs with proper machining on the external face of the closure for attachment of high-pressure piping.

Vessel evacuation is accomplished through a large orifice valve that is fastened to the lower face of the closure.



The top closure will be similar to the bottom closure without feed throughs. The sealing arrangement for the top closure is identical to the bottom closure. For heat transfer considerations, the top seal is cooled by a grooved plate, which is bolted to the seal plate. This assembly is suspended from a lifting device allowing the seal plate assembly to be put in & out of the vessel thus minimizing the potential of damaging the sealing surface. The cooling water lines for the top closure are connected through the top closure hoist.



Pressure Systems, Inc.

2.4 Top and Bottom Seal Plate Cooling and Vessel Body Cooling Components

The top seal plate assembly will consist of two steel plates, which are bolted together. One half of the seal plate assembly will be supplied with concentric machined grooves, which are interconnected. This labyrinth of passages will be used to pass cooling water to the seal area where the top closure mates to the vessel body.

The bottom seal plate assembly will be supplied with cooling rings with similar concentric passages. These cooling rings will be spaced such that the seal area where the bottom seal ring mates with the vessel body will be water-cooled. Material of fabrication for the bottom seal plate and rings will be low alloy steel.

The vessel body will be cooled dry jackets. The dry jackets will be water cooled on the OD by means of multiple concentric stainless steel cooling panels, strapped one above the other along the length of the vessel.

In order to obtain proper heat transfer properties between the inside vessel wall and the vessel OD, we will use a special mastic between the vessel steel and the cooling coils.

These components are fabricated from stainless steel to eliminate the potential of corrosion of the vessel components. The cooling ring manufacturing process is held to very close tolerances so that proper heat transfer is accomplished.

2.5 Pressure Vessel Support Stand

The vessel assembly will be supported on a steel stand. This stand will be designed from steel beams and will support the weight of the vessel & yoke assembly, furnace and heat shield assembly, as well as the workload and argon.

The height of the pressure vessel assembly stand can vary depending on the type of installation and location of the system.

2.6 User Design Specification

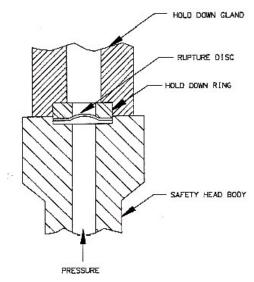
ASME Section VIII Div 3 vessels require a certified Users Design Specification. EPSI has included the cost to certify a mutually agreed Users Design Specification.



2.7 Dual Safety Rupture Disc Assembly

To safeguard the HP Pumping System and the Pressure Vessel Assembly against overpressure at all times, we will provide Rupture Discs at appropriate locations in the associated piping. This will include Rupture Discs in the high-pressure inlet lines immediately adjacent to the Pressure Vessel.

Rupture Discs will be located in the system piping so as to facilitate inspection and maintenance. From a rating standpoint, the Rupture Disc on the inlet line of the Vessel will be ¼ Range Discs stamped at between 16,000 and 16,500 Psi since it is relatively isolated from pressure fluctuations caused by the High Pressure.



In addition as a result of the ASME rules related to rupture discs (relief device).

- No isolation valve is allowed in the relief valve line.
- Rupture discs will eventually fatigue and burst after repeated use at pressures below the \pm 5% from published burst ranges.

EPSI has developed a special dual rupture disc assembly. The assembly includes two rupture discs arranged in one relief line. The first disc is always subjected to internal vessel pressure. The second is never subjected to internal vessel pressure. If the first disc breaks as a result of fatigue a small leak between the first and second disc indicates the occurrence. The leak can be isolated with a shut off valve. If the second disc burst it would only burst from an actual over pressure condition.

If there is no actual over pressure condition the process cycle can be completed. Both the discs (isolated and unisolated) can be replaced allowing continuous operation without loss of a process cycle.



3 Top Closure Hoist Assembly

3.1 Top Closure Hoist

EPSI will provide assembly drawings and installation specification for mounting and locating vessel and yoke supports.

The Top Closure is removed from the vessel body by employing hydraulically operated cylinder. A hydraulic cylinder is utilized for vertical lifting and lowering the top closure. The top closure can only be removed from the vessel when a limit switch is activated by an alignment pin confirmation the yoke assembly is in the open position.

The opening and closing of the vessel can be done at the local control console in an automatic mode by pressing and holding a single pushbutton. In the maintenance mode, the closure movements can be operated manually. The top closure and yoke movements can be stepped individually by appropriately trained personnel.

Limit switches are located on the yoke and top closure removal device to confirm location of top closure and position of yoke plates. These limit switches need to sense when the vessel and yoke are in the correct position before pressurization of the system can occur.

EPSI will provide limit switches on top and bottom of the vessel assembly. Each proximity switch will need to sense the proper positioning of the vessel relative to the yoke at all times. The bottom of the vessel will have the same proximity switch arrangement as the top.

A packaged hydraulic module provides hydraulic power for the closure and yoke movements. This module, connects to the yoke and closure hydraulic cylinders using fixed tubing, consists of the following:

- 1200 to 1500 psi gear pump with 480V, 3 phase, 60Hz motor
- Reservoir with filters, sight glass, suction strainer, air vent and other standard components
- Solenoid directional valves plus adjustable flow control valves



3.2 Load Insertion Tooling

The load tray shelves attach to the bottom support plate and will be secured in a load insertion tooling system. This system will support these components from the bottom base plate and will index from the vessel wall to assure axial alignment.

Rotational orientation will be obtained from a register bar on the insertion system. In addition, this system will ensure sufficient clearance of the load to the furnace for subsequent furnace/mantle installation.

A similar arrangement will be utilized for the furnace and mantle insertion, assuring axial rotational alignment with to the vessel.

Furnace & Heat Shield Assembly

4 EPSI Furnace and Heat Shield Assembly

4.1 Furnace and Heat Shield Assembly

We will supply a moly, 3 zone Furnace Assembly for your HIP system. The Furnace Assembly will consist of a heatshield, main heating module and base module. Furnace specifications are listed in Table 1.

The furnace heat shield which will be a closed top design that controls the convective, radiative, and conductive heat transfer from the furnace hot-zone to the top closure and vessel bore. Consequently, the heatshield contributes to the control of the temperature uniformity within the hot-zone. The heat shield is designed to maintain the furnace at maximum temperature within a specified range of total power input to the heating zones.

This power input is typically referred to as the steady-state power, which varies as a function of furnace temperature and vessel pressure. The steady-state power at maximum rated operating conditions is always less than the total installed power available for furnace heating. This allows the correct furnace heating rates during the HIP cycle regardless of furnace temperature or vessel pressure.

Each heating element is rated for a maximum power output of 75 kW. 3 elements in the furnace control work-zone control temperature uniformity, and if one heating element becomes inoperative under certain circumstances the other heating element can make up the power loss and avoid aborting the cycle. The furnace design affords this redundancy of operation. The heating elements are fabricated from moly.



Pressure Systems, Inc.

The furnace elements are protected by individual ground fault detection units. These disconnect the power from the faulty element before significant otherwise undetectable damage to the furnace internals can occur.

The temperature of each heating zone is monitored by two Type "S" thermocouples. Heating zone power input can be controlled using either of the two thermocouples since both are contained in relatively the same location within the zone. This design provides the redundancy required to continue a cycle even if one thermocouple fails. A furnace stand is included which supports the furnace when it is removed from the vessel. The stand can be used for furnace storage or furnace maintenance.

Table 1 Moly Furnace Assembly Specifications

Furnace Inside Diameter	11"
Nominal Workload Weight	1,000
Maximum Workload OD	10"
Maximum Workload Inside Height	60"
Work Tooling approximate weight	600 lbs (customer supplied)
Rated Operating Temperature	2300°F
Dwell temperature tolerance:	±20° F
Number Heating Elements	6
Number Thermal Zones	3
Power Available Each Element	75 kW
Steady-State Power	_
Normal Heating Time	15,000 psi argon 100°F per hour (15°F/min)
Normal Cooling Time	4 to 5 hours
Rapid Cool	Estimated less than 3 hrs cooling time from 2300° to 700° with 1,000 lbs load with tooling
Furnace Control Thermocouples	
Furnace T/C Temperature Uniformity	± 20°F



4.2 Furnace Plug-In Assembly

4.2.1 Furnace Shells

• Moly furnace shell, Note: easily removed from the vessel.

4.2.2 Heating Elements

• Estimated one moly furnace elements for each zone will be provided complete with buss bars.

4.2.3 Furnace Ceramics

- EPSI will supply furnace ceramics.
- Furnace ceramics are not covered under any warranty.

4.2.4 Furnace Thermocouples

- EPSI will supply furnace T/C type "S" wire
- EPSI will not provide any thermocouple wire for loads. **Idaho National Laboratory** can purchase the T/C directly from the suppliers.
- EPSI will provide one set of ceramics and moly T/C support and T/C brackets for "K" type load T/C.

4.2.5 Furnace Side Shield Insulation Package

• EPSI will provide a moly side shield with an insulation package.

4.2.6 Furnace Plug-In Components

- EPSI will provide knife blade plug-in connections.
- EPSI will provide thermocouples plug-in connection blocks for furnace and load T/C.



Pressure Systems, Inc.

4.3 High Performance Clopen Top Mantle for Furnace Plug-In Design with Enhanced Cooling

4.3.1 Mantle High Performance Clopen Top Design

EPSI will provide a moly-closed top mantle with a High Performance open top design valve in the top center of the heatshield assembly.

This valve disperses the hot gases directly onto the top center closure enhanced cooling plate. This is a maintenance free valve with no moving components. We also incorporate a valve in the bottom seal plate. See figure 5

With this design we eliminate the removable mantle top, and we add a second moly shell. EPSI will plasma spray the outside of moly mantle top. EPSI will provide outer inconnel and stainless steel shells for optimum performance.

Circulating gas for enhanced cooling

Analog flow control valve

Figure 5



4.3.2 Mantle Insulation Package

• EPSI will wrap Mantle shells with 2,600°F rated ceramic paper insulation.

4.3.3 Furnace/Mantle Lifting Fixture

- EPSI will provide a guided self-aligning furnace and mantle-lifting fixture.
- The furnace and mantle lifting fixture will be attached by the operator to the top of the mantle and lowered into the vessel repeated for the furnace. We will provide a guide pin for proper alignment on the top of the vessel.

4.3.4 Gas Purity

Pressurization medium: argon, purity requested by EPSI: Total impurities < 350 ppm.

Maximum impurities for the furnace:

O_2	<= 25 ppm
H_2O	<= 30 ppm
N_2	<= 150 ppm
H_2	<= 200 ppm
C_nH_m	<= 50 ppm
CO	<= 100 ppm
CO_2	<= 25 ppm

4.4 Plug-In Bottom Zone Heater

4.4.1 Bottom Zone Heater (BZH)

- EPSI will provide a BZH that will plug into the seal plate connecting the load thermocouples, BZH thermocouples and knife blade power connections.
- The BZH will be designed to hold up to a 2,000 pound load.
- Design temperature: 2300° Fahrenheit
- Estimated work zone void length 60 in.



4.4.2 Load Thermocouples

- EPSI will not provide load "K" type thermocouple wire. We will supply the feedthroughs and plug-ins.
- EPSI will supply one "K" type thermocouple feedthru (5 T/Cs)
- EPSI will provide one thermocouple plug-in racks to support 5 "K" type load thermocouples.

EPSI will provide 5 sets of "K" type thermocouple wire for trials. EPSI will put supplied thermocouple wire into T/C assemblies corresponding with each zone for acceptance cycles. Load thermocouple location will be proposed by EPSI for **Idaho National Laboratory's** approval.

4.4.3 BZH (Bottom Zone Heaters) Ceramics

- EPSI will supply standard ceramics. These ceramics performed excellent under normal hip cycles.
- BZH ceramics are not covered under any warranty

4.5 BZH/Tooling Lifting Fixture

4.5.1 BZH/Tooling Lifting Fixture

- EPSI will supply tooling that aligns on the vessel bore that will lift the BZH and the tooling. This fixture will center the tooling in the vessel and plug the BZH into the seal plate.
- The BZH/Tooling lifting fixture is designed to lift a maximum load of 1,000 pound load.
- The BZH load-lifting fixture is designed to be used when the load has cooled below 700°

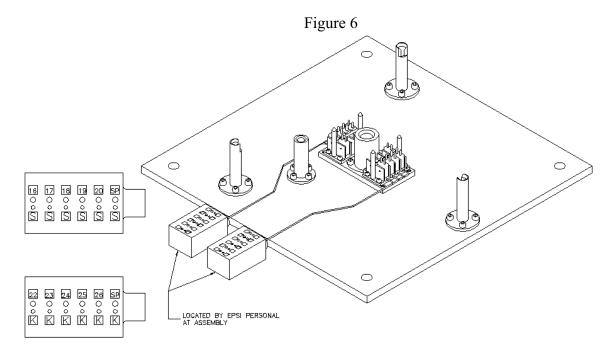
4.5.2 BZH Tooling Support Plate

- EPSI will provide a BZH tooling support plate. This plate will be used to place the BZH on the floor to emulate the seal plate. The BZH will be placed on this plate with a specific orientation. The BZH/Tooling lifting fixture will be lowered over the load and tooling. The operator will have to lineup arrows, orientate the BZH/Tooling with the BZH/Tooling lifting fixture in the correct orientation. The BZH/load lifting fixture will then be turned into a locked position allowing load-lifting fixture to lift to the BZH/Tooling.
- This will allow for proper alignment when the BZH/Tooling is plug into the seal plate.



Pressure Systems, Inc.

- 4.5.3 Optional BZH Support Plate T/C Testing Junction Box
 - EPSI will provide thermocouple connection plug-in blocks located on BZH/Tooling support plate, with thermocouple extension wire connecting to a display box mounted on a nearby wall or post. The display will provide a continuity check.
 - The main purpose for this junction box and additional T/C plug-ins are used for when the operators are making up the loads. They will be able to bring their T/C testing meter over to the Junction box and check load T/C's before the BZH/Tooling is lowered into the vessel. See Concept Figure 6



4.6 Seal Plate

4.6.1 EPSI Supplied Bottom Seal Plate

EPSI will supply a seal plate so that there is minimal drill through cooling passages.

4.6.2 Plug-In Design Seal Plate with Components

EPSI will supply a complete seal plate with the following components.

• T/C feedthroughs (estimated 3 five channel furnace "S" Type, 1 five channel Loads, "K" Type)



- Power feedthroughs
- Furnace and BZH power plug-ins
- All necessary guide pins
- Thermocouple connection blocks for BZH and furnace
- Cooling line connection pipes
- Seal plate-lifting fixture will be provided.
- EPSI will provide 2 separate BZH plug-in racks "S" type for furnace control and "K" type for loads.

4.7 Electrical Power Distribution System

Idaho National Laboratory will be required to provide the electrical power required to operate the overall HIP system to an EPSI supplied disconnect. From there, we will supply the equipment necessary to convert this electrical power to the various levels and phases required for all of the HIP system components that we are supplying.

This will encompass the use of standard switches, transformers, relays, SCR power controllers with GFI protection and motor starters. The furnace power will be wired for 480 volt, 3 phase, 60 Hz. All wiring will be in accordance with the National Electrical Code and state and local ordinances. **Note: the motor control center will use IDAHO NATIONAL LABORATORY Electrical.**

Isolation Transformer

EPSI believes the best way to protect the furnace from unforeseen short circuits is to provide ground fault protection. The ground fault protection is not the same as used in residential wiring for personnel protection, but is intended to protect the furnace. High resistance shorts can damage expensive internal furnace or vessel components. Providing ground fault protection provides an additional safety margin against otherwise undetectable short circuits.

It is necessary to have an isolated neutral to complete the ground fault circuit. Therefore, an isolation transformer is required to take conventional 3 phase power and provide a grounded neutral. It is necessary for EPSI to include the transformer in the scope of supply so that we can test the system with ground fault protection in our facility. The transformer will use 480 volt 3 phase inputs and will be procured that has the correct voltage to match the design voltage requested by Idaho National Laboratory.



If Idaho National Laboratory wished to purchase the unit we would match the transformer to the requested 3 phase power and have 480 volt 3 phase 4 wire output to the EPSI furnace. The cost of the transformer is approximately \$15,000

5 Cooling System & Vacuum System

5.1 Cooling

The water-cooling system is designed to cool the vessel assembly, compressor and power supply, if required. The system will consist of a circulation pump, heat exchanger, water reservoir and appropriate flow switches for monitoring and alarming. EPSI will be supplying a cooling tower.

The HIP system components requiring cooling water are:

- Pressure Vessel Body OD (by means of stainless steel cooling coils banded on the vessel OD)
- Pressure Vessel Top Seal Plate
- Pressure Vessel Bottom Seal Plate
- High Pressure Compressors TBD
- Vacuum Pump

Coolant on the secondary side is pumped from the reservoir tank to the components listed above. Sensors on the outlet side of each component and in the reservoir ensure that the coolant temperatures do not exceed safe system operating limits. Flow meters and switches also monitor the system to make sure coolant flow is continuous.

Coolant returning from the HIP system components to the reservoir is first circulated through a heat exchanger to decrease its temperature.

5.2 Vacuum System

Before each HIP cycle, most of the time it is necessary to evacuate the vessel. To meet this requirement, we will provide a complete vacuum system. The vacuum system will consist of a mechanical pump, a bottom closure vacuum valve, vacuum pressure gauge, interconnecting valves and piping, and a pressure relief device vacuum pump isolation valve. All these items shall be located in the pit or in proximity to the vessel. The discharge of the vacuum system will be to atmosphere.



Pressure Systems, Inc.

Vacuum system capabilities are 100 Microns in 30 minutes

Note: Vacuum performance is affected by moisture and humidity. The performance estimated is based on successive production cycles where the system has not be idle or the furnace / heat shield has not been left out of the vessel for more than 8 hours. When starting the system after periods of down time the system will reach 100 microns but it will take a longer time period to reach.

- 6 Argon Delivery System
- **6.1** Included Liquid Pump System

As a point of interest, the argon system we are proposing here is similar to the systems used by other HIP customers. This type of argon delivery system saves the cost of bottles and provides no means of reclaim and is the cleanest gas source.

- 1. 1.5 gpm at 15,000 PSI (103.4 MPa) Liquid Argon Pump.
- 2. Pump is model 3-GMPD, 1.0" bore x 0.905" stroke, high pressure reciprocating pump with purgeable intermediate and standard suction manifold.
- 3. 25HP (37 kW), 480V, 3ph, 60Hz, TEFC, inverter duty motor complete with belt drive and steel baseplate. Skid will be complete with forced oil system including oil pump and reservoir, lube piping, & automatic low pressure cut off switch, along with surge chamber, high pressure relief valve and combination pressure switch gauge. A boost pump to insure positive NPSH to inlet of 3-Head pump will also be included on skid, along with control panel.
- 4. Natural draft ambient vaporizer rated at 1,000 scfh (606 Nm³) (1.5 GPM) for 8 hours in LA2 service, Aluminum finned construction with stainless steel wetted liner for high pressure cryogenic service. Vaporizer will be mounted out side near pump skid which will also be mounted out side.
- 5. Nomenclature

TEFC - Totally Enclosed Fan Cooled

NPSH - Net Positive Suction Head

SCFH – Standard Cubic Feet per Hour

NM³- Normal Cubic Meters

SCF - Standard Cubic Feet

CFM – Cubic Feet per Minute

The gas systems are used in operations when gas reclamation is desired. In a small HIP unit, this is not the case, which allows use of the simpler lower cost liquid system.



The primary function of the process gas handling System is to route argon gas to the HIP Vessel. The system consists of a high pressure liquid argon pump with integral vaporizer, valves, fittings, piping relief devices and pressure transducers. Idaho National Laboratory will need to supply liquid argon storage. A minimum of 200 Nm³ (7,000 SCF) of argon will be needed for each cycle. For HIP operation it is typical to vent or throw away all gas after each cycle.

Therefore, a reasonable estimate of consumption per cycle is 100 gallon of liquid argon. For HIP operation it is typical to vent or throw away all gas after each cycle.

The bulk liquid storage volume should be larger than 1500 gallons

6.2 High Pressure Piping, Valves and Low Pressure Piping

EPSI will provide all high-pressure piping and control valves. EPSI will supply all high-pressure connections and installation.

Gas flow control valves for both high and low pressure levels are of standard air-to-open or air-to-close design. You can use a standard compressor to supply air (100 psi @ 100 CFM) to these valves. All high-pressure valves, piping, and fittings will be rated for 20,000 psi.

7 Controls

7.1 PLC Controls

- PLC for control and monitoring of all discrete and analog signals.
- An Ethernet network for communicating all discrete and analog signals with the PLC and PC.

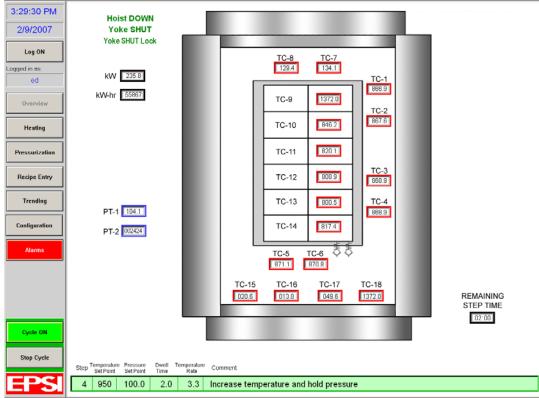
7.2 HMI (Operator Interface)

- Windows based software on a personal computer for operator interface, report generation, alarm logging, data archiving
- The control system will contain the necessary hardware and software to connect to the internet. The customer has to agree to provide an internet connection and to assign a static IP address to the HIP PC.
- System can be setup for password protection. This would prohibit unauthorized personnel from operating the equipment.
- **Typical** screens would be as described below. Screens may vary per customer's application and software package selected.



Overview - This screen is intended to give a quick overview of the process. Typical items displayed are analog and TC signals. The load thermocouples can be viewed from this screen. This is the default screen on power up. This screen will allow the operator to view the current segment status, process values, place on HOLD, Restart or Stop the HIP Unit.





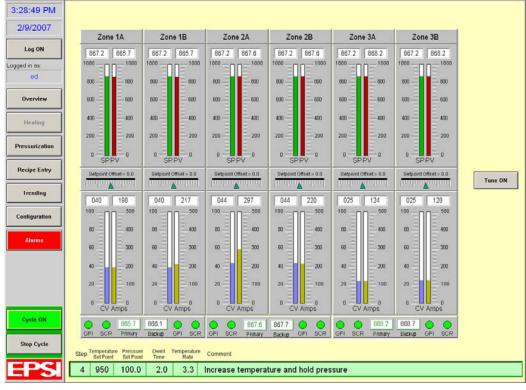
 Alarm - The screen will show all current and recent alarms from the HIP system. The operator will be able to select either current alarms or historical alarms for the selected source(s).



6/9/2006	Time	Name /	Pri	Tag Description	State	Comment		
	06/09/2006 11:27:39 AM	Alarm 025	1	TC-5 Break Zone 3 Primary	UNACK	TC-5 Break Zo	ne 3 Primary	
	08/09/2006 11:27:39 AM		1	TC-8 Break Zone 3 Secondary	UNACK		ne 3 Secondary	
Log ON	06/08/2006 03:18:45 PM		1	TC-9 Break Load 1	ACK	TC-9 Break Lo		
0.000.000	06/08/2008 03.18.46 PM	Alarm 030	1	TC-10 Break Load 2	ACK	TC-10 Break L	oad 2	
gged in as:	06/08/2006 03:18:47 PM	Alarm 031	1	TC-11 Break Load 3	ACK	TC-11 Break L	oad 3	
ed	06/08/2006 03:18:47 PM	Alarm 032	- 1	TC-12 Break Load 4	ACK	TC-12 Break L	oad 4	
eu	06/08/2006 03:18:48 PM	Alarm 033	1	TC-13 Break Load 5	ACK	TC-13 Break L	oad 5	
Overview	06/08/2006 03:18:48 PM	Alarm_034	1	TC-14 Break Load 6	ACK	TC-14 Break L	oad 6	
Heating	Displaying 1 to	8 of 8 alarms	ST.	Default Query		100 % Comp	olete	
	Alarm History (Dou	ble click to refres	h)					
Pressurization	Time ∇	Name	Pri	Alarm Comment	State	Duration		
	08/09/2006 11:27:39 AM		1	TC-5 Break Zone 3 Primary	UNACK_ALM			
Recipe Entry	06/09/2006 11:27:39 AM		1	TC-6 Break Zone 3 Secondary	UNACK_ALM			
recipe Entry	06/08/2006 04:03:57 PM		1	M-6 Trip Evaporative Cooler Pump	ACK_RTN	000 00:42:0		
	06/08/2006 04:03:57 PM		1	M-7 Trip Evaporative Fan	ACK_RTN	000 00:42:0		
Trending	06/08/2006 03:22:32 PM		1	FLS-4 Low Cooling Flow Bottom Seal Plate	ACK_RTN	000 00:00:3		
	06/08/2006 03:22:20 PM			FLS-3 Low Cooling Flow Platecoil Side 2	ACK_RTN	000 00 00.2		_
	06/08/2006 03:22:02 PM		1	FLS-1 Low Cooling Flow Top Seal Plate	ACK_RTN	000 00:00:0		_
Configuration	08/08/2006 03:22:01 PM		1	FLS-1 Low Cooling Flow Top Seal Plate	ACK_ALM			
	06/08/2006 03:22:00 PM 06/08/2006 03:22:00 PM		1	FLS-3 Low Cooling Flow Platecoil Side 2 FLS-4 Low Cooling Flow Bottom Seal Plate	ACK_ALM			
	06/08/2006 03:21:59 PM		1	M-6 Trip Evaporative Cooler Pump	ACK_ALM ACK_ALM			
	06/08/2006 03:21:58 PM		1	M-7 Trip Evaporative Cooler Furrip	ACK_ALM			- 8
Alarms	06/09/2006 03:21:56 PM		1	FLS-1 Low Cooling Flow Top Seal Plate	UNACK ALM			63
	06/08/2006 03:21:56 PM		1	FLS-1 Low Cooling Flow Flatecoil Side 2	UNACK ALM			
	06/08/2006 03:21:56 PM		1	FLS-4 Low Cooling Flow Pottom Seal Plate	UNACK ALM			100
	08/08/2006 03:21:56 PM		1	M-6 Trip Evaporative Cooler Pump	UNACK ALM			
	06/08/2006 03:21:56 PM		1	M-7 Trip Evaporative Cooler Furtip	UNACK ALM			
	06/08/2006 03:20:17 PM		1	TC-5 Break Zone 3 Primary	ACK RTN			
	08/08/2008 03:18:50 PM		1	DeviceNet Node 01 Failure	ACK RTN	000 00 55 2		
	06/08/2006 03:18:49 PM		1	DeviceNet Node 01 Failure	ACK ALM			
	06/08/2006 03:18:48 PM		1	TC-14 Break Load 6	ACK ALM			
	06/08/2006 03:18:48 PM		1	TC-13 Break Load 5	ACK ALM			
System ON	06/08/2006 03:18:47 PM		1	TC-12 Break Load 4	ACK ALM			1
-74.6.0. 4.1	06/08/2006 03:18:47 PM		1	TC-11 Break Load 3	ACK ALM			
	06/08/2006 03:18:46 PM		1	TC-10 Break Load 2	ACK_ALM			1
Contain OCT	06/08/2006 03:18:46 PM	Alarm_025	1	TC-5 Break Zone 3 Primary	UNACK RTN	000 03:52:5		
System OFF	06/08/2006 03:18:45 PM		1	TC-9 Break Load 1	ACK_ALM			
The state of the s	06/08/2006 03:18:45 PM	Alarm 020	1	Check air is OK & PS-12	ACK_RTN	000 00.55.2		in the second
- Control	06/08/2006 03:18:45 PM 06/06/2006 03:18:45 PM	Al 050	1.0	TC 6 Proply Zono 2 Secondary	ACK DTN	000 02 52 5		-1

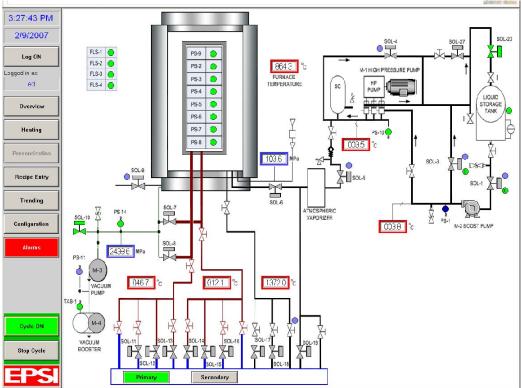
- **Heating** This screen allows the operator to adjust tuning parameters and review the furnace operation.
 - Active Ground Fault Status
 - The screen indicates the current temperature and whether the thermocouple is enabled or disabled.





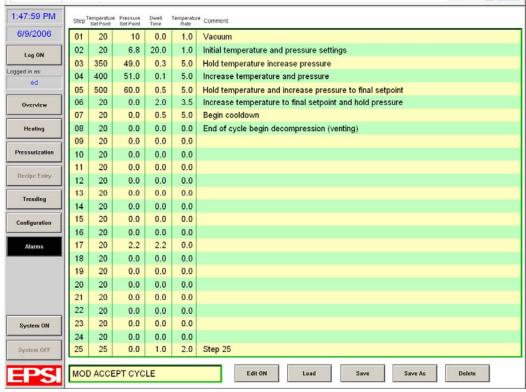
- Pressurization This will be a P&ID representation of the vessel's current status. This screen will be modified to reflect this unit P&ID (screen shown is of a cryogenic liquid pressurization system). Some other key functions or displays are:
 - Water Temperature
 - Water Flow Indication
 - Vessel Pressure
 - Closure Status
 - Start and stop Semi-Automatic cycles
 - Manual Control of valves and pumps with safety interlocks
 - Provide ability for the operator to restart (actually continue) the cycle at the beginning of a specified segment





o **Recipe Entry** – This screen allows the operator to input the cycle parameters. The system has the capability that will allow the operator to change parameters even mid step of a cycle.

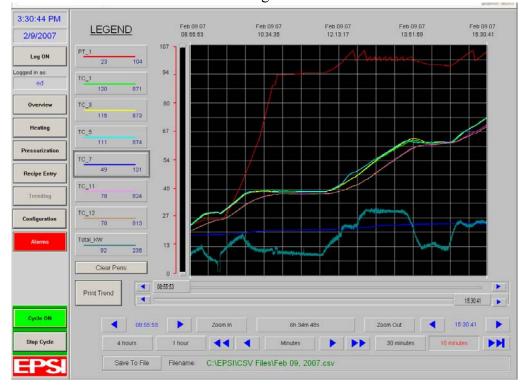




O **Historical Trend** - This screen allows viewing of locally logged process data in a trend screen format. The operator can choose up to 8 analog devices to be shown on the trend screen at one time. The system also has the ability to save a .csv file based on the current date.

Engineered Pressure Systems, Inc.

Trending



 Configuration Screen – This screen allows appropriate personnel to adjust process parameters that are not included in the recipe functions. These parameters are not expected to have to be changed each cycle.





7.3 The process steps will include:

- Load and close vessel Manual function
- Evacuate pressure vessel
- Pressurize with gas compressors
- Start furnace (Ramp/Soak)
- Stop furnace
- Vent
- Cycle complete

8 Installation

8.1 Supervision of Installation

EPSI will provide supervision of installation for vessel system, hoist alignment, controls and training. EPSI will be responsible for all high pressure piping.

Idaho National Laboratory will be responsible for all electrical interconnections, low pressure piping, installing vessel, controls and miscellaneous support equipment.



8.1.1 Optional Turnkey Installation

EPSI has provided budget turnkey installation price as an option. We are assuming the location will be in the Shanghai, China area. When the location has been disclosed and building details have been released we will need to reevaluate our proposed price.

Shipping: includes shipping all equipment to your facility in Shanghai, China

Rigging: EPSI to include offloading and transportation to your facility and for installation of all equipment and to be located and anchored.

Interconnections: EPSI to provide power and signal wiring between main power panels and the subassemblies including: furnace, compressor, vacuum pump, hoist hydraulic system. High pressure piping and low pressure piping is included.

Cost of power wiring from the customer's substation to EPSI main power panels is excluded.

Our intentions are to set up this HIP System in our facility for trials and the hydrotest per ASME specifications will be performed.

Idaho National Laboratory provides:

- Adequate access to the plant site.
- Reinforcement on floors, overhead protection from the elements and otherwise, and such modifications in user's building or premises as are necessary for proper installation of the apparatus covered by this proposal.
- Air, and water piping not furnished as an integral part of the apparatus.
- Electrical power, compressed air, compressor, cooling water and other utilities.
- Lifting equipment (Crane with Cane operator) with appropriate capacity to lift the vessel and yokes from a flat bed truck into position in Idaho National Laboratory's building

8.2 Acceptance Cycles

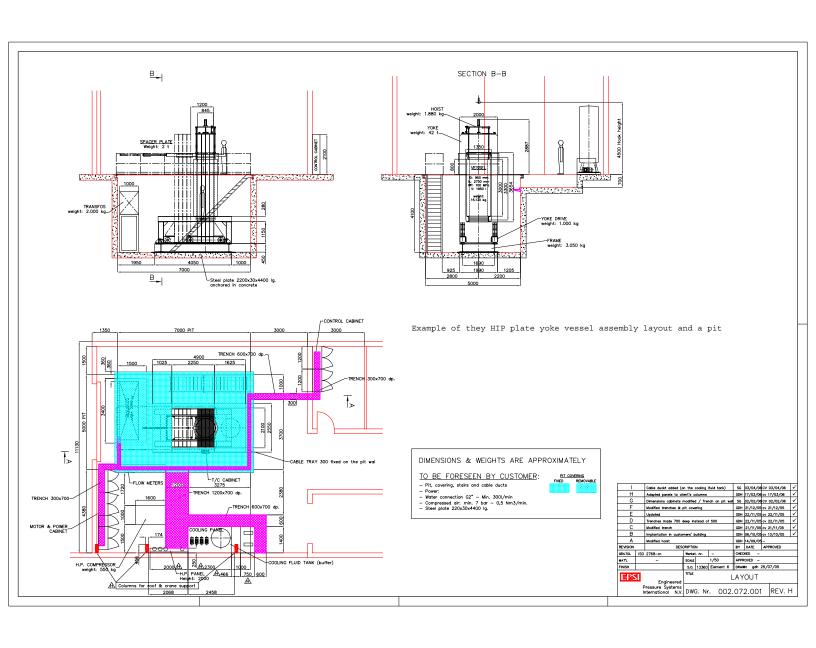
- EPSI will confirm set up of HIP system and perform operational test cycles with test load or if supplied customers product.
- These tests will be functional tests based on this proposal and Idaho National Laboratory specification not product quality tests.



8.3 Training

Five days of hands on operational and maintenance training will be supplied by EPSI at EPSI Haverhill, MA. We suggest that Idaho National Laboratory personnel be available during the installation to receive maintenance training during that time.

- Our technicians will provide training at Idaho National Laboratory.
- We will provide 2 days of training after functional tests are completed.
- Training will contain controls, operation of hoist and pressurization system.
- Coordination of training will be Idaho National Laboratory responsibility and time will be mutually agreed with EPSI.





9 Miscellaneous

9.1 Documentation

EPSI will supply the following updated and current documentation:

- Overall dimensional drawings showing equipment location and interconnecting piping
- All component assembly drawings load support trays, furnace, load support, vessel, yoke, top and bottom closures, t/c and power feed throughs, hoist, load assembly tooling, furnace assembly tooling. Schematics: argon gas system, source code: PLC and PC on CD.
- Hoist control schematic
- Vacuum piping schematic
- Electrical schematics
- Control ladder logic
- Control layout drawings
- Complete manuals for operation and maintenance.

Excluded are:

- Detail drawings
- Foundation engineering
- Building modifications

9.2 Utilities

The utility requirements for your HIP are:

Electrical: 480VAC, 3 phase, 400-amp service. Air: 100 psi minimum, nominal volume

Water: To fill the reservoir and cooling exchangers

9.3 References

DuPont Engineering Polymers

Yr Supplied
1967
1979
1997
1997
2001
2004
2005
2006



Pressure Systems, Inc.

Los Alamos National Laboratory	
Equipment	Yr Supplied
30" ID x 25 Void Length 270°F 30,000 psi WIP/Drybag	2003

12" ID x 36 Void Length 70°F 30,000 psi CIP/Drybag

BWXT Pantex (Mason & Hanger-Silas Mason Company, Inc.)

Equipment	Yr Supplied
20" ID x 30" VL, 20,000 PSI WIP	1968
19.5 ID x 30" VL, 20,000 PSI WIP	1977
25" ID x 35" VL, 30,000 PSI WIP	1981

Schlumberger Well Services

Equipment	Yr Supplied
5" ID x 36" Void Length, 650°F 30,000 PSI Deep Well Simulator	1973
8" ID x 360" Void Length, 650°F 35,000 PSI Deep Well Simulator	1974
7.5" ID x 30" Void Length, 650°F 35,000 PSI Deep Well Simulator	1977
8" ID x 16" Void Length, 650°F 35,000 PSI Deep Well Simulator	1981
14" ID x 388" Void Length, 650°F 35,000 PSI Deep Well Simulato	r 2003
14" ID x 388" Void Length, 650°F 35,000 PSI Deep Well Simulato	r 2005
14" ID x 342" Void Length, 450°F 20,000 PSI Deep Well Simulato	r 2006

Bodycote IMT Andover Equipment (Please Note all HIP Systems have Undated Plug-in Fr

Equipment (Please Note all HIP Systems have Updated Plug-in Furnaces since					
1998)	Yr Supplied				
16" ID x 48" Void Length, 15,000 PSI HIP	1968				
16" ID x 88" Void Length, 15,000 PSI HIP	1972				
16" ID x 48" Void Length, 15,000 PSI HIP	1974				
48" ID x 132" Void Length, 15,000 PSI HIP/650°C. HIPIC	1979				
25" ID x 100" Void Length, 45,000 PSI HIP	1982				
48" ID x 132" Void Length, 15,000 PSI HIP	1985				
10.5" ID x 60" Void Length, 60,000 PSI CIP	1998				

Alliant Tech Systems (ATK)

Equipment	Yr Supplied
12" ID x 36"Void Length, 30,000 PSI CIP	1982
38" ID x 140" Void Length, 15,000 PSI, 650° C. HIPIC	1988
(28" ID x 102" Void Length, Isolation Chamber)	

Fiber Materials, Inc. (FMI)

Equipment	Yr Supplied
38.5" ID x 77" Void Length, 15,000 PSI, 1000°C, HIPIC	1976
36" ID x 110" Void Length, 15,000 PSI HIPIC	1983
24" ID x 82" Void Length, 15,000 PSI HIPIC	1983
36" ID x 110" Void Length, 15,000 PSI HIPIC	1988

1985



9.5 Vessel Inspection

EPSI suggests a vessel inspection periodically. EPSI will review and approve the inspection procedure and report for a minimal charge.

Inspection should consist of the following:

Mag Particle and UT inspection. If unable to perform a mag particle inspection of the entire vessel bore. Idaho National Laboratory should substitute a liquid penetrant exam for the areas not accessible with magnetic particle.

The vessel will have to be completely disassembled, cleaned and dried for the purposes of the inspection.

A complete disassembly of the vessel means that all vessel components, such as closures, seal plates, vacuum valves, etc. have to be taken apart, free of any oil or grease and be dried. The top and bottom closure needs to be disassembled. Depending on the inspectors the yoke plates may not need to be disassembled.

Should you wish to hire EPSI to perform any of the functions of dismantling the vessel, we will charge our standard labor rate of \$1,000 per 8-hour day, travel time at \$90 per hour, overtime at \$187.50 per hour and all travel related expenses at cost.

Estimated cost for qualified inspectors to perform the above inspection: \$15,000

Idaho National Laboratory will need to be able to supply a source of power for our inspector and a clean surface to work from.



10 General Conditions of Sale

10.1 Price:

Complete 10" HIP system with out turnkey installation:	\$1,300,000				
Spare Furnace/Mantle and BZH Assembly	\$250,000				
Budget Turnkey Installation without Crane\$75,	\$75,000 to \$150,00				
Optional Base Plate T/C Plug-In Test Plate	\$10,000				
Future Vessel Assembly NDT Inspection	\$15,000				
Reclaimed Argon gas System	\$120,000				
Budget 14" HIP system with out turnkey installation:	\$1,750,000				
Budget 12" HIP system with out turnkey installation:	\$1,500,000				
Budget Spare Parts:	\$15,000				
Suggested spare parts to be, \$5,000 of consumable spare parts no	ot counting load				
thermocouples and \$10,000 of strategic spare parts on hand. EPS complete list of spare parts before shipment of HIP system	SI will provide a				

Not included in this proposal are:

- Pit Design
- Civil Engineering
- Grating, stairways or other access means to or around the vessel.
- Workload tooling

10.2 Delivery

- Delivery: 12 to 14 months after export license, **Deliveries are subject to** allocation of melting capacity. Deliveries to be adjusted after meeting melting commitment are secured.
- Delivery is Ex works EPSI Haverhill, MA
- Transportation, rigging and installation of vessel and components to be responsibility of EPSI if turnkey is purchased. **Not Duties**
- Commissioning by end of TBD



10.3 Validity:

• This proposal is valid for <u>30</u> days after the firm pricing has been provided. Orders placed after the validity periods are subject to our confirmation of both the quoted price and delivery time given above.

10.4 Payment terms:

Our Standard Terms and Conditions are attached for your review.

Payment terms are suggested as follows:

- 30% At time of order placement, Net 30
- 20% At time of mechanical test of steel, test certificates to prove milestone achievement. Net 30
- 30% At time of hydrostatic test, test certificates to prove milestone Achievement, Net 30
- 10% At time of acceptance at EPSI, Net 30
- 10% At time of acceptance, no later than 30 days after completion of installation or 60 days after delivery, Net 30

10.5 Warranty

EPSI warrants all components, which will be supplied new, as outlined in this detailed proposal will be warrantied for one year after start up or 14 months after delivery.

Exceptions to warranty components

Wear items that fail under normal operation are not covered under the one year warranty. Example: furnace and load thermocouples, O-rings, packing for compressor or liquid pump and ceramics.

10.6 Conditions of Sale

- PRICES
 - Unless otherwise specified, the prices quoted are firm and are not subject to adjustment unless the Buyer causes shipment to be delayed.
- 2. TAXES

The Buyer agrees to pay the amount of any excise, sales gross receipts, use or occupation tax or other tax levied upon this transaction or upon any sale, contract, shipment or delivery incident thereto, or to furnish Seller with necessary funds for such payment if payable by Seller, in addition to the price or prices provided herein.

- 3. <u>DELAY</u>
 - Delivery is subject to delays due to war, Acts of God or of the Public Enemy, Acts of Government, fire, floods, strikes, labor trouble, sabotage, freight and transportation delays, inability to obtain materials, procurement elements for fuel at the planned time during order execution, or any cause of the same or any other kind beyond the control of the Seller.
- 4. <u>IDAHO NATIONAL LABORATORYNERAL PROVISIONS</u>
 a. The Seller shall be liable only to replace such products as may be found to be defective or to allow credit for such products at its option, and shall not be liable for transportation or installation charges, expenses for repairs or replacements, including, but not limited to Buyer's machining expense, for any loss or reduction of profits or for loss of use or for indirect or consequential damages of any kind,

whether arising from delay in delivery, breach of warranty or from any other cause whatsoever.

Pressure Systems, Inc.

b. In the event of a conflict between the terms and conditions of the Buyer's purchase order and these Conditions of Sale, the latter shall govern the contract between the Buyer and the Seller.

c. This quotation is submitted solely for the information of the Buyer and shall become a contract only after approval by the Buyer and acceptance in writing by the Seller at its home office in Haverhill, Massachusetts. Upon such acceptance by the Seller, the above terms and conditions shall constitute the entire agreement between the parties and there are no terms obligations, covenants, representations, statements or other conditions other than those contained herein or in any specifications attached thereto. This contract shall be construed and governed by the laws of the Commonwealth of Massachusetts.

d. When material or equipment is supplied by the Buyer in connection with performance of labor or services by EPSI on such material or equipment or for any other reason, whether or not such material or equipment is listed as a part of this order, the following additional and supplementary terms and conditions shall apply and shall supersede for foregoing terms and conditions to the degree they conflict with such terms and conditions, if any:

EPSI shall not, under any circumstances, be liable either for any direct or consequential damages which may result from acts which it performs or from its failure to perform any act with respect to such material or equipment or for any loss of or any damage PSI shall not be entitled to compensation for processing material furnished by the buyer when such material has been rendered defective by such processing. If a defect in the processed product is caused by a defect in the material supplied or by error in the drawings or instructions furnished by the Buyer, EPSI shall, nevertheless, be entitled to full payment of the costs of processing. Defective parts and material shall be returned to the Buyer.

CREDIT APPROVAL

Shipments, deliveries and performance of work shall at all times be subject of the Seller's Credit Department and the Seller may at any time decline to make any shipment or delivery or perform any work except upon receipt of payment or upon terms and conditions or security satisfactory to such Department.

6. COMPLIANCE WITH LAWS

The seller intends to comply with all laws applicable to its performance of any accepted order resulting form the accompanying quotation.

7. CANCELLATION

If any order placed against this quotation shall be canceled or suspended by Buyer and agreed to by Seller, Buyer will pay to Seller a cancellation or suspension charge amount to: a. A minimum of 20% of the base selling price, plus increased by: b. If prior to cancellation, the order has been placed in engineering and/or procurement stage, additional charges based on escalating that portion of work completed or committed through purchase ordering by EPSI from sub-suppliers this portion to be calculated a percentage of the total selling price.

8. GUARANTEE

Engineered Pressure Systems, Inc., guarantees the quoted equipment except expendable items such as o-rings, packing, seals, heating elements, thermocouples, etc., to be free from defects in materials and workmanship for a period of one (1) year from date of delivery except for the vessel, provided the equipment is used in accordance with EPSI recommendations. Defects discovered while the system is under guarantee shall be remedied by the Seller at his expense. The Seller shall have the option of repairing or replacing the defective part or component at the Buyer's plant or when returned PREPAID to the Seller's plant.

The guarantee is restricted to the replacement of defective part and shall in no case give the buyer the right to claim reimbursement of consequential damages caused by the defect or losses caused by the non-operative time of the system.

For the parts not manufactured by EPSI, EPSI attempts to obtain from its suppliers, guarantee provisions equivalent to its own. Therefore, this guarantee is limited to those guarantees which are given to us by each supplier.

Except as expressly set forth herein, Seller makes no warranty, express or implied, as to the fitness of the goods for a particular purpose, there are no warranties which extend beyond the description set forth in any specification mutually agreed on by the parties hereto. By acceptance hereof, Buyer waives all rights it may have under any other express or implied warranty provided by law.

If you have any questions or concerns, please do not hesitate in contacting EPSI.

Sincerely,

Kenneth D. Morse Jr.

Kemmet DMmf

Sales Manger

APPENDIX B– ESTIMATE DETAILS REVISION 1

- 1. ESTIMATE DETAILS BASE CASE (FRICTION BONDING)
- 2. ESTIMATE DETAILS HIP ALTERNATE

Estimate Summary

Base Case (Friction Bonding)

Revision 1

Client: INL
Project: FFC
Location: GREEN FIELD SITE
Facility: Entire Estimate

GREEN FIELD SITE
Entire Estimate Washington Division
Green Field Site

11:39AM

Job No: 27989-325 ACCT DESCRIPTION WORKHOURS LABOR MATERIAL SUBS TOTAL 01 Demolition 10,501 \$867,563 \$353,652 \$1,267,365 02 Improvements to Site \$46,150 03 Earthwork 11,882 \$959,804 \$4,056 \$963,860 04 Concrete/Masonry 72,070 \$5,644,796 \$1,763,044 \$7,407,840 05 Structural Steel/Platework 1,858 \$169,561 \$244,090 \$413,652 06 Permanent Equipment 9,533 \$844,864 \$11,722,390 \$2,654,150 \$15,221,404 11 Piping Bulks 18,485 \$1,608,332 \$149,881 \$1,758,213 12 Electrical Bulks 17,394 \$1,480,813 \$1,329,359 \$2,810,172 13 1,423 \$126,983 \$4,844,521 \$4,971,504 Instrumentation Bulks 14 Painting/Coatings/Liners 15 Insulation \$2,914,541 \$492,487 \$5,363,725 16 Buildings 37,425 \$1,956,697 21 Spare Parts 22 Freight \$14,617,256 DIRECT FIELD COST 180,570 \$22,367,690 \$3,192,787 \$40,177,734 31 20,984 \$1,477,274 \$238,220 \$1,715,494 Constr. Mgt. Staff & Services 32 Craft Labor Related Expenses 33 Temporary Construction Facilities, Furnishings, Services 41 Construction Equipment 51 Start Up Services INDIRECT FIELD COST 20,984 \$1,477,274 \$238,220 \$1,715,494 TOTAL FIELD COST 201,554 \$16,094,530 \$22,367,690 \$3,431,007 \$41,893,227 Home Office Services 68,600 \$7,203,000 \$7,203,000 61 TOTAL FIELD, HOME OFFICE AND ENGINEERING \$22,367,690 \$3,431,007.31 270,154 \$23,297,530 \$49,096,227 INSURANCE CGL & Pkg Policy 74.10 0.51% \$250,087 74.20 TAXES (EXCLUDED) \$0 74.30 BONDS (EXCLUDED) 74.40 PERMITS (EXCLUDED) \$0 FREIGHT 5% on Material Costs 74.50 2.28% \$1,118,385 79.50 ESCALATION \$0 CONTINGENCY 27.47% 80.10 \$13,860,281 % of Sales : 89.1 G&A ?? Prov. Rate: 0.00% \$64,324,980 TOTAL PROJECT COST Basis for FEE 90 90.1 0.00% \$0 91 WARRANTY RESERVE \$0 100.1 CLIENT COSTS \$0 100.2 FEES ON CLIENT COSTS \$64,324,980 GRAND TOTAL PROJECT 110

Grand Total Summary Page 1 of 1

Estimate Details

Base Case (Friction Bonding)

Revision 1

Location: GREEN FIELD SITE
Account: 02 Improvements to Site
Facility: Entire Estimate

Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

	Green Field Site				JOD NO:	21989-323	Rev No: 0				Estimate: FF	C	
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Above and Below (Grade Earthwork					351	82.56			\$28,961	\$49,003	\$0	\$77,964
020403	Install Concrete Lined Ditch (1000 lnft)	222.00	cuyd	1.20	0.94	207.60	\$82.56	\$187.48		\$17,139	\$41,620	\$0	\$58,759
020403	Install Silt Fence 3,015 Inft	1	each	1.20	51.96	51.96	\$82.56	\$1,130.22		\$4,290	\$1,130	\$0	\$5,420
020403	Install Haybales 100 ea	1	each	1.20	24.00	24.00	\$82.56	\$1,071.30		\$1,981	\$1,071	\$0	\$3,053
020403	Install Concrete Valley Gutter at Project Entrance	18.00	cuyd	1.20	1.92	34.56	\$82.56	\$74.99		\$2,853	\$1,350	\$0	\$4,203
020403	Install 6" Compacted Subgrade for Conc Ditch	111.00	cuyd	1.20	0.29	32.67	\$82.56	\$34.52		\$2,698	\$3,831	\$0	\$6,529
Fencing						701	82.56			\$57,857	\$142,200	\$0	\$200,057
021002	CHAINLINK FENCE 12' hight w/razor wire	2,800.00	lnft	1.20	0.24	672.00	\$82.56	\$50.00		\$55,480	\$140,000	\$0	\$195,480
021010	GATE 3' wide Personnel Entrance	1	each	1.20	4.80	4.80	\$82.56	\$200.00		\$396	\$200	\$0	\$596
021010	GATE 40	2	each	1.20	12.00	24.00	\$82.56	\$1,000.00		\$1,981	\$2,000	\$0	\$3,981
Parking lot						2,938	82.56			\$242,525	\$56,644	\$0	\$299,169
020403	4" ASPHALT WEARING COURSE (parking lot)	6,800.00	sqyd	1.20	0.24	1,632.00	\$82.56	\$6.33		\$134,736	\$43,044	\$0	\$177,780
020404	6" COMPACTED LOCAL GRAVEL (parking lot)	6,800.00	sqyd	1.20	0.19	1,305.60	\$82.56	\$2.00		\$107,789	\$13,600	\$0	\$121,389
Road Work						5,670	82.56			\$468,109	\$96,390	\$0	\$564,499
020403	4" ASPHALT WEARING COURSE (for roads)	10,500.00	sqyd	1.20	0.24	2,520.00	\$82.56	\$6.33		\$208,048	\$66,465	\$0	\$274,513
020404	12" COMPACTED LOCAL GRAVEL (for roads)	10,500.00	sqyd	1.20	0.30	3,150.00	\$82.56	\$2.85		\$260,060	\$29,925	\$0	\$289,985
Site Drainage	GLG 40 FUD					80	79.58			\$6,356	\$3,260	\$0	\$9,616
020304	CMP 18 END	8	each	1.20	2.18	17.47	\$79.58	\$70.00		\$1,390	\$560	\$0	\$1,950
020304	CMP 18 14G	200.00	lnft	1.20	0.31	62.40	\$79.58	\$13.50		\$4,966	\$2,700	\$0	\$7,666
Site Preparation						576	83.91			\$48,350	\$0	\$46,150	\$94,500
020202	CLEAR & GRUB LIGHT site, roads & parking lot	13.00	acre	1.20					\$3,550.00	\$0	\$0	\$46,150	\$46,150
020203	Clear Grub, Strip: 6"	8,003.00	cuyd	1.20	0.07	576.22	\$83.91			\$48,350	\$0	\$0	\$48,350
	TE WORK & FOUNDATIONS					186	82.82			\$15,405	\$6,155	\$0	\$21,560
020202	ROUGH & FINE GRADE	300.00	sqyd	1.20	0.12	36.00	\$83.91			\$3,021	\$0	\$0	\$3,021
020404	12" COMPACTED LOCAL GRAVEL	300.00	sqyd	1.20	0.30	90.00	\$82.56	\$3.85		\$7,430	\$1,155	\$0	\$8,585
021003	Fence, Chain Link 8'	200.00	lnft	1.20	0.30	60.00	\$82.56	\$25.00		\$4,954	\$5,000	\$0	\$9,954

Totals	02-Improvements to Site	10,501 \$82.61	\$867,563	\$353,652	\$46,150	\$1,267,365
	Entire Estimate					

Location: GREEN FIELD SITE
Account: 03 Earthwork
Facility: Entire Estimate
Green Field Site

URS

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

	Green Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Sanitary Sewer Lin	ne 475 Inft by 6' deep					545	79.65			\$43,400	\$0	\$0	\$43,400
030102	REMOVE SURPLUS EXCAVATION	316.67	cuyd	1.20	0.04	11.40	\$83.91			\$957	\$0	\$0	\$957
030104	HAND EXCAVATION	95.00	cuyd	1.20	1.62	153.90	\$74.33			\$11,439	\$0	\$0	\$11,439
030105	TRENCH EXCAVATION	855.00	cuyd	1.20	0.13	112.86	\$79.58			\$8,981	\$0	\$0	\$8,981
030204	HAND BACKFILL	63.33	cuyd	1.20	2.16	136.80	\$82.56			\$11,294	\$0	\$0	\$11,294
030205	TRENCH BACKFILL	570.00	cuyd	1.20	0.23	129.96	\$82.56			\$10,729	\$0	\$0	\$10,729
Concrete Footing by						2,725	81.24			\$221,387	\$0	\$0	\$221,387
030102	REMOVE SURPLUS EXCAVATION	750.00	cuyd	1.20	0.16	117.00	\$83.91			\$9,817	\$0	\$0	\$9,817
030103	STRUCTURAL EXCAVATION	3,037.50	cuyd	1.20	0.18	546.75	\$83.91			\$45,878	\$0	\$0	\$45,878
030104	HAND EXCAVATION	337.50	cuyd	1.20	1.62	546.75	\$74.33			\$40,640	\$0	\$0	\$40,640
030203	STRUCTURAL BACKFILL	3,037.50	cuyd	1.20	0.31	947.70	\$82.56			\$78,241	\$0	\$0	\$78,241
030204	HAND BACKFILL	262.50	cuyd	1.20	2.16	567.00	\$82.56			\$46,811	\$0	\$0	\$46,811
	y Dimension Security Bldg					106	81.26			\$8,589	\$0	\$0	\$8,589
030102	REMOVE SURPLUS EXCAVATION	44.00	cuyd	1.20	0.16	6.86	\$83.91			\$576	\$0	\$0	\$576
030103	STRUCTURAL EXCAVATION	118.80	cuyd	1.20	0.18	21.38	\$83.91			\$1,794	\$0	\$0	\$1,794
030104	HAND EXCAVATION	13.20	cuyd	1.20	1.62	21.38	\$74.33			\$1,589	\$0	\$0	\$1,589
030203	STRUCTURAL BACKFILL	118.80	cuyd	1.20	0.31	37.07	\$82.56			\$3,060	\$0	\$0	\$3,060
030204	HAND BACKFILL	8.80	cuyd	1.20	2.16	19.01	\$82.56			\$1,569	\$0	\$0	\$1,569
Concrete Footing by 030102	y Dimension under Warehouse Slab	59.00	cuyd	1.20	0.16	139	81.26 \$83.91			\$11,322 \$759	\$0 \$0	\$0 \$0	\$11,322 \$759
	REMOVE SURPLUS EXCAVATION	58.00	•			9.05						\$0 \$0	
030103 030104	STRUCTURAL EXCAVATION HAND EXCAVATION	156.60 17.40	cuyd cuyd	1.20	0.18 1.62	28.19 28.19	\$83.91 \$74.33			\$2,365 \$2,095	\$0 \$0	\$0 \$0	\$2,365 \$2,095
030104	STRUCTURAL BACKFILL	156.60	•		0.31	48.86	\$74.33 \$82.56			\$4,034	\$0 \$0	\$0 \$0	\$2,093 \$4,034
			cuyd	1.20								\$0 \$0	
030204	HAND BACKFILL - BY VOLUME Security Bldg	11.60	cuyd	1.20	2.16	25.06 15	\$82.56 80.91			\$2,069 \$1,192	\$0 \$0	\$0 \$0	\$2,069 \$1,192
030102	REMOVE SURPLUS EXCAVATION	17.00	cuyd	1.20	0.16	2.65	\$83.91			\$223	\$0 \$0	\$0 \$0	\$223
030103	STRUCTURAL EXCAVATION	22.50	cuyd	1.20	0.18	4.05	\$83.91			\$340	\$0	\$0	\$340
030104	HAND EXCAVATION	2.50	cuyd	1.20	1.62	4.05	\$74.33			\$301	\$0	\$0	\$301
030203	STRUCTURAL BACKFILL	7.20	cuyd	1.20	0.31	2.25	\$82.56			\$185	\$0	\$0	\$185
030204	HAND BACKFILL	0.80	cuyd	1.20	2.16	1.73	\$82.56			\$143	\$0	\$0	\$143
	- BY VOLUME Sidewalk to Bldg	3.00	,		2.70	37	80.92			\$3,026	\$0	\$0	\$3,026
030102	REMOVE SURPLUS EXCAVATION	42.00	cuyd	1.20	0.16	6.55	\$83.91			\$550	\$0	\$0	\$550
030103	STRUCTURAL EXCAVATION	56.70	cuyd	1.20	0.18	10.21	\$83.91			\$856	\$0	\$0	\$856
030104	HAND EXCAVATION	6.30	cuyd	1.20	1.62	10.21	\$74.33			\$759	\$0	\$0	\$759
030203	STRUCTURAL BACKFILL	18.90	cuyd	1.20	0.31	5.90	\$82.56			\$487	\$0	\$0	\$487
			-										

Page 2 of 62

Location: GREEN FIELD SITE
Account: 03 Earthwork
Facility: Entire Estimate
Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

	Green Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
030204	HAND BACKFILL	2.10	cuyd	1.20	2.16	4.54	\$82.56			\$374	\$0	\$0	\$374
	BY VOLUME Slab under Office Section					91	80.93			\$7,394	\$0	\$0	\$7,394
030102	REMOVE SURPLUS EXCAVATION	98.00	cuyd	1.20	0.16	15.29	\$83.91			\$1,283	\$0	\$0	\$1,283
030103	STRUCTURAL EXCAVATION	136.80	cuyd	1.20	0.18	24.62	\$83.91			\$2,066	\$0	\$0	\$2,066
030104	HAND EXCAVATION	15.20	cuyd	1.20	1.62	24.62	\$74.33			\$1,830	\$0	\$0	\$1,830
030203	STRUCTURAL BACKFILL	48.60	cuyd	1.20	0.31	15.16	\$82.56			\$1,252	\$0	\$0	\$1,252
030204	HAND BACKFILL	5.40	cuyd	1.20	2.16	11.66	\$82.56			\$963	\$0	\$0	\$963
	BY VOLUME Warehouse					68	80.92			\$5,476	\$0	\$0	\$5,476
030102	REMOVE SURPLUS EXCAVATION	76.00	cuyd	1.20	0.16	11.86	\$83.91			\$995	\$0	\$0	\$995
030103	STRUCTURAL EXCAVATION	102.60	cuyd	1.20	0.18	18.47	\$83.91			\$1,550	\$0	\$0	\$1,550
030104	HAND EXCAVATION	11.40	cuyd	1.20	1.62	18.47	\$74.33			\$1,373	\$0	\$0	\$1,373
030203	STRUCTURAL BACKFILL	34.20	cuyd	1.20	0.31	10.67	\$82.56			\$881	\$0	\$0	\$881
030204	HAND BACKFILL	3.80	cuyd	1.20	2.16	8.21	\$82.56			\$678	\$0	\$0	\$678
-	sion (2.5' X 2.5' X 500')					650	81.16			\$52,763	\$0	\$0	\$52,763
030102	REMOVE SURPLUS EXCAVATION	115.00	cuyd	1.20	0.16	17.94	\$83.91			\$1,505	\$0	\$0	\$1,505
030103	STRUCTURAL EXCAVATION	756.25	cuyd	1.20	0.18	136.13	\$83.91			\$11,422	\$0	\$0	\$11,422
030104	HAND EXCAVATION	84.03	cuyd	1.20	1.62	136.13	\$74.33			\$10,118	\$0	\$0	\$10,118
030203	STRUCTURAL BACKFILL	652.08	cuyd	1.20	0.31	203.45	\$82.56			\$16,797	\$0	\$0	\$16,797
030204	HAND BACKFILL	72.45	cuyd	1.20	2.16	156.50	\$82.56			\$12,920	\$0	\$0	\$12,920
	Volume Under Process Areas					3,792	80.92			\$306,828	\$0	\$0	\$306,828
030102	REMOVE SURPLUS EXCAVATION	4,251.00	cuyd	1.20	0.16	663.16	\$83.91			\$55,645	\$0	\$0	\$55,645
030103	STRUCTURAL EXCAVATION	5,747.40	cuyd	1.20	0.18	1,034.53	\$83.91			\$86,807	\$0	\$0	\$86,807
030104	HAND EXCAVATION	638.60	cuyd	1.20	1.62	1,034.53	\$74.33			\$76,897	\$0	\$0	\$76,897
030203	STRUCTURAL BACKFILL	1,921.50	cuyd	1.20	0.31	599.51	\$82.56			\$49,495	\$0	\$0	\$49,495
030204	HAND BACKFILL	213.00	cuyd	1.20	2.16	460.08	\$82.56			\$37,984	\$0	\$0	\$37,984
Parking Lot						53	83.91			\$4,430	\$0	\$0	\$4,430
030102	MASS EXCAVATION Cut to Fill for Parking Lots 1'	4,400.00	cuyd	1.20	0.01	52.80	\$83.91			\$4,430	\$0	\$0	\$4,430
Road Work						27	83.91			\$2,248	\$0	\$0	\$2,248
030102	MASS EXCAVATION Cut to Fill for Roads 1'	2,233.00	cuyd	1.20	0.01	26.80	\$83.91			\$2,248	\$0	\$0	\$2,248
Site Drainage		400			0.51	5	83.91			\$425	\$0	\$0	\$425
030102	MASS EXCAVATION ditch 3' wide by 2' deep by 3806 lnft	422.00	cuyd	1.20	0.01	5.06	\$83.91			\$425	\$0	\$0	\$425
Site Preparation						385	83.91			\$32,342	\$0	\$0	\$32,342
030102	MASS EXCAVATION Cut to Fill to Level site 2'	32,120.00	cuyd	1.20	0.01	385.44	\$83.91			\$32,342	\$0	\$0	\$32,342
Structural Excavati	ion / Backfill Fire Water Collection Tanks					373	80.94			\$30,199	\$0	\$0	\$30,199

Page 3 of 62

Location: GREEN FIELD SITE Account: 03 Earthwork Facility: Entire Estimate Green Field Site



Washington Division

11:37AM Priced By: ADC Office: Denver

Date: 7/17/2008

Product Line: Gov Estimate: FFC

	T deline	Green Field Site				Job No:	27989-325	Rev No: 0			I	Product Line: Gov Estimate: FFC		
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	030102	REMOVE SURPLUS EXCAVATION	170.00	cuyd	1.20	0.04	6.12	\$83.91			\$514	\$0	\$0	\$514
	030103	STRUCTURAL EXCAVATION	495.00	cuyd	1.20	0.18	89.10	\$83.91			\$7,476	\$0	\$0	\$7,476
	030104	HAND EXCAVATION	55.00	cuyd	1.20	1.62	89.10	\$74.33			\$6,623	\$0	\$0	\$6,623
	030203	STRUCTURAL BACKFILL	342.00	cuyd	1.20	0.31	106.70	\$82.56			\$8,809	\$0	\$0	\$8,809
	030204	HAND BACKFILL	38.00	cuyd	1.20	2.16	82.08	\$82.56			\$6,776	\$0	\$0	\$6,776
	ench Excavation / 00 Inft 6' deep	Backfill by Lineal Feet Fire Water Line					2,322	79.68			\$185,050	\$2,667	\$0	\$187,717
10	030102	REMOVE SURPLUS EXCAVATION	1,333.33	cuyd	1.20	0.04	48.00	\$83.91			\$4,028	\$0	\$0	\$4,028
	030104	HAND EXCAVATION	400.00	cuyd	1.20	1.62	648.00	\$74.33			\$48,166	\$0	\$0	\$48,166
	030105	TRENCH EXCAVATION	3,600.00	cuyd	1.20	0.13	475.20	\$79.58			\$37,815	\$0	\$0	\$37,815
	030204	HAND BACKFILL	266.67	cuyd	1.20	2.16	576.00	\$82.56			\$47,554	\$0	\$0	\$47,554
	030205	TRENCH BACKFILL	2,400.00	cuyd	1.20	0.23	547.20	\$82.56			\$45,176	\$0	\$0	\$45,176
	030205	BEDDING	333.33	cuyd	1.20	0.08	28.00	\$82.56	\$8.00		\$2,312	\$2,667	\$0	\$4,978
	ench Excavation/	Backfill for underground conduits & ground					548	79.84			\$43,731	\$1,389	\$0	\$45,120
cai	030102	REMOVE SURPLUS EXCAVATION	222.22	cuyd	1.20	0.04	8.00	\$83.91			\$671	\$0	\$0	\$671
	030104	HAND EXCAVATION	88.89	cuyd	1.20	1.62	144.00	\$74.33			\$10,704	\$0	\$0	\$10,704
	030105	TRENCH EXCAVATION	800.00	cuyd	1.20	0.13	105.60	\$79.58			\$8,403	\$0	\$0	\$8,403
	030204	HAND BACKFILL	66.67	cuyd	1.20	2.16	144.00	\$82.56			\$11,888	\$0	\$0	\$11,888
	030205	TRENCH BACKFILL	600.00	cuyd	1.20	0.23	136.80	\$82.56			\$11,294	\$0	\$0	\$11,294
	030205	BEDDING	111.11	cuyd	1.20	0.08	9.33	\$82.56	\$12.50		\$771	\$1,389	\$0	\$2,159

1	Totals 03-Earthwork Entire Estimate	11,882 \$80.78	\$959,804	\$4,056	\$0	\$963,860

Account: 04 Concrete/Masonry Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver Product Line: Gov

Green Field Site				Job No:	27989-325	Rev No: 0			r			
			Lab.		Workhours						Totals	
Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
y Commodity												
Reinforcing Steel	399	ton	1.20	24.00	9,564.03	\$92.37	\$1,358.08		\$883,410	\$541,197	\$0	\$1,424,607
Formwork	83,730	sqft	1.20	0.48	40,190.28	\$75.57	\$3.00		\$3,037,156	\$251,325	\$0	\$3,288,482
Embeds	18,276	lb	1.20	0.06	1,134.54	\$85.33	\$2.50		\$96,813	\$45,691	\$0	\$142,504
Concrete	6,475	cuyd	1.20	1.87	12,173.94	\$76.74	\$137.38		\$934,219	\$894,252	\$0	\$1,828,471
Finishing	155,107	sqft	1.20	0.02	3,845.03	\$76.74	\$0.01		\$295,065	\$1,551	\$0	\$296,616
Anchor Bolts	3,930	lb	1.20	0.24	943.22	\$82.43	\$1.40		\$77,746	\$5,502	\$0	\$83,248
Fine Grade	93,698	sqft	1.20	0.04	3,373.12	\$75.77	\$0.03		\$255,565	\$2,811	\$0	\$258,376
Waterstop	2,071	lnft	1.20	0.07	149.10	\$76.44	\$5.00		\$11,398	\$10,354	\$0	\$21,751
Grout	164	cuft	1.20	3.70	608.54	\$76.74	\$60.00		\$46,699	\$9,857	\$0	\$56,556
Hardener	16,714	sqft	1.20	0.00	80.22	\$76.74	\$0.03		\$6,156	\$501	\$0	\$6,658
Keyway	104	lnft	1.20	0.07	7.51	\$75.57	\$0.03		\$568	\$3	\$0	\$571
	Description r Commodity Reinforcing Steel Formwork Embeds Concrete Finishing Anchor Bolts Fine Grade Waterstop Grout Hardener	Description Qty	Description Qty UM	Description Qty UM Fact.	Description Qty	Description Qty UM Fact Workhours Per Unit Total	Description Qty UM Fact.	Description Qty	Description Qty	Commodity	Description Qty	Commodity Commodity Commodity Commodity Says S

Overall Ratios:

FormWork: 12.93 SF/CUYD Rebar: 123.08 LB/CUYD Embedments: 2.82 LB/CUYD

> Wkhr/CY 11.13 Total/CUYD \$1,144.01

Grand Total: Concrete / Masonry	6,475	CUYD	1.20	11.13	72,070	\$78.32	\$5,644,796	\$1,763,044	\$0	\$7,407,840
							\$871.74 /CY	\$272.27 /CY	\$0.00 /CY	

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site

Washington Division

Rev No: 0

Job No: 27989-325

Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

Workhours Totals Lab. Account No. Total Description UM Mat'l Unit Subs Unit Labor Qty Per Unit Rate Material Subs Total Fact. 04.03 Concrete by Pour Type 0402 13.8% 895 1.20 10.74 9,607.46 \$77.78 \$256.21 \$747,314 \$229,187 \$976,501 Footings cuyd FormWork 15.80 SF/CY 106.25 LB/CY Wkhrs/CY 10.74 Rebar Embedments 0.07 LB/CY Total\$/CY 1,091.65 \$231.61 \$172,118 \$61,527 0407 Slab On Grade 4.1% 266 cuyd 1.20 8.20 2,177.84 \$79.03 \$233,645 FormWork 2.05 SF/CY Rebar 75.24 LB/CY Wkhrs/CY 8.20 4.29 Total\$/CY 879.52 LB/CY Embedments 0408 122 cuyd 1.20 12.98 1,577.77 \$76.47 \$284.61 \$120,646 \$34,588 \$155,234 Ductbank FormWork 21.90 SE/CY LB/CY Wkhrs/CY 12.98 Embedments 0.00 LB/CY Total\$/CY 1,277.36 0409 Wall 8.1% 522 cuyd 1.20 56.31 29,415.91 \$76.62 \$587.66 \$2,253,785 \$306,979 \$2,560,764 FormWork 101.44 SF/CY Wkhrs/CY Rebar 157.14 LB/CY 56.31 Embedments 12.06 LB/CY Total\$/CY 4,902.16 0411 69.0% \$80.27 \$238.94 \$2,173,946 \$1,067,764 \$3,241,710 4,469 cuyd 1.20 27.081.63 Mat 6.06 FormWork 2.86 SF/CY 126.67 LB/CY Wkhrs/CY 6.06 Rebar Embedments 1.90 LB/CY Total\$/CY 725.41 0418 Piers 0.1% 4 cuyd 1.20 9.60 38.40 \$76.74 \$200.00 \$2,947 \$800 \$3,747 FormWork 0.00 SF/CY

9.60

936.70

0.00

0.00

Embedments

LB/CY

LB/CY

Wkhrs/CY

Total\$/CY

Account: 04 Concrete/Masonry Facility: Entire Estimate

Washington Division

Date: 7/17/2008 11:37AM

Priced By: ADC Office: Denver Product Line: Gov Estimate: FFC

Job No: 27989-325 Rev No: 0

	Green Field Sile					JOD 140.	21909-323	KCV IVO. 0				Estimate. FFC		
					Lab.		Workhours					,	Γotals	
Account	No. Description	n		Qty UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
0425	Precast Concrete			0 cuyd	1.20		28.66	\$76.74			\$2,199	\$4,050		\$6,249
0432	Elevated Slab - On Dec	FormWork Rebar Embedments	0.00 0.00 0.00	LB/CY		Wkhrs/CY Total\$/CY	0.00 0.00	\$80.72	\$293.02		\$151,582	\$58,150		\$209,731
		FormWork Rebar Embedments	3.22 141.90 11.43	SF/CY LB/CY		Wkhrs/CY Γotal\$/CY	9.46 1,056.85]						
0499	Non-Standard Pour Type MISC ALL-IN			0 cuyd 22 cuyd	1.20 1.20	12.00	264.00 264.00	\$76.74 \$76.74			\$20,259 \$20,259			\$20,259 \$20,259

Overall Ratios: FormWork 12.93 SF/CY Rebar 123.08 LB/CY Embedments 2.82 LB/CY Wkhrs/CY 11.13 Total\$/CY \$1,144.01

Grand Total:	Concrete / Masonry	6,475 cuyd	1.20	11.13	72,070	\$78.32	\$5,644,796	\$1,763,044	\$0	\$7,407,840
							\$871.74 /CY	\$272.27/CY	\$0.00 /CY	

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

Green Field Site				Job No:	2/989-325	Rev No: 0				Estimate: FFC		
			Lab.		Workhours						Totals	
Account No. Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
04.02 Concrete by Assembly - Summary												
Concrete Footing by Dimension	787	cuyd	1.20	9.27	7,298	\$78.10	\$246.45		\$570,033	\$193,984	\$0	\$764,017
Concrete Footing by Dimension Security Bldg	47	cuyd	1.20	28.88	1,350	\$76.58	\$382.26		\$103,402	\$17,868	\$0	\$121,270
Concrete Footing by Dimension under Warehouse Slab	61	cuyd	1.20	15.80	959	\$77.06	\$285.73		\$73,879	\$17,334	\$0	\$91,213
CONCRETE SOG - BY VOLUME Fire water Collection Tank	20	cuyd	1.20	6.87	137	\$79.47	\$230.18		\$10,899	\$4,592	\$0	\$15,491
CONCRETE SOG - BY VOLUME Security Bldg	18	cuyd	1.20	7.71	138	\$79.18	\$231.08		\$10,893	\$4,125	\$0	\$15,018
CONCRETE SOG - BY VOLUME Sidewalk to Bldg	44	cuyd	1.20	11.04	487	\$78.44	\$234.68		\$38,191	\$10,349	\$0	\$48,540
CONCRETE SOG - BY VOLUME Slab under Office Section	104	cuyd	1.20	7.71	801	\$79.18	\$231.08		\$63,436	\$24,021	\$0	\$87,457
CONCRETE SOG - BY VOLUME Warehouse	80	cuyd	1.20	7.71	615	\$79.18	\$231.08		\$48,699	\$18,440	\$0	\$67,139
Ductbank by Dimension (2.5' X 2.5' X 500')	122	cuyd	1.20	12.98	1,578	\$76.47	\$284.61		\$120,646	\$34,588	\$0	\$155,234
Elevated Slab on Metal Deck- by Volume	95	cuyd	1.20	9.46	894	\$80.72	\$293.02		\$72,182	\$27,690	\$0	\$99,872
Elevated Slab on Metal Deck- by Volume HVAC Filter Floor	86	cuyd	1.20	9.46	815	\$80.72	\$293.02		\$65,766	\$25,229	\$0	\$90,995
Elevated Slab on Metal Deck- by Volume Security Bldg Roof	18	cuyd	1.20	9.46	169	\$80.72	\$293.02		\$13,634	\$5,230	\$0	\$18,865
Fence/Fence lighting Pole	0	cuyd	1.20		264	\$76.74			\$20,259	\$0	\$0	\$20,259
Mat (@Grade) - By Volume Under Process Areas	4,469	cuyd	1.20	6.06	27,082	\$80.27	\$238.94		\$2,173,946	\$1,067,764	\$0	\$3,241,710
Roofing Fire water Collection Tank Sump	0	cuyd	1.20		29	\$76.74			\$2,199	\$4,050	\$0	\$6,249
SUBSTATION SITE WORK & FOUNDATIONS	4	cuyd	1.20	9.60	38	\$76.74	\$200.00		\$2,947	\$800	\$0	\$3,747
Wall by Volume Greater than 8' high Fire Water Collection Tank	26	cuyd	1.20	42.50	1,116	\$76.93	\$506.75		\$85,828	\$13,302	\$0	\$99,130
Wall by Volume Greater than 8' high Radiography Area	496	cuyd	1.20	57.04	28,300	\$76.61	\$591.94		\$2,167,957	\$293,677	\$0	\$2,461,634

	Entire Estimate	
Formwork	12.93	SF/CY
Rebar	123.08	LB/CY
Embeds	2.82	LB/CY

WKHR/CUYD 11.13
Total/CY \$1,144.01

Grand Total: Entire Estimate	6,475 cuyd	1.20	11.13	72,070	\$78.32	\$5,644,796	\$1,763,044	\$0	\$7,407,840
						\$871.74/CY	\$272.27 /CY	\$0.00 /CY	

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site

Washington Division

Job No: 27989-325

Date: 7/17/2008
11:37AM
Priced By: ADC

n Division
Office: Denver

Product Line: Gov Estimate: FFC

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

04.01 Concrete by Assembly Detail

Concrete Footing by Dimension

040202	REBAR @ FOOTINGS	41	ton 1.20	24.00	989.51	\$92.37	\$1,362.08	\$0.00	\$91,399	\$56,158	\$0	\$147,557
040203	FORMWORK @ FOOTINGS	10,152	sqft 1.20	0.48	4,872.96	\$75.57	\$3.00	\$0.00	\$368,247	\$30,456	\$0	\$398,703
040204	EMBEDS @ FOOTINGS	52	lb 1.20	0.24	12.59	\$92.37	\$2.50	\$0.00	\$1,163	\$131	\$0	\$1,294
040208	4000PSI@FOOTINGS PUMPED	787	cuyd 1.20	1.80	1,416.80	\$76.74	\$136.24	\$0.00	\$108,724	\$107,236	\$0	\$215,960
040207	KEYWAY @ FOOTINGS	92	Inft 1.20	0.07	6.61	\$75.57	\$0.03	\$0.00	\$500	\$3	\$0	\$502

 Concrete Footing by Dimension

 Formwork
 12.90
 SF/CY

 Rebar
 104.76
 LB/CY

 Embedments
 0.07
 LB/CY

Wkhr/CY 9.27
Total/CY \$970.66

Total Con	ncrete Footing by Dimension	787	CY 1.20	9.27	7,298	\$78.10			\$570,033 \$724.21 /CY	\$193,984 \$246.45 /CY	\$0 \$0.00 /CY	\$764,017
Concrete F	Footing by Dimension Security Bldg											
040202	REBAR @ FOOTINGS	3	ton 1.20	24.00	74.79	\$92.37	\$1,362.08	\$0.00	\$6,908	\$4,245	\$0	\$11,153
040203	FORMWORK @ FOOTINGS	2,406	sqft 1.20	0.48	1,154.88	\$75.57	\$3.00	\$0.00	\$87,274	\$7,218	\$0	\$94,492
040204	EMBEDS @ FOOTINGS	3	lb 1.20	0.24	0.75	\$92.37	\$2.50	\$0.00	\$69	\$8	\$0	\$77
040208	4000PSI@FOOTINGS PUMPED	47	cuyd 1.20	1.80	84.14	\$76.74	\$136.24	\$0.00	\$6,457	\$6,368	\$0	\$12,825
040209	FINE GRADE @ FOOTING	979	sqft 1.20	0.04	35.26	\$75.57	\$0.03	\$0.00	\$2,664	\$29	\$0	\$2,694
040207	KEYWAY @ FOOTINGS	5	Inft 1.20	0.07	0.39	\$75.57	\$0.03	\$0.00	\$30	\$0	\$0	\$30

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site

Washington Division

Job No: 27989-325

Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC
Office: Denver
Product Line: Gov
Estimate: FFC

						Workhours				Totals			
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

Concrete Footing by Dimension Security Bldg

 Formwork
 51.47
 SF/CY

 Rebar
 133.33
 LB/CY

 Embedments
 0.07
 LB/CY

Wkhr/CY 28.88

Total/CY \$2,594.33

Total	Concrete Footing by Dimension Security Bldg	47	CY 1.20	28.88	1,350	\$76.58			\$103,402 \$2,212.07/CY	\$17,868 \$382.26 /CY	\$0 \$0.00 /CY	\$121,270
Concre	ete Footing by Dimension under Warehouse Slab											
040202	REBAR @ FOOTINGS	3	ton 1.20	24.00	76.27	\$92.37	\$1,362.08	\$0.00	\$7,045	\$4,328	\$0	\$11,373
040203	FORMWORK @ FOOTINGS	1,572	sqft 1.20	0.48	754.56	\$75.57	\$3.00	\$0.00	\$57,022	\$4,716	\$0	\$61,738
040204	EMBEDS @ FOOTINGS	4	lb 1.20	0.24	0.97	\$92.37	\$2.50	\$0.00	\$90	\$10	\$0	\$100
040208	4000PSI@FOOTINGS PUMPED	61	cuyd 1.20	1.80	109.20	\$76.74	\$136.24	\$0.00	\$8,380	\$8,265	\$0	\$16,645
040209	FINE GRADE @ FOOTING	480	sqft 1.20	0.04	17.26	\$75.57	\$0.03	\$0.00	\$1,305	\$14	\$0	\$1,319
040207	KEYWAY @ FOOTINGS	7	Inft 1.20	0.07	0.51	\$75.57	\$0.03	\$0.00	\$39	\$0	\$0	\$39

 Concrete Footing by Dimension under War-burse Slad

 Formwork
 25.91
 SF/CY

 Rebar
 104.76
 LB/CY

 Embedments
 0.07
 LB/CY

Wkhr/CY 15.80

Total/CY \$1,503.52

Total	Concrete Footing by Dimension under Warehouse Slab	61 CY	1.20	15.80	959	\$77.06	\$73,879 \$1,217,78/CY	\$17,334 \$285.73 /CY	\$0 \$0.00 /CY	\$91,213
	Siau		- 1				\$1,217.78/CY	\$285.73 /CY	\$0.00 /CY	

Account: 04 Concrete/Masonry Facility: Entire Estimate Green Field Site

Embedments



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

	Green Field Site			300 110.	21909-323	RCV NO. 0				Estillate. FFC		
			Lab.		Workhours						Totals	
Account No.	Description	Qty I	JM Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
CONCRETE S	SOG - BY VOLUME Fire water Colle	ction Tank										
040702	REBAR @ SOG	1	ton 1.20	24.00	18.01	\$92.37	\$1,362.08	\$0.00	\$1,664	\$1,022	\$0	\$2,686
040703	FORMWORK @ SOG	41	sqft 1.20	0.48	19.61	\$75.57	\$3.25	\$0.00	\$1,482	\$133	\$0	\$1,615
040704	EMBEDS @ SOG	86	lb 1.20	0.06	5.13	\$92.37	\$2.50	\$0.00	\$474	\$214	\$0	\$688
040708	4000PSI@SOG PUMPED	20	cuyd 1.20	1.80	35.91	\$76.74	\$136.24	\$0.00	\$2,756	\$2,718	\$0	\$5,474
040709	FINISHING @ SOG	770	sqft 1.20	0.02	18.47	\$76.74	\$0.01	\$0.00	\$1,417	\$8	\$0	\$1,425
040705	ANCHOR BOLTS @ SOG	10	lb 1.20	0.24	2.31	\$92.37	\$1.40	\$0.00	\$214	\$13	\$0	\$227
040709	FINE GRADE @ SOG	770	sqft 1.20	0.04	27.70	\$76.74	\$0.03	\$0.00	\$2,126	\$23	\$0	\$2,149
040706	WATERSTOP @ SOG	88	lnft 1.20	0.07	6.31	\$76.74	\$5.00	\$0.00	\$484	\$438	\$0	\$922
040710	HARDENER @ SOG	770	sqft 1.20	0.00	3.69	\$76.74	\$0.03	\$0.00	\$283	\$23	\$0	\$307

CONCRETE SOG - BY VOLUME Fire water Collection
ormwork Tank 2.05 SF/CY 2.05 SF/CY Formwork 75.24 LB/CY 4.29 LB/CY Rebar

> Wkhr/CY 6.87 Total/CY \$776.50

Total	CONCRETE SOG - BY VOLUME Fire water Collection Tank	20	CY 1.20	6.87	137	\$79.47			\$10,899 \$546.32/CY	\$4,592 \$230.18 /CY	\$0 \$0.00 /CY	\$15,491
CONG	CRETE SOG - BY VOLUME Security Bldg											
040702	REBAR @ SOG	1	ton 1.20	24.00	16.12	\$92.37	\$1,362.08	\$0.00	\$1,489	\$915	\$0	\$2,403
040703	FORMWORK @ SOG	37	sqft 1.20	0.48	17.54	\$75.57	\$3.25	\$0.00	\$1,326	\$119	\$0	\$1,445
040704	EMBEDS @ SOG	77	lb 1.20	0.06	4.59	\$92.37	\$2.50	\$0.00	\$424	\$191	\$0	\$615
040708	4000PSI@SOG PUMPED	18	cuyd 1.20	1.80	32.13	\$76.74	\$136.24	\$0.00	\$2,466	\$2,432	\$0	\$4,898
040709	FINISHING @ SOG	918	sqft 1.20	0.02	22.03	\$76.74	\$0.01	\$0.00	\$1,691	\$9	\$0	\$1,700
040705	ANCHOR BOLTS @ SOG	9	lb 1.20	0.24	2.07	\$92.37	\$1.40	\$0.00	\$191	\$12	\$0	\$203
040709	FINE GRADE @ SOG	918	sqft 1.20	0.04	33.05	\$76.74	\$0.03	\$0.00	\$2,536	\$28	\$0	\$2,564
040706	WATERSTOP @ SOG	78	Inft 1.20	0.07	5.64	\$76.74	\$5.00	\$0.00	\$433	\$392	\$0	\$825
040710	HARDENER @ SOG	918	sqft 1.20	0.00	4.41	\$76.74	\$0.03	\$0.00	\$338	\$28	\$0	\$366

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site

Washington Division

Job No: 27989-325

Product Line: Gov Estimate: FFC

				T -1-		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

CONCRETE SOG - BY VOLUME Security Bldg

 Formwork
 2.05
 SF/CY

 Rebar
 75.24
 LB/CY

 Embedments
 4.29
 LB/CY

Wkhr/CY 7.71
Total/CY \$841.34

Total	CONCRETE SOG - BY VOLUME Security Bldg	18	CY	1.20	7.71	138	\$79.18			\$10,893 \$610.26/CY	\$4,125 \$231.08 /CY	\$0 \$0.00 /CY	\$15,018
CONC	CRETE SOG - BY VOLUME Sidewalk to Bldg												
040702	REBAR @ SOG	2	ton	1.20	24.00	39.82	\$92.37	\$1,362.08	\$0.00	\$3,678	\$2,260	\$0	\$5,937
040703	FORMWORK @ SOG	90	sqft	1.20	0.48	43.34	\$75.57	\$3.25	\$0.00	\$3,275	\$293	\$0	\$3,569
040704	EMBEDS @ SOG	189	lb	1.20	0.06	11.34	\$92.37	\$2.50	\$0.00	\$1,047	\$473	\$0	\$1,520
040708	4000PSI@SOG PUMPED	44	cuyd	1.20	1.80	79.38	\$76.74	\$136.24	\$0.00	\$6,092	\$6,008	\$0	\$12,100
040709	FINISHING @ SOG	4,536	sqft	1.20	0.02	108.86	\$76.74	\$0.01	\$0.00	\$8,354	\$45	\$0	\$8,400
040705	ANCHOR BOLTS @ SOG	21	lb	1.20	0.24	5.11	\$92.37	\$1.40	\$0.00	\$472	\$30	\$0	\$502
040709	FINE GRADE @ SOG	4,536	sqft	1.20	0.04	163.30	\$76.74	\$0.03	\$0.00	\$12,531	\$136	\$0	\$12,667
040706	WATERSTOP @ SOG	194	lnft	1.20	0.07	13.94	\$76.74	\$5.00	\$0.00	\$1,070	\$968	\$0	\$2,038
040710	HARDENER @ SOG	4,536	sqft	1.20	0.00	21.77	\$76.74	\$0.03	\$0.00	\$1,671	\$136	\$0	\$1,807

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site

Washington Division

Job No: 27989-325

Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

CONCRETE SOG - BY VOLUME Sidewalk to Bldg

 Formwork
 2.05
 SF/CY

 Rebar
 75.24
 LB/CY

 Embedments
 4.29
 LB/CY

Wkhr/CY 11.04
Total/CY \$1,100.68

Total	CONCRETE SOG - BY VOLUME Sidewalk to Bldg	44	CY 1.20	11.04	487	\$78.44			\$38,191 \$866.00/CY	\$10,349 \$234.68 /CY	\$0 \$0.00 /CY	\$48,540
CONG	CRETE SOG - BY VOLUME Slab under Office Section											
040702	REBAR @ SOG	4	ton 1.20	24.00	93.85	\$92.37	\$1,362.08	\$0.00	\$8,669	\$5,326	\$0	\$13,995
040703	FORMWORK @ SOG	213	sqft 1.20	0.48	102.17	\$75.57	\$3.25	\$0.00	\$7,721	\$692	\$0	\$8,413
040704	EMBEDS @ SOG	446	lb 1.20	0.06	26.73	\$92.37	\$2.50	\$0.00	\$2,469	\$1,114	\$0	\$3,583
040708	4000PSI@SOG PUMPED	104	cuyd 1.20	1.80	187.11	\$76.74	\$136.24	\$0.00	\$14,359	\$14,162	\$0	\$28,521
040709	FINISHING @ SOG	5,346	sqft 1.20	0.02	128.30	\$76.74	\$0.01	\$0.00	\$9,846	\$53	\$0	\$9,899
040705	ANCHOR BOLTS @ SOG	50	lb 1.20	0.24	12.05	\$92.37	\$1.40	\$0.00	\$1,113	\$70	\$0	\$1,184
040709	FINE GRADE @ SOG	5,346	sqft 1.20	0.04	192.46	\$76.74	\$0.03	\$0.00	\$14,769	\$160	\$0	\$14,929
040706	WATERSTOP @ SOG	456	Inft 1.20	0.07	32.86	\$76.74	\$5.00	\$0.00	\$2,522	\$2,282	\$0	\$4,804
040710	HARDENER @ SOG	5,346	sqft 1.20	0.00	25.66	\$76.74	\$0.03	\$0.00	\$1,969	\$160	\$0	\$2,130

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site

Washington Division

Job No: 27989-325

| Date: 7/17/2008 | 11:37AM |
| Priced By: ADC |
| Sion | Office: Denver

Product Line: Gov Estimate: FFC

Account No. Description Qty UM Fact. | Workhours | Workhours | Per Unit Total Rate | Mat'l Unit Subs Unit | Labor | Material Subs Total | Tota

Rev No: 0

CONCRETE SOG - BY VOLUME Slab under Office Section

 Formwork
 2.05
 SF/CY

 Rebar
 75.24
 LB/CY

 Embedments
 4.29
 LB/CY

Wkhr/CY 7.71
Total/CY \$841.34

Total	CONCRETE SOG - BY VOLUME Slab under Office Section	104	CY	1.20	7.71	801	\$79.18			\$63,436 \$610.26/CY	\$24,021 \$231.08 /CY	\$0 \$0.00 /CY	\$87,457
CONC	CRETE SOG - BY VOLUME Warehouse												
040702	REBAR @ SOG	3	ton	1.20	24.00	72.05	\$92.37	\$1,362.08	\$0.00	\$6,655	\$4,089	\$0	\$10,744
040703	FORMWORK @ SOG	163	sqft	1.20	0.48	78.43	\$75.57	\$3.25	\$0.00	\$5,927	\$531	\$0	\$6,458
040704	EMBEDS @ SOG	342	lb	1.20	0.06	20.52	\$92.37	\$2.50	\$0.00	\$1,895	\$855	\$0	\$2,750
040708	4000PSI@SOG PUMPED	80	cuyd	1.20	1.80	143.64	\$76.74	\$136.24	\$0.00	\$11,023	\$10,872	\$0	\$21,895
040709	FINISHING @ SOG	4,104	sqft	1.20	0.02	98.50	\$76.74	\$0.01	\$0.00	\$7,559	\$41	\$0	\$7,600
040705	ANCHOR BOLTS @ SOG	39	lb	1.20	0.24	9.25	\$92.37	\$1.40	\$0.00	\$855	\$54	\$0	\$909
040709	FINE GRADE @ SOG	4,104	sqft	1.20	0.04	147.74	\$76.74	\$0.03	\$0.00	\$11,338	\$123	\$0	\$11,461
040706	WATERSTOP @ SOG	350	lnft	1.20	0.07	25.23	\$76.74	\$5.00	\$0.00	\$1,936	\$1,752	\$0	\$3,688
040710	HARDENER @ SOG	4,104	sqft	1.20	0.00	19.70	\$76.74	\$0.03	\$0.00	\$1,512	\$123	\$0	\$1,635

Account: 04 Concrete/Masonry Facility: Entire Estimate

Washington Division

Job No: 27989-325

Date: 7/17/2008 11:37AM

Priced By: ADC Office: Denver Product Line: Gov Estimate: FFC

Green Field Site

				Lah		Workhours						Totals	
Account No.	Description	Qty	UM	Lab. Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

CONCRETE SOG - BY VOLUME Warehouse

Formwork 2.05 SF/CY Rebar 75.24 LB/CY 4.29 LB/CY Embedments

> Wkhr/CY 7.71 Total/CY \$841.34

Total CO	NCRETE SOG - BY VOLUME Warehouse	80	CY 1.2	7.71	615	\$79.18			\$48,699 \$610.26/CY	\$18,440 \$231.08 /CY	\$0 \$0.00 /CY	\$67,139
Ductbank l	by Dimension (2.5' X 2.5' X 500')											
040802	REBAR @ DUCTBANK	3	ton 1.20	24.00	68.06	\$92.37	\$800.00	\$0.00	\$6,286	\$2,269	\$0	\$8,555
040803	FORMWORK @ DUCTBANK	2,661	sqft 1.20	0.48	1,277.22	\$75.57	\$3.00	\$0.00	\$96,519	\$7,983	\$0	\$104,502
040808	4000PSI@DUCTBANK PUMPED	122	cuyd 1.20	1.87	227.50	\$76.74	\$200.00	\$0.00	\$17,458	\$24,306	\$0	\$41,764
040810	ADDED COLOR @ DUCTBANK	1,040	sqft 1.20	0.00	4.99	\$76.74	\$0.03	\$0.00	\$383	\$31	\$0	\$414

Ductbank by Dimension (2.5' X 2.5' X 500') 21.90 SF/CY Formwork 46.67 LB/CY Rebar Embedments 0.00 LB/CY

> Wkhr/CY 12.98 Total/CY \$1,277.36

Total	Ductbank by Dimension (2.5' X 2.5' X 500')	122	CY	1.20	12.98	1,578	\$76.47			\$120,646 \$992.75/CY	\$34,588 \$284.61 /CY	\$0 \$0.00 /CY	\$155,234
Elevate 043202	ed Slab on Metal Deck- by Volume REBAR @ ELEV SLAB ON DECK	7	ton	1.20	24.00	160.92	\$92.37	\$1,362.08	\$0.00	\$14,864	\$9,133	\$0 Page 1	\$23,997 5 of 62

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site

URS

Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

	Green Field Site			Job No:	27989-325	Rev No: 0			Р	roduct Line: Gov Estimate: FFC		
			Lab.		Workhours						Totals	
Account No.	Description	Qty	UM Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
043203	FORMWORK@ELEV SLAB ON DECK	304	sqft 1.20	0.48	146.02	\$75.57	\$3.00	\$0.00	\$11,034	\$913	\$0	\$11,947
043204	EMBEDS @ ELEV SLAB ON DECK	1,080	lb 1.20	0.07	77.76	\$92.37	\$2.50	\$0.00	\$7,183	\$2,700	\$0	\$9,883
043208	4000PSI@ESOMD PUMPED	95	cuyd 1.20	2.74	258.55	\$76.74	\$136.24	\$0.00	\$19,841	\$12,875	\$0	\$32,716
043209	FINISHING,CURE,HRDNR@ESOMD	4,860	sqft 1.20	0.04	174.96	\$76.74	\$0.01	\$0.00	\$13,426	\$49	\$0	\$13,475
043211	GROUT @ ESOMD	34	cuft 1.20	2.26	76.02	\$76.74	\$60.00	\$0.00	\$5,834	\$2,022	\$0	\$7,855

Elevated Slab on Metal Deck- by Volume

 Formwork
 3.22
 SF/CY

 Rebar
 141.90
 LB/CY

 Embedments
 11.43
 LB/CY

Wkhr/CY 9.46

Total/CY \$1,056.85

Total	Elevated Slab on Metal Deck- by Volume	95	CY 1.20	9.46	894	\$80.72			\$72,182 \$763.83 /CY	\$27,690 \$293.02 /CY	\$0 \$0.00 /CY	\$99,872
Elevat	ted Slab on Metal Deck- by Volume HVAC Filter Floor											
043202	REBAR @ ELEV SLAB ON DECK	6	ton 1.20	24.00	146.62	\$92.37	\$1,362.08	\$0.00	\$13,543	\$8,321	\$0	\$21,864
043203	FORMWORK@ELEV SLAB ON DECK	277	sqft 1.20	0.48	133.04	\$75.57	\$3.00	\$0.00	\$10,054	\$831	\$0	\$10,885
043204	EMBEDS @ ELEV SLAB ON DECK	984	lb 1.20	0.07	70.85	\$92.37	\$2.50	\$0.00	\$6,544	\$2,460	\$0	\$9,004
043208	4000PSI@ESOMD PUMPED	86	cuyd 1.20	2.74	235.57	\$76.74	\$136.24	\$0.00	\$18,077	\$11,730	\$0	\$29,808
043209	FINISHING,CURE,HRDNR@ESOMD	4,428	sqft 1.20	0.04	159.41	\$76.74	\$0.01	\$0.00	\$12,233	\$44	\$0	\$12,277
043211	GROUT @ ESOMD	31	cuft 1.20	2.26	69.26	\$76.74	\$60.00	\$0.00	\$5,315	\$1,842	\$0	\$7,157

Account: 04 Concrete/Masonry Facility: Entire Estimate Green Field Site

Description

Account No.

Washington Division

Total

Rate

Mat'l Unit

Subs Unit

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

Job No: 27989-325 Rev No: 0 Workhours Lab. Fact.

Qty

UM

Per Unit

Totals Labor Material Subs Total

Elevated Slab on Metal Deck- by Volume HVAC Filter Floor Formwork 3.22 SF/CY Rebar 141.90 LB/CY 11.43 LB/CY Embedments

> Wkhr/CY 9.46 Total/CY \$1,056.85

Total	Elevated Slab on Metal Deck- by Volume HVAC Filter Floor	86	CY 1.20	9.46	815	\$80.72			\$65,766 \$763.83 /CY	\$25,229 \$293.02 /CY	\$0 \$0.00 /CY	\$90,995
Elevat	ted Slab on Metal Deck- by Volume Security Bldg Roof											
043202	REBAR @ ELEV SLAB ON DECK	1	ton 1.20	24.00	30.40	\$92.37	\$1,362.08	\$0.00	\$2,808	\$1,725	\$0	\$4,533
043203	FORMWORK@ELEV SLAB ON DECK	57	sqft 1.20	0.48	27.58	\$75.57	\$3.00	\$0.00	\$2,084	\$172	\$0	\$2,257
043204	EMBEDS @ ELEV SLAB ON DECK	204	lb 1.20	0.07	14.69	\$92.37	\$2.50	\$0.00	\$1,357	\$510	\$0	\$1,867
043208	4000PSI@ESOMD PUMPED	18	cuyd 1.20	2.74	48.84	\$76.74	\$136.24	\$0.00	\$3,748	\$2,432	\$0	\$6,180
043209	FINISHING,CURE,HRDNR@ESOMD	918	sqft 1.20	0.04	33.05	\$76.74	\$0.01	\$0.00	\$2,536	\$9	\$0	\$2,545
043211	GROUT @ ESOMD	6	cuft 1.20	2.26	14.36	\$76.74	\$60.00	\$0.00	\$1,102	\$382	\$0	\$1,484

Elevated Slab on Metal Deck- by Volume Security Bldg Roof 3.22 SF/CY Formwork 141.90 LB/CY Rebar 11.43 LB/CY Embedments

> Wkhr/CY 9.46 Total/CY \$1,056.85

Total	Elevated Slab on Metal Deck- by Volume Security Bldg Roof	18 CY	1.20	9.46	169	\$80.72	\$13,634 \$763.83 /CY	\$5,230 \$293.02 /CY	\$0 \$0.00 /CY	\$18,865
							\$705.057€1	3273.02 / С 1	30.00 / С 1	

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site

URS

Job No: 27989-325

Washington Division

Rev No: 0

11:37AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

Date: 7/17/2008

				Lab.		Workhours						Totals	
Account N	No. Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Fence/Fen	ce lighting Pole												
049908	MISC ALL-IN	22	cu	yd 1.20	12.00	264.00	\$76.74	\$0.00	\$0.00	\$20,259	\$0	\$0	\$20,259

Total	Fence/Fence lighting Pole	0	CY 1.20	0.00	264	\$76.74			\$20,259 \$0.00/CY	\$0 \$0.00 /CY	\$0 \$0.00 /CY	\$20,259
Mat (@	® Grade) - By Volume Under Process Areas											
041102	REBAR @ MATS	283	ton 1.20	24.00	6,792.58	\$92.37	\$1,362.08	\$0.00	\$627,417	\$385,501	\$0	\$1,012,918
041103	FORMWORK 1.5 Ft. Thick @ MATS	12,768	sqft 1.20	0.48	6,128.64	\$75.57	\$3.00	\$0.00	\$463,138	\$38,304	\$0	\$501,442
041104	EMBEDS @ MATS	8,512	lb 1.20	0.06	510.72	\$76.74	\$2.50	\$0.00	\$39,192	\$21,280	\$0	\$60,472
041108	4000PSI@MATS PUMPED	4,469	cuyd 1.20	1.80	8,043.84	\$76.74	\$136.24	\$0.00	\$617,278	\$608,829	\$0	\$1,226,108
041109	FINISHING @ MATS	76,565	sqft 1.20	0.02	1,837.57	\$76.74	\$0.01	\$0.00	\$141,014	\$766	\$0	\$141,779
041105	ANCHOR BOLTS @ MATS	2,500	lb 1.20	0.24	599.99	\$76.74	\$1.40	\$0.00	\$46,043	\$3,500	\$0	\$49,543
041109	FINE GRADE @ MAT	76,565	sqft 1.20	0.04	2,756.36	\$75.57	\$0.03	\$0.00	\$208,296	\$2,297	\$0	\$210,593
041106	WATERSTOP @ MATS	521	Inft 1.20	0.07	37.54	\$75.57	\$5.00	\$0.00	\$2,837	\$2,607	\$0	\$5,444
041111	GROUT @ MATS	78	cuft 1.20	4.80	374.40	\$76.74	\$60.00	\$0.00	\$28,731	\$4,680	\$0	\$33,411

Account: 04 Concrete/Masonry Facility: Entire Estimate Green Field Site

Embedments

Washington Division

Job No: 27989-325

Date: 7/17/2008 11:37AM

Priced By: ADC Office: Denver Product Line: Gov Estimate: FFC

				Lah		Workhours						Totals	
Account No.	Description	Qty	UM	Lab. Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

Mat (@Grade) - By Volume Under Process Areas Formwork 2.86 SF/CY Rebar 126.67 LB/CY

1.90 LB/CY Embedments

> Wkhr/CY 6.06 Total/CY \$725.41

Total Mat (@	@Grade) - By Volume Under Process Areas	4,469	CY 1.20	6.06	27,082	\$80.27			\$2,173,946 \$486.47/CY	\$1,067,764 \$238.94 /CY	\$0 \$3,241,710 \$0.00 /CY
Roofing Fire	water Collection Tank Sump PRECAST ALL-IN	12	cuyd 1.20	2.39	28.66	\$76.74	\$337.50	\$0.00	\$2,199	\$4,050	\$0 \$6,249
	Roofing Fire water Collection Ta Formwork 0.1 Rebar 0.1	00 SF/CY									

Wkhr/CY 0.00 Total/CY \$0.00

0.00 LB/CY

Total Roo	ofing Fire water Collection Tank Sump	0 (CY	1.20	0.00	29	\$76.74			\$2,199 \$0.00/CY	\$4,050 \$0.00 /CY	\$0 \$0.00 /CY	\$6,249
SUBSTAT	TION SITE WORK & FOUNDATIONS												
041808	4000PSI@PIERS PUMPED	4	cuyd	1.20	9.60	38.40	\$76.74	\$200.00 \$	00.08	\$2,947	\$800	\$0	\$3,747

Account: 04 Concrete/Masonry Facility: Entire Estimate Green Field Site

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

SUBSTATION SITE WORK & FOUNDATIONS

Formwork 0.00 SF/CY Rebar 0.00 LB/CY 0.00 LB/CY Embedments

> Wkhr/CY 9.60 Total/CY \$936.70

Total	SUBSTATION SITE WORK & FOUNDATIONS	4	CY 1.20	9.60	38	\$76.74			\$2,947 \$736.70 /CY	\$800 \$200.00 /CY	\$0 \$0.00 /CY	\$3,747
Wall by	Volume Greater than 8' high Fire Water Collection T	`ank										
040902	REBAR @ WALLS	2	ton 1.20	24.00	49.50	\$92.37	\$1,362.08	\$0.00	\$4,572	\$2,809	\$0	\$7,382
040903	FORMWORK @ WALLS OVER 8' HIGH	1,958	sqft 1.20	0.48	939.89	\$75.57	\$3.00	\$0.00	\$71,027	\$5,874	\$0	\$76,901
040904	EMBEDS @ WALLS	317	lb 1.20	0.06	18.99	\$92.37	\$2.50	\$0.00	\$1,754	\$791	\$0	\$2,545
040908	4000PSI@WALLS PUMPED	26	cuyd 1.20	1.80	47.25	\$76.74	\$136.24	\$0.00	\$3,626	\$3,576	\$0	\$7,202
040909	FINISHING @ WALLS	1,632	sqft 1.20	0.02	39.16	\$76.74	\$0.01	\$0.00	\$3,005	\$16	\$0	\$3,022
040905	ANCHOR BOLTS @ WALLS	65	lb 1.20	0.24	15.70	\$92.37	\$1.40	\$0.00	\$1,450	\$92	\$0	\$1,542
040906	WATERSTOP @ WALL	19	Inft 1.20	0.07	1.39	\$76.74	\$5.00	\$0.00	\$106	\$96	\$0	\$203
040911	GROUT @ WALLS	1	cuft 1.20	4.80	3.74	\$76.74	\$60.00	\$0.00	\$287	\$47	\$0	\$334

Location: GREEN FIELD SITE
Account: 04 Concrete/Masonry
Facility: Entire Estimate
Green Field Site

URSWashington Division

Job No: 27989-325

| Date: 7/17/2008 | 11:37AM |
| Priced By: ADC |
| Vision | Office: Denver |

Product Line: Gov Estimate: FFC

Workhours Totals Lab. Fact. Account No. Total Mat'l Unit Subs Unit Description Qty UM Per Unit Labor Material Subs Rate Total

Rev No: 0

 Wall by Volume Greater than 8' high Fire Water Collection

 Formwork
 74.59
 SF/CY

 Rebar
 157.14
 LB/CY

 Embedments
 12.06
 LB/CY

Wkhr/CY 42.50
Total/CY \$3,776.39

Total	Wall by Volume Greater than 8' high Fire Water Collection Tank	26	CY 1.20	42.50	1,116	\$76.93			\$85,828 \$3,269.64/CY	\$13,302 \$506.75 /CY	\$0 \$0.00 /CY	\$99,130
Wall I	y Volume Greater than 8' high Radiography Area											
040902	REBAR @ WALLS	39	ton 1.20	24.00	935,55	\$92.37	\$1,362.08	\$0.00	\$86,415	\$53,096	\$0	\$139,510
040902	FORMWORK @ WALLS OVER 8' HIGH	51,030	sqft 1.20	0.48	24.494.40	\$75.57	\$3.00	\$0.00	\$1.851.028	\$153,090	\$0	\$2,004,118
040904	EMBEDS @ WALLS	5,982	lb 1.20	0.06	358.91	\$92.37	\$2.50	\$0.00	\$33,152	\$14,955	\$0	\$48,107
040908	4000PSI@WALLS PUMPED	496	cuyd 1.20	1.80	893.03	\$76.74	\$136.24	\$0.00	\$68,530	\$67,592	\$0	\$136,122
040909	FINISHING @ WALLS	51,030	sqft 1.20	0.02	1,224.72	\$76.74	\$0.01	\$0.00	\$93,984	\$510	\$0	\$94,494
040905	ANCHOR BOLTS @ WALLS	1,236	lb 1.20	0.24	296.72	\$92.37	\$1.40	\$0.00	\$27,408	\$1,731	\$0	\$29,139
040906	WATERSTOP @ WALL	364	Inft 1.20	0.07	26.20	\$76.74	\$5.00	\$0.00	\$2,010	\$1,819	\$0	\$3,829
040911	GROUT @ WALLS	15	cuft 1.20	4.80	70.76	\$76.74	\$60.00	\$0.00	\$5,430	\$885	\$0	\$6,315

Account: 04 Concrete/Masonry Facility: Entire Estimate

Washington Division

Job No: 27989-325

Date: 7/17/2008 11:37AM

Priced By: ADC Office: Denver Product Line: Gov Estimate: FFC

Green Field Site

								_					
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

Wall by Volume Greater than 8' high Radiography Area Formwork 102.86 SF/CY Rebar 157.14 LB/CY 12.06 LB/CY Embedments

> Wkhr/CY 57.04 Total/CY \$4,961.72

Total Wall by Volume Greater than 8' high 496 CY 1. Radiography Area	1.20 57.04 28,300 \$76.61	\$2,167,957 \$293,677 \$0 \$2,461,634 \$4,369.78/CY \$591.94 /CY \$0.00 /CY
--	---------------------------	--

Location: GREEN FIELD SITE
Account: 05 Structual Steel/Platework
Facility: Entire Estimate

URS

Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver Product Line: Gov

Green Field Site				Job No:	27989-325	Rev No: 0			Pr	educt Line: Gov Estimate: FFC		
			Lab.		Workhours					,	Γotals	
Account No. Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
05 Structural Steel by Class												
Structural Steel: Sub Total (incl xLight - xHvy)	43	tons	1.20	27.15	1,167	\$91.25	\$4,462		\$106,512	\$191,871	\$0	\$298,383
05xx03** Light Steel - 5-20#/LF	15	tons	1.20	33.30	500	\$91.25	\$5,564		\$45,578	\$83,465	\$0	\$129,043
Light Steel - 5-20#/LF \$8,603 Total Cost/Ton												
05xx04** Medium Steel - 20-40#/LF	28	tons	1.20	23.85	668	\$91.25	\$3,872		\$60,934	\$108,406	\$0	\$169,340
Medium Steel - 20-40#/LF \$6,048 Total Cost/Ton												
Minor Struct Steel : Sub Total (incl xLight - xHvy)	5	tons	1.20	48.00	242	\$91.25	\$6,454		\$22,118	\$32,594	\$0	\$54,712
05xx03** Light Steel - 5-20#/LF	2	tons	1.20	48.00	108	\$91.25	\$6,454		\$9,855	\$14,522	\$0	\$24,377
05xx04** Medium Steel - 20-40#/LF	3	tons	1.20	48.00	134	\$91.25	\$6,454		\$12,263	\$18,072	\$0	\$30,335
Minor Struct Steel : Sub Total (48.00 Workhours/Ton \$6,454 Material Cost/Ton \$10,834 Total Cost/Ton	incl xLight -	xHvy)										
Decking and Flooring	9,345	sqft	1.20		449	\$91.25	·		\$40,931	\$19,625	\$0	\$60,557

	Overall Ratios:	
38.67	Workhours/Ton	
\$5,080	Material Cost/Ton	
\$8,609	Total Cost/Ton	

Grand Total: Structural Steel / Platework	48 tons 1.20	38.67	1,858	\$91.25	\$169,561	\$244,090	\$0	\$413,652

Location: GREEN FIELD SITE
Account: 05 Structual Steel/Platework
Facility: Entire Estimate

Green Field Site

Washington Division

URS

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver
Product Line: Gov

	Green Fi	eld Site					Job No:	27989-325	Rev No: 0				Estimate: FFC		
						Lab.		Workhours						Totals	
A	ccount No. Des	scription		Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
05 Str	uctural Steel Summary	% of tot	al % of commodity	,											
0501	Building Steel	100.00	%	48	tons	1.20	29.34	1,410	\$91.25	\$4,671		\$128,630	\$224,465	\$0	\$353,095
	Light Stee	el - 5-20#/LF	35.90%	17	tons	1.20	35.22	608	\$91.25	\$5,680		\$55,432	\$97,987	\$0	\$153,419
	Medium S	Steel - 20-40#/LF	64.10%	31	tons	1.20	26.05	802	\$91.25	\$4,106		\$73,198	\$126,478	\$0	\$199,675
		\$7,348 Total Co	nilding Steel st/Ton												
0505	Decking and Flooring			9,345	sqft	1.20	0.05	449	\$91.25			\$40,931	\$19,625	\$0	\$60,557

Overall Ratios:

38.67 Workhours/Ton \$5,080 Material Cost/Ton \$8,609 Total Cost/Ton

Grand Total: Structural Steel / Platework	48 tons	1.20	38.67	1,858	\$91.25	\$169,561	\$244,090	\$0	\$413,652	

Location: GREEN FIELD SITE
Account: 05 Structual Steel/Platework
Facility: Entire Estimate

Green Field Site

URS

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

	Green Field Site				JOD INO.	21909-323	Kev No. 0				Estimate: FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
20 #/Inft Light Cra	ne Steel-Painted	4.60	ton			162	91.25			\$14,782	\$26,130	\$0	\$40,912
050103	LIGHT STEEL-PAINTED-Crane Support	4.00	ton	1.20	33.30	133.20	\$91.25	\$5,564.34		\$12,154	\$22,257	\$0	\$34,411
050103	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.60	ton	1.20	48.00	28.80	\$91.25	\$6,454.22		\$2,628	\$3,873	\$0	\$6,500
20 #/Inft Light Cra	ne Steel-Painted 2 5 ton cranes	5.75	ton			203	91.25			\$18,477	\$32,662	\$0	\$51,140
050103	LIGHT STEEL-PAINTED-Crane Support	5.00	ton	1.20	33.30	166.50	\$91.25	\$5,564.34		\$15,193	\$27,822	\$0	\$43,014
050103	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.75	ton	1.20	48.00	36.00	\$91.25	\$6,454.22		\$3,285	\$4,841	\$0	\$8,126
	closure Support Steel-Painted Interior	6.90	ton			243	91.25			\$22,173	\$39,195	\$0	\$61,368
nclosure													
050103	LIGHT STEEL-PAINTED-BLDG Siding Support	6.00	ton	1.20	33.30	199.80	\$91.25	\$5,564.34		\$18,231	\$33,386	\$0	\$51,617
050103	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.90	ton	1.20	48.00	43.20	\$91.25	\$6,454.22		\$3,942	\$5,809	\$0	\$9,751
0 - 40 #/Inft Mediu	m Crane Steel-Painted	8.80	ton			229	91.25			\$20,914	\$36,136	\$0	\$57,050
050104	MEDIUM STEEL-PAINTED-Crane Support	8.00	ton	1.20	23.85	190.80	\$91.25	\$3,871.64		\$17,410	\$30,973	\$0	\$48,383
050104	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.80	ton	1.20	48.00	38.40	\$91.25	\$6,454.22		\$3,504	\$5,163	\$0	\$8,667
0 - 40 #/Inft Mediu	m Crane Steel-Painted 2 5 ton cranes	22.00	ton			573	91.25			\$52,284	\$90,341	\$0	\$142,625
050104	MEDIUM STEEL-PAINTED-Crane Support	20.00	ton	1.20	23.85	477.00	\$91.25	\$3,871.64		\$43,524	\$77,433	\$0	\$120,957
050104	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	2.00	ton	1.20	48.00	96.00	\$91.25	\$6,454.22		\$8,760	\$12,908	\$0	\$21,668
levated Slab on M	etal Deck- by Volume	0.00	ton			233	91.25			\$21,286	\$10,206	\$0	\$31,492
050503	FLOOR DECK	4,860.00	sqft	1.20	0.05	233.28	\$91.25	\$2.10		\$21,286	\$10,206	\$0	\$31,492
levated Slab on M	etal Deck- by Volume HVAC Filter Floor	0.00	ton			213	91.25			\$19,394	\$9,299	\$0	\$28,693
050503	FLOOR DECK	4,428.00	sqft	1.20	0.05	212.54	\$91.25	\$2.10		\$19,394	\$9,299	\$0	\$28,693
levated Slab on M	etal Deck- by Volume Security Bldg Roof	0.00	ton			3	91.25			\$252	\$121	\$0	\$372
050503	FLOOR DECK	57.46	sqft	1.20	0.05	2.76	\$91.25	\$2.10		\$252	\$121	\$0	\$372
			•										

 Steel Ratios:
 Entire Estimate

 38.67
 Workhours/Ton

 \$5,080
 Material Cost/Ton

 \$8,609
 Total Cost/Ton

Totals	Structual Steel/Platework	48 Tons	38.67	1,858	\$91.25	5,079.92	\$169,561	\$244,090	\$0	\$413,652
	Entire Estimate									

Location: GREEN FIELD SITE
Account: 06 Process Equipment
Facility: Entire Estimate
Green Field Site

wasnington Division

Rev No: 0

Job No: 27989-325

11:37/
Priced By: ADC
Washington Division
Office: Denve

Office: Denver
Product Line: Gov
Estimate: FFC

Date: 7/17/2008

11:37AM

1														
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Sw	vaging Item D						346	88.63			\$30,629	\$1,743,000	\$0	\$1,773,629
	060101	Process Equipment-PROCESS EQ -Swaging Equipment	2	each	1.20	172.80	345.60	\$88.63	\$800,000.00		\$30,629	\$1,600,000	\$0	\$1,630,629
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$1,600,000.00		\$0	\$64,000	\$0	\$64,000
	068900	Process Equipment-VENDOR REPS	10.00	days					\$1,500.00		\$0	\$15,000	\$0	\$15,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$1,600,000.00		\$0	\$64,000	\$0	\$64,000
AT	R Milling Item J						130	88.63			\$11,486	\$332,700	\$0	\$344,186
	060101	Process Equipment-PROCESS EQ Milling Model VR 11	1	each	1.20	129.60	129.60	\$88.63	\$300,000.00		\$11,486	\$300,000	\$0	\$311,486
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$300,000.00		\$0	\$13,200	\$0	\$13,200
	068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$300,000.00		\$0	\$12,000	\$0	\$12,000
Au	toclave Item P						19	88.63			\$1,702	\$81,600	\$0	\$83,302
	060126	Process Equipment-PROCESS EQ Autoclave Item P	1	each	1.20	19.20	19.20	\$88.63	\$80,000.00		\$1,702	\$80,000	\$0	\$81,702
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%	1.20				\$80,000.00		\$0	\$1,600	\$0	\$1,600
Co	nv, Elev, & Proces	s Handling					230	88.63			\$20,419	\$64,500	\$0	\$84,919
	060116	Casting Area-PROCESS EQ Mtl Pass Thru Casting & Shop to Storage	2	each	1.20	115.20	230.40	\$88.63	\$30,000.00		\$20,419	\$60,000	\$0	\$80,419
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$30,000.00		\$0	\$1,500	\$0	\$1,500
	068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
Ele	ement Wash Item !	N					38	88.63			\$3,403	\$21,600	\$0	\$25,003
	060101	Process Equipment-PROCESS EQ Element Wash	1	each	1.20	38.40	38.40	\$88.63	\$20,000.00		\$3,403	\$20,000	\$0	\$23,403
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$20,000.00		\$0	\$800	\$0	\$800
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$20,000.00		\$0	\$800	\$0	\$800
Fir	m Elev, & Process	Handling Motion Table					346	88.63			\$30,629	\$313,500	\$0	\$344,129
	060116	Process Equipment-PROCESS EQ Motion Table	2	each	1.20	172.80	345.60	\$88.63	\$150,000.00		\$30,629	\$300,000	\$0	\$330,629
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$150,000.00		\$0	\$7,500	\$0	\$7,500
	068900	Process Equipment-VENDOR REPS	4.00	days					\$1,500.00		\$0	\$6,000	\$0	\$6,000
Fir	m Heat Transfer l	Eq RF Heating & Cooling Coils					288	88.63			\$25,524	\$2,225,500	\$0	\$2,251,024
	060126	Casting Area-PROCESS EQ Crucibles	20	each					\$2,500.00		\$0	\$50,000	\$0	\$50,000
	060126	Casting Area-PROCESS EQ Casting Molds	32	each					\$4,000.00		\$0	\$128,000	\$0	\$128,000
	060126	Casting Area-PROCESS EQ RF Heating & Cooling Coils	2	each	1.20	144.00	288.00	\$88.63	\$1,000,000.00		\$25,524	\$2,000,000	\$0	\$2,025,524

Account: 06 Process Equipment
Facility: Entire Estimate

Washington Divi

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver

		Green Field Site				Job No:	27989-325	Rev No:)			Estimate: FFC	!	
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$2,000,000.00		\$0	\$40,000	\$0	\$40,000
	068900	Casting Area-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
Fir	m Price-Al Claddi	ing Cleaning Station Item 29					38	88.63			\$3,403	\$108,000	\$0	\$111,403
	060101	Process Equipment-PROCESS EQ Al Cladding Cleaning Station	1	each	1.20	38.40	38.40	\$88.63	\$100,000.00		\$3,403	\$100,000	\$0	\$103,403
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
Fir	m Price-AL Clado	ling Washing Item 27					19	88.63			\$1,702	\$10,800	\$0	\$12,502
	060101	Process Equipment-PROCESS EQ Washing Station	1	each	1.20	19.20	19.20	\$88.63	\$10,000.00		\$1,702	\$10,000	\$0	\$11,702
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
Fir	m Price-Annealin	g Furnace 24					43	88.63			\$3,829	\$40,800	\$0	\$44,629
	060126	Process Equipment-PROCESS EQ Annealing Furnace	1	each	1.20	43.20	43.20	\$88.63	\$40,000.00		\$3,829	\$40,000	\$0	\$43,829
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$40,000.00		\$0	\$800	\$0	\$800
Fir	m Price-Argon Su	pply & Distrib Sys					38	88.63			\$3,403	\$42,500	\$0	\$45,903
	060150	Casting Area-PROCESS EQ Argon Recycle System	1	each	1.20	38.40	38.40	\$88.63	\$40,000.00		\$3,403	\$40,000	\$0	\$43,403
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.03	%	1.20				\$40,000.00		\$0	\$1,000	\$0	\$1,000
	068900	Casting Area-VENDOR REPS	1.00	days	1.20				\$1,500.00		\$0	\$1,500	\$0	\$1,500
Fir	m Price-Canning	Machines Item 33					77	88.63			\$6,806	\$165,000	\$0	\$171,806
	060101	Process Equipment-PROCESS EQ Canning Machine 33	1	each	1.20	76.80	76.80	\$88.63	\$150,000.00		\$6,806	\$150,000	\$0	\$156,806
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$150,000.00		\$0	\$6,000	\$0	\$6,000
	068900	Process Equipment-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$150,000.00		\$0	\$6,000	\$0	\$6,000
Fir	m Price-Conv, Cr	anes 2 5 ton Cap Units					192	88.63			\$17,016	\$136,620	\$0	\$153,636
	060116	Mechanical Equipment-PROCESS EQ Cranes 5 ton cal 30' span	2	each	1.20	96.00	192.00	\$88.63	\$62,200.00		\$17,016	\$124,400	\$0	\$141,416
	060199	Mechanical Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$124,400.00		\$0	\$6,220	\$0	\$6,220
	068900	Mechanical Equipment-VENDOR REPS	4.00	days					\$1,500.00		\$0	\$6,000	\$0	\$6,000
Fir	m Price-Conv, Cr	anes 5.0 ton Cap Monorail 2Units					77	88.63			\$6,806	\$39,900	\$0	\$46,706
	060116	Mechanical Equipment-PROCESS EQ Cranes 5.0 ton cal Monorail Type	2	each	1.20	38.40	76.80	\$88.63	\$18,000.00		\$6,806	\$36,000	\$0	\$42,806
	060199	Mechanical Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%	1.20				\$18,000.00		\$0	\$900	\$0	\$900

Location: GREEN FIELD SITE
Account: 06 Process Equipment
Facility: Entire Estimate

URS

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov
Estimate: EEC

		Green Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	068900	Mechanical Equipment-VENDOR REPS	2.00	days	1.20				\$1,500.00		\$0	\$3,000	\$0	\$3,000
Fir	m Price-Foil Clea	ning Station Item 30					38	88.63			\$3,403	\$108,000	\$0	\$111,403
	060101	Process Equipment-PROCESS EQ Al Cladding Cleaning Station	1	each	1.20	38.40	38.40	\$88.63	\$100,000.00		\$3,403	\$100,000	\$0	\$103,403
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
Fir	m Price-Hydrauli	ic Press Item 20					29	88.63			\$2,552	\$34,500	\$0	\$37,052
	060101	Process Equipment-PROCESS EQ Hydraulic Press 20	1	each	1.20	28.80	28.80	\$88.63	\$25,000.00		\$2,552	\$25,000	\$0	\$27,552
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$25,000.00		\$0	\$1,000	\$0	\$1,000
	068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$25,000.00		\$0	\$1,000	\$0	\$1,000
Fir	m Price-Hydrauli	ic Shear 23					154	88.63			\$13,613	\$120,000	\$0	\$133,613
	060101	Process Equipment-PROCESS EQ Hydraulic Shear	4	each	1.20	38.40	153.60	\$88.63	\$25,000.00		\$13,613	\$100,000	\$0	\$113,613
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
	068900	Process Equipment-VENDOR REPS SAMPLE-FIRM PRICE MATERIAL	8.00	days					\$1,500.00		\$0	\$12,000	\$0	\$12,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
Fir	m Price-Ingot Cle	eaning Station Item 32					38	88.63			\$3,403	\$86,400	\$0	\$89,803
	060101	Process Equipment-PROCESS EQ Ingot Cleaning Station	1	each	1.20	38.40	38.40	\$88.63	\$80,000.00		\$3,403	\$80,000	\$0	\$83,403
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$80,000.00		\$0	\$3,200	\$0	\$3,200
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$80,000.00		\$0	\$3,200	\$0	\$3,200
Fir	m Price-Inspectio	on Tables Item K					96	88.63			\$8,508	\$17,280	\$0	\$25,788
	060101	Process Equipment-PROCESS EQ Inspection Tables	5	each	1.20	19.20	96.00	\$88.63	\$3,200.00		\$8,508	\$16,000	\$0	\$24,508
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%	1.20				\$16,000.00		\$0	\$640	\$0	\$640
	069900	Process Equipment-BID CONDITIONING	0.04	%	1.20				\$16,000.00		\$0	\$640	\$0	\$640
Fir	m Price-Jib Cran	es					58	88.63			\$5,105	\$32,250	\$0	\$37,355
	060116	Casting Area-PROCESS EQ Jib Cranes	2	each	1.20	28.80	57.60	\$88.63	\$15,000.00		\$5,105	\$30,000	\$0	\$35,105
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$15,000.00		\$0	\$750	\$0	\$750
	068900	Casting Area-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
Fir	m Price-Marking	Station Item 28					19	88.63			\$1,702	\$12,960	\$0	\$14,662
	060101	Process Equipment-PROCESS EQ Marking Station	1	each	1.20	19.20	19.20	\$88.63	\$12,000.00		\$1,702	\$12,000	\$0	\$13,702

Account: 06 Process Equipment
Facility: Entire Estimate

Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

		Green Field Site				Job No:	27989-325	Rev No: 0)			Estimate: FFC		
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$12,000.00		\$0	\$480	\$0	\$480
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$12,000.00		\$0	\$480	\$0	\$480
Fir	m Price-Milling N	Machines Salt Removal Item 31					43	88.63			\$3,829	\$54,000	\$0	\$57,829
	060101	Process Equipment-PROCESS EQ Milling Machines 31	1	each	1.20	43.20	43.20	\$88.63	\$50,000.00		\$3,829	\$50,000	\$0	\$53,829
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000
Fir	-	Machines Surface Finish 21					480	88.63			\$42,540	\$979,500	\$0	\$1,022,040
	060101	Process Equipment-PROCESS EQ Milling Machines 21	5	each	1.20	96.00	480.00	\$88.63	\$180,000.00		\$42,540	\$900,000	\$0	\$942,540
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$900,000.00		\$0	\$36,000	\$0	\$36,000
	068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$900,000.00		\$0	\$36,000	\$0	\$36,000
Fir	m Price-MIT/MU	RR Welding Station Item 32					10	88.63			\$851	\$10,800	\$0	\$11,651
	060101	Casting Area-PROCESS EQ Ingot Cleaning Station	1	each	1.20	9.60	9.60	\$88.63	\$10,000.00		\$851	\$10,000	\$0	\$10,851
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
	069900	Casting Area-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
Fir	m Price-Plate Cle	aning System Item C					38	88.63			\$3,403	\$12,300	\$0	\$15,703
	060101	Process Equipment-PROCESS EQ Plate Degreaser	1	each	1.20	38.40	38.40	\$88.63	\$10,000.00		\$3,403	\$10,000	\$0	\$13,403
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
	068900	Process Equipment-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
Fir	m Price-Plate Deg	greaser System Item 11					38	88.63			\$3,403	\$12,300	\$0	\$15,703
	060101	Process Equipment-PROCESS EQ Plate Degreaser	1	each	1.20	38.40	38.40	\$88.63	\$10,000.00		\$3,403	\$10,000	\$0	\$13,403
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
	068900	Process Equipment-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
Fir	m Price-Polishing	Wheel					5	88.63			\$425	\$5,250	\$0	\$5,675
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%	1.20				\$5,000.00		\$0	\$250	\$0	\$250
	060201	Process Equipment-PROCESS EQ Polishing Wheel	1	each	1.20	4.80	4.80	\$88.63	\$5,000.00		\$425	\$5,000	\$0	\$5,425
Fir	m Price-Raw Allo	y Wash Station tem 72					38	88.63			\$3,403	\$12,300	\$0	\$15,703
	060101	Casting Area-PROCESS EQ Wash Station Item 72	1	each	1.20	38.40	38.40	\$88.63	\$10,000.00		\$3,403	\$10,000	\$0	\$13,403
		nem /2											Page	e 29 of 62

Page 29 of 62

Location: GREEN FIELD SITE
Account: 06 Process Equipment
Facility: Entire Estimate

URS

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

	Green Field Site				Job No:	27989-325	Rev No:	0			Estimate: FF0	2	
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
068900	Casting Area-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
069900	Casting Area-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
Firm Price-Rolling	Mill w/Tunnel Furnace 25					144	88.63			\$12,762	\$1,087,500	\$0	\$1,100,262
060101	Process Equipment-PROCESS EQ Rolling Mill W/Tunnel Furnace	1	each	1.20	144.00	144.00	\$88.63	\$1,000,000.00		\$12,762	\$1,000,000	\$0	\$1,012,762
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$1,000,000.00		\$0	\$40,000	\$0	\$40,000
068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
069900	Process Equipment-BID CONDITIONING	0.04	%					\$1,000,000.00		\$0	\$40,000	\$0	\$40,000
Firm Price-Stack						336	88.63			\$29,778	\$19,438	\$0	\$49,216
060161	Bldg All In-PROCESS EQ Stack 70" diameter by 80' high	1	each	1.20	336.00	336.00	\$88.63	\$17,500.00		\$29,778	\$17,500	\$0	\$47,278
060199	Bldg All In-DESIGN DEVELOPMENT ALLOW (DDA)	0.03	%					\$17,500.00		\$0	\$438	\$0	\$438
068900	Bldg All In-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
Firm Price-Tanks	& Platework Fire Water Collection Crit tanks					19	88.63			\$1,702	\$21,900	\$0	\$23,602
060161	Fire Water Collection-PROCESS EQ Pencil Tank Assembly	1	each	1.20	19.20	19.20	\$88.63	\$20,000.00		\$1,702	\$20,000	\$0	\$21,702
060199	Fire Water Collection-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$20,000.00		\$0	\$400	\$0	\$400
068900	Fire Water Collection-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
Firm Price-Tanks	& Platework Fire Water Collection Tank					19	88.63			\$1,702	\$11,016	\$0	\$12,718
060161	Fire Water Collection-PROCESS EQ Tank Single Walled Plastic	1	each	1.20	19.20	19.20	\$88.63	\$10,800.00		\$1,702	\$10,800	\$0	\$12,502
060199	Fire Water Collection-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$10,800.00		\$0	\$216	\$0	\$216
Forklifts and Powe	er PalletTruck Elec					10	88.63			\$851	\$87,750	\$0	\$88,601
069900	Mechanical Equipment- Front End Loader 6000 lb cap	3	each	1.20	2.40	7.20	\$88.63	\$28,000.00		\$638	\$84,000	\$0	\$84,638
069900	Mechanical Equipment-Pallet Truck	1	each	1.20	2.40	2.40	\$88.63	\$3,750.00		\$213	\$3,750	\$0	\$3,963
Friction Welders It	tem 22					307	88.63			\$27,226	\$1,248,000	\$0	\$1,275,226
060101	Process Equipment-PROCESS EQ Friction Stir Welders	4	each	1.20	76.80	307.20	\$88.63	\$287,500.00		\$27,226	\$1,150,000	\$0	\$1,177,226
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$1,150,000.00		\$0	\$46,000	\$0	\$46,000
068900	Process Equipment-VENDOR REPS	4.00	days					\$1,500.00		\$0	\$6,000	\$0	\$6,000
069900	Process Equipment-BID CONDITIONING	0.04	%					\$1,150,000.00		\$0	\$46,000	\$0	\$46,000
Heat Transfer Eq (Curcible Tilter					12	88.63			\$1,064	\$11,700	\$0	\$12,764
060126	Casting Area-PROCESS EQ Crucible Tilter	1	each	1.20	12.00	12.00	\$88.63	\$10,000.00		\$1,064	\$10,000	\$0	\$11,064

Location: GREEN FIELD SITE
Account: 06 Process Equipment
Facility: Entire Estimate

UKS Washington

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

		Green Field Site				Job No:	27989-325	Rev No: 0				Estimate:	FFC	
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Mate	rial S	ubs Total
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$10,000.00		\$0	\$200	\$0	\$200
	068900	Casting Area-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
HE	PA Filters and A	ir Handling Sys for Fuel Fabrication Area					4,920	88.63			\$436,037	\$154,017	\$2,654,150	\$3,244,204
	060129	Mechanical Equipment-HVAC EQUIPMENT Process Area craft labor support (38900 sqft)	1	each	1.20	4,548.00	4,548.00	\$88.63	\$154,017.00		\$403,068	\$154,017	\$0	\$557,085
	060129	Mechanical Equipment-HVAC EQUIPMENT Process Area Subcontract furnish & install (38900 sqft)	1	each						\$2,654,150.00	\$0	\$0	\$2,654,150	\$2,654,150
	060129	Mechanical Equipment-HVAC EQUIPMENT Process Area HEPA Filter Install Craft Support	1	each	1.20	372.00	372.00	\$88.63			\$32,969	\$0	\$0	\$32,969
Ins	tron Item O						48	88.63			\$4,254	\$64,800	\$0	\$69,054
	060101	Casting Area-PROCESS EQ Pull Testor	1	each	1.20	48.00	48.00	\$88.63	\$60,000.00		\$4,254	\$60,000	\$0	\$64,254
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$60,000.00		\$0	\$2,400	\$0	\$2,400
	069900	Casting Area-BID CONDITIONING	0.04	%					\$60,000.00		\$0	\$2,400	\$0	\$2,400
NI	ST/HIFR Welding	g Item G					48	88.63			\$4,254	\$105,900	\$0	\$110,154
	060101	Process Equipment-PROCESS EQ Welding Station	1	each	1.20	48.00	48.00	\$88.63	\$100,000.00		\$4,254	\$100,000	\$0	\$104,254
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.00	%					\$100,000.00		\$0	\$400	\$0	\$400
	068900	Process Equipment-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
Nit	ric Acid Wash Sy	stem (incl Piping)					94	88.63			\$8,295	\$469	\$0	\$8,764
	060101	Mechanical Equipment-Nitric Acid Wash System	1	each	1.20	93.60	93.60	\$88.63	\$469.00		\$8,295	\$469	\$0	\$8,764
Pla		Cleaning Station Glovebox Item 39					19	88.63			\$1,702	\$55,000	\$0	\$56,702
	060161	Casting Area-PROCESS EQ Crucible Cleaning Station Glovebox Item 39	1	each	1.20	19.20	19.20	\$88.63	\$50,000.00		\$1,702	\$50,000	\$0	\$51,702
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000
	068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
Pla		Loading Station Item 38					19	88.63			\$1,702	\$34,200	\$0	\$35,902
	060161	Casting Area-PROCESS EQ Crucible Loading Station Item 38	1	each	1.20	19.20	19.20	\$88.63	\$30,000.00		\$1,702	\$30,000	\$0	\$31,702
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$30,000.00		\$0	\$1,200	\$0	\$1,200
	068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
Pla	tework Entry Glo	ovebox					58	88.63			\$5,105	\$55,000	\$0	\$60,105
	060161	Casting Area-PROCESS EQ Casting Mold Entry Glovebox	1	each	1.20	57.60	57.60	\$88.63	\$50,000.00		\$5,105	\$50,000	\$0	\$55,105
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000

Page 31 of 62

Location: GREEN FIELD SITE Account: 06 Process Equipment Facility: Entire Estimate URS

Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver Product Line: Gov

		Green Field Site				Job No:	27989-325	Rev No: 0	1			Estimate: FFC		
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
Pla	tework Exit Glov	ebox					58	88.63			\$5,105	\$55,000	\$0	\$60,105
	060161	Casting Area-PROCESS EQ Casting Mold Exit Glovebox	1	each	1.20	57.60	57.60	\$88.63	\$50,000.00		\$5,105	\$50,000	\$0	\$55,105
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000
	068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
Pla	tework Removal	Station Glovebox Item 37					19	88.63			\$1,702	\$13,400	\$0	\$15,102
	060161	Casting Area-PROCESS EQ Removal Glovebox Item 37	1	each	1.20	19.20	19.20	\$88.63	\$10,000.00		\$1,702	\$10,000	\$0	\$11,702
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
	068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
Pro	cess Equipment (Channel Probe Item B					115	88.63			\$10,220	\$871,500	\$0	\$881,720
	060101	Process Equipment-PROCESS EQ Channel Probe	1	each	1.20	115.32	115.32	\$88.63	\$800,000.00		\$10,220	\$800,000	\$0	\$810,220
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%	1.20				\$800,000.00		\$0	\$32,000	\$0	\$32,000
	068900	Process Equipment-VENDOR REPS	5.00	days	1.20				\$1,500.00		\$0	\$7,500	\$0	\$7,500
	069900	Process Equipment-BID CONDITIONING	0.04	%	1.20				\$800,000.00		\$0	\$32,000	\$0	\$32,000
Pro	cess Equipment I	HIFR Lathe Item H					67	88.63			\$5,962	\$118,320	\$0	\$124,282
	060101	Process Equipment-PROCESS EQ-Lathe Model SL 40	1	each	1.20	67.27	67.27	\$88.63	\$105,000.00		\$5,962	\$105,000	\$0	\$110,962
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%	1.20				\$105,000.00		\$0	\$4,620	\$0	\$4,620
	068900	Process Equipment-VENDOR REPS	3.00	days	1.20				\$1,500.00		\$0	\$4,500	\$0	\$4,500
	069900	Process Equipment-BID CONDITIONING	0.04	%	1.20				\$105,000.00		\$0	\$4,200	\$0	\$4,200
Pro	cess Equipment !	MIT Milling Item I					77	88.63			\$6,806	\$121,320	\$0	\$128,126
	060101	Process Equipment-PROCESS EQ-MIlling Mode IVR 8	1	each	1.20	76.80	76.80	\$88.63	\$105,000.00		\$6,806	\$105,000	\$0	\$111,806
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$105,000.00		\$0	\$4,620	\$0	\$4,620
	068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$105,000.00		\$0	\$4,200	\$0	\$4,200
Rol	ler Levelers Item	1 19					48	88.63			\$4,254	\$40,800	\$0	\$45,054
	060101	Process Equipment-PROCESS EQ Roller Levelers	1	each	1.20	48.00	48.00	\$88.63	\$35,000.00		\$4,254	\$35,000	\$0	\$39,254
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%	1.20				\$35,000.00		\$0	\$1,400	\$0	\$1,400
	068900	Process Equipment-VENDOR REPS	2.00	days	1.20				\$1,500.00		\$0	\$3,000	\$0	\$3,000
	069900	Process Equipment-BID CONDITIONING	0.04	%	1.20				\$35,000.00		\$0	\$1,400	\$0	\$1,400
Sal	Bath with Load	ling Equipment & Rolling Mill Item 26					130	88.63			\$11,486	\$532,500	\$0	\$543,986

Page 32 of 62

Location: GREEN FIELD SITE
Account: 06 Process Equipment
Facility: Entire Estimate
Green Field Site

URS

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:37AM

Priced By: ADC
Office: Denver
Product Line: Gov
Estimate: FFC

	Lab.			Workhours						Totals			
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
060116	Process Equipment-PROCESS EQ Loading Equipment	1	each	1.20	129.60	129.60	\$88.63	\$500,000.00		\$11,486	\$500,000	\$0	\$511,486
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$500,000.00		\$0	\$25,000	\$0	\$25,000
068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500

Totals	06-Process Equipment	9,533 \$88.63	\$844,864	\$11,533,390	\$2,654,150	\$15,032,404
	Entire Estimate					

Location: GREEN FIELD SITE Account: 11 Piping Facility: Entire Estimate



Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

Green Field Site Job No: 27989-325 Rev No: 0

			·		Lab.		Workhours						Totals	
Account No.	Description		Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
														_
11.01 PIPE BY ME	ETALLURGY													
11***** 1X	Carbon Steel													
Small	Bore	1	.500 1,000.0	0 LF	1.20	1.481	1,481	\$87.01	\$10.97		\$128,873	\$10,965	\$0	\$139,839
		28.60 F	tgs & Vlvs/100 LF Pi	pe	0.00	LF/	Valve	\$ 140	Total Cost/LF					
11***** 2X	Stainless Steel													
Small	Bore	1	.000 150.0	0 LF	1.20	2.843	426	\$87.01	\$66.54		\$37,102	\$9,981	\$0	\$47,083
		83.33 F	tgs & Vlvs/100 LF Pi	pe	2.05	5 LF/	Valve	\$ 314	Total Cost/LF					
11***** 5X	Plastic/Fiberglass													
Large 1	Bore	3	5,275.0	0 LF	1.20	0.699	3,686	\$87.01	\$2.54		\$320,706	\$13,418	\$0	\$334,124
		7.83 F	tgs & Vlvs/100 LF Pi	pe	0.00	LF/	Valve	\$ 63	Total Cost/LF					
11***** 61(62,	.63) Iron													
Large 1	Bore	0	.000	0 LF	1.20		556	\$87.01			\$48,342	\$11,575	\$0	\$59,916
1103****	Specialities						19	\$87.01			\$1,671	\$3,930	\$0	\$5,601
1104***	Hangers & Supports						2,429	\$87.01			\$211,336	\$25,039	\$0	\$236,375
11*****	Unspecified Metallurgy													
110116	Out of Spec - Pipe		1,800.0	0 lnft				\$87.01			\$0	\$0	\$0	\$0
110102	OVERALL PIPING ALLOW WEIGHTED Compressed A		1,844.0	0 lnft		1.96	3,606.86	\$87.01	\$12.05		\$313,827	\$22,217	\$0	\$336,044
110102	OVERALL PIPING ALLOV WEIGHTED Instrument Air	WANCE-A/G	3,211.0	0 lnft		1.96	6,280.72	\$87.01	\$16.43		\$546,475	\$52,757	\$0	\$599,231
110121	Out of Spec Unions		4.0	0 each				\$87.01			\$0	\$0	\$0	\$0
		0.06 F	tgs & Vlvs/100 LF Pi	pe	0.00) LF/	Valve	\$ 136	Total Cost/LF					
		-												

Overall	Ratios

6.57 Ftgs & Vlvs/100 LF Pipe

113.50 LF/Valve 1.39 Workhours/LF

\$132.40 Total Cost/LF

Grand Total: 11: Piping	1.423	13,280	LF	1.20	1.39	18,485	\$87.01	\$1,608,332	\$149,881	\$0 \$1,758,213
								\$121.11 /LF	\$11.29 /LF	\$0.00 /LF

Location: GREEN FIELD SITE
Account: 11 Piping
Facility: Entire Estimate
Green Field Site

URSWashington Division

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

Site Job No: 27989-325 Rev No: 0

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	_	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

11.02 PIPE BY SERVICE SYSTEM

\$87.01 \$11.29 \$1,608,332 \$0 \$1,758,213 1.423 13,280.00 LF 1.392 18,484.80 \$0.00 \$149,881 1.20 Ftgs & Vlvs/100 LF 113.50 Total Cost/LF LF/Valve \$ 132.40 6.57

 Overall Ratios

 6.57
 Ftgs & Vlvs/100 LF P

 113.50
 LF/Valve

 1.39
 Workhours/LF

\$132.40 Total Cost/LF

Grand Total: 11: Piping	1.423	13,280 LF	1.20	1.39	18,485	\$87.01	\$1,608,332	\$149,881	\$0	\$1,758,213
. 0					,		\$121.11 /LF	\$11.29 /LF	\$0.00/LF	

Location: GREEN FIELD SITE Account: 11 Piping
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov

Green Field Site					Job No:	27989-325	Rev No: 0			rı	Estimate: FFC		
				Lab.		Workhours						Totals	
Account No. Description		Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
11.04 PIPE BY ASSEMBLY - SUMMARY]												
Bldg Plumbing	_	0.00	LF	1.20	0.00	19	\$87.01	\$0.00	\$0.00	\$1,671	\$3,930	\$0	\$5,601
Carbon Steel (400s Specs) Plumbing Water Pipe (50 Inft per fixture)L	1.500	1,000.00	LF	1.20	1.91	1,908	\$87.01	\$17.05	\$0.00	\$166,043	\$17,047	\$0	\$183,090
Plastic (800s) Fire Protection Loop		1,800.00	LF	1.20	0.89	1,608	\$87.01	\$10.41	\$0.00	\$139,889	\$18,746	\$0	\$158,635
Plastic (800s) Floor Drain Pipe (100 Inft per floor drain)	3.000	2,400.00	LF	1.20	0.72	1,723	\$87.01	\$3.83	\$0.00	\$149,933	\$9,180	\$0	\$159,113
Plastic (800s) Outside Sanitary Sewer Line	6.000	475.00	LF	1.20	1.14	540	\$87.01	\$9.30	\$0.00	\$46,985	\$4,416	\$0	\$51,400
Plastic (800s) Roof drain pipe(70 lnft per roof drain)	3.000	1,400.00	LF	1.20	0.70	986	\$87.01	\$3.79	\$0.00	\$85,762	\$5,304	\$0	\$91,066
Plastic (800s) Sanitary Sewer piping (50 Inft per fixture)	3.000	1,000.00	LF	1.20	1.54	1,538	\$87.01	\$9.20	\$0.00	\$133,801	\$9,204	\$0	\$143,005
Stainless Steel (700s) Argon Supply Piping	1.000	150.00	LF	1.20	1.83	275	\$87.01	\$47.21	\$0.00	\$23,946	\$7,081	\$0	\$31,028
Utilities		5,055.00	LF	1.20	1.96	9,888	\$87.01	\$14.83	\$0.00	\$860,302	\$74,973	\$0	\$935,275

Overall Ratios

6.57 Ftgs & VLvs/100 LF Pipe

113.50 LF / Valve

1.39 Workhours/LF

\$132.40 Total Cost/LF

Grand Total: 11: Piping	1.423	13,280 LF	1.20	1.39	18,485	\$87.01	\$1,608,332	\$149,881	\$0	\$1,758,213
							\$121.11 /LF	\$11.29 /LF	\$0.00 /LF	

Location: GREEN FIELD SITE Account: 11 Piping
Facility: Entire Estimate Green Field Site



Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

Job No: 27989-325 Rev No: 0

		Green ricid Site								-			Louisiane. 11 C		
						Lab.		Workhours						Totals	
	Account No.	Description		Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
11.	03 PIPE BY CO	MMODITY													
110	Pipe,	Fittings, Welds, and Shopcosts	13,280.00	lnft	1.42	1.20	1.149	15,258	\$87.01	\$7.70		\$1,327,573	\$102,211		\$1,429,785
110	O2 Valve	s	117.00	ea		1.20	6.655	779	\$87.01	\$159.83		\$67,752	\$18,701		\$86,452
110	O3 Specia	alties				1.20	9.600	19	\$87.01	\$1,965.00		\$1,671	\$3,930		\$5,601
110	04 Hange	ers & Supports	640.00	ea		1.20	3.795	2,429	\$87.01	\$39.12		\$211,336	\$25,039		\$236,375

Overall Ratios

6.57 Ftgs & Vlvs/100 LF Pipe

113.50 LF / Valve 1.39 Workhours/LF \$132.40 Total Cost/LF

Grand Total: 11: Piping	13,280	LF	1.423	1.20	1.39	18,485	\$87.01	\$1,608,332	\$149,881	\$0	\$1,758,213
								\$121.11 /LF	\$11.29 /LF	\$0.00 /LF	

Location: GREEN FIELD SITE Account: 11 Piping
Facility: Entire Estimate Green Field Site



Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

\$3,930

\$5,601

\$0

\$1,671

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

11.05 Pipe by Assembly - Detail

Bldg Plumbing

LB SPECIALTIES - Safety Shower & Eyewash Station W/ Eye & Face Wash 110311

\$87.01 \$1,965.00 2.00 each 1.20 9.60 19

Bldg Plumbing

0.00 Ftgs & Vlvs/100 LF Pipe

0.00 LF / Valve Workhours/LF 0.00 \$0.00 Total Cost/LF

11: Piping	Bldg Plumbing	0.000 0 L	F 1.20	0.00	19	\$87.01		\$1,671 \$0.00 /LF	\$3,930 \$0.00 /LF	\$0 \$0.00 /LF	\$5,601
Carbon Ste	el (400s Specs) Plumbing Water Pipe (50 lnft p	er fixture)L									
110111	1.5" PIPE,A106 STD/S40 SMLS	1,000.00 lnf	t 1.20	0.49	492	\$87.01	\$3.70	\$42,808	\$3,703	\$0	\$46,511
110121	1.5" 90 ELL CS 3000# SW	71.00 eac	ch 1.20	1.68	119	\$87.01	\$24.56	\$10,378	\$1,744	\$0	\$12,122
110121	1.5" 45 ELL CS 3000# SW	7.00 eac	ch 1.20	1.68	12	\$87.01	\$28.44	\$1,023	\$199	\$0	\$1,222
110121	1.5" TEE CS 3000# SW	43.00 ea	ch 1.20	2.52	108	\$87.01	\$37.02	\$9,428	\$1,592	\$0	\$11,020
110121	1.5" RED CS 3000# SW	29.00 ea	h 1.20	1.68	49	\$87.01	\$35.14	\$4,239	\$1,019	\$0	\$5,258
110121	1.5" CAP CS 3000# SW	7.00 ea	ch 1.20	0.84	6	\$87.01	\$16.56	\$512	\$116	\$0	\$628
110121	1.5" CS 150# STD RF SW	129.00 ea	ch 1.20	0.96	124	\$87.01	\$20.10	\$10,775	\$2,593	\$0	\$13,368
110132	1.5" FIELD WELD, STD	529.00 ea	ch 1.20	1.08	571	\$87.01		\$49,710	\$0	\$0	\$49,710
110206	1 1/2" GATEVALVE 63SA 1.50	60.00 ea	ch 1.20	3.12	187	\$87.01	\$55.21	\$16,288	\$3,313	\$0	\$19,601
110406	1 1/2" Hanger, Standard 1.5"	100.00 eac	ch 1.20	2.40	240	\$87.01	\$27.69	\$20,882	\$2,769	\$0	\$23,651

Carbon Steel (400s Specs) Plumbing Water P

34.60 Ftgs & Vlvs/100 LF Pipe 16.67 LF / Valve Workhours/LF 1.91 Total Cost/LF \$183.09

							r				
11: Piping	Carbon Steel (400s Specs) Plumbing	1.500	1,000 LF 1.20	1.91	1,908	\$87.01		\$166,043	\$17,047	\$0	\$183,090
	Water Pipe (50 Inft per fixture)L							\$166.04 /LF	\$17.05 /LF	\$0.00 /LF	

Location: GREEN FIELD SITE Account: 11 Piping Facility: Entire Estimate



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

	Green Field Site			300 110.	21707-323	RCV 140. 0				Estillate. FFC		
			Lab.		Workhours						Totals	
Account No.	Description	Qty UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Plastic (800s) F	ire Protection Loop											
110116	Out of Spec - Pipe	1,800.00 lnft	1.20			\$87.01			\$0	\$0	\$0	\$0
110126	8" 90 ELL S80 PVC SW	28.00 each	1.20	4.08	114	\$87.01	\$64.30		\$9,940	\$1,800	\$0	\$11,740
110126	8" TEE S80 PVC SW	8.00 each	1.20	6.24	50	\$87.01	\$90.98		\$4,343	\$728	\$0	\$5,071
110126	8" FLG SCH 80 SW PVC	50.00 each	1.20	2.04	102	\$87.01	\$38.44		\$8,875	\$1,922	\$0	\$10,797
110126	8" SM. INLINE Tie into existing fire line 8"	1.00 each	1.20	16.44	16	\$87.01			\$1,430	\$0	\$0	\$1,430
110126	8" LG. INLINE Hydrants 8"	6.00 each	1.20	20.52	123	\$87.01			\$10,712	\$0	\$0	\$10,712
110137	8" PLAST FIELD WELD	140.00 each	1.20	2.52	353	\$87.01	\$2.00		\$30,697	\$280	\$0	\$30,977
110146	8" 150# BOLT-UP,PLAST	25.00 each	1.20	3.60	90	\$87.01			\$7,831	\$0	\$0	\$7,831
110211	8" GATEVALVE 11FA 8.00	12.00 each	1.20	20.52	246	\$87.01	\$572.25		\$21,425	\$6,867	\$0	\$28,292
110411	8" Supports, Standard 8"	95.00 each	1.20	5.40	513	\$87.01	\$75.25		\$44,635	\$7,149	\$0	\$51,784

Plastic (800s) Fire Protection Loop

5.44 Ftgs & Vlvs/100 LF Pipe 150.00 LF / Valve 0.89 Workhours/LF \$88.13 Total Cost/LF

11: Piping	Plastic (800s) Fire Protection Loop	0.000	1,800 LF	1.20	0.89	1,608	\$87.01		\$139,889 \$77.72 /LF	\$18,746 \$10.41 /LF	\$0 \$0.00 /LF	\$158,635
Plastic (800	s) Floor Drain Pipe (100 Inft per floor drain)											
110116	3" PIPE, SCH 40 PVC		2,400.00 lnft	1.20	0.31	749	\$87.01	\$0.98	\$65,152	\$2,352	\$0	\$67,504
110126	3" 90 ELL S40 PVC SW		24.00 each	1.20	1.56	37	\$87.01	\$4.39	\$3,258	\$105	\$0	\$3,363
110126	3" 45 ELL S40 PVC SW		12.00 each	1.20			\$87.01	\$5.70	\$0	\$68	\$0	\$68
110126	3" WYE S40 PVC SW		24.00 each	1.20	2.28	55	\$87.01	\$7.03	\$4,761	\$169	\$0	\$4,930
110137	3" PLAST FIELD WELD		144.00 each	1.20	0.96	138	\$87.01		\$12,028	\$0	\$0	\$12,028
110411	3" Supports, Standard 3"		200.00 each	1.20	3.72	744	\$87.01	\$32.43	\$64,734	\$6,486	\$0	\$71,220

Location: GREEN FIELD SITE
Account: 11 Piping
Facility: Entire Estimate
Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

				T -1-		Workhours						Totals	
Account No.	Description	Qty	UM	Lab. Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Plastic (800s) Floor Drain Pipe (100 Inft per fl 2.50 Ftgs & Vlvs/100 LF Pipe 0.00 LF / Valve 0.72 Workhours/LF

\$66.30 Total Cost/LF

11: Piping	Plastic (800s) Floor Drain Pipe (100 Inft per floor drain)	3.000 2,400	LF 1.20	0.72	1,723	\$87.01		\$149,93 : \$62.47 /LF	\$9,180 \$3.83 /LF	\$0 \$0.00 /LF	\$159,113
Plastic (800	s) Outside Sanitary Sewer Line										
110116	6" PIPE, SCH 40 PVC	475.00 1	nft 1.2	0 0.46	217	\$87.01	\$2.56	\$18,846	\$1,216	\$0	\$20,062
110126	6" 90 ELL S40 PVC SW	6.00	ach 1.2	0 3.12	19	\$87.01	\$24.97	\$1,629	\$150	\$0	\$1,779
110126	6" 45 ELL S40 PVC SW	2.00	ach 1.2	0		\$87.01	\$25.26	\$0	\$51	\$0	\$51
110126	6" TEE S40 PVC SW	1.00	ach 1.2	0 4.68	5	\$87.01	\$39.23	\$407	\$39	\$0	\$446
110126	6" RED S40 PVC SW	1.00	ach 1.2	0 3.12	3	\$87.01	\$11.80	\$271	\$12	\$0	\$283
110121	Out of Spec Unions	4.00	ach 1.2	0		\$87.01		\$0	\$0	\$0	\$0
110126	6" FLG SCH 40 SW PVC	31.00	ach 1.2	0 1.56	48	\$87.01	\$19.79	\$4,208	\$613	\$0	\$4,821
110126	6" LG. INLINE Tie In to Existing Sewer Line 6"	1.00	ach 1.2	0 14.28	14	\$87.01		\$1,242	\$0	\$0	\$1,242
110137	6" PLAST FIELD WELD	30.00	ach 1.2	0 2.04	61	\$87.01	\$1.00	\$5,325	\$30	\$0	\$5,355
110211	6" GATEVALVE 11FA 6.00	2.00	ach 1.2	0 14.28	29	\$87.01	\$316.75	\$2,485	\$634	\$0	\$3,118
110411	6" Supports, Standard 6"	28.00 6	ach 1.2	0 5.16	144	\$87.01	\$59.70	\$12,571	\$1,672	\$0	\$14,243

Plastic (800s) Outside Sanitary Sewer Line

9.89 Figs & Vlvs/100 LF Pipe
237.50 LF / Valve
1.14 Workhours/LF
\$108.21 Total Cost/LF

11: Piping	Plastic (800s) Outside Sanitary Sewer Line	6.000	475 LF	1.20	1.14	540	\$87.01		\$46,98 \$98.91 /LF	5 \$4,416 \$9.30 /LF	\$0 \$0.00 /LF	\$51,400
Plastic (80	0s) Roof drain pipe(70 lnft per roof drain)											
110116	3" PIPE, SCH 40 PVC		1,400.00 Inft	1.20	0.31	437	\$87.01	\$0.98	\$38,005	\$1,372	\$0	\$39,377
110126	3" 90 ELL S40 PVC SW		20.00 each	1.20	1.56	31	\$87.01	\$4.39	\$2,715	\$88	\$0	\$2,802
110126	3" 45 ELL S40 PVC SW		3.00 each	1.20			\$87.01	\$5.70	\$0	\$17	\$0	\$17
											Page 4	0 of 62

Location: GREEN FIELD SITE Account: 11 Piping
Facility: Entire Estimate Green Field Site



Washington Division

Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

Date: 7/17/2008

11:37AM

					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
1	10137	3" PLAST FIELD WELD	82	2.00 each	1.20	0.96	79	\$87.01			\$6,849	\$0	\$0	\$6,849
1	10411	3" Hanger, Standard 3"	118	3.00 each	1.20	3.72	439	\$87.01	\$32.43		\$38,193	\$3,827	\$0	\$42,020

Job No: 27989-325 Rev No: 0

Plastic (800s) Roof drain pipe(70 lnft per roof

1.64 Ftgs & Vlvs/100 LF Pipe 0.00 LF / Valve 0.70 Workhours/LF \$65.05 Total Cost/LF

11: Piping	Plastic (800s) Roof drain pipe(70 lnft per roof drain)	3.000 1,400 LF	1.20	0.70	986	\$87.01		\$85,76 \$61.26 /LF	2 \$5,304 \$3.79 /LF	\$0 \$0.00 /LF	\$91,066
Plastic (800	s) Sanitary Sewer piping (50 lnft per fixture)										
110116	3" PIPE, SCH 40 PVC	1,000.00 lnft	1.20	0.31	312	\$87.01	\$0.98	\$27,147	\$980	\$0	\$28,127
110126	3" 90 ELL S40 PVC SW	50.00 each	1.20	1.56	78	\$87.01	\$4.39	\$6,787	\$220	\$0	\$7,006
110126	3" 45 ELL S40 PVC SW	6.00 each	1.20			\$87.01	\$5.70	\$0	\$34	\$0	\$34
110126	3" TEE S40 PVC SW	30.00 each	1.20	2.28	68	\$87.01	\$7.03	\$5,951	\$211	\$0	\$6,162
110126	3" RED S40 PVC SW	20.00 each	1.20	1.56	31	\$87.01	\$2.13	\$2,715	\$43	\$0	\$2,757
110126	3" CAP S40 PVC SW	6.00 each	1.20	0.84	5	\$87.01	\$2.15	\$439	\$13	\$0	\$451
110126	3" FLG SCH 40 SW PVC	91.00 each	1.20	0.84	76	\$87.01	\$9.95	\$6,651	\$905	\$0	\$7,556
110137	3" PLAST FIELD WELD	389.00 each	1.20	0.96	373	\$87.01		\$32,492	\$0	\$0	\$32,492
110211	3" GATEVALVE 11FA 3.00	30.00 each	1.20	9.36	281	\$87.01	\$135.80	\$24,432	\$4,074	\$0	\$28,506
110411	3" Hanger, Standard 3"	84.00 each	1.20	3.72	312	\$87.01	\$32.43	\$27,188	\$2,724	\$0	\$29,912

Plastic (800s) Sanitary Sewer piping (50 lnft pe

23.30 Ftgs & Vlvs/100 LF Pipe 33.33 LF / Valve Workhours/LF 1.54 \$143.01 Total Cost/LF

11: Piping	Plastic (800s) Sanitary Sewer piping (50 lnft per fixture)	3.000	1,000 LF	1.20	1.54	1,538	\$87.01		\$133,80 \$133.80 /LF	\$9,204 \$9.20 /LF	\$0 \$0.00 /LF	\$143,005
Stainless S	teel (700s) Argon Supply Piping											
110111	1" PIPE,S40 316L SMLS		150.00 Inft	1.20	0.49	74	\$87.01	\$6.28	\$6,421	\$941	\$0	\$7,363
110121	1" 90 ELL 316L 3000# SW		13.00 each	1.20	0.96	12	\$87.01	\$16.39	\$1,086	\$213	\$0	\$1,299
110121	1" 45 ELL 316L 3000# SW		1.00 each	1.20	0.96	1	\$87.01	\$21.01	\$84	\$21	\$0	\$105
											Page 4	41 of 62

Location: GREEN FIELD SITE
Account: 11 Piping
Facility: Entire Estimate
Green Field Site

URS

Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

,	Green Field Site				Job No: 27989-325 Rev No: 0 Product Line: Gov Estimate: FFC								
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
110121	1" TEE 316L 3000# SW	8.00	each	1.20	1.44	12	\$87.01	\$21.70		\$1,002	\$174	\$0	\$1,176
110121	1" RED 316L 3000# SW	5.00	each	1.20	0.96	5	\$87.01	\$11.56		\$418	\$58	\$0	\$475
110121	1" CAP 316L 3000# SW	1.00	each	1.20	0.48	0	\$87.01	\$7.66		\$42	\$8	\$0	\$49
110121	1" SS 316L 600# RF SW	24.00	each	1.20	0.48	12	\$87.01	\$60.00		\$1,002	\$1,440	\$0	\$2,442
110132	1" FIELD WELD, SCH 40	95.00	each	1.20	0.92	88	\$87.01			\$7,638	\$0	\$0	\$7,638
110206	1" GATEVALVE 73SA 1.00	13.00	each	1.20	2.76	36	\$87.01	\$293.35		\$3,122	\$3,814	\$0	\$6,935
110406	1" Hanger, Standard 1"	15.00	each	1.20	2.40	36	\$87.01	\$27.53		\$3,132	\$413	\$0	\$3,545
l	10121 10121 10121 10121 10121 10132 10206	Account No. Description 10121 1" TEE 316L 3000# SW 10121 1" RED 316L 3000# SW 10121 1" CAP 316L 3000# SW 10121 1" SS 316L 600# RF SW 10132 1" FIELD WELD, SCH 40 10206 1" GATEVALVE 73SA 1.00	Account No. Description Qty 10121 1" TEE 316L 3000# SW 8.00 10121 1" RED 316L 3000# SW 5.00 10121 1" CAP 316L 3000# SW 1.00 10121 1" SS 316L 600# RF SW 24.00 10132 1" FIELD WELD, SCH 40 95.00 10206 1" GATEVALVE 73SA 1.00 13.00	Account No. Description Qty UM 10121 1" TEE 316L 3000# SW 8.00 each 10121 1" RED 316L 3000# SW 5.00 each 10121 1" CAP 316L 3000# SW 1.00 each 10121 1" SS 316L 600# RF SW 24.00 each 10121 1" SS 316L 600# RF SW 24.00 each 10132 1" FIELD WELD, SCH 40 95.00 each 10206 1" GATEVALVE 73SA 1.00 13.00 each	Account No. Description Qty UM Fact. 10121 1"TEE 316L 3000# SW 8.00 each 1.20 10121 1"RED 316L 3000# SW 5.00 each 1.20 10121 1"CAP 316L 3000# SW 1.00 each 1.20 10121 1"SS 316L 600# RF SW 24.00 each 1.20 10121 1"SS 316L 600# RF SW 24.00 each 1.20 10132 1"FIELD WELD, SCH 40 95.00 each 1.20 10206 1"GATEVALVE 73SA 1.00 13.00 each 1.20	Account No. Description Qty UM Fact. Per Unit 10121 1" TEE 316L 3000# SW 8.00 each 1.20 1.44 10121 1" RED 316L 3000# SW 5.00 each 1.20 0.96 10121 1" CAP 316L 3000# SW 1.00 each 1.20 0.48 10121 1" SS 316L 600# RF SW 24.00 each 1.20 0.48 10132 1" FIELD WELD, SCH 40 95.00 each 1.20 0.92 10206 1" GATEVALVE 73SA 1.00 13.00 each 1.20 2.76	Account No. Description Qty UM Fact. Lab. 10121	Account No. Description Qty UM Fact. Workhours Workhours Per Unit Total Rate	Account No. Description Qty UM Fact. Lab. Qty UM Fact Per Unit Total Rate Mat'l Unit	Account No. Description Qty UM Fact. Lab. Account No. Description Qty UM Fact. Lab. Per Unit Total Rate Mat'l Unit Subs Unit	Account No. Description Qty UM Fact	Account No. Description Qty UM Fact. Workhours Lab. Workhours Subs Unit Labor Material	Account No. Description Qty UM Fact. Per Unit Total Rate Mat'l Unit Subs Unit Labor Material Subs Unit Labor Material Subs Unit Labor Material Subs Unit Umaterial Subs Unit Umaterial Subs Unit Umaterial Umate

Stainless Steel (700s) Argon Supply Piping

43.33 Ftgs & Vlvs/100 LF Pipe
11.54 LF / Valve
1.83 Workhours/LF
\$206.85 Total Cost/LF

11: Piping	Stainless Steel (700s) Argon Supply Piping	1.000	150 LF	1.20	1.83	275	\$87.01		\$23,946 \$159.64 /LF	\$7,081 \$47.21 /LF	\$0 \$0.00 /LF	\$31,028
Utilities												
110102	OVERALL PIPING ALLOWANCE-A/G WEIGHTED Compressed Air		1,844.00 lnft	1.20	1.96	3,607	\$87.01	\$12.05	\$313,827	\$22,217	\$0	\$336,044
110102	OVERALL PIPING ALLOWANCE-A/G WEIGHTED Instrument Air		3,211.00 lnft	1.20	1.96	6,281	\$87.01	\$16.43	\$546,475	\$52,757	\$0	\$599,231

 Utilities

 0.00
 Ftgs & Vlvs/100 LF Pipe

 0.00
 LF / Valve

 1.96
 Workhours/LF

 \$185.02
 Total Cost/LF

11: Piping	Utilities	0.000	5,055 LF 1.20	1.96	9,888	\$87.01	\$860,302	\$74,973	\$0	\$935,275
1							\$170.19 /LF	\$14.83 /LF	\$0.00 /LF	

Location: GREEN FIELD SITE
Account: 11 Piping
Facility: Entire Estimate
Green Field Site



Job No: 27989-325

Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

Account No. Description Qty UM Fact. Per Unit Total Rate Mat'l Unit Subs Unit Labor Material Subs Total

Rev No: 0

Overall Ratios

6.57 Ftgs & Vlvs/100 LF Pipe

113.50 LF / Valve

1.39 Workhours/LF \$132.40 Total Cost/LF

Grand Total:	11: Piping	1.423	13,280 LF	1.20	1.96	18,485 \$87.01	\$1,608,332	\$149,881	\$0	\$1,758,213
							\$121.11 /LF	\$11.29 /LF	\$0.00 /LF	
							-			

Location: GREEN FIELD SITE
Account: 12 Electrical
Facility: Entire Estimate
Green Field Site

URS

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

					T -1		Workhours						Totals	
Accoun	t No. Des	scription	Qty	UM	Lab. Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12 Electri	cal Sum by Commo	odity												
1216*	Electrical Equips	ment			1.20		929.16	85.13			\$79,103	\$585,250	\$0	\$664,353
	121604	Power Distribution Center #1 (15' X 25')	375.00	sqft	1.20	0.60	225.00	\$85.13	\$950.00		\$19,155	\$356,250		\$375,405
	121602	15KV/5KV/3PHASE 2000 KVA	2.00	each	1.20	160.08	320.16	\$85.13	\$35,000.00		\$27,257	\$70,000		\$97,257
	121615	Batteries & Chargers	1.00	each	1.20	384.00	384.00	\$85.13	\$159,000.00		\$32,691	\$159,000		\$191,691
1201*	Conduit 120103	1 RGS CONDUIT	17,500 3,500.00	lnft	1.20 1.20	0.13 0.19	2,330.77 672.00	85.13 \$85.13	2.65 \$1.30		\$198,428 \$57,210	\$46,379 \$4,550	\$0	\$244,807 \$61,760
	120103	1 RGS ELL	105.00		1.20	0.28	28.98		\$4.90		\$2,467	\$515		\$2,982
	120103	1 RGS LB	105.00		1.20	0.62		\$85.13	\$13.15		\$5,578	\$1,381		\$6,959
	120103	1 RGS UNION	140.00		1.20	0.79	110.88		\$13.93		\$9,440	\$1,950		\$11,390
	120105	3 PVC COND ALL IN	4,500.00		1.20	0.12	540.00		\$4.73		\$45,972	\$21,285		\$67,257
	120105	3 PVC ELL	36.00		1.20	0.97		\$85.13	\$16.00		\$2,979	\$576		\$3,555
	120103	1" Conduit Hanger-2Holer	350.00		1.20	0.02	8.40		\$0.35		\$715	\$123		\$838
	120103	1 1/2 PVC CONDUIT	3,500.00	lnft	1.20	0.08	294.00	\$85.13	\$1.40		\$25,029	\$4,900		\$29,929
	120105	2 PVC CONDUIT	2,500.00	lnft	1.20	0.10	240.00	\$85.13	\$1.85		\$20,432	\$4,625		\$25,057
	120105	2 PVC CONDUIT	3,500.00	lnft	1.20	0.10	336.00	\$85.13	\$1.85		\$28,605	\$6,475		\$35,080
				\$ / Inft										
1203*	Wire & Cable 120303	1/C - 6 AWG - TERMS 600V	22,50 60.00) Inft	1.20 1.20	0.06 0.41	1,368.05 24.48		2.79 \$0.94		\$116,468 \$2,084	\$62,695 \$56	\$0	\$179,163 \$2,140
	120303	1/C - 250 MCM 5KV TERMS	16.00		1.20	5.57	89.09		\$18.50		\$7,584	\$296		\$7,880
	120309	3/C - 250 MCM SHIELDED EPR/PVC 15KV CU	1,000.00	lnft	1.20	0.12	120.00		\$18.60		\$10,216	\$18,600		\$28,816
	120314	Coaxial Cable - TERMS	36.00	each	1.20	0.66	23.76	\$85.13	\$5.50		\$2,023	\$198		\$2,221
	120301	OVERALL WIRE & CABLE ALLOWANCE Power Feeds to Process Equipment	10,500.00	lnft	1.20	0.06	630.00	\$85.13	\$2.74		\$53,634	\$28,770		\$82,404
	120303	3/C - 6 AWG CU THHN-THWN	3,000.00	lnft	1.20	0.04	108.00	\$85.13	\$1.87		\$9,194	\$5,610		\$14,804
	120303	3/C - 6 AWG CU THHN-THWN	4,000.00	lnft	1.20	0.04	144.00	\$85.13	\$1.87		\$12,259	\$7,480		\$19,739
	120303	1/C - 6 AWG - TERMS 600V	90.00	each	1.20	0.41	36.72	\$85.13	\$0.94		\$3,126	\$85		\$3,211
	120317	Coaxial Video Cable	4,000.00	lnft	1.20	0.05	192.00	\$85.13	\$0.40		\$16,346	\$1,600		\$17,946
			\$7.96	\$ / lnft										
1204*	Lighting				1.20		5,390.49	85.13			\$458,915	\$238,480	\$0	\$697,395
	120401	OVERALL LIGHT FIXTURE	200.00	each	1.20	8.00	1,600.80		\$350.00		\$136,283	\$70,000		\$206,283
	120401	ALLOWANCE (incl light fixtures & wire OVERALL LIGHT FIXTURE ALLOWANCE 400W Hi-Bay	100.00	each	1.20	13.00	1,299.60	\$85.13	\$600.00		\$110,640	\$60,000		\$170,640

Page 44 of 62

Location: GREEN FIELD SITE
Account: 12 Electrical
Facility: Entire Estimate
Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

	Gre	en Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
					Lab.		Workhours						Totals	
Accoun	nt No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	120401	OVERALL LIGHT FIXTURE	175.00	each	1.20	10.00	1,749.93	\$85.13	\$500.00		\$148,979	\$87,500		\$236,479
	120405	ALLOWANCE 150W Low-Bay MAST ARM 250W	14.00	each	1.20	5.28	73.92	\$85.13	\$450.00		\$6,293	\$6,300		\$12,593
	120405	MAST ARM 400W	8.00	each	1.20	5.28	42.24	\$85.13	\$600.00		\$3,596	\$4,800		\$8,396
	120405	40' POLE, ALUMINUM	14.00	each	1.20	24.00	336.00	\$85.13	\$420.00		\$28,605	\$5,880		\$34,485
	120405	50' POLE, ALUMINUM	8.00	each	1.20	36.00	288.00	\$85.13	\$500.00		\$24,519	\$4,000		\$28,519
1205*	Grounding				1.20		3,977.28	85.13			\$338,602	\$81,633	\$0	\$420,235
	120503	1/C - #4/0 AWG BARE GRND WIRE O	CU 4,500.00	lnft	1.20	0.04	162.00	\$85.13	\$1.91		\$13,792	\$8,595		\$22,387
	120503	TERMIN LUGS-CU WIRE 4/0AWG	120.00	each	1.20	1.10	132.48	\$85.13	\$4.20		\$11,279	\$504		\$11,783
	120501	GROUNDING ALLOWANCE	1.00	lsum	1.20	3,578.40	3,578.40	\$85.13	\$72,067.00		\$304,644	\$72,067		\$376,711
	120502	COPPERWELD GR ROD 3/4"X10'	30.00	each	1.20	3.48	104.40	\$85.13	\$15.55		\$8,888	\$467		\$9,355
1209*	Fire Alarm	Control			1.20		525.34	85.13			\$44,724	\$55,342	\$0	\$100,066
	120901	ALARM ALLOWANCE/Emergency Lighting	82,600.00	sqft	1.20	0.01	525.34	\$85.13	\$0.67		\$44,724	\$55,342		\$100,066
1212*	Lightning P	rotection			1.20		794.40	85.13			\$67,631	\$40,000	\$0	\$107,631
	121201	LIGHTING PROTECTION ALLOWANCE	1.00	lsum	1.20	794.40	794.40	\$85.13	\$40,000.00		\$67,631	\$40,000		\$107,631
1214*		mmunication			1.20		2,078.40				\$176,943	\$219,581	\$0	\$396,524
	121405	Emergency Telephones	15.00	each	1.20	18.00	270.00		\$850.00		\$22,986	\$12,750		\$35,736
	121402	SECURITY Card Reader	1.00	each	1.20	480.00	480.00	\$85.13	\$40,000.00		\$40,864	\$40,000		\$80,864
	121403	CCTV System Inside Bldg (50 each)	1.00	lsum	1.20	1,058.40	1,058.40	\$85.13	\$155,626.00		\$90,106	\$155,626		\$245,732
	121404	PAGING System	15.00	each	1.20	18.00	270.00	\$85.13	\$747.00		\$22,986	\$11,205		\$34,191

Grand Total: 12: Electrical	1.20	17,394 \$85.13	\$33.23 \$0.00	\$1,480,813	\$1,329,359	\$0 \$2,810),172
Grand Tollin 121 Electrical	1.20	17,554 \$65.15	\$33.23 \$6.00	\$1,400,013	91,027,007	30 32,010	,1/2

Page 45 of 62

Location: GREEN FIELD SITE
Account: 12 Electrical
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

	Green Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
				Lab.		Workhours						Totals	
Account No	o. Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12.01 Electric	cal Equipment												
	Elec. EquipTransformers					320	\$85.13			\$27,257	\$70,000	\$0	\$97,257
121602	15KV/5KV/3PHASE 2000 KVA		2 eacl	h 1.20	160.08	320.16	85.13	35,000.00		\$27,257	\$70,000	\$0	\$97,257
	Electrical Equipment					384	\$85.13			\$32,691	\$159,000	\$0	\$191,691
121615	Batteries & Chargers		1 eacl	h 1.20	384.00	384.00	85.13	159,000.00		\$32,691	\$159,000	\$0	\$191,691
121604	ELECTRICAL SUBSTATION Power Distribution Center #1 (15' X 25')	37	5 sqt	t 1.20	0.60	225 225.00	\$85.13 85.13	950.00		\$19,155 \$19,155	\$356,250 \$356,250	\$0 \$0	\$375,405 \$375,405

Grand Total: 1216: Electrical Equipment	1.20	929 85.13	\$79,103	\$585,250	\$0	\$664,353

Location: GREEN FIELD SITE
Account: 12 Electrical
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

	Green Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
				Lab.		Workhours					,	Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12.01 Electrical Co	nduit												
	AREA FENCE LIGHTING CONDUIT	3,500.00	LF			336				28,605	6,475	0	35,080
120105	2 PVC CONDUIT	3,500.00	lnft	1.20	0.10	336.00	\$85.13	\$1.85		\$28,605	\$6,475	\$0	\$35,080
	Conduit All-In RGS 1" dia For Power	3,500.00	LF			886				75,410	8,518	0	83,928
	Feed to Equipment												
120103	1 RGS CONDUIT	3,500.00	lnft	1.20	0.19	672.00	\$85.13	\$1.30		\$57,210	\$4,550	\$0	\$61,760
120103	1 RGS ELL	105.00	each	1.20	0.28	28.98	\$85.13	\$4.90		\$2,467	\$515	\$0	\$2,982
120103	1 RGS LB	105.00	each	1.20	0.62	65.52	\$85.13	\$13.15		\$5,578	\$1,381	\$0	\$6,959
120103	1 RGS UNION	140.00	each	1.20	0.79	110.88	\$85.13	\$13.93		\$9,440	\$1,950	\$0	\$11,390
120103	1" Conduit Hanger-2Holer	350.00	each	1.20	0.02	8.40	\$85.13	\$0.35		\$715	\$123	\$0	\$838
	Ductbank by Dimension (2.5' X 2.5' X 500')	4,500.00	LF			575				48,951	21,861	0	70,812
120105	3 PVC COND ALL IN	4,500.00	lnft	1.20	0.12	540.00	\$85.13	\$4.73		\$45,972	\$21,285	\$0	\$67,257
120105	3 PVC ELL	36.00	each	1.20	0.97	34.99	\$85.13	\$16.00		\$2,979	\$576	\$0	\$3,555
	ROADWAY LIGHTING CONDUIT	2,500.00	LF			240				20,432	4,625	0	25,057
120105	2 PVC CONDUIT	2,500.00	lnft	1.20	0.10	240.00	\$85.13	\$1.85		\$20,432	\$4,625	\$0	\$25,057
	SECURITY CAMERA CONDUIT	3,500.00	LF			294				25,029	4,900	0	29,929
120103	1 1/2 PVC CONDUIT	3,500.00	lnft	1.20	0.08	294.00	\$85.13	\$1.40		\$25,029	\$4,900	\$0	\$29,929

Overall Ratios:

0.13 Workhours/LF

\$2.65 Material Cost/LF

\$13.99 Total Cost/LF

Grand Total:	17,500 LF	1.20	0.13	2,331 \$85.13	\$198,428	\$46,379	\$0	\$244,807
					\$11.34 /LF	\$2.65 /LF	\$0.00 /LF	

Location: GREEN FIELD SITE
Account: 12 Electrical
Facility: Entire Estimate
Green Field Site



Job No: 27989-325

sion

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver Product Line: Gov Estimate: FFC

				Lab.		Workhours						Γotals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12.03 Electrical Wir	re/Cable												
	AREA FENCE LIGHTING CABLE	4,000	lnft			168	85.13			\$14,343	\$7,536	\$0	\$21,880
120303	3/C - 6 AWG CU THHN-THWN	4,000	lnft	1.20	0.04	144.00	85.13	1.87		\$12,259	\$7,480	\$0	\$19,739
120303	1/C - 6 AWG - TERMS 600V	60	ach	1.20	0.41	24.48	85.13	0.94		\$2,084	\$56	\$0	\$2,140
	Power Feeds Process Area	10,500	lnft			630	85.13			\$53,634	\$28,770	\$0	\$82,404
120301	OVERALL WIRE & CABLE ALLOWANCE Power Feeds to Process Equipment	10,500	lnft	1.20	0.06	630.00	85.13	2.74		\$53,634	\$28,770	\$0	\$82,404
	ROADWAY LIGHTING CABLE	3,000	lnft			145	85.13			\$12,321	\$5,695	\$0	\$18,015
120303	3/C - 6 AWG CU THHN-THWN	3,000	lnft	1.20	0.04	108.00	85.13	1.87		\$9,194	\$5,610	\$0	\$14,804
120303	1/C - 6 AWG - TERMS 600V	90	ach	1.20	0.41	36.72	85.13	0.94		\$3,126	\$85	\$0	\$3,211
	SECURITY CAMERA CABLE	4,000	lnft			216	85.13			\$18,369	\$1,798	\$0	\$20,167
120314	Coaxial Cable - TERMS	36	ach	1.20	0.66	23.76	85.13	5.50		\$2,023	\$198	\$0	\$2,221
120317	Coaxial Video Cable	4,000	lnft	1.20	0.05	192.00	85.13	0.40		\$16,346	\$1,600	\$0	\$17,946
	Wire & Cable-Medium Voltage (5 & 15kV)	1,000	lnft			209	85.13			\$17,801	\$18,896	\$0	\$36,697
120307	1/C - 250 MCM 5KV TERMS	16	ach	1.20	5.57	89.09	85.13	18.50		\$7,584	\$296	\$0	\$7,880
120309	3/C - 250 MCM SHIELDED EPR/PVC 15KV CU	1,000	lnft	1.20	0.12	120.00	85.13	18.60		\$10,216	\$18,600	\$0	\$28,816

Rev No: 0

Overall Ratios:

0.06 Workhours/LF \$2.79 Material Cost/LF \$7.96 Total Cost/LF

Grand Total: Wire & Cable 22,500 Inft 1.20 0.06 1,368 85.13 \$116,468 \$62,695 \$0 \$179,163 \$5.18 /LF \$2.79/LF \$0.00 /LF

Location: GREEN FIELD SITE
Account: 12 Electrical
Facility: Entire Estimate



Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC
Office: Denver
Product Line: Gov
Estimate: FFC

Green Field Site Job No: 27989-325 Rev No: 0

				Lab		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

1203a Electical Wire/Cable Summary						
High Voltage						
Cable	4.4%	1,000	LF	0.12	120	
Terms		0	EA	0.00	0	
Ratio (LF / Term)		0.00				
Cable + Terms (per LF wire)				0.12	120	Per LF of Wire
Medium Voltage						
Cable	0.0%	0	LF	0.00	0	
Terms		16	EA	5.57	89	
Ratio (LF / Term)		0.00				
Cable + Terms (per LF wire)				0.00	89	Per LF of Wire
Low Voltage / Control						
Cable	31.1%	7,000	LF	0.04	252	
Terms		186	EA	0.46	85	
Ratio (LF / Term)		37.63				
Cable + Terms (per LF wire)				0.05	337	Per LF of Wire
MIsc Wire/Cable						
Cable	64.4%	14,500	LF	0.06	822	
Terms		0	EA	0.00	0	
Ratio (LF / Term)		0.00				
Cable + Terms (per LF wire)				0.06	822	Per LF of Wire

|--|--|

Cable	100.0%	22,500	LF	0.05	1,194	
Terms			EA	0.86	174	
Ratio (LF / Term)		111.39				
Cable + Terms				0.06	1,368	Per LF of Wire

Location: GREEN FIELD SITE Account: 12 Electrical Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver
Product Line: Gov

	Green Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12.04 Electrical Li	ighting												
	AREA FENCE LIGHTING					330	\$85.13			\$28,115	\$8,800	\$0	\$36,915
120405	MAST ARM 400W	8.00	each	1.20	5.28	42.24	\$85.13	\$600.00		\$3,596	\$4,800	\$0	\$8,396
120405	50' POLE, ALUMINUM	8.00	each	1.20	36.00	288.00	\$85.13	\$500.00		\$24,519	\$4,000	\$0	\$28,519
	Finishes Office Area					1,601	\$85.13			\$136,283	\$70,000	\$0	\$206,283
120401	OVERALL LIGHT FIXTURE ALLOWANCE (incl light fixtures & wire)	200.00	each	1.20	8.00	1,600.80	\$85.13	\$350.00		\$136,283	\$70,000	\$0	\$206,283
	Finishes Process Area					3,050	\$85.13			\$259,619	\$147,500	\$0	\$407,119
120401	OVERALL LIGHT FIXTURE ALLOWANCE 400W Hi-Bay	100.00	each	1.20	13.00	1,299.60	\$85.13	\$600.00		\$110,640	\$60,000	\$0	\$170,640
120401	OVERALL LIGHT FIXTURE ALLOWANCE 150W Low-Bay	175.00	each	1.20	10.00	1,749.93	\$85.13	\$500.00		\$148,979	\$87,500	\$0	\$236,479
	ROADWAY LIGHTING					410	\$85.13			\$34,898	\$12,180	\$0	\$47,078
120405	MAST ARM 250W	14.00	each	1.20	5.28	73.92	\$85.13	\$450.00		\$6,293	\$6,300	\$0	\$12,593
120405	40' POLE, ALUMINUM	14.00	each	1.20	24.00	336.00	\$85.13	\$420.00		\$28,605	\$5,880	\$0	\$34,485

Grand Total: 12.04 Electrical Lighting	1.20	5,390	\$85.13		\$458,915	\$238,480	\$0	\$697,39	5
--	------	-------	---------	--	-----------	-----------	-----	----------	---

Page 50 of 62

1214*

Security/Communication

0.00

lnft 1.20

Location: GREEN FIELD SITE Account: 12 Electrical Facility: Entire Estimate



Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

\$176,943

\$219,581

	Green Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12 Electrical O	Other												
	Electrical Systems					3,578	\$85.13			\$304,644	\$72,067	\$0	\$376,711
120501	GROUNDING ALLOWANCE	1.00	lsum	1.20	3,578.40	3,578.40	\$85.13	\$72,067.00		\$304,644	\$72,067	\$0	\$376,711
	FENCE GROUND CABLE					294	\$85.13			\$25,070	\$9,099	\$0	\$34,169
120503	1/C - #4/0 AWG BARE GRND WIRE CU	4,500.00	lnft	1.20	0.04	162.00	\$85.13	\$1.91		\$13,792	\$8,595	\$0	\$22,387
120503	TERMIN LUGS-CU WIRE 4/0AWG	120.00	each	1.20	1.10	132.48	\$85.13	\$4.20		\$11,279	\$504	\$0	\$11,783
	FENCE GROUND RODS					104	\$85.13			\$8,888	\$467	\$0	\$9,355
120502	COPPERWELD GR ROD 3/4"X10'	30.00	each	1.20	3.48	104.40	\$85.13	\$15.55		\$8,888	\$467	\$0	\$9,355
1205*	Grounding	4,500.00	lnft	1.20		3,977	\$85.13			\$338,602	\$81,633	\$0	\$420,235
	Alarm Systems					525	\$85.13			\$44,724	\$55,342	\$0	\$100,066
120901	ALARM ALLOWANCE/Emergency Lighting	82,600.00	sqft	1.20	0.01	525.34	\$85.13	\$0.67		\$44,724	\$55,342	\$0	\$100,066
1209*	Fire Alarm Control	0.00	lnft	1.20		525	\$85.13			\$44,724	\$55,342	\$0	\$100,066
	Electrical Systems					794	\$85.13			\$67,631	\$40,000	\$0	\$107,631
121201	LIGHTING PROTECTION ALLOWANCE	1.00	lsum	1.20	794.40	794.40	\$85.13	\$40,000.00		\$67,631	\$40,000	\$0	\$107,631
1212*	Lightning Protection	0.00	lnft	1.20		794	\$85.13			\$67,631	\$40,000	\$0	\$107,631
	Access System					480	\$85.13			\$40,864	\$40,000	\$0	\$80,864
121402	SECURITY Card Reader	1.00	each	1.20	480.00	480.00	\$85.13	\$40,000.00		\$40,864	\$40,000	\$0	\$80,864
	Electrical Systems					1,598	\$85.13			\$136,078	\$179,581	\$0	\$315,659
121403	CCTV System Inside Bldg (50 each)	1.00	lsum	1.20	1,058.40	1,058.40	\$85.13	\$155,626.00		\$90,106	\$155,626	\$0	\$245,732
121404	PAGING System	15.00	each	1.20	18.00	270.00	\$85.13	\$747.00		\$22,986	\$11,205	\$0	\$34,191
121405	Emergency Telephones	15.00	each	1.20	18.00	270.00	\$85.13	\$850.00		\$22,986	\$12,750	\$0	\$35,736
	6 1 16 1 1	0.00					00= 40			04 7 6 0 40	0040 504		0006 504

2,078

\$85.13

Grand Total: 12.xx Electrical Other Systems	1.20	7,375 \$85.13	\$627,899	\$396,556 \$	0 \$1,024,455
---	------	---------------	-----------	--------------	---------------

\$396,524

Bulks

Misc

13xx

13xxxx

Location: GREEN FIELD SITE Account: 13 Instrumentation
Facility: Entire Estimate Washington Division

Job No: 27989-325

1.20

1.20

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

\$4,101

\$20,400

\$0 \$53,896

\$0

\$34,294

\$49,795

\$13,894

Green Field Site

				Lab.	Workhours						Totals	
Account N	No. Description	Qty	UM	Fact.	Per Unit Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
3 Instrumentation Summary							-					
1301	Field Instruments	9.00	ea	1.20	6	4 \$89.78			\$5,764	\$17,880	\$0	\$23,644
131007	Analyzers	20.00	ea	1.20	64	1 \$89.78			\$57,530	\$4,802,140	\$0	\$4,859,670

555

163

Rev No: 0

\$89.78

\$85.13

						_				
Grand Total: Instrumentation	9 Field Inst Count	1.20	0.00	1,423	\$89.25		\$126,983	\$4,844,521	\$0	\$4,971,504

Location: GREEN FIELD SITE Account: 13 Instrumentation Facility: Entire Estimate



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FEC

	Green Field Site				Job No:	27989-325	Rev No:	0			Estimate: FFC	2	
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Analyzer- w/ Bulks						138	89.78			\$12,368	\$105,428	\$0	\$117,796
130404	1/4" BALL VALVE WHITEY 43	1	each	1.20	0.48	0.48	\$89.78	\$29.67		\$43	\$30	\$0	\$73
130404	1/4" BALL VALVE WHITEY 43	1	each	1.20	0.48	0.48	\$89.78	\$29.67		\$43	\$30	\$0	\$73
130703	3/8" TUBING (SS)	150.00	lnft	1.20	0.22	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
130703	3/8" TUBING (SS)	150.00	lnft	1.20	0.22	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
131007	Determinator O N ANALYZER	1	each	1.20	36.00	36.00	\$89.78	\$80,000.00		\$3,232	\$80,000	\$0	\$83,232
131007	Determinator C S ANALYZER	1	each	1.20	36.00	36.00	\$89.78	\$25,000.00		\$3,232	\$25,000	\$0	\$28,232
Body Scanners						58	89.78			\$5,171	\$180,000	\$0	\$185,171
131007	Body Scanner	3	each	1.20	19.20	57.60	\$89.78	\$60,000.00		\$5,171	\$180,000	\$0	\$185,171
Field Instr Allow - w						3	89.78			\$231	\$2,000	\$0	\$2,231
130101	Scale	1	each	1.20	2.57	2.57	\$89.78	\$2,000.00		\$231	\$2,000	\$0	\$2,231
	y/ Bulks Fire Water Collection					208	89.78			\$18,634	\$17,142	\$0	\$35,776
130101	OVERALL INSTRUMENTS ALLOWANCE	8	each	1.20	7.70	61.63	\$89.78	\$1,985.00		\$5,533	\$15,880	\$0	\$21,413
130404	1/4" BALL VALVE WHITEY 43	16	each	1.20	0.48	7.68	\$89.78	\$29.67		\$690	\$475	\$0	\$1,164
130703	3/8" TUBING (SS)	640.00	lnft	1.20	0.22	138.24	\$89.78	\$1.23		\$12,411	\$787	\$0	\$13,198
Fluorscope Analyze						81	89.78			\$7,304	\$200,244	\$0	\$207,548
130404	1/4" BALL VALVE WHITEY 43	2	each	1.20	0.48	0.96	\$89.78	\$29.67		\$86	\$59	\$0	\$146
130703	3/8" TUBING (SS) cooling water	150.00	lnft	1.20	0.22	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
131007	Fluoroscope DO	1	each	1.20	48.00	48.00	\$89.78	\$200,000.00		\$4,309	\$200,000	\$0	\$204,309
Gamma Scanner- w						124	89.78			\$11,161	\$1,000,488	\$0	\$1,011,649
130404	1/4" BALL VALVE WHITEY 43	4	each	1.20	0.48	1.92	\$89.78	\$29.67		\$172	\$119	\$0	\$291
130703	3/8" TUBING (SS)	300.00	lnft	1.20	0.22	64.80	\$89.78	\$1.23		\$5,818	\$369	\$0	\$6,187
131007	Gamma Scanner DO	1	each	1.20	57.60	57.60	\$89.78	\$1,000,000.00		\$5,171	\$1,000,000	\$0	\$1,005,171
Gamma Spectroscop						36	89.78			\$3,232	\$80,000	\$0	\$83,232
131007	Gamm Spectroscopy Item M	1	each	1.20	36.00	36.00	\$89.78	\$80,000.00		\$3,232	\$80,000	\$0	\$83,232
	by (PLate) w/ Bulks Item L				0.40	81	89.78	000 (#		\$7,261	\$200,214	\$0	\$207,475
130404	1/4" BALL VALVE WHITEY 43	1	each	1.20	0.48	0.48	\$89.78	\$29.67		\$43	\$30	\$0	\$73
130703	3/8" TUBING (SS)	150.00	lnft	1.20	0.22	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
131007	Gamma Spectroscopy	1	each	1.20	48.00	48.00	\$89.78	\$200,000.00		\$4,309	\$200,000	\$0	\$204,309
Hand & Foot Monit						72	89.78			\$6,464	\$145,000	\$0	\$151,464
131007	Hand & Foot Monitor	5	each	1.20	14.40	72.00	\$89.78	\$29,000.00		\$6,464	\$145,000	\$0	\$151,464
Mass Spectrometer-		2		1.20	0.49	62	89.78	620.67		\$5,581	\$250,244	\$0	\$255,824
130404	1/4" BALL VALVE WHITEY 43	2	each	1.20	0.48	0.96	\$89.78	\$29.67		\$86	\$59	\$0	\$146
130703	3/8" TUBING (SS)	150.00	lnft	1.20	0.22	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
131007	Mass Spectrometer Hook-up & Test	1	each	1.20	28.80	28.80	\$89.78	\$250,000.00		\$2,586	\$250,000	\$0	\$252,586

Page 53 of 62

Location: GREEN FIELD SITE Account: 13 Instrumentation Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver

		Green Field Site				Job No:	27989-325	Rev No:	0			Estimate: FFC	2	
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Op	tical Microscope						10	89.78			\$862	\$2,140	\$0	\$3,002
	131007	Microscope 1000X w/Camera & computer	1	each	1.20	9.60	9.60	\$89.78	\$2,140.00		\$862	\$2,140	\$0	\$3,002
Ra	diography Analyz	zer- w/ Bulks Item 16					184	89.78			\$16,548	\$640,611	\$0	\$657,159
	130404	1/4" BALL VALVE WHITEY 43	4	each	1.20	0.48	1.92	\$89.78	\$29.67		\$172	\$119	\$0	\$291
	130703	3/8" TUBING (SS) water & gas	400.00	lnft	1.20	0.22	86.40	\$89.78	\$1.23		\$7,757	\$492	\$0	\$8,249
	131007	ANALYZER DO	2	each	1.20	48.00	96.00	\$89.78	\$320,000.00		\$8,619	\$640,000	\$0	\$648,619
SE	CURITY CAME	RA					163	85.13			\$13,894	\$20,400	\$0	\$34,294
	139900	FENCE SECURITY CAMERA (mount on fence lighting poles)	17	each	1.20	9.60	163.20	\$85.13	\$1,200.00		\$13,894	\$20,400	\$0	\$34,294
Ult	rasonc Tester- w/	Bulks Item 12					204	89.78			\$18,272	\$2,000,611	\$0	\$2,018,882
	130404	1/4" BALL VALVE WHITEY 43	4	each	1.20	0.48	1.92	\$89.78	\$29.67		\$172	\$119	\$0	\$291
	130703	3/8" TUBING (SS)	400.00	lnft	1.20	0.22	86.40	\$89.78	\$1.23		\$7,757	\$492	\$0	\$8,249
	131007	ANALYZER DO	2	each	1.20	57.60	115.20	\$89.78	\$1,000,000.00		\$10,343	\$2,000,000	\$0	\$2,010,343

7	Fotals 13-Instrumentation Entire Estimate	9 each Field Inst Count	1,423 \$89.25	\$126,983	\$4,844,521	\$0	\$4,971,504
L	Entire Estimate	Field flist Count					

Location: GREEN FIELD SITE
Account: 16 Buildings
Facility: Entire Estimate
Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

		Green Field Site				Job No:	27989-325	Rev No:	U			Estimate: FF	С	
					Lab.		Workhours					-	Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Blo	lg Furnishings					•	144	80.41	•		\$11,580	\$33,642	\$6,360	\$51,581
	161101	SPECIALTIES-LOCKERS	36	each	1.20	2.40	86.40	\$80.41	\$267.82		\$6,948	\$9,642	\$0	\$16,589
	161103	OFFICE FURNISHINGS	24	each	1.20	2.40	57.60	\$80.41	\$1,000.00	\$265.00	\$4,632	\$24,000	\$6,360	\$34,992
Blo	lg Plumbing						19	80.41			\$1,544	\$3,940	\$26,020	\$31,503
	160403	SERVICE SINK,PE ON CI,WALL HUNG,22"x18" (Janitor Closet)	1	each	1.20					\$1,424.90	\$0	\$0	\$1,425	\$1,425
	160403	WC (Incl Fixture, Water, Vent & Drain Pipe)	10	each	1.20					\$1,000.00	\$0	\$0	\$10,000	\$10,000
	160403	URINAL	4	each	1.20					\$700.00	\$0	\$0	\$2,800	\$2,800
	160403	Safety Showers W/Eye wash Incl Waste Vent & Drain Pipe	2	each	1.20	9.60	19.20	\$80.41	\$1,970.00		\$1,544	\$3,940	\$0	\$5,484
	160403	SHOWER,STALL,BAKED ENAM,TERRAZZO RECEPTOR,30" Incl Warer, Vent & Drain Pipe	2	each	1.20					\$1,245.30	\$0	\$0	\$2,491	\$2,491
	160403	LAVATORY W/TRIM WALL HUNG PE ON CI,18"x15"	10	each	1.20					\$930.40	\$0	\$0	\$9,304	\$9,304
Blo	lg Specialties						3,452	82.22			\$283,822	\$282,641	\$6,006	\$572,469
	160501	ALLOWANCE Fire Protection (Wet Pipe Sprinkler Sys)	82,600.00	sqft	1.20	0.03	2,478.00	\$80.41	\$1.25		\$199,268	\$103,250	\$0	\$302,518
	161004	CERAMIC TILE Floors Locker & Bathrooms 6" by 6" Thin Set	1,275.00	sqft	1.20	0.10	122.40	\$80.41	\$3.36	\$3.90	\$9,843	\$4,284	\$4,973	\$19,099
	161004	CERAMIC TILE Floors Locker & Bathrooms Wainscoting 6" by 4-1/2"	265.00	lnft	1.20	0.21	54.70	\$80.41	\$3.61	\$3.90	\$4,398	\$957	\$1,034	\$6,389
	161101	SPECIALTIES-Building Elevator 2 stop	1.00	lsum	1.20	192.00	192.00	\$80.41	\$15,500.00		\$15,440	\$15,500	\$0	\$30,940
	161102	SPECIALTIES-ALLOWANCE Furniture Cubicles	1.00	lsum	1.20	28.80	28.80	\$80.41	\$58,650.00		\$2,316	\$58,650	\$0	\$60,966
	161199	SPECIALTIES-OTHER Shelving Cans & Fuel	1.00	lsum	1.20	576.00	576.00	\$91.25	\$100,000.00		\$52,558	\$100,000	\$0	\$152,558
Bu	ilding						16,632	80.41			\$1,337,456	\$912,533	\$0	\$2,249,989
	160100	Building Incl Insul Siding, Roofing, & Support Steel	82,500.00	sqft	1.20	0.20	16,632.00	\$80.41	\$11.06		\$1,337,456	\$912,533	\$0	\$2,249,989
CM		pressor, MCC Mech & Elec Maint Rooms									\$0	\$0	\$290,738	\$290,738
	160203	CONC BLK,REG WT.,HOLLOW,12"THK W/PERLITE INSUL CORE FILL	15,350.00	sqft	1.20					\$18.94	\$0	\$0	\$290,738	\$290,738
Do	ors & Windows										\$0	\$0	\$56,619	\$56,619
	160302	HOLLOW METAL,18GA. STEEL,NO LABEL,3'-0"x7'-0" Exterior	7	each	1.20					\$935.30	\$0	\$0	\$6,547	\$6,547
	160302	HOLLOW METAL,18GA. STEEL,NO LABEL,3'-0"x7'-0" Interior	20	each	1.20					\$935.30	\$0	\$0	\$18,706	\$18,706
	160302	HOLLOW METAL,18GA. STEEL,NO LABEL,DBL.,6'-0"x7'-0"	4	each	1.20					\$1,890.00	\$0	\$0	\$7,560	\$7,560
	160302	HOLLOW METAL,18GA. STEEL,A LABEL,DBL.,6'-0"x7'-0" (Furnace Area)	1	each	1.20					\$2,145.50	\$0	\$0	\$2,146	\$2,146
	160302	sample - Wood Doors	20	each	1.20					\$1,083.00	\$0	\$0	\$21,660	\$21,660
Fir	ishes						3,511	51.59			\$181,139	\$37,660	\$106,745	\$325,544

Page 55 of 62

Location: GREEN FIELD SITE
Account: 16 Buildings
Facility: Entire Estimate
Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC Office: Denver

Office: Denver
Product Line: Gov
Estimate: FFC

	Green Field Site				JOB NO:	21989-323	Rev No: 0				Estimate: FF	C	
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
160402	Roof Drain 3" Diameter	20	each	1.20	1.60	31.92	\$80.41	\$207.00		\$2,567	\$4,140	\$0	\$6,707
160402	3" Floor Drains W/P Trap	24	each	1.20	2.96	71.14	\$80.41	\$220.50		\$5,720	\$5,292	\$0	\$11,012
161004	PAINTING Sealer on Concrete Floor	37,746.50	sqft	1.20	0.00	139.81	\$50.69	\$0.05		\$7,087	\$2,073	\$0	\$9,160
161004	PAINTING Epoxy Paint Coating Floor	41,140.00	sqft	1.20	0.00	152.37	\$54.00	\$0.04		\$8,229	\$1,784	\$0	\$10,013
161004	VCT Lunch/Break Room 12" by 12" by 3/32" Embossed	1,350.00	sqft	1.20	0.02	25.92	\$80.41	\$1.18	\$1.11	\$2,084	\$1,593	\$1,499	\$5,176
161004	CARPET Office Areas	9,600.00	sqft	1.20					\$3.25	\$0	\$0	\$31,200	\$31,200
161004	Rubber Base	2,259.40	lnft	1.20					\$1.61	\$0	\$0	\$3,631	\$3,631
161004	Resilient Flooring	4,052.40	lnft	1.20	0.11	435.23	\$54.00	\$0.57		\$23,504	\$2,301	\$0	\$25,805
161006	PAINTING Latex Paint on CMU	1,993.20	sqft	1.20	0.02	40.11	\$49.70	\$0.16		\$1,993	\$317	\$0	\$2,310
161006	PAINTING Latex Paint on Drywall	38,135.90	sqft	1.20	0.01	411.97	\$49.70	\$0.07		\$20,474	\$2,756	\$0	\$23,230
161006	PAINTING Epoxy Paint on Drywall	40,667.00	sqft	1.20	0.02	818.38	\$49.70	\$0.16		\$40,672	\$6,466	\$0	\$47,137
161006	PAINTING Sealer on Concrete	8,606.40	sqft	1.20	0.02	173.19	\$49.70	\$0.16		\$8,607	\$1,368	\$0	\$9,976
161006	PAINTING Latex Paint on Concrete	8,382.00	sqft	1.20	0.02	168.68	\$49.70	\$0.16		\$8,383	\$1,333	\$0	\$9,716
161006	PAINTING Epoxy Paint on Concrete	26,877.40	sqft	1.20	0.02	540.88	\$49.70	\$0.16		\$26,880	\$4,273	\$0	\$31,154
161006	PAINTING Epoxy Paint on CMU	3,533.20	sqft	1.20	0.02	71.10	\$49.70	\$0.16		\$3,534	\$562	\$0	\$4,095
161006	PAINTING Decon coating on Concrete	21,401.60	sqft	1.20	0.02	430.68	\$49.70	\$0.16		\$21,404	\$3,403	\$0	\$24,807
161006	GYPSUM BD PARTITION (5/8" Gypsum both sides) Office Areas	7,000.00	sqft	1.20					\$5.38	\$0	\$0	\$37,660	\$37,660
161006	GYPSUM BD PARTITION (5/8" Gypsum both sides) Lab, Programmer's & supervisor'sO	1,200.00	sqft	1.20					\$5.38	\$0	\$0	\$6,456	\$6,456
161006	GYPSUM BD PARTITION (5/8" Gypsum ONE sides) Office Areas	6,000.00	sqft	1.20					\$3.55	\$0	\$0	\$21,300	\$21,300
161103	TOILET ACCESSORIES Partitions	10	each	1.20					\$500.00	\$0	\$0	\$5,000	\$5,000
e Protection						452	80.41			\$36,377	\$2,775	\$0	\$39,152
160501	Fire Protection Allowance Fire Line From Blgd Exterior to Sprinkler Sys	287.00	lnft	1.20	1.58	452.37	\$80.41	\$9.67		\$36,377	\$2,775	\$0	\$39,152
AC Equipment						3,523	80.41			\$283,269	\$209,502	\$0	\$492,771
160901	ALLOWANCE Process Area Non Radiological	30,900.00	sqft	1.20	0.11	3,522.60	\$80.41	\$6.78		\$283,269	\$209,502	\$0	\$492,771
AC Equipment St	tandard Hvac Office area					1,359	80.41			\$109,255	\$81,396	\$0	\$190,651
160901	Office area	10,200.00	sqft	1.20	0.13	1,358.64	\$80.41	\$7.98		\$109,255	\$81,396	\$0	\$190,651
erior Finish						431	80.41			\$34,652	\$32,832	\$0	\$67,484
161005	ACT CEILING SYSTEM w/ GRID (2' by 4' by 3/4" panels) Office & Radiographic Area	15,000.00	sqft	1.20	0.03	378.00	\$80.41	\$1.92		\$30,397	\$28,800	\$0	\$59,197
161005	ACT CEILING SYSTEM w/ GRID (2' by 4' by 3/4" panels) Lab, Programmers & Supervi	2,100.00	sqft	1.20	0.03	52.92	\$80.41	\$1.92		\$4,256	\$4,032	\$0	\$8,288

Page 56 of 62

Location: GREEN FIELD SITE
Account: 16 Buildings
Facility: Entire Estimate



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

		Green Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Me	etal Siding Interio	r Enclosure					2,157	80.41			\$173,488	\$113,572	\$0	\$287,060
	160706	20 GA Metal Panel on metal framing Interim Storage area	8,430.00	sqft	1.20	0.05	414.76	\$80.41	\$2.59		\$33,352	\$21,834	\$0	\$55,186
	160706	20 GA Metal Panel on metal framing Final Prduct Assembly Area	9,370.00	sqft	1.20	0.05	461.00	\$80.41	\$2.59		\$37,071	\$24,268	\$0	\$61,340
	160706	20 GA Metal Panel on metal framing Prduct Prep	26,050.00	sqft	1.20	0.05	1,281.66	\$80.41	\$2.59		\$103,064	\$67,470	\$0	\$170,534
Ov	verhead Coiling D	oors					148	80.41			\$11,914	\$9,324	\$0	\$21,238
	160203	OVERHEAD,ROLLING,STEEL,ELEC. OPER.,7'-0"x15'-0" Bldg	3	each	1.20	37.04	111.11	\$80.41	\$2,331.00		\$8,935	\$6,993	\$0	\$15,928
	160203	OVERHEAD,ROLLING,STEEL,ELEC. OPER.,7'-0"x15'-0" Warehouse	1	each	1.20	37.04	37.04	\$80.41	\$2,331.00		\$2,978	\$2,331	\$0	\$5,309
Pr	e-engineered Bldg	s					2,079	80.41			\$167,182	\$127,586	\$0	\$294,768
	160801	PREFAB BLDGS Warehouse Complete	4,125.00	sqft	1.20	0.50	2,079.00	\$80.41	\$30.93		\$167,182	\$127,586	\$0	\$294,768
Se	curity Bldg						1,123	80.41			\$90,322	\$67,014	\$0	\$157,336
	160100	ALLOWANCE All-IN Cost	900.00	sqft	1.20	1.25	1,123.20	\$80.41	\$74.46		\$90,322	\$67,014	\$0	\$157,336
Sk	y Lights						513	80.41			\$41,253	\$23,520	\$0	\$64,773
	160399	Speciality Items Skylights	50	each	1.20	10.26	513.00	\$80.41	\$470.40		\$41,253	\$23,520	\$0	\$64,773
Tv	vo Hour Rated Fir	ewall Furnace Room Enclosure					649	80.41			\$52,186	\$13,645	\$0	\$65,831
	161006	DW PARTITIONS Metal Studs NLB 3-5/8" on 16" ctrs Btwn Furnace Area & Process Are	8,320.00	sqft	1.20	0.08	648.96	\$80.41	\$1.64		\$52,186	\$13,645	\$0	\$65,831
Ut	ilities	1110					1,232	80.41			\$99,103	\$5,117	\$0	\$104,220
	161101	SPECIALTIES-ALLOWANCE Compressed Air System Compressor	1.00	lsum	1.20	344.40	344.40	\$80.41	\$1,430.00		\$27,695	\$1,430	\$0	\$29,125
	161101	SPECIALTIES-ALLOWANCE Treated Water System Pump	1.00	lsum	1.20	102.00	102.00	\$80.41	\$425.00		\$8,202	\$425	\$0	\$8,627
	161101	SPECIALTIES Wash Down Spray System Pump & Piping	1.00	lsum	1.20	786.00	786.00	\$80.41	\$3,262.00		\$63,206	\$3,262	\$0	\$66,468

Location: GREEN FIELD SITE
Account: 21 Spare Parts
Facility: Entire Estimate
Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

		Green Field Site					JOD NO:	2/989-323	Rev No: 0				Estimate: FF	C	
			A			Lab.		Workhours						Totals	
Accou	int No.	Description	Avg Diam	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Swaging I	tem D											\$0	\$15,000	\$0	\$15,000
210	101	SPARE PARTS		2	each					\$7,500.00		\$0	\$15,000	\$0	\$15,000
210	101	SPARE PARTS		2	each							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each	1.20						\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		2	each							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
Firm Price	-Al Claddi	ng Cleaning Station Item 29										\$0	\$10,000	\$0	\$10,000
210	101	SPARE PARTS		1	each					\$10,000.00		\$0	\$10,000	\$0	\$10,000
210	101	sample-SPARE PARTS		1.00	lsum							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each	1.20						\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		2	each	1.20						\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
Firm Price	-Hydrauli	Press Item 20										\$0	\$5,000	\$0	\$5,000
210	101	SPARE PARTS		1	each					\$5,000.00		\$0	\$5,000	\$0	\$5,000
210	101	SPARE PARTS		4	each							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		2	each	1.20						\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
Firm Price	-Marking	Station Item 28										\$0	\$5,000	\$0	\$5,000
210		SPARE PARTS		1	each					\$5,000.00		\$0	\$5,000	\$0	\$5,000
	-	lachines Salt Removal Item 31										\$0	\$5,000	\$0	\$5,000
210		SPARE PARTS		1	each					\$5,000.00		\$0	\$5,000	\$0	\$5,000
210		SPARE PARTS		5	each							\$0	\$0	\$0	\$0
210		SPARE PARTS		1	each							\$0	\$0	\$0	\$0
210		SPARE PARTS		1	each							\$0	\$0	\$0	\$0
210		SPARE PARTS		1	each							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each	1.20						\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
	-	fill w/Tunnel Furnace 25								0.000.00		\$0	\$6,000	\$0	\$6,000
210		SPARE PARTS		1	each					\$6,000.00		\$0	\$6,000	\$0	\$6,000
210		SPARE PARTS		1	each							\$0	\$0	\$0	\$0
210	101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0

Page 58 of 62

Location: GREEN FIELD SITE
Account: 21 Spare Parts
Facility: Entire Estimate
Green Field Site



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC
Office: Denver
Product Line: Gov

		Green Field Site				Job No:	27989-325	Rev No: 0				Estimate: FFC		
			Avg		Lab.		Workhours						Totals	
	Account No.	Description	Diam Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Fr	iction Welders Ite	m 22									\$0	\$40,000	\$0	\$40,000
	210101	SPARE PARTS	4	eac	h				\$10,000.00		\$0	\$40,000	\$0	\$40,000
	210101	SPARE PARTS		eac	h						\$0	\$0	\$0	\$0
	210101	SPARE PARTS		eac	h						\$0	\$0	\$0	\$0
	210101	SPARE PARTS		eac	h						\$0	\$0	\$0	\$0
	210101	SPARE PARTS		eac	h						\$0	\$0	\$0	\$0
	210101	SPARE PARTS		eac	h						\$0	\$0	\$0	\$0
	210101	SPARE PARTS		eac	h						\$0	\$0	\$0	\$0
	210101	SPARE PARTS		eac	h						\$0	\$0	\$0	\$0
Pr	ocess Equipment	Channel Probe Item B									\$0	\$100,000	\$0	\$100,000
	210101	SPARE PARTS		eac	h 1.20				\$100,000.00		\$0	\$100,000	\$0	\$100,000
	210101	SPARE PARTS	2	eac	h 1.20						\$0	\$0	\$0	\$0
	210101	SPARE PARTS	3	eac	h						\$0	\$0	\$0	\$0
Ro	oller Levelers Iten	ı 19									\$0	\$3,000	\$0	\$3,000
	210101	SPARE PARTS		eac	h 1.20				\$3,000.00		\$0	\$3,000	\$0	\$3,000
	210101	SPARE PARTS		eac	h						\$0	\$0	\$0	\$0

Location: GREEN FIELD SITE

Account: 31 Construction Management Staff & Services
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:37AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

	racinty	Green Field Site		Job No: 27989-325 Rev No: 0						Pro	Product Line: Gov Estimate: FFC			
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Si	ubs Total
Cor	nstruction Manage	ement - URS					20,984	70.40			\$1,477,274	\$0	\$238,220	\$1,715,494
	310101	Site Manager	24.00	mnth		172.00	4,128.00	\$95.00		\$2,150.00	\$392,160	\$0	\$51,600	\$443,760
	310603	Project Secretary (Local)	24.00	mnth		172.00	4,128.00	\$38.20		\$1,720.00	\$157,690	\$0	\$41,280	\$198,970
	310901	Safety Professional	24.00	mnth		172.00	4,128.00	\$81.00		\$2,150.00	\$334,368	\$0	\$51,600	\$385,968
	310901	Superientendant Civil/Structural (local)	8.00	mnth		172.00	1,376.00	\$65.00		\$1,720.00	\$89,440	\$0	\$13,760	\$103,200
	310901	Superientendant Piping/Mech (local)	4.00	mnth		172.00	688.00	\$65.00		\$1,720.00	\$44,720	\$0	\$6,880	\$51,600
	310901	Superientendant Elec/I& C (local)	6.00	mnth		172.00	1,032.00	\$65.00		\$1,720.00	\$67,080	\$0	\$10,320	\$77,400
	310901	Project Controls	18.00	mnth		172.00	3,096.00	\$76.00		\$2,150.00	\$235,296	\$0	\$38,700	\$273,996
	310901	Superientendant Elec/I& C (local)	14.00	mnth		172.00	2,408.00	\$65.00		\$1,720.00	\$156,520	\$0	\$24,080	\$180,600

Т	otals 31-Construction Management Staff & Services	20,984 \$70.40	\$1,477,274	\$0	\$238,220	\$1,715,494
	Entire Estimate					

Client: INL Project: FFC Location: GREEN FIELD SITE

Account: 61 Home Office Services
Facility: Entire Estimate

Green Field Site

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:37AM

Priced By: ADC Office: Denver Product Line: Gov Estimate: FFC

					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
All	-In Home Office at	t 105\$/hr					68,600	105.00			\$7,203,000	\$0	\$0	\$7,203,000
	610000	ALL IN HOME OFFICE w/ Overhead & other costs	68,600.00	mnhr		1.00	68,600.00	\$105.00			\$7,203,000	\$0	\$0	\$7,203,000

To	als 61-Home Office Services	68,600 \$105.00	\$7,203,000	\$0	\$0	\$7,203,000
	Entire Estimate					

Location: GREEN FIELD SITE

Account:

Facility: Entire Estimate

Green Field Site

URSWashington Division

Job No: 27989-325

Date: 7/17/2008 11:37AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

				Lah		Workhours						Totals	
Account No.	Description	Qty	UM	Lab. Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

Grand Total: Entire Estimate	270,154 86.24	\$23,297,530	\$22,367,690	\$3,431,007	\$49,096,227

Estimate Summary

HIP Alternate

Revision 1

Client: INL
Project: FFC
Location: GREEN FIELD SITE HIP Option
Facility: Entire Estimate

Washington Division

Date: 7/17/2008
Priced By: ADC
Office: Denver
Product Line: Gov

11:41AM

File Name: FFC

	HIP Option	Job No: 27989-325	Rev No: 0	File Nam	e: FFC	
ACCT	DESCRIPTION	WORKHOURS	LABOR	MATERIAL	SUBS	TOTAL
01	Demolition					
02	Improvements to Site	10,501	\$867,563	\$353,652	\$46,150	\$1,267,365
03	Earthwork	13,404	\$1,082,984	\$4,056		\$1,087,040
04	Concrete/Masonry	78,706	\$6,163,231	\$1,853,693		\$8,016,924
05	Structural Steel/Platework	1,939	\$176,914	\$257,204		\$434,119
06	Permanent Equipment	12,533	\$1,110,740	\$19,234,532	\$6,939,750	\$27,285,022
11	Piping Bulks	19,008	\$1,653,839	\$158,279		\$1,812,118
12	Electrical Bulks	18,128	\$1,543,287	\$1,367,206		\$2,910,494
13	Instrumentation Bulks	1,495	\$133,447	\$4,989,521		\$5,122,968
14	Painting/Coatings/Liners					
15	Insulation					
16	Buildings	38,398	\$2,992,762	\$2,008,403	\$492,487	\$5,493,652
21	Spare Parts					
22	Freight					
	DIRECT FIELD COST	194,111	\$15,724,767	\$30,226,546	\$7,478,387	\$53,429,701
31	Constr. Mgt. Staff & Services	20,984	\$1,477,274		\$238,220	\$1,715,494
32	Craft Labor Related Expenses					
33	Temporary Construction Facilities, Furnishings, Services					
41	Construction Equipment					
51	Start Up Services					
	INDIRECT FIELD COST	20,984	\$1,477,274	\$0	\$238,220	\$1,715,494
	TOTAL FIELD COST	215,095	\$17,202,041	\$30,226,546	\$7,716,607	\$55,145,195
61	Home Office Services	85,714	\$8,999,970			\$8,999,970
	TOTAL FIELD, HOME OFFICE AND ENGINEERING	300,809	\$26,202,011	\$30,226,546	\$7,716,607.31	\$64,145,165
74.10	INSURANCE CGL & Pkg Policy	0.42%				\$267,475
74.20	TAXES (EXCLUDED)					\$0
74.30	BONDS (EXCLUDED)					\$0
74.40	PERMITS (EXCLUDED)					\$0
74.50	FREIGHT 5% on Material Costs	2.36%				\$1,511,327
79.50	ESCALATION					\$0
80.10	CONTINGENCY	26.77%				\$17,651,034
89.1	G&A ??	Prov. Rate:	% of Sales : 0.00%			\$0
90	TOTAL PROJECT COST Basis for FEE	1707 Aute.	70 by Saites 1 0.00 70			\$83,575,001
90.1	FEES		0.00%			\$0
91	WARRANTY RESERVE		0.0078			\$0 \$0
100.1	CLIENT COSTS					\$0 \$0
ı						
100.2 110	FEES ON CLIENT COSTS	+				\$0 \$83,575,001
110	GRAND TOTAL PROJECT	-				\$65,575,001
ĺ						
ĺ						
	otal Summary					Dogg 1 of 1

Grand Total Summary Page 1 of 1

Estimate Details

HIP Alternate

Revision 1

Location: GREEN FIELD SITE HIP Option Account: 02 Improvements to Site Facility: Entire Estimate

HIP Option

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

												-	
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Tota
ove and Below G						351	82.56			\$28,961	\$49,003	\$0	\$77,964
020403	Install Concrete Lined Ditch (1000 lnft)	222.00	cuyd	1.20	0.94	207.60	\$82.56	\$187.48		\$17,139	\$41,620	\$0	\$58,759
020403	Install Silt Fence 3,015 Inft	1	each	1.20	51.96	51.96	\$82.56	\$1,130.22		\$4,290	\$1,130	\$0	\$5,420
020403	Install Haybales 100 ea	1	each	1.20	24.00	24.00	\$82.56	\$1,071.30		\$1,981	\$1,071	\$0	\$3,053
020403	Install Concrete Valley Gutter at Project Entrance	18.00	cuyd	1.20	1.92	34.56	\$82.56	\$74.99		\$2,853	\$1,350	\$0	\$4,203
020403	Install 6" Compacted Subgrade for Conc Ditch	111.00	cuyd	1.20	0.29	32.67	\$82.56	\$34.52		\$2,698	\$3,831	\$0	\$6,529
ncing						701	82.56			\$57,857	\$142,200	\$0	\$200,057
021002	CHAINLINK FENCE 12' hight w/razor wire	2,800.00	lnft	1.20	0.24	672.00	\$82.56	\$50.00		\$55,480	\$140,000	\$0	\$195,480
021010	GATE 3' wide Personnel Entrance	1	each	1.20	4.80	4.80	\$82.56	\$200.00		\$396	\$200	\$0	\$596
021010	GATE 40	2	each	1.20	12.00	24.00	\$82.56	\$1,000.00		\$1,981	\$2,000	\$0	\$3,981
king lot						2,938	82.56			\$242,525	\$56,644	\$0	\$299,169
020403	4" ASPHALT WEARING COURSE (parking lot)	6,800.00	sqyd	1.20	0.24	1,632.00	\$82.56	\$6.33		\$134,736	\$43,044	\$0	\$177,780
020404	6" COMPACTED LOCAL GRAVEL (parking lot)	6,800.00	sqyd	1.20	0.19	1,305.60	\$82.56	\$2.00		\$107,789	\$13,600	\$0	\$121,389
ad Work						5,670	82.56			\$468,109	\$96,390	\$0	\$564,499
020403	4" ASPHALT WEARING COURSE (for roads)	10,500.00	sqyd	1.20	0.24	2,520.00	\$82.56	\$6.33		\$208,048	\$66,465	\$0	\$274,513
020404	12" COMPACTED LOCAL GRAVEL (for roads)	10,500.00	sqyd	1.20	0.30	3,150.00	\$82.56	\$2.85		\$260,060	\$29,925	\$0	\$289,985
e Drainage	CM IN TO FAID			4.00		80	79.58	000.00		\$6,356	\$3,260	\$0	\$9,616
020304	CMP 18 END	8	each	1.20	2.18	17.47	\$79.58	\$70.00		\$1,390	\$560	\$0	\$1,950
020304	CMP 18 14G	200.00	lnft	1.20	0.31	62.40	\$79.58	\$13.50		\$4,966	\$2,700	\$0	\$7,666
Preparation						576	83.91			\$48,350	\$0	\$46,150	\$94,500
020202	CLEAR & GRUB LIGHT site, roads & parking lot	13.00	acre	1.20					\$3,550.00	\$0	\$0	\$46,150	\$46,150
020203	Clear Grub, Strip: 6"	8,003.00	cuyd	1.20	0.07	576.22	\$83.91			\$48,350	\$0	\$0	\$48,350
	E WORK & FOUNDATIONS					186	82.82			\$15,405	\$6,155	\$0	\$21,560
020202	ROUGH & FINE GRADE	300.00	sqyd	1.20	0.12	36.00	\$83.91			\$3,021	\$0	\$0	\$3,021
020404	12" COMPACTED LOCAL GRAVEL	300.00	sqyd	1.20	0.30	90.00	\$82.56	\$3.85		\$7,430	\$1,155	\$0	\$8,585
021003	Fence, Chain Link 8'	200.00	lnft	1.20	0.30	60.00	\$82.56	\$25.00		\$4,954	\$5,000	\$0	\$9,954

Totals	02-Improvements to Site	10,501 \$82.61	\$867,563	\$353,652	\$46,150	\$1,267,365
	Entire Estimate					

Page 1 of 69

Location: GREEN FIELD SITE HIP Option

Account: 03 Earthwork
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

		III opuon												
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Sani	tary Sewer Line	e 475 lnft by 6' deep					545	79.65			\$43,400	\$0	\$0	\$43,400
	030102	REMOVE SURPLUS EXCAVATION	316.67	cuyd	1.20	0.04	11.40	\$83.91			\$957	\$0	\$0	\$957
	030104	HAND EXCAVATION	95.00	cuyd	1.20	1.62	153.90	\$74.33			\$11,439	\$0	\$0	\$11,439
	030105	TRENCH EXCAVATION	855.00	cuyd	1.20	0.13	112.86	\$79.58			\$8,981	\$0	\$0	\$8,981
	030204	HAND BACKFILL	63.33	cuyd	1.20	2.16	136.80	\$82.56			\$11,294	\$0	\$0	\$11,294
	030205	TRENCH BACKFILL	570.00	cuyd	1.20	0.23	129.96	\$82.56			\$10,729	\$0	\$0	\$10,729
Conc	rete Footing by	Dimension					2,725	81.24			\$221,387	\$0	\$0	\$221,387
	030102	REMOVE SURPLUS EXCAVATION	750.00	cuyd	1.20	0.16	117.00	\$83.91			\$9,817	\$0	\$0	\$9,817
	030103	STRUCTURAL EXCAVATION	3,037.50	cuyd	1.20	0.18	546.75	\$83.91			\$45,878	\$0	\$0	\$45,878
	030104	HAND EXCAVATION	337.50	cuyd	1.20	1.62	546.75	\$74.33			\$40,640	\$0	\$0	\$40,640
	030203	STRUCTURAL BACKFILL	3,037.50	cuyd	1.20	0.31	947.70	\$82.56			\$78,241	\$0	\$0	\$78,241
	030204	HAND BACKFILL	262.50	cuyd	1.20	2.16	567.00	\$82.56			\$46,811	\$0	\$0	\$46,811
Conc	rete Footing by	Dimension Security Bldg					106	81.26			\$8,589	\$0	\$0	\$8,589
	030102	REMOVE SURPLUS EXCAVATION	44.00	cuyd	1.20	0.16	6.86	\$83.91			\$576	\$0	\$0	\$576
	030103	STRUCTURAL EXCAVATION	118.80	cuyd	1.20	0.18	21.38	\$83.91			\$1,794	\$0	\$0	\$1,794
	030104	HAND EXCAVATION	13.20	cuyd	1.20	1.62	21.38	\$74.33			\$1,589	\$0	\$0	\$1,589
	030203	STRUCTURAL BACKFILL	118.80	cuyd	1.20	0.31	37.07	\$82.56			\$3,060	\$0	\$0	\$3,060
	030204	HAND BACKFILL	8.80	cuyd	1.20	2.16	19.01	\$82.56			\$1,569	\$0	\$0	\$1,569
Conc		Dimension under Warehouse Slab					139	81.26			\$11,322	\$0	\$0	\$11,322
	030102	REMOVE SURPLUS EXCAVATION	58.00	cuyd	1.20	0.16	9.05	\$83.91			\$759	\$0	\$0	\$759
	030103	STRUCTURAL EXCAVATION	156.60	cuyd	1.20	0.18	28.19	\$83.91			\$2,365	\$0	\$0	\$2,365
	030104	HAND EXCAVATION	17.40	cuyd	1.20	1.62	28.19	\$74.33			\$2,095	\$0	\$0	\$2,095
	030203	STRUCTURAL BACKFILL	156.60	cuyd	1.20	0.31	48.86	\$82.56			\$4,034	\$0	\$0	\$4,034
	030204	HAND BACKFILL	11.60	cuyd	1.20	2.16	25.06	\$82.56			\$2,069	\$0	\$0	\$2,069
CON		BY VOLUME Security Bldg					15	80.91			\$1,192	\$0	\$0	\$1,192
	030102	REMOVE SURPLUS EXCAVATION	17.00	cuyd	1.20	0.16	2.65	\$83.91			\$223	\$0	\$0	\$223
	030103	STRUCTURAL EXCAVATION	22.50	cuyd	1.20	0.18	4.05	\$83.91			\$340	\$0	\$0	\$340
	030104	HAND EXCAVATION	2.50	cuyd	1.20	1.62	4.05	\$74.33			\$301	\$0	\$0	\$301
	030203	STRUCTURAL BACKFILL	7.20	cuyd	1.20	0.31	2.25	\$82.56			\$185	\$0	\$0	\$185
	030204	HAND BACKFILL	0.80	cuyd	1.20	2.16	1.73	\$82.56			\$143	\$0	\$0	\$143
CON		BY VOLUME Sidewalk to Bldg					37	80.92			\$3,026	\$0	\$0	\$3,026
	030102	REMOVE SURPLUS EXCAVATION	42.00	cuyd	1.20	0.16	6.55	\$83.91			\$550	\$0	\$0	\$550
	030103	STRUCTURAL EXCAVATION	56.70	cuyd	1.20	0.18	10.21	\$83.91			\$856	\$0	\$0	\$856
	030104	HAND EXCAVATION	6.30	cuyd	1.20	1.62	10.21	\$74.33			\$759	\$0	\$0	\$759
	030203	STRUCTURAL BACKFILL	18.90	cuyd	1.20	0.31	5.90	\$82.56			\$487	\$0	\$0	\$487
													Dogo 1) of 60

Page 2 of 69

Location: GREEN FIELD SITE HIP Option

Account: 03 Earthwork
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

		HIP Option				300 140.	21909-323	KCV NO. 0				Estimate. FFC		
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	030204	HAND BACKFILL	2.10	cuyd	1.20	2.16	4.54	\$82.56			\$374	\$0	\$0	\$374
CC	NCRETE SOG -	BY VOLUME Slab under Office Section					91	80.93			\$7,394	\$0	\$0	\$7,394
	030102	REMOVE SURPLUS EXCAVATION	98.00	cuyd	1.20	0.16	15.29	\$83.91			\$1,283	\$0	\$0	\$1,283
	030103	STRUCTURAL EXCAVATION	136.80	cuyd	1.20	0.18	24.62	\$83.91			\$2,066	\$0	\$0	\$2,066
	030104	HAND EXCAVATION	15.20	cuyd	1.20	1.62	24.62	\$74.33			\$1,830	\$0	\$0	\$1,830
	030203	STRUCTURAL BACKFILL	48.60	cuyd	1.20	0.31	15.16	\$82.56			\$1,252	\$0	\$0	\$1,252
	030204	HAND BACKFILL	5.40	cuyd	1.20	2.16	11.66	\$82.56			\$963	\$0	\$0	\$963
CC	ONCRETE SOG -	BY VOLUME Warehouse					68	80.92			\$5,476	\$0	\$0	\$5,476
	030102	REMOVE SURPLUS EXCAVATION	76.00	cuyd	1.20	0.16	11.86	\$83.91			\$995	\$0	\$0	\$995
	030103	STRUCTURAL EXCAVATION	102.60	cuyd	1.20	0.18	18.47	\$83.91			\$1,550	\$0	\$0	\$1,550
	030104	HAND EXCAVATION	11.40	cuyd	1.20	1.62	18.47	\$74.33			\$1,373	\$0	\$0	\$1,373
	030203	STRUCTURAL BACKFILL	34.20	cuyd	1.20	0.31	10.67	\$82.56			\$881	\$0	\$0	\$881
	030204	HAND BACKFILL	3.80	cuyd	1.20	2.16	8.21	\$82.56			\$678	\$0	\$0	\$678
Du	ctbank by Dimen	sion (2.5' X 2.5' X 500')					650	81.16			\$52,763	\$0	\$0	\$52,763
	030102	REMOVE SURPLUS EXCAVATION	115.00	cuyd	1.20	0.16	17.94	\$83.91			\$1,505	\$0	\$0	\$1,505
	030103	STRUCTURAL EXCAVATION	756.25	cuyd	1.20	0.18	136.13	\$83.91			\$11,422	\$0	\$0	\$11,422
	030104	HAND EXCAVATION	84.03	cuyd	1.20	1.62	136.13	\$74.33			\$10,118	\$0	\$0	\$10,118
	030203	STRUCTURAL BACKFILL	652.08	cuyd	1.20	0.31	203.45	\$82.56			\$16,797	\$0	\$0	\$16,797
	030204	HAND BACKFILL	72.45	cuyd	1.20	2.16	156.50	\$82.56			\$12,920	\$0	\$0	\$12,920
Ma	at (@Grade) - By	Volume Under Process Areas					3,792	80.92			\$306,828	\$0	\$0	\$306,828
	030102	REMOVE SURPLUS EXCAVATION	4,251.00	cuyd	1.20	0.16	663.16	\$83.91			\$55,645	\$0	\$0	\$55,645
	030103	STRUCTURAL EXCAVATION	5,747.40	cuyd	1.20	0.18	1,034.53	\$83.91			\$86,807	\$0	\$0	\$86,807
	030104	HAND EXCAVATION	638.60	cuyd	1.20	1.62	1,034.53	\$74.33			\$76,897	\$0	\$0	\$76,897
	030203	STRUCTURAL BACKFILL	1,921.50	cuyd	1.20	0.31	599.51	\$82.56			\$49,495	\$0	\$0	\$49,495
	030204	HAND BACKFILL	213.00	cuyd	1.20	2.16	460.08	\$82.56			\$37,984	\$0	\$0	\$37,984
Pa	rking Lot						53	83.91			\$4,430	\$0	\$0	\$4,430
	030102	MASS EXCAVATION Cut to Fill for Parking Lots 1'	4,400.00	cuyd	1.20	0.01	52.80	\$83.91			\$4,430	\$0	\$0	\$4,430
Ro	ad Work 030102	MASS EXCAVATION Cut to Fill for	2,233.00	1	1.20	0.01	27 26.80	83.91 \$83.91			\$2,248 \$2,248	\$0 \$0	\$0 \$0	\$2,248 \$2,248
	030102	Roads 1'	2,233.00	cuya	1.20	0.01	26.80	\$83.91			\$2,248	\$0	\$0	\$2,248
Sit	e Drainage						5	83.91			\$425	\$0	\$0	\$425
	030102	MASS EXCAVATION ditch 3' wide by 2' deep by 3806 lnft	422.00	cuyd	1.20	0.01	5.06	\$83.91			\$425	\$0	\$0	\$425
Sit	e Preparation						385	83.91			\$32,342	\$0	\$0	\$32,342
	030102	MASS EXCAVATION Cut to Fill to Level site 2'	32,120.00	cuyd	1.20	0.01	385.44	\$83.91			\$32,342	\$0	\$0	\$32,342
Str	uctural Excavati	ion / Backfill Fire Water Collection Tanks					373	80.94			\$30,199	\$0	\$0	\$30,199
													Page 3	of 69

Page 3 of 69

Location: GREEN FIELD SITE HIP Option

Account: 03 Earthwork
Facility: Entire Estimate
HIP Option



Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

		F												
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	030102	REMOVE SURPLUS EXCAVATION	170.00	cuyd	1.20	0.04	6.12	\$83.91			\$514	\$0	\$0	\$514
	030103	STRUCTURAL EXCAVATION	495.00	cuyd	1.20	0.18	89.10	\$83.91			\$7,476	\$0	\$0	\$7,476
	030104	HAND EXCAVATION	55.00	cuyd	1.20	1.62	89.10	\$74.33			\$6,623	\$0	\$0	\$6,623
	030203	STRUCTURAL BACKFILL	342.00	cuyd	1.20	0.31	106.70	\$82.56			\$8,809	\$0	\$0	\$8,809
	030204	HAND BACKFILL	38.00	cuyd	1.20	2.16	82.08	\$82.56			\$6,776	\$0	\$0	\$6,776
Str		on / Backfill HIP Foundations					1,522	80.92			\$123,180	\$0	\$0	\$123,180
	030102	REMOVE SURPLUS EXCAVATION	740.00	cuyd	1.20	0.04	26.64	\$83.91			\$2,235	\$0	\$0	\$2,235
	030103	STRUCTURAL EXCAVATION	2,043.00	cuyd	1.20	0.18	367.74	\$83.91			\$30,857	\$0	\$0	\$30,857
	030104	HAND EXCAVATION	227.00	cuyd	1.20	1.62	367.74	\$74.33			\$27,334	\$0	\$0	\$27,334
	030203	STRUCTURAL BACKFILL	1,377.00	cuyd	1.20	0.31	429.62	\$82.56			\$35,469	\$0	\$0	\$35,469
	030204	HAND BACKFILL	153.00	cuyd	1.20	2.16	330.48	\$82.56			\$27,284	\$0	\$0	\$27,284
	ench Excavation / 00 lnft 6' deep	Backfill by Lineal Feet Fire Water Line					2,322	79.68			\$185,050	\$2,667	\$0	\$187,717
100	030102	REMOVE SURPLUS EXCAVATION	1,333.33	cuyd	1.20	0.04	48.00	\$83.91			\$4,028	\$0	\$0	\$4,028
	030104	HAND EXCAVATION	400.00	cuyd	1.20	1.62	648.00	\$74.33			\$48,166	\$0	\$0	\$48,166
	030105	TRENCH EXCAVATION	3,600.00	cuyd	1.20	0.13	475.20	\$79.58			\$37,815	\$0	\$0	\$37,815
	030204	HAND BACKFILL	266.67	cuyd	1.20	2.16	576.00	\$82.56			\$47,554	\$0	\$0	\$47,554
	030205	TRENCH BACKFILL	2,400.00	cuyd	1.20	0.23	547.20	\$82.56			\$45,176	\$0	\$0	\$45,176
	030205	BEDDING	333.33	cuyd	1.20	0.08	28.00	\$82.56	\$8.00		\$2,312	\$2,667	\$0	\$4,978
		Backfill for underground conduits & ground					548	79.84			\$43,731	\$1,389	\$0	\$45,120
cal	030102	REMOVE SURPLUS EXCAVATION	222.22	cuyd	1.20	0.04	8.00	\$83.91			\$671	\$0	\$0	\$671
	030102	HAND EXCAVATION	88.89	cuyd	1.20	1.62	144.00	\$74.33			\$10,704	\$0 \$0	\$0	\$10,704
	030104	TRENCH EXCAVATION	800.00	cuyd	1.20	0.13	105.60	\$79.58			\$8,403	\$0 \$0	\$0	\$8,403
	030204	HAND BACKFILL	66.67	cuyd	1.20	2.16	144.00	\$82.56			\$11,888	\$0	\$0	\$11,888
	030204	TRENCH BACKFILL	600.00	cuyd	1.20	0.23	136.80	\$82.56			\$11,000	\$0 \$0	\$0 \$0	\$11,294
	030205	BEDDING	111.11	-	1.20	0.23	9.33	\$82.56 \$82.56	\$12.50		\$11,294 \$771	\$1,389	\$0 \$0	\$2,159
	030203	DEDDING	111.11	cuyd	1.20	0.08	9.55	\$82.30	\$12.50		\$//1	\$1,389	20	\$2,139

Totals	03-Earthwork Entire Estimate	13,404 \$80.80	\$1,082,984	\$4,056	\$0	\$1,087,040

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

URS

Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov

	HIP Option				Job No:	27989-325	Rev No: 0			F	Estimate: FFC		
				Lab.		Workhours						Totals	
Account No	o. Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
04.04 Concrete	by Commodity												
04xx02**	Reinforcing Steel	430	ton	1.20	24.00	10,311.36	\$92.37	\$1,317.63		\$952,440	\$566,108	\$0	\$1,518,548
04xx03**	Formwork	92,570	sqft	1.20	0.48	44,433.74	\$75.57	\$3.00		\$3,357,832	\$277,847	\$0	\$3,635,679
04xx04**	Embeds	20,497	lb	1.20	0.06	1,267.77	\$85.57	\$2.50		\$108,486	\$51,243	\$0	\$159,728
04xx08**	Concrete	6,958	cuyd	1.20	1.87	13,043.34	\$76.74	\$132.38		\$1,000,936	\$925,647	\$0	\$1,926,583
04xx09**	Finishing	166,707	sqft	1.20	0.02	4,123.43	\$76.74	\$0.01		\$316,429	\$1,667	\$0	\$318,096
04xx05**	Anchor Bolts	4,448	lb	1.20	0.24	1,067.48	\$82.89	\$1.40		\$88,479	\$6,227	\$0	\$94,706
04xx09**	Fine Grade	98,776	sqft	1.20	0.04	3,555.93	\$75.76	\$0.03		\$269,379	\$2,963	\$0	\$272,343
04xx06**	Waterstop	2,206	lnft	1.20	0.07	158.84	\$76.44	\$5.00		\$12,142	\$11,031	\$0	\$23,172
04xx11**	Grout	174	cuft	1.20	3.77	656.54	\$76.74	\$60.00		\$50,383	\$10,457	\$0	\$60,840
04xx10**	Hardener	16,714	sqft	1.20	0.00	80.22	\$76.74	\$0.03		\$6,156	\$501	\$0	\$6,658
04xx07**	Keyway	104	lnft	1.20	0.07	7.51	\$75.57	\$0.03		\$568	\$3	\$0	\$571

Overall Ratios:

FormWork: 13.30 SF/CUYD Rebar: 123.49 LB/CUYD Embedments: **2.95** LB/CUYD

> Wkhr/CY 11.31 Total/CUYD \$1,152.13

Grand Total: Concrete / Masonry	6,958	CUYD	1.20	11.31	78,706	\$78.31	\$6,163,231	\$1,853,693	\$0	\$8,016,924
							\$885.73 /CY	\$266.40 /CY	\$0.00 /CY	

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

Descript Pour Type pootings lab On Grade	FormWork Rebar Embedments	12.9%		Qty UM 895 cuyd SF/CY LB/CY LB/CY	1.20		Workhours Total 9,607.46	Rate \$77.78	Mat'l Unit	Subs Unit	Labor \$747,314	Material	Totals Subs	Total
Pour Type pootings	FormWork Rebar Embedments		15.80 106.25	895 cuyd SF/CY LB/CY	1.20	10.74				Subs Unit			Subs	Total \$976,501
ootings	Rebar Embedments		15.80 106.25	SF/CY LB/CY			9,607.46	\$77.78	\$256.21		\$747,314	\$229,187		\$976,501
	Rebar Embedments		15.80 106.25	SF/CY LB/CY			9,607.46	\$77.78	\$256.21		\$747,314	\$229,187		\$976,501
lab On Grade	Rebar Embedments	3.8%	106.25	LB/CY										
lab On Grade		3.8%				Wkhrs/CY Total\$/CY	10.74 1,091.65							
		5.070		266 cuyd	1.20	8.20	2,177.84	\$79.03	\$231.61		\$172,118	\$61,527		\$233,645
	FormWork Rebar Embedments		2.05 75.24 4.29	SF/CY LB/CY LB/CY		Wkhrs/CY Total\$/CY	8.20 879.52							
uctbank	٦	1.7%		122 cuyd	1.20	12.98	1,577.77	\$76.47	\$284.61		\$120,646	\$34,588		\$155,234
	FormWork Rebar Embedments		21.90 46.67 0.00	SF/CY LB/CY LB/CY			12.98 1,277.36							
/all		9.3%		650 cuyd	1.20	52.21	33,961.96	\$76.68	\$539.28		\$2,604,146	\$350,786		\$2,954,932
	FormWork Rebar Embedments		93.49 152.83 12.06	SF/CY LB/CY LB/CY			52.21 4,542.73]						
lat		69.3%	4,	,824 cuyd	1.20	6.05	29,172.21	\$80.28	\$231.07		\$2,342,020	\$1,114,606		\$3,456,626
	FormWork Rebar Embedments		2.86 126.67 1.90	SF/CY LB/CY LB/CY			6.05 716.59							
iers		0.1%		4 cuyd	1.20	9.60	38.40	\$76.74	\$200.00		\$2,947	\$800		\$3,747
	FormWork Rebar Embedments		0.00 0.00 0.00	SF/CY LB/CY LB/CY			9.60 936.70							
/a	ull u	FormWork Rebar Embedments FormWork Rebar Embedments TormWork Rebar Embedments FormWork Rebar Embedments	FormWork Rebar Embedments 9.3% FormWork Rebar Embedments 4 69.3% FormWork Rebar Embedments 1 0.1% FormWork Rebar Embedments	FormWork 21.90 Rebar 46.67 Embedments 0.00	FormWork	FormWork 21.90 SF/CY Rebar 46.67 LB/CY Embedments 0.00 LB/CY 1.20	FormWork 21.90 SF/CY Rebar 46.67 LB/CY Embedments 0.00 LB/CY	FormWork 21.90 SF/CY Rebar 46.67 LB/CY L20 S2.21 33,961.96	FormWork 21.90 SF/CY Rebar 46.67 LB/CY Embedments 0.00 LB/CY	FormWork 21.90 SF/CY Rebar 46.67 LB/CY LB/CY LB/CY L2.98 Total\$/CY 1,277.36	FormWork 21.90 SF/CY Rebar 46.67 LB/CY TotalS/CY 12.98 TotalS/CY 1,277.36	FormWork 21.90 SF/CY Rebar 46.67 LB/CY Embedments 0.00 LB/CY	FormWork	FormWork 21.90 SF/CY Rebar 46.67 LB/CY Embedments 0.00 LB/CY

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

URS

Washington Division

Date: 7/17/2008 11:31AM

Priced By: ADC Office: Denver Product Line: Gov

	HIP Option						Job No:	27989-325	Rev No: 0				Estimate: FFC		
					La	h		Workhours						Totals	
Account	No. Description	1		Qty	JM Fa		Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
0425	Precast Concrete			0 cuy	d	1.20		28.66	\$76.74			\$2,199	\$4,050		\$6,249
		FormWork Rebar Embedments	0.00 0.00 0.00	SF/CY LB/CY LB/CY][Tot	khrs/CY ral\$/CY	0.00 0.00]						
0432	Elevated Slab - On Dec	FormWork Rebar Embedments	2.9% 3.22 141.90 11.43	LB/CY	d		9.46 chrs/CY al\$/CY	9.46 1,056.85	\$80.72	\$293.02		\$151,582	\$58,150		\$209,731
0499	Non-Standard Pour Type MISC ALL-IN			0 cuy 22 cuyd		.20 1.20	12.00	264.00 264.00	\$76.74 \$76.74			\$20,259 \$20,259			\$20,259 \$20,259

Overall Ratios: FormWork 13.30 SF/CY Rebar **123.49** LB/CY Embedments 2.95 LB/CY Wkhrs/CY 11.31 Total\$/CY \$1,152.13

Grand Total:	Concrete / Masonry	6,958 cuyd	1.20	11.31	78,706	\$78.31	\$6,163,231	\$1,853,693	\$0	\$8,016,924
							\$885.73 /CY	\$266.40/CY	\$0.00 /CY	

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

URS

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

HIP Option				JOB NO:	2/989-323	Rev No: 0				Estimate: FFC		
			Lab.		Workhours						Totals	
Account No. Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
04.02 Concrete by Assembly - Summary												
Concrete Footing by Dimension	787	cuyd	1.20	9.27	7,298	\$78.10	\$246.45		\$570,033	\$193,984	\$0	\$764,017
Concrete Footing by Dimension Security Bldg	47	cuyd	1.20	28.88	1,350	\$76.58	\$382.26		\$103,402	\$17,868	\$0	\$121,270
Concrete Footing by Dimension under Warehouse Slab	61	cuyd	1.20	15.80	959	\$77.06	\$285.73		\$73,879	\$17,334	\$0	\$91,213
CONCRETE SOG - BY VOLUME Fire water Collection Tank	20	cuyd	1.20	6.87	137	\$79.47	\$230.18		\$10,899	\$4,592	\$0	\$15,491
CONCRETE SOG - BY VOLUME Security Bldg	18	cuyd	1.20	7.71	138	\$79.18	\$231.08		\$10,893	\$4,125	\$0	\$15,018
CONCRETE SOG - BY VOLUME Sidewalk to Bldg	44	cuyd	1.20	11.04	487	\$78.44	\$234.68		\$38,191	\$10,349	\$0	\$48,540
CONCRETE SOG - BY VOLUME Slab under Office	104	cuyd	1.20	7.71	801	\$79.18	\$231.08		\$63,436	\$24,021	\$0	\$87,457
Section												
CONCRETE SOG - BY VOLUME Warehouse	80	cuyd	1.20	7.71	615	\$79.18	\$231.08		\$48,699	\$18,440	\$0	\$67,139
Ductbank by Dimension (2.5' X 2.5' X 500')	122	cuyd	1.20	12.98	1,578	\$76.47	\$284.61		\$120,646	\$34,588	\$0	\$155,234
Elevated Slab on Metal Deck- by Volume	95	cuyd	1.20	9.46	894	\$80.72	\$293.02		\$72,182	\$27,690	\$0	\$99,872
Elevated Slab on Metal Deck- by Volume HVAC Filter Floor	86	cuyd	1.20	9.46	815	\$80.72	\$293.02		\$65,766	\$25,229	\$0	\$90,995
Elevated Slab on Metal Deck- by Volume Security Bldg Roof	18	cuyd	1.20	9.46	169	\$80.72	\$293.02		\$13,634	\$5,230	\$0	\$18,865
Fence/Fence lighting Pole	0	cuyd	1.20		264	\$76.74			\$20,259	\$0	\$0	\$20,259
Mat (@Grade) - By Volume Hip Fdn	156	cuyd	1.20	5.68	888	\$80.56	\$131.84		\$71,534	\$20,627	\$0	\$92,160
Mat (@Grade) - By Volume HIP Fdn 18" Thk	198	cuyd	1.20	6.06	1,203	\$80.27	\$132.10		\$96,540	\$26,215	\$0	\$122,755
Mat (@Grade) - By Volume Under Process Areas	4,469	cuyd	1.20	6.06	27,082	\$80.27	\$238.94		\$2,173,946	\$1,067,764	\$0	\$3,241,710
Roofing Fire water Collection Tank Sump	0	cuyd	1.20		29	\$76.74			\$2,199	\$4,050	\$0	\$6,249
SUBSTATION SITE WORK & FOUNDATIONS	4	cuyd	1.20	9.60	38	\$76.74	\$200.00		\$2,947	\$800	\$0	\$3,747
Wall by Volume Greater than 8' high	128	cuyd	1.20	35.49	4,546	\$77.07	\$341.98		\$350,361	\$43,807	\$0	\$394,168
Wall by Volume Greater than 8' high Fire Water Collection Tank	26	cuyd	1.20	42.50	1,116	\$76.93	\$506.75		\$85,828	\$13,302	\$0	\$99,130
Wall by Volume Greater than 8' high Radiography Area	496	cuyd	1.20	57.04	28,300	\$76.61	\$591.94		\$2,167,957	\$293,677	\$0	\$2,461,634

	Entire Estimate	
Formwork	13.30	SF/CY
Rebar	123.49	LB/CY
Embeds	2.95	LB/CY

WKHR/CUYD 11.31
Total/CY \$1,152.13

Grand Total: Entire Estimate	6,958 cuyd	1.20	11.31	78,706	\$78.31	\$6,163,231	\$1,853,693	\$0	\$8,016,924
						\$885.73 /CY	\$266.40 /CY	\$0.00 /CY	

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

URSWashington Division

Job No: 27989-325

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

								_					
				Lal		Workhours						Totals	
Account No.	Description	Qt	ty U	M Fac	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

04.01 Concrete by Assembly Detail

Concrete Footing by Dimension

040202	REBAR @ FOOTINGS	41	ton 1.20	24.00	989.51	\$92.37	\$1,362.08	\$0.00	\$91,399	\$56,158	\$0	\$147,557
040203	FORMWORK @ FOOTINGS	10,152	sqft 1.20	0.48	4,872.96	\$75.57	\$3.00	\$0.00	\$368,247	\$30,456	\$0	\$398,703
040204	EMBEDS @ FOOTINGS	52	lb 1.20	0.24	12.59	\$92.37	\$2.50	\$0.00	\$1,163	\$131	\$0	\$1,294
040208	4000PSI@FOOTINGS PUMPED	787	cuyd 1.20	1.80	1,416.80	\$76.74	\$136.24	\$0.00	\$108,724	\$107,236	\$0	\$215,960
040207	KEYWAY @ FOOTINGS	92	Inft. 1.20	0.07	6.61	\$75.57	\$0.03	\$0.00	\$500	\$3	\$0	\$502

 Concrete Footing by Dimension

 Formwork
 12.90
 SF/CY

 Rebar
 104.76
 LB/CY

 Embedments
 0.07
 LB/CY

Wkhr/CY 9.27
Total/CY \$970.66

Total	Concrete Footing by Dimension	787	CY 1.20	9.27	7,298	\$78.10			\$570,033 \$724.21 /CY	\$193,984 \$246.45 /CY	\$0 \$0.00 /CY	\$764,017
Concr	rete Footing by Dimension Security Bldg											
040202	REBAR @ FOOTINGS	3	ton 1.20	24.00	74.79	\$92.37	\$1,362.08	\$0.00	\$6,908	\$4,245	\$0	\$11,153
040203	FORMWORK @ FOOTINGS	2,406	sqft 1.20	0.48	1,154.88	\$75.57	\$3.00	\$0.00	\$87,274	\$7,218	\$0	\$94,492
040204	EMBEDS @ FOOTINGS	3	lb 1.20	0.24	0.75	\$92.37	\$2.50	\$0.00	\$69	\$8	\$0	\$77
040208	4000PSI@FOOTINGS PUMPED	47	cuyd 1.20	1.80	84.14	\$76.74	\$136.24	\$0.00	\$6,457	\$6,368	\$0	\$12,825
040209	FINE GRADE @ FOOTING	979	sqft 1.20	0.04	35.26	\$75.57	\$0.03	\$0.00	\$2,664	\$29	\$0	\$2,694
040207	KEYWAY @ FOOTINGS	5	Inft 1.20	0.07	0.39	\$75.57	\$0.03	\$0.00	\$30	\$0	\$0	\$30

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

HIP Option

Job No: 27989-325 Rev No: 0

					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
•									-					

51.47 SF/CY Formwork 133.33 LB/CY Rebar 0.07 LB/CY Embedments

Concrete Footing by Dimension Security Bldg

Wkhr/CY 28.88 Total/CY \$2,594.33

Total	Concrete Footing by Dimension Security Bldg	47	CY 1.20	28.88	1,350	\$76.58			\$103,402 \$2,212.07/CY	\$17,868 \$382.26 /CY	\$0 \$0.00 /CY	\$121,270
Concr	ete Footing by Dimension under Warehouse Slab											
040202	REBAR @ FOOTINGS	3	ton 1.20	24.00	76.27	\$92.37	\$1,362.08	\$0.00	\$7,045	\$4,328	\$0	\$11,373
040203	FORMWORK @ FOOTINGS	1,572	sqft 1.20	0.48	754.56	\$75.57	\$3.00	\$0.00	\$57,022	\$4,716	\$0	\$61,738
040204	EMBEDS @ FOOTINGS	4	lb 1.20	0.24	0.97	\$92.37	\$2.50	\$0.00	\$90	\$10	\$0	\$100
040208	4000PSI@FOOTINGS PUMPED	61	cuyd 1.20	1.80	109.20	\$76.74	\$136.24	\$0.00	\$8,380	\$8,265	\$0	\$16,645
040209	FINE GRADE @ FOOTING	480	sqft 1.20	0.04	17.26	\$75.57	\$0.03	\$0.00	\$1,305	\$14	\$0	\$1,319
040207	KEYWAY @ FOOTINGS	7	Inft 1.20	0.07	0.51	\$75.57	\$0.03	\$0.00	\$39	\$0	\$0	\$39

Concrete Footing by Dimension under Warehouse Slab 25.91 SF/CY Formwork 104.76 LB/CY Rebar 0.07 LB/CY Embedments

> Wkhr/CY 15.80 Total/CY \$1,503.52

Total	Concrete Footing by Dimension under Warehouse Slab	61 CY	1.20	15.80	959	\$77.06	\$73,879 \$1,217,78/CY	\$17,334 \$285.73 /CY	\$0 \$0.00 /CY	\$91,213
	Siau						\$1,217.78/CY	\$285.73 /CY	\$0.00 /CY	

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

Job No: 27989-325 Rev No: 0

			1	Lab.		Workhours						Totals	
Account No.	Description	Qty			Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
CONCRETE S	SOG - BY VOLUME Fire water Collecti	on Tank											
040702	REBAR @ SOG	1	ton	1.20	24.00	18.01	\$92.37	\$1,362.08	\$0.00	\$1,664	\$1,022	\$0	\$2,686
040703	FORMWORK @ SOG	41	sqft	1.20	0.48	19.61	\$75.57	\$3.25	\$0.00	\$1,482	\$133	\$0	\$1,615
040704	EMBEDS @ SOG	86	lb	1.20	0.06	5.13	\$92.37	\$2.50	\$0.00	\$474	\$214	\$0	\$688
040708	4000PSI@SOG PUMPED	20	cuyd	1.20	1.80	35.91	\$76.74	\$136.24	\$0.00	\$2,756	\$2,718	\$0	\$5,474
040709	FINISHING @ SOG	770	sqft	1.20	0.02	18.47	\$76.74	\$0.01	\$0.00	\$1,417	\$8	\$0	\$1,425
040705	ANCHOR BOLTS @ SOG	10	lb	1.20	0.24	2.31	\$92.37	\$1.40	\$0.00	\$214	\$13	\$0	\$227
040709	FINE GRADE @ SOG	770	sqft	1.20	0.04	27.70	\$76.74	\$0.03	\$0.00	\$2,126	\$23	\$0	\$2,149
040706	WATERSTOP @ SOG	88	lnft	1.20	0.07	6.31	\$76.74	\$5.00	\$0.00	\$484	\$438	\$0	\$922
040710	HARDENER @ SOG	770	sqft	1.20	0.00	3.69	\$76.74	\$0.03	\$0.00	\$283	\$23	\$0	\$307

CONCRETE SOG - BY VOLUME Fire water Collection
ormwork Tank 2.05 SF/CY 2.05 SF/CY Formwork 75.24 LB/CY 4.29 LB/CY Rebar Embedments

> Wkhr/CY 6.87 Total/CY \$776.50

Total	CONCRETE SOG - BY VOLUME Fire water Collection Tank	20	CY	1.20	6.87	137	\$79.47			\$10,899 \$546.32/CY	\$4,592 \$230.18 /CY	\$0 \$0.00 /CY	\$15,491
CONC	CRETE SOG - BY VOLUME Security Bldg												
040702	REBAR @ SOG	1	ton 1	.20	24.00	16.12	\$92.37	\$1,362.08	\$0.00	\$1,489	\$915	\$0	\$2,403
040703	FORMWORK @ SOG	37	sqft 1	.20	0.48	17.54	\$75.57	\$3.25	\$0.00	\$1,326	\$119	\$0	\$1,445
040704	EMBEDS @ SOG	77	lb 1	.20	0.06	4.59	\$92.37	\$2.50	\$0.00	\$424	\$191	\$0	\$615
040708	4000PSI@SOG PUMPED	18	cuyd 1	.20	1.80	32.13	\$76.74	\$136.24	\$0.00	\$2,466	\$2,432	\$0	\$4,898
040709	FINISHING @ SOG	918	sqft 1	.20	0.02	22.03	\$76.74	\$0.01	\$0.00	\$1,691	\$9	\$0	\$1,700
040705	ANCHOR BOLTS @ SOG	9	lb 1	.20	0.24	2.07	\$92.37	\$1.40	\$0.00	\$191	\$12	\$0	\$203
040709	FINE GRADE @ SOG	918	sqft 1	.20	0.04	33.05	\$76.74	\$0.03	\$0.00	\$2,536	\$28	\$0	\$2,564
040706	WATERSTOP @ SOG	78	lnft 1	.20	0.07	5.64	\$76.74	\$5.00	\$0.00	\$433	\$392	\$0	\$825
040710	HARDENER @ SOG	918	sqft 1	.20	0.00	4.41	\$76.74	\$0.03	\$0.00	\$338	\$28	\$0	\$366

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

				T -1-		Workhours						Totals	
Account No.	Description	Qty	UM	Lab. Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

CONCRETE SOG - BY VOLUME Security Bldg

Formwork 2.05 SF/CY Rebar 75.24 LB/CY 4.29 LB/CY Embedments

> Wkhr/CY 7.71 Total/CY \$841.34

Total	CONCRETE SOG - BY VOLUME Security Bldg	18	CY 1.20	7.71	138	\$79.18			\$10,893 \$610.26/CY	\$4,125 \$231.08 /CY	\$0 \$0.00 /CY	\$15,018
CONC	CRETE SOG - BY VOLUME Sidewalk to Bldg											
040702	REBAR @ SOG	2	ton 1.20	24.00	39.82	\$92.37	\$1,362.08	\$0.00	\$3,678	\$2,260	\$0	\$5,937
040703	FORMWORK @ SOG	90	sqft 1.20	0.48	43.34	\$75.57	\$3.25	\$0.00	\$3,275	\$293	\$0	\$3,569
040704	EMBEDS @ SOG	189	lb 1.20	0.06	11.34	\$92.37	\$2.50	\$0.00	\$1,047	\$473	\$0	\$1,520
040708	4000PSI@SOG PUMPED	44	cuyd 1.20	1.80	79.38	\$76.74	\$136.24	\$0.00	\$6,092	\$6,008	\$0	\$12,100
040709	FINISHING @ SOG	4,536	sqft 1.20	0.02	108.86	\$76.74	\$0.01	\$0.00	\$8,354	\$45	\$0	\$8,400
040705	ANCHOR BOLTS @ SOG	21	lb 1.20	0.24	5.11	\$92.37	\$1.40	\$0.00	\$472	\$30	\$0	\$502
040709	FINE GRADE @ SOG	4,536	sqft 1.20	0.04	163.30	\$76.74	\$0.03	\$0.00	\$12,531	\$136	\$0	\$12,667
040706	WATERSTOP @ SOG	194	Inft 1.20	0.07	13.94	\$76.74	\$5.00	\$0.00	\$1,070	\$968	\$0	\$2,038
040710	HARDENER @ SOG	4,536	sqft 1.20	0.00	21.77	\$76.74	\$0.03	\$0.00	\$1,671	\$136	\$0	\$1,807

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

URSWashington Division

Job No: 27989-325

Product Line: Gov Estimate: FFC

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

CONCRETE SOG - BY VOLUME Sidewalk to Bldg

 Formwork
 2.05
 SF/CY

 Rebar
 75.24
 LB/CY

 Embedments
 4.29
 LB/CY

Wkhr/CY 11.04

Total/CY \$1,100.68

Total	CONCRETE SOG - BY VOLUME Sidewalk to Bldg	44	CY	1.20	11.04	487	\$78.44			\$38,191 \$866.00 /CY	\$10,349 \$234.68 /CY	\$0 \$0.00 /CY	\$48,540
CONC	CRETE SOG - BY VOLUME Slab under Office Section												
040702	REBAR @ SOG	4	ton	1.20	24.00	93.85	\$92.37	\$1,362.08	\$0.00	\$8,669	\$5,326	\$0	\$13,995
040703	FORMWORK @ SOG	213	sqft	1.20	0.48	102.17	\$75.57	\$3.25	\$0.00	\$7,721	\$692	\$0	\$8,413
040704	EMBEDS @ SOG	446	lb	1.20	0.06	26.73	\$92.37	\$2.50	\$0.00	\$2,469	\$1,114	\$0	\$3,583
040708	4000PSI@SOG PUMPED	104	cuyd	1.20	1.80	187.11	\$76.74	\$136.24	\$0.00	\$14,359	\$14,162	\$0	\$28,521
040709	FINISHING @ SOG	5,346	sqft	1.20	0.02	128.30	\$76.74	\$0.01	\$0.00	\$9,846	\$53	\$0	\$9,899
040705	ANCHOR BOLTS @ SOG	50	lb	1.20	0.24	12.05	\$92.37	\$1.40	\$0.00	\$1,113	\$70	\$0	\$1,184
040709	FINE GRADE @ SOG	5,346	sqft	1.20	0.04	192.46	\$76.74	\$0.03	\$0.00	\$14,769	\$160	\$0	\$14,929
040706	WATERSTOP @ SOG	456	lnft	1.20	0.07	32.86	\$76.74	\$5.00	\$0.00	\$2,522	\$2,282	\$0	\$4,804
040710	HARDENER @ SOG	5,346	sqft	1.20	0.00	25.66	\$76.74	\$0.03	\$0.00	\$1,969	\$160	\$0	\$2,130

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

				T -1-		Workhours						Totals	
Account No.	Description	Qty	UM	Lab. Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

CONCRETE SOG - BY VOLUME Slab under Office Section

Formwork 2.05 SF/CY Rebar 75.24 LB/CY 4.29 LB/CY Embedments

> Wkhr/CY 7.71 Total/CY \$841.34

Total	CONCRETE SOG - BY VOLUME Slab under Office Section	104	CY 1.20	7.71	801	\$79.18			\$63,436 \$610.26/CY	\$24,021 \$231.08 /CY	\$0 \$0.00 /CY	\$87,457
CONG	CRETE SOG - BY VOLUME Warehouse											
040702	REBAR @ SOG	3	ton 1.20	24.00	72.05	\$92.37	\$1,362.08	\$0.00	\$6,655	\$4,089	\$0	\$10,744
040703	FORMWORK @ SOG	163	sqft 1.20	0.48	78.43	\$75.57	\$3.25	\$0.00	\$5,927	\$531	\$0	\$6,458
040704	EMBEDS @ SOG	342	lb 1.20	0.06	20.52	\$92.37	\$2.50	\$0.00	\$1,895	\$855	\$0	\$2,750
040708	4000PSI@SOG PUMPED	80	cuyd 1.20	1.80	143.64	\$76.74	\$136.24	\$0.00	\$11,023	\$10,872	\$0	\$21,895
040709	FINISHING @ SOG	4,104	sqft 1.20	0.02	98.50	\$76.74	\$0.01	\$0.00	\$7,559	\$41	\$0	\$7,600
040705	ANCHOR BOLTS @ SOG	39	lb 1.20	0.24	9.25	\$92.37	\$1.40	\$0.00	\$855	\$54	\$0	\$909
040709	FINE GRADE @ SOG	4,104	sqft 1.20	0.04	147.74	\$76.74	\$0.03	\$0.00	\$11,338	\$123	\$0	\$11,461
040706	WATERSTOP @ SOG	350	Inft 1.20	0.07	25.23	\$76.74	\$5.00	\$0.00	\$1,936	\$1,752	\$0	\$3,688
040710	HARDENER @ SOG	4,104	sqft 1.20	0.00	19.70	\$76.74	\$0.03	\$0.00	\$1,512	\$123	\$0	\$1,635

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

CONCRETE SOG - BY VOLUME Warehouse

Formwork 2.05 SF/CY Rebar 75.24 LB/CY 4.29 LB/CY Embedments

> Wkhr/CY 7.71 Total/CY \$841.34

Total CO	NCRETE SOG - BY VOLUME Warehouse	80	CY 1.2	7.71	615	\$79.18			\$48,699 \$610.26/CY	\$18,440 \$231.08 /CY	\$0 \$0.00 /CY	\$67,139
Ductbank l	by Dimension (2.5' X 2.5' X 500')											
040802	REBAR @ DUCTBANK	3	ton 1.20	24.00	68.06	\$92.37	\$800.00	\$0.00	\$6,286	\$2,269	\$0	\$8,555
040803	FORMWORK @ DUCTBANK	2,661	sqft 1.20	0.48	1,277.22	\$75.57	\$3.00	\$0.00	\$96,519	\$7,983	\$0	\$104,502
040808	4000PSI@DUCTBANK PUMPED	122	cuyd 1.20	1.87	227.50	\$76.74	\$200.00	\$0.00	\$17,458	\$24,306	\$0	\$41,764
040810	ADDED COLOR @ DUCTBANK	1,040	sqft 1.20	0.00	4.99	\$76.74	\$0.03	\$0.00	\$383	\$31	\$0	\$414

Ductbank by Dimension (2.5' X 2.5' X 500') 21.90 SF/CY Formwork 46.67 LB/CY Rebar Embedments 0.00 LB/CY

> Wkhr/CY 12.98 Total/CY \$1,277.36

Total	Ductbank by Dimension (2.5' X 2.5' X 500')	122 (Y 1.20	12.98	1,578	\$76.47			\$120,646 \$992.75/CY	\$34,588 \$284.61 /CY	\$0 \$0.00 /CY	\$155,234
Elev: 043202	ated Slab on Metal Deck- by Volume REBAR @ ELEV SLAB ON DECK	7	ton 1.20	24.00	160.92	\$92.37	\$1,362.08	\$0.00	\$14,864	\$9,133	\$0 Page 1	\$23,997 5 of 69

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

URS

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM

Priced By: ADC
Office: Denver
Product Line: Gov
Estimate: FFC

	•											
			Lab.		Workhours					Totals		
Account No.	Description	Qty	UM Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
043203	FORMWORK@ELEV SLAB ON DECK	304	sqft 1.20	0.48	146.02	\$75.57	\$3.00	\$0.00	\$11,034	\$913	\$0	\$11,947
043204	EMBEDS @ ELEV SLAB ON DECK	1,080	lb 1.20	0.07	77.76	\$92.37	\$2.50	\$0.00	\$7,183	\$2,700	\$0	\$9,883
043208	4000PSI@ESOMD PUMPED	95	cuyd 1.20	2.74	258.55	\$76.74	\$136.24	\$0.00	\$19,841	\$12,875	\$0	\$32,716
043209	FINISHING,CURE,HRDNR@ESOMD	4,860	sqft 1.20	0.04	174.96	\$76.74	\$0.01	\$0.00	\$13,426	\$49	\$0	\$13,475
043211	GROUT @ ESOMD	34	cuft 1.20	2.26	76.02	\$76.74	\$60.00	\$0.00	\$5,834	\$2,022	\$0	\$7,855

Elevated Slab on Metal Deck- by Volume

 Formwork
 3.22
 SF/CY

 Rebar
 141.90
 LB/CY

 Embedments
 11.43
 LB/CY

Wkhr/CY 9.46

Total/CY \$1,056.85

Total Elevated Slab on Metal Deck- by Volume			CY 1.20	9.46	894	\$80.72			\$72,182 \$763.83 /CY	\$27,690 \$293.02 /CY	\$0 \$0.00 /CY	\$99,872
Elevat	ted Slab on Metal Deck- by Volume HVAC Filter Floor											
043202	REBAR @ ELEV SLAB ON DECK	6	ton 1.20	24.00	146.62	\$92.37	\$1,362.08	\$0.00	\$13,543	\$8,321	\$0	\$21,864
043203	FORMWORK@ELEV SLAB ON DECK	277	sqft 1.20	0.48	133.04	\$75.57	\$3.00	\$0.00	\$10,054	\$831	\$0	\$10,885
043204	EMBEDS @ ELEV SLAB ON DECK	984	lb 1.20	0.07	70.85	\$92.37	\$2.50	\$0.00	\$6,544	\$2,460	\$0	\$9,004
043208	4000PSI@ESOMD PUMPED	86	cuyd 1.20	2.74	235.57	\$76.74	\$136.24	\$0.00	\$18,077	\$11,730	\$0	\$29,808
043209	FINISHING,CURE,HRDNR@ESOMD	4,428	sqft 1.20	0.04	159.41	\$76.74	\$0.01	\$0.00	\$12,233	\$44	\$0	\$12,277
043211	GROUT @ ESOMD	31	cuft 1.20	2.26	69.26	\$76.74	\$60.00	\$0.00	\$5,315	\$1,842	\$0	\$7,157

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

HIP Option Job No: 27989-325 Rev No: 0

				Lob		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Elevated Slab on Metal Deck- by Volume HVAC Filter Floor

Formwork 3.22 SF/CY Rebar 141.90 LB/CY 11.43 LB/CY Embedments

> Wkhr/CY 9.46 Total/CY \$1,056.85

Total	Elevated Slab on Metal Deck- by Volume HVAC Filter Floor	86	CY 1.20	9.46	815	\$80.72			\$65,766 \$763.83 /CY	\$25,229 \$293.02 /CY	\$0 \$0.00 /CY	\$90,995
Elevat	ted Slab on Metal Deck- by Volume Security Bldg Roof											
043202	REBAR @ ELEV SLAB ON DECK	1	ton 1.20	24.00	30.40	\$92.37	\$1,362.08	\$0.00	\$2,808	\$1,725	\$0	\$4,533
043203	FORMWORK@ELEV SLAB ON DECK	57	sqft 1.20	0.48	27.58	\$75.57	\$3.00	\$0.00	\$2,084	\$172	\$0	\$2,257
043204	EMBEDS @ ELEV SLAB ON DECK	204	lb 1.20	0.07	14.69	\$92.37	\$2.50	\$0.00	\$1,357	\$510	\$0	\$1,867
043208	4000PSI@ESOMD PUMPED	18	cuyd 1.20	2.74	48.84	\$76.74	\$136.24	\$0.00	\$3,748	\$2,432	\$0	\$6,180
043209	FINISHING,CURE,HRDNR@ESOMD	918	sqft 1.20	0.04	33.05	\$76.74	\$0.01	\$0.00	\$2,536	\$9	\$0	\$2,545
043211	GROUT @ ESOMD	6	cuft 1.20	2.26	14.36	\$76.74	\$60.00	\$0.00	\$1,102	\$382	\$0	\$1,484

Elevated Slab on Metal Deck- by Volume Security Bldg Roof 3.22 SF/CY Formwork 141.90 LB/CY Rebar 11.43 LB/CY Embedments

> Wkhr/CY 9.46 Total/CY \$1,056.85

Total	Elevated Slab on Metal Deck- by Volume Security Bldg Roof	18 CY	1.20	9.46	169	\$80.72	\$13,634 \$763.83 /CY	\$5,230 \$293.02 /CY	\$0 \$0.00 /CY	\$18,865
							\$705.057€1	3273.02 / С 1	\$0.00 / € 1	

Location: GREEN FIELD SITE HIP Option
Account: 04 Concrete/Masonry
Facility: Entire Estimate
HIP Option

URS

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM

Priced By: ADC
Office: Denver
Product Line: Gov
Estimate: FFC

					I.	ab.		Workhours						Totals	
Acce	count No.	Description	Qty	U			Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Fence	e/Fence lighting	g Pole													
049908	M	MISC ALL-IN		22	cuyd	1.20	12.00	264.00	\$76.74	\$0.00	\$0.00	\$20,259	\$0	\$0	\$20,259

Wkhr/CY 0.00

Total/CY \$0.00

Total	Fence/Fence lighting Pole	0	CY 1.20	0.00	264	\$76.74			\$20,259 \$0.00/CY	\$0 \$0.00 /CY	\$0 \$0.00 /CY	\$20,259
Mat (@	(Grade) - By Volume Hip Fdn											
041102	REBAR @ MATS	10	ton 1.20	24.00	237.80	\$92.37	\$800.00	\$0.00	\$21,965	\$7,927	\$0	\$29,892
041103	FORMWORK 2.5 Ft. Thick @ MATS	447	sqft 1.20	0.48	214.56	\$75.57	\$3.00	\$0.00	\$16,214	\$1,341	\$0	\$17,555
041104	EMBEDS @ MATS	298	lb 1.20	0.06	17.88	\$76.74	\$2.50	\$0.00	\$1,372	\$745	\$0	\$2,117
041108	4000PSI@MATS PUMPED	156	cuyd 1.20	1.80	281.61	\$76.74	\$65.00	\$0.00	\$21,611	\$10,169	\$0	\$31,780
041109	FINISHING @ MATS	1,678	sqft 1.20	0.02	40.27	\$76.74	\$0.01	\$0.00	\$3,090	\$17	\$0	\$3,107
041105	ANCHOR BOLTS @ MATS	88	lb 1.20	0.24	21.01	\$76.74	\$1.40	\$0.00	\$1,612	\$123	\$0	\$1,734
041109	FINE GRADE @ MAT	1,678	sqft 1.20	0.04	60.40	\$75.57	\$0.03	\$0.00	\$4,564	\$50	\$0	\$4,615
041106	WATERSTOP @ MATS	18	Inft 1.20	0.07	1.31	\$75.57	\$5.00	\$0.00	\$99	\$91	\$0	\$191
041111	GROUT @ MATS	3	cuft 1.20	4.80	13.11	\$76.74	\$60.00	\$0.00	\$1,006	\$164	\$0	\$1,170

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option



Job No: 27989-325

Priced By: ADC Office: Denver

Date: 7/17/2008

Product Line: Gov Estimate: FFC

11:31AM

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

Mat (@Grade) - By Volume Hip Fdn Formwork 2.86 SF/CY Rebar 126.67 LB/CY

1.90 LB/CY Embedments

> Wkhr/CY 5.68 Total/CY \$589.07

Total	Mat (@Grade) - By Volume Hip Fdn	156	CY 1.20	5.68	888	\$80.56			\$71,534 \$457.23 /CY	\$20,627 \$131.84 /CY	\$0 \$0.00 /CY	\$92,160
Mat (@	@Grade) - By Volume HIP Fdn 18" Thk											
041102	REBAR @ MATS	13	ton 1.20	24.00	301.64	\$92.37	\$800.00	\$0.00	\$27,862	\$10,055	\$0	\$37,917
041103	FORMWORK 1.5 Ft. Thick @ MATS	567	sqft 1.20	0.48	272.16	\$75.57	\$3.00	\$0.00	\$20,567	\$1,701	\$0	\$22,268
041104	EMBEDS @ MATS	378	lb 1.20	0.06	22.68	\$76.74	\$2.50	\$0.00	\$1,740	\$945	\$0	\$2,685
041108	4000PSI@MATS PUMPED	198	cuyd 1.20	1.80	357.21	\$76.74	\$65.00	\$0.00	\$27,412	\$12,899	\$0	\$40,311
041109	FINISHING @ MATS	3,400	sqft 1.20	0.02	81.60	\$76.74	\$0.01	\$0.00	\$6,262	\$34	\$0	\$6,296
041105	ANCHOR BOLTS @ MATS	111	lb 1.20	0.24	26.64	\$76.74	\$1.40	\$0.00	\$2,045	\$155	\$0	\$2,200
041109	FINE GRADE @ MAT	3,400	sqft 1.20	0.04	122.40	\$75.57	\$0.03	\$0.00	\$9,250	\$102	\$0	\$9,352
041106	WATERSTOP @ MATS	23	Inft 1.20	0.07	1.67	\$75.57	\$5.00	\$0.00	\$126	\$116	\$0	\$242
041111	GROUT @ MATS	3	cuft 1.20	4.80	16.63	\$76.74	\$60.00	\$0.00	\$1,276	\$208	\$0	\$1,484

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

Washington Division

Job No: 27989-325

Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

						Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Mat (@Grade) - By Volume HIP Fdn 18" Thk

Formwork 2.86 SF/CY Rebar 126.67 LB/CY 1.90 LB/CY Embedments

> Wkhr/CY 6.06 Total/CY \$618.57

Total	Mat (@Grade) - By Volume HIP Fdn 18" Thk	198	CY 1.20	6.06	1,203	\$80.27			\$96,540 \$486.47/CY	\$26,215 \$132.10 /CY	\$0 \$0.00 /CY	\$122,755
Mat (@	@Grade) - By Volume Under Process Areas											
041102	REBAR @ MATS	283	ton 1.20	24.00	6,792.58	\$92.37	\$1,362.08	\$0.00	\$627,417	\$385,501	\$0	\$1,012,918
041103	FORMWORK 1.5 Ft. Thick @ MATS	12,768	sqft 1.20	0.48	6,128.64	\$75.57	\$3.00	\$0.00	\$463,138	\$38,304	\$0	\$501,442
041104	EMBEDS @ MATS	8,512	lb 1.20	0.06	510.72	\$76.74	\$2.50	\$0.00	\$39,192	\$21,280	\$0	\$60,472
041108	4000PSI@MATS PUMPED	4,469	cuyd 1.20	1.80	8,043.84	\$76.74	\$136.24	\$0.00	\$617,278	\$608,829	\$0	\$1,226,108
041109	FINISHING @ MATS	76,565	sqft 1.20	0.02	1,837.57	\$76.74	\$0.01	\$0.00	\$141,014	\$766	\$0	\$141,779
041105	ANCHOR BOLTS @ MATS	2,500	lb 1.20	0.24	599.99	\$76.74	\$1.40	\$0.00	\$46,043	\$3,500	\$0	\$49,543
041109	FINE GRADE @ MAT	76,565	sqft 1.20	0.04	2,756.36	\$75.57	\$0.03	\$0.00	\$208,296	\$2,297	\$0	\$210,593
041106	WATERSTOP @ MATS	521	Inft 1.20	0.07	37.54	\$75.57	\$5.00	\$0.00	\$2,837	\$2,607	\$0	\$5,444
041111	GROUT @ MATS	78	cuft 1.20	4.80	374.40	\$76.74	\$60.00	\$0.00	\$28,731	\$4,680	\$0	\$33,411

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

Rebar

Embedments

Washington Division

Job No: 27989-325

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

Workhours Totals Lab. Fact. Total Account No. UM Mat'l Unit Subs Unit Labor Material Description Per Unit Rate Subs Qty Total

Rev No: 0

Mat (@Grade) - By Volume Under Process Areas

 Formwork
 2.86
 SF/CY

 Rebar
 126.67
 LB/CY

 Embedments
 1.90
 LB/CY

Wkhr/CY 6.06

Total/CY \$725.41

Total Mat	t (@Grade) - By Volume Under Process Areas	4,469	CY 1.2	6.06	27,082	\$80.27			\$2,173,946 \$486.47/CY	\$1,067,764 \$238.94 /CY	\$0 \$3,241,710 \$0.00 /CY
Roofing Fir	re water Collection Tank Sump PRECAST ALL-IN	12	cuyd 1.20	2.39	28.66	\$76.74	\$337.50	\$0.00	\$2,199	\$4,050	\$0 \$6,249
	Roofing Fire water Collection Tank Sump Formwork 0.00 SF	p F/CY	Ì								

0.00 LB/CY

Wkhr/CY 0.00

Total/CY

0.00 LB/CY

\$0.00

Total	Roofing Fire water Collection Tank Sump	0	CY 1	1.20	0.00	29	\$76.74			\$2,199 \$0.00/CY	\$4,050 \$0.00 /CY	\$0 \$0.00 /CY	\$6,249
SUBST	TATION SITE WORK & FOUNDATIONS												_
041808	4000PSI@PIERS PUMPED	4	cuyd 1	.20	9.60	38.40	\$76.74	\$200.00	\$0.00	\$2,947	\$800	\$0	\$3,747

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

URS Westington Di

Job No: 27989-325

Washington Division

Rev No: 0

11:31AM Priced By: ADC

Date: 7/17/2008

Office: Denver
Product Line: Gov
Estimate: FFC

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

SUBSTATION SITE WORK & FOUNDATIONS

 Formwork
 0.00
 SF/CY

 Rebar
 0.00
 LB/CY

 Embedments
 0.00
 LB/CY

Wkhr/CY 9.60

Total/CY \$936.70

Total	SUBSTATION SITE WORK & FOUNDATIONS	4	CY 1.20	9.60	38	\$76.74			\$2,947 \$736.70 /CY	\$800 \$200.00 /CY	\$0 \$0.00 /CY	\$3,747
Wall b	oy Volume Greater than 8' high											
040902	REBAR @ WALLS	9	ton 1.20	24.00	207.89	\$92.37	\$800.00	\$0.00	\$19,202	\$6,930	\$0	\$26,132
040903	FORMWORK @ WALLS OVER 8' HIGH	7,827	sqft 1.20	0.48	3,756.74	\$75.57	\$3.00	\$0.00	\$283,895	\$23,480	\$0	\$307,374
040904	EMBEDS @ WALLS	1,545	lb 1.20	0.06	92.67	\$92.37	\$2.50	\$0.00	\$8,560	\$3,861	\$0	\$12,421
040908	4000PSI@WALLS PUMPED	128	cuyd 1.20	1.80	230.58	\$76.74	\$65.00	\$0.00	\$17,695	\$8,327	\$0	\$26,021
040909	FINISHING @ WALLS	6,522	sqft 1.20	0.02	156.53	\$76.74	\$0.01	\$0.00	\$12,012	\$65	\$0	\$12,077
040905	ANCHOR BOLTS @ WALLS	319	lb 1.20	0.24	76.61	\$92.37	\$1.40	\$0.00	\$7,077	\$447	\$0	\$7,524
040906	WATERSTOP @ WALL	94	Inft 1.20	0.07	6.76	\$76.74	\$5.00	\$0.00	\$519	\$470	\$0	\$989
040911	GROUT @ WALLS	4	cuft 1.20	4.80	18.27	\$76.74	\$60.00	\$0.00	\$1,402	\$228	\$0	\$1,630

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

				Lab		Workhours						Totals	
Account No.	Description	Q	ty U		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Wall by Volume Greater than 8' high

 Formwork
 61.10
 SF/CY

 Rebar
 135.24
 LB/CY

 Embedments
 12.06
 LB/CY

Wkhr/CY 35.49
Total/CY \$3,077.04

Total	Wall by Volume Greater than 8' high	128	CY	1.20	35.49	4,546	\$77.07			\$350,361 \$2,735.06/CY	\$43,807 \$341.98 /CY	\$0 \$0.00 /CY	\$394,168
Wall I	by Volume Greater than 8' high Fire Water Collection Ta	nk											
040902	REBAR @ WALLS	2	ton	1.20	24.00	49.50	\$92.37	\$1,362.08	\$0.00	\$4,572	\$2,809	\$0	\$7,382
040903	FORMWORK @ WALLS OVER 8' HIGH	1,958	sqft	1.20	0.48	939.89	\$75.57	\$3.00	\$0.00	\$71,027	\$5,874	\$0	\$76,901
040904	EMBEDS @ WALLS	317	lb	1.20	0.06	18.99	\$92.37	\$2.50	\$0.00	\$1,754	\$791	\$0	\$2,545
040908	4000PSI@WALLS PUMPED	26	cuyd	1.20	1.80	47.25	\$76.74	\$136.24	\$0.00	\$3,626	\$3,576	\$0	\$7,202
040909	FINISHING @ WALLS	1,632	sqft	1.20	0.02	39.16	\$76.74	\$0.01	\$0.00	\$3,005	\$16	\$0	\$3,022
040905	ANCHOR BOLTS @ WALLS	65	lb	1.20	0.24	15.70	\$92.37	\$1.40	\$0.00	\$1,450	\$92	\$0	\$1,542
040906	WATERSTOP @ WALL	19	lnft	1.20	0.07	1.39	\$76.74	\$5.00	\$0.00	\$106	\$96	\$0	\$203
040911	GROUT @ WALLS	1	cuft	1.20	4.80	3.74	\$76.74	\$60.00	\$0.00	\$287	\$47	\$0	\$334

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

URSWashington Division

Job No: 27989-325

Tradining to 11 Dividio 11

Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Wall by Volume Greater than 8' high Fire Water Collection
Formwork Tank 74.59 SF/CY

 Formwork
 Tank
 74.59
 SF/CY

 Rebar
 157.14
 LB/CY

 Embedments
 12.06
 LB/CY

Wkhr/CY 42.50
Total/CY \$3,776.39

Total	Wall by Volume Greater than 8' high Fire Water Collection Tank	26	CY 1.20	42.50	1,116	\$76.93			\$85,828 \$3,269.64/CY	\$13,302 \$506.75 /CY	\$0 \$0.00 /CY	\$99,130
Wall I	oy Volume Greater than 8' high Radiography Area											
040902	REBAR @ WALLS	39	ton 1.20	24.00	935.55	\$92.37	\$1,362.08	\$0.00	\$86,415	\$53,096	\$0	\$139,510
040903	FORMWORK @ WALLS OVER 8' HIGH	51,030	sqft 1.20	0.48	24,494.40	\$75.57	\$3.00	\$0.00	\$1,851,028	\$153,090	\$0	\$2,004,118
040904	EMBEDS @ WALLS	5,982	lb 1.20	0.06	358.91	\$92.37	\$2.50	\$0.00	\$33,152	\$14,955	\$0	\$48,107
040908	4000PSI@WALLS PUMPED	496	cuyd 1.20	1.80	893.03	\$76.74	\$136.24	\$0.00	\$68,530	\$67,592	\$0	\$136,122
040909	FINISHING @ WALLS	51,030	sqft 1.20	0.02	1,224.72	\$76.74	\$0.01	\$0.00	\$93,984	\$510	\$0	\$94,494
040905	ANCHOR BOLTS @ WALLS	1,236	lb 1.20	0.24	296.72	\$92.37	\$1.40	\$0.00	\$27,408	\$1,731	\$0	\$29,139
040906	WATERSTOP @ WALL	364	Inft 1.20	0.07	26.20	\$76.74	\$5.00	\$0.00	\$2,010	\$1,819	\$0	\$3,829
040911	GROUT @ WALLS	15	cuft 1.20	4.80	70.76	\$76.74	\$60.00	\$0.00	\$5,430	\$885	\$0	\$6,315

Location: GREEN FIELD SITE HIP Option Account: 04 Concrete/Masonry Facility: Entire Estimate

HIP Option

URS Machinettee Di

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

				Lab		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Wall by Volume Greater than 8' high Radiography Area

 Formwork
 102.86
 SF/CY

 Rebar
 157.14
 LB/CY

 Embedments
 12.06
 LB/CY

Wkhr/CY 57.04

Total/CY \$4,961.72

Total	Wall by Volume Greater than 8' high Radiography Area	496 CY	1.20	57.04	28,300	\$76.61	\$2,167,957 \$4,369.78/CY	\$293,677 \$591.94 /CY	\$0 \$2 \$0.00 /CY	2,461,634
							1			

Decking and Flooring

Location: GREEN FIELD SITE HIP Option Account: 05 Structual Steel/Platework Facility: Entire Estimate

HIP Option

URS

Washington Division

Date: 7/17/2008 11:31AM

Priced By: ADC
Office: Denver
Product Line: Gov

\$42,209

\$22,197

HIP Option				Job No:	27989-325	Rev No: 0				Estimate: FFC		
			Lab.		Workhours					1	Totals	
Account No. Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
05 Structural Steel by Class												
Structural Steel: Sub Total (incl xLight - xHvy)	45	tons	1.20	27.05	1,223	\$91.25	\$4,445		\$111,558	\$200,896	\$0	\$312,455
05xx03** Light Steel - 5-20#/LF	15	tons	1.20	33.30	509	\$91.25	\$5,564		\$46,489	\$85,134	\$0	\$131,623
Light Steel - 5-20#/LF \$8,603 Total Cost/Ton 05xx04** Medium Steel - 20-40#/LF Medium Steel - 20-40#/LF \$6,048 Total Cost/Ton	30	tons	1.20	23.85	713	\$91.25	\$3,872		\$65,069	\$115,762	\$0	\$180,831
Minor Struct Steel : Sub Total (incl xLight - xHvy)	5	tons	1.20	48.00	254	\$91.25	\$6,454		\$23,147	\$34,111	\$0	\$57,258
05xx03** Light Steel - 5-20#/LF	2	tons	1.20	48.00	110	\$91.25	\$6,454		\$10,052	\$14,812	\$0	\$24,864
05xx04** Medium Steel - 20-40#/LF	3	tons	1.20	48.00	144	\$91.25	\$6,454		\$13,096	\$19,298	\$0	\$32,394
Minor Struct Steel : Sub Total 48.00 Workhours/Ton	(incl xLight -	xHvy)										
\$6,454 Material Cost/Ton												
\$10,834 Total Cost/Ton												

463

\$91.25

	Overall Ratios:	
38.40	Workhours/Ton	
\$5,095	Material Cost/Ton	
\$8,599	Total Cost/Ton	

9,545

sqft 1.13

Grand Total: Structural Steel / Platework 50 tons 1.20 38	38.40 1,939 \$91.25	\$176,914 \$257,204 \$0 \$434,119
---	----------------------------	-----------------------------------

\$0 \$64,406

Location: GREEN FIELD SITE HIP Option Account: 05 Structual Steel/Platework
Facility: Entire Estimate

URS

Washington Division

Date: 7/17/2008 11:31AM

Priced By: ADC Office: Denver Product Line: Gov

		HIP Option						Job No:	27989-325	Rev No: 0				Estimate: FFC		
							Lab.		Workhours						Totals	
	Account No.	Description			Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
05 S	tructural Steel Sui	nmary	% of total	% of commodity												
050	1 Building Stee	el	100.00%		50	tons	1.20	29.24	1,476	\$91.25	\$4,655		\$134,705	\$235,007	\$0	\$369,712
		Light Steel - 5-20#/LF		34.85%	18	tons	1.20	35.22	620	\$91.25	\$5,680		\$56,541	\$99,947	\$0	\$156,488
		Medium Steel - 20-40#	‡/LF	65.15%	33	tons	1.20	26.05	857	\$91.25	\$4,106		\$78,165	\$135,060	\$0	\$213,225
		\$7,323		ing Steel Ton												
0505	5 Decking and	Flooring			9,545	sqft	1.13	0.05	463	\$91.25			\$42,209	\$22,197	\$0	\$64,406

Overall Ratios:

38.40 Workhours/Ton \$5,095 Material Cost/Ton \$8,599 Total Cost/Ton

Grand Total: Structural Steel / Platework	50 tons	1.20	38.40	1,939	\$91.25	\$176,914	\$257,204	\$0	\$434,119	

Location: GREEN FIELD SITE HIP Option Account: 05 Structual Steel/Platework
Facility: Entire Estimate

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov

	HIP Option				Job No:	27989-325	Rev No: 0				Estimate: FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
<20 #/Inft Light C	Crane Steel-Painted	4.60	ton			162	91.25			\$14,782	\$26,130	\$0	\$40,912
050103	LIGHT STEEL-PAINTED-Crane Support	4.00	ton	1.20	33.30	133.20	\$91.25	\$5,564.34		\$12,154	\$22,257	\$0	\$34,411
050103	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.60	ton	1.20	48.00	28.80	\$91.25	\$6,454.22		\$2,628	\$3,873	\$0	\$6,500
<20 #/Inft Light C	Crane Steel-Painted 2 5 ton cranes	5.75	ton			203	91.25			\$18,477	\$32,662	\$0	\$51,140
050103	LIGHT STEEL-PAINTED-Crane Support	5.00	ton	1.20	33.30	166.50	\$91.25	\$5,564.34		\$15,193	\$27,822	\$0	\$43,014
050103	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.75	ton	1.20	48.00	36.00	\$91.25	\$6,454.22		\$3,285	\$4,841	\$0	\$8,126
<20 #/Inft Light F Enclosure	Enclosure Support Steel-Painted Interior	6.90	ton			243	91.25			\$22,173	\$39,195	\$0	\$61,368
050103	LIGHT STEEL-PAINTED-BLDG Siding Support	6.00	ton	1.20	33.30	199.80	\$91.25	\$5,564.34		\$18,231	\$33,386	\$0	\$51,617
050103	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.90	ton	1.20	48.00	43.20	\$91.25	\$6,454.22		\$3,942	\$5,809	\$0	\$9,751
	Equip Suppt Steel-Painted Hoist Support HIP	0.35	ton			12	91.25			\$1,109	\$1,960	\$0	\$3,068
050103	LIGHT STEEL-PAINTED-EQUIP SUPPORT	0.30	ton	1.20	33.30	9.99	\$91.25	\$5,564.34		\$912	\$1,669	\$0	\$2,581
050103	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.05	ton	1.20	48.00	2.16	\$91.25	\$6,454.22		\$197	\$290	\$0	\$488
	lium Crane Steel-Painted	8.80	ton			229	91.25			\$20,914	\$36,136	\$0	\$57,050
050104	MEDIUM STEEL-PAINTED-Crane Support	8.00	ton	1.20	23.85	190.80	\$91.25	\$3,871.64		\$17,410	\$30,973	\$0	\$48,383
050104	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.80	ton	1.20	48.00	38.40	\$91.25	\$6,454.22		\$3,504	\$5,163	\$0	\$8,667
	lium Crane Steel-Painted 2 5 ton cranes	22.00	ton		****	573	91.25	00.054.64		\$52,284	\$90,341	\$0	\$142,625
050104	MEDIUM STEEL-PAINTED-Crane Support	20.00	ton	1.20	23.85	477.00	\$91.25	\$3,871.64		\$43,524	\$77,433	\$0	\$120,957
050104	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	2.00	ton	1.20	48.00	96.00	\$91.25	\$6,454.22		\$8,760	\$12,908	\$0 \$0	\$21,668
HIP	lium Equip Suppt Steel-Painted Hoist Support	2.09	ton			54	91.25			\$4,967	\$8,582	30	\$13,549
050104	MEDIUM STEEL-PAINTED-EQUIP SUPPORT	1.90	ton	1.20	23.85	45.32	\$91.25	\$3,871.64		\$4,135	\$7,356	\$0	\$11,491
050104	Minor Struct Steel (Girts, Purlins, Clips, Gussets, stiffeners, etc)	0.19	ton	1.20	48.00	9.12	\$91.25	\$6,454.22		\$832	\$1,226	\$0	\$2,058
Elevated Slab on	Metal Deck- by Volume	0.00	ton			233	91.25			\$21,286	\$10,206	\$0	\$31,492
050503	FLOOR DECK	4,860.00	sqft	1.20	0.05	233.28	\$91.25	\$2.10		\$21,286	\$10,206	\$0	\$31,492
Elevated Slab on	Metal Deck- by Volume HVAC Filter Floor	0.00	ton			213	91.25			\$19,394	\$9,299	\$0	\$28,693
050503	FLOOR DECK	4,428.00	sqft	1.20	0.05	212.54	\$91.25	\$2.10		\$19,394	\$9,299	\$0	\$28,693
Elevated Slab on	Metal Deck- by Volume Security Bldg Roof	0.00	ton			3	91.25			\$252	\$121	80	\$372
050503	FLOOR DECK	57.46	sqft	1.20	0.05	2.76	\$91.25	\$2.10		\$252	\$121	\$0	\$372
Grating HIP Are	a	0.00	ton			14	91.25			\$1,277	\$2,572	\$0	\$3,849
050505	METAL GRATING 1 1/4" Over Trenches	200.00	sqft		0.07	14.00	\$91.25	\$12.86		\$1,277	\$2,572	\$0	\$3,849

Location: GREEN FIELD SITE HIP Option Account: 05 Structual Steel/Platework
Facility: Entire Estimate

HIP Option



Job No: 27989-325

Date: 7/17/2008 11:31AM

Priced By: ADC Office: Denver Product Line: Gov Estimate: FFC

				1 -1-		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

Steel Ratios: Entire Estimate 38.40 Workhours/Ton \$5,095 Material Cost/Ton \$8,599 Total Cost/Ton

Totals	Structual Steel/Platework	50 Tons	38.40	1,939	\$91.25	5,094.67	\$176,914	\$257,204	\$0	\$434,119
	Entire Estimate									

Location: GREEN FIELD SITE HIP Option Account: 06 Process Equipment Facility: Entire Estimate

HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

		HIP Option				J00 NO.	21989-323	KCV IVO.				Estimate. Fr	L	
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Sw	aging Item D						346	88.63			\$30,629	\$1,743,000	\$0	\$1,773,629
	060101	Process Equipment-PROCESS EQ -Swaging Equipment	2	each	1.20	172.80	345.60	\$88.63	\$800,000.00		\$30,629	\$1,600,000	\$0	\$1,630,629
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$1,600,000.00		\$0	\$64,000	\$0	\$64,000
	068900	Process Equipment-VENDOR REPS	10.00	days					\$1,500.00		\$0	\$15,000	\$0	\$15,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$1,600,000.00		\$0	\$64,000	\$0	\$64,000
AT	R Milling Item J						130	88.63			\$11,486	\$332,700	\$0	\$344,186
	060101	Process Equipment-PROCESS EQ Milling Model VR 11	1	each	1.20	129.60	129.60	\$88.63	\$300,000.00		\$11,486	\$300,000	\$0	\$311,486
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$300,000.00		\$0	\$13,200	\$0	\$13,200
	068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$300,000.00		\$0	\$12,000	\$0	\$12,000
Au	toclave Item P						19	88.63			\$1,702	\$81,600	\$0	\$83,302
	060126	Process Equipment-PROCESS EQ Autoclave Item P	1	each	1.20	19.20	19.20	\$88.63	\$80,000.00		\$1,702	\$80,000	\$0	\$81,702
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%	1.20				\$80,000.00		\$0	\$1,600	\$0	\$1,600
Co	nv, Elev, & Proce	ss Handling					230	88.63			\$20,419	\$64,500	\$0	\$84,919
	060116	Casting Area-PROCESS EQ Mtl Pass Thru Casting & Shop to Storage	2	each	1.20	115.20	230.40	\$88.63	\$30,000.00		\$20,419	\$60,000	\$0	\$80,419
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$30,000.00		\$0	\$1,500	\$0	\$1,500
	068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
Ele	ment Wash Item	N					38	88.63			\$3,403	\$21,600	\$0	\$25,003
	060101	Process Equipment-PROCESS EQ Element Wash	1	each	1.20	38.40	38.40	\$88.63	\$20,000.00		\$3,403	\$20,000	\$0	\$23,403
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$20,000.00		\$0	\$800	\$0	\$800
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$20,000.00		\$0	\$800	\$0	\$800
Fir	m Elev, & Proces	s Handling Motion Table					346	88.63			\$30,629	\$313,500	\$0	\$344,129
	060116	Process Equipment-PROCESS EQ Motion Table	2	each	1.20	172.80	345.60	\$88.63	\$150,000.00		\$30,629	\$300,000	\$0	\$330,629
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$150,000.00		\$0	\$7,500	\$0	\$7,500
	068900	Process Equipment-VENDOR REPS	4.00	days					\$1,500.00		\$0	\$6,000	\$0	\$6,000
Fir	m Heat Transfer	Eq RF Heating & Cooling Coils					288	88.63			\$25,524	\$2,225,500	\$0	\$2,251,024
	060126	Casting Area-PROCESS EQ RF Heating & Cooling Coils	2	each	1.20	144.00	288.00	\$88.63	\$1,000,000.00		\$25,524	\$2,000,000	\$0	\$2,025,524
	060126	Casting Area-PROCESS EQ Crucibles	20	each					\$2,500.00		\$0	\$50,000	\$0	\$50,000
	060126	Casting Area-PROCESS EQ Casting Molds	32	each					\$4,000.00		\$0	\$128,000	\$0	\$128,000

Location: GREEN FIELD SITE HIP Option Account: 06 Process Equipment Facility: Entire Estimate

HIP Option

URS

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

		HIP Option				Job No:	27989-325	Rev No:	0			Estimate: FFC		
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$2,000,000.00		\$0	\$40,000	\$0	\$40,000
	068900	Casting Area-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
Fir	m Price-Al Cladd	ing Cleaning Station Item 29					38	88.63			\$3,403	\$108,000	\$0	\$111,403
	060101	Process Equipment-PROCESS EQ Al Cladding Cleaning Station	1	each	1.20	38.40	38.40	\$88.63	\$100,000.00		\$3,403	\$100,000	\$0	\$103,403
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
Fir	m Price-AL Clade	ling Washing Item 27					19	88.63			\$1,702	\$10,800	\$0	\$12,502
	060101	Process Equipment-PROCESS EQ Washing Station	1	each	1.20	19.20	19.20	\$88.63	\$10,000.00		\$1,702	\$10,000	\$0	\$11,702
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
Fir	m Price-Annealin	g Furnace 24					43	88.63			\$3,829	\$40,800	\$0	\$44,629
	060126	Process Equipment-PROCESS EQ Annealing Furnace	1	each	1.20	43.20	43.20	\$88.63	\$40,000.00		\$3,829	\$40,000	\$0	\$43,829
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$40,000.00		\$0	\$800	\$0	\$800
Fir	m Price-Argon Su	pply & Distrib Sys					38	88.63			\$3,403	\$42,500	\$0	\$45,903
	060150	Casting Area-PROCESS EQ Argon Recycle System	1	each	1.20	38.40	38.40	\$88.63	\$40,000.00		\$3,403	\$40,000	\$0	\$43,403
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.03	%	1.20				\$40,000.00		\$0	\$1,000	\$0	\$1,000
	068900	Casting Area-VENDOR REPS	1.00	days	1.20				\$1,500.00		\$0	\$1,500	\$0	\$1,500
Fir	m Price-Argon Su	pply & Distrib Sys for HIP Sys					38	88.63			\$3,403	\$27,125	\$0	\$30,528
	060150	HIP Area-PROCESS EQ Argon Recycle System	1	each	1.20	38.40	38.40	\$88.63	\$25,000.00		\$3,403	\$25,000	\$0	\$28,403
	060199	HIP Area-DESIGN DEVELOPMENT ALLOW (DDA) SAMPLE-FIRM PRICE MATERIAL	0.03	%	1.20				\$25,000.00		\$0	\$625	\$0	\$625
	068900	HIP Area-VENDOR REPS SAMPLE-FIRM PRICE MATERIAL	1.00	days	1.20				\$1,500.00		\$0	\$1,500	\$0	\$1,500
Fir	m Price-Canning	Machines Item 33					77	88.63			\$6,806	\$165,000	\$0	\$171,806
	060101	Process Equipment-PROCESS EQ Canning Machine 33	1	each	1.20	76.80	76.80	\$88.63	\$150,000.00		\$6,806	\$150,000	\$0	\$156,806
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$150,000.00		\$0	\$6,000	\$0	\$6,000
	068900	Process Equipment-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$150,000.00		\$0	\$6,000	\$0	\$6,000
Fir	m Price-Conv, Cr	anes 2 5 ton Cap Units					192	88.63			\$17,016	\$136,620	\$0	\$153,636
	060116	Mechanical Equipment-PROCESS EQ Cranes 5 ton cal 30' span	2	each	1.20	96.00	192.00	\$88.63	\$62,200.00		\$17,016	\$124,400	\$0	\$141,416

Location: GREEN FIELD SITE HIP Option Account: 06 Process Equipment Facility: Entire Estimate

HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

	тит Орион										Estimate. TTC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Tota
060199	Mechanical Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$124,400.00		\$0	\$6,220	\$0	\$6,220
068900	Mechanical Equipment-VENDOR REPS	4.00	days					\$1,500.00		\$0	\$6,000	\$0	\$6,000
irm Price-Conv, C	ranes 5.0 ton Cap Monorail 2Units					77	88.63			\$6,806	\$39,900	\$0	\$46,706
060116	Mechanical Equipment-PROCESS EQ Cranes 5.0 ton cal Monorail Type	2	each	1.20	38.40	76.80	\$88.63	\$18,000.00		\$6,806	\$36,000	\$0	\$42,806
060199	Mechanical Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%	1.20				\$18,000.00		\$0	\$900	\$0	\$900
068900	Mechanical Equipment-VENDOR REPS	2.00	days	1.20				\$1,500.00		\$0	\$3,000	\$0	\$3,000
irm Price-Conv, El	lev, & Process Handling					115	88.63			\$10,210	\$34,500	\$0	\$44,710
060116	HIP Area-PROCESS EQ Mtl Pass Thru to HIP Process	1	each	1.20	115.20	115.20	\$88.63	\$30,000.00		\$10,210	\$30,000	\$0	\$40,210
060199	HIP Area-DESIGN DEVELOPMENT ALLOW (DDA) SAMPLE-FIRM PRICE MATERIAL	0.05	%	1.20				\$30,000.00		\$0	\$1,500	\$0	\$1,500
068900	HIP Area-VENDOR REPS SAMPLE-FIRM PRICE MATERIAL	2.00	days	1.20				\$1,500.00		\$0	\$3,000	\$0	\$3,000
irm Price-EB Can	Assy Station HIP Area Item 1					19	88.63			\$1,702	\$13,400	\$0	\$15,102
060101	HIP Area-PROCESS EQ Canning Machine 33	1	each	1.20	19.20	19.20	\$88.63	\$10,000.00		\$1,702	\$10,000	\$0	\$11,702
060199	HIP Area-DESIGN DEVELOPMENT ALLOW (DDA) SAMPLE-FIRM PRICE MATERIAL	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
068900	HIP Area-VENDOR REPS SAMPLE-FIRM PRICE MATERIAL	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
irm Price-Foil Clea	aning Station Item 30					38	88.63			\$3,403	\$108,000	\$0	\$111,403
060101	Process Equipment-PROCESS EQ Al Cladding Cleaning Station	1	each	1.20	38.40	38.40	\$88.63	\$100,000.00		\$3,403	\$100,000	\$0	\$103,403
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
069900	Process Equipment-BID CONDITIONING	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
irm Price-Hoist Mo	onorail 25 Ton cap					48	88.63			\$4,254	\$68,700	\$0	\$72,954
060116	HIP Area-PROCESS EQ SAMPLE-FIRM PRICE MATERIAL	1	each	1.20	48.00	48.00	\$88.63	\$64,000.00		\$4,254	\$64,000	\$0	\$68,254
060199	HIP Area-DESIGN DEVELOPMENT ALLOW (DDA) SAMPLE-FIRM PRICE MATERIAL	0.05	%	1.20				\$64,000.00		\$0	\$3,200	\$0	\$3,200
068900	HIP Area-VENDOR REPS SAMPLE-FIRM PRICE MATERIAL	1.00	days	1.20				\$1,500.00		\$0	\$1,500	\$0	\$1,500
irm Price-Hydraul	lic Press Item 20					29	88.63			\$2,552	\$34,500	\$0	\$37,052
060101	Process Equipment-PROCESS EQ Hydraulic Press 20	1	each	1.20	28.80	28.80	\$88.63	\$25,000.00		\$2,552	\$25,000	\$0	\$27,552
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$25,000.00		\$0	\$1,000	\$0	\$1,000
068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
069900	Process Equipment-BID CONDITIONING	0.04	%					\$25,000.00		\$0	\$1,000	\$0	\$1,000
												Dogo 2	2 of 69

Page 32 of 69

Location: GREEN FIELD SITE HIP Option Account: 06 Process Equipment Facility: Entire Estimate

HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

		HIP Option				Job No:	2/989-325	Rev No: 0)			Estimate: FFC		
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Fir	m Price-Hydraul	ic Shear 23					154	88.63			\$13,613	\$120,000	\$0	\$133,613
	060101	Process Equipment-PROCESS EQ Hydraulic Shear	4	each	1.20	38.40	153.60	\$88.63	\$25,000.00		\$13,613	\$100,000	\$0	\$113,613
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
	068900	Process Equipment-VENDOR REPS SAMPLE-FIRM PRICE MATERIAL	8.00	days					\$1,500.00		\$0	\$12,000	\$0	\$12,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
Fir	m Price-Ingot Cl	eaning Station Item 32					38	88.63			\$3,403	\$86,400	\$0	\$89,803
	060101	Process Equipment-PROCESS EQ Ingot Cleaning Station	1	each	1.20	38.40	38.40	\$88.63	\$80,000.00		\$3,403	\$80,000	\$0	\$83,403
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$80,000.00		\$0	\$3,200	\$0	\$3,200
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$80,000.00		\$0	\$3,200	\$0	\$3,200
Fir	m Price-Inspectio	on Tables Item K					96	88.63			\$8,508	\$17,280	\$0	\$25,788
	060101	Process Equipment-PROCESS EQ Inspection Tables	5	each	1.20	19.20	96.00	\$88.63	\$3,200.00		\$8,508	\$16,000	\$0	\$24,508
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%	1.20				\$16,000.00		\$0	\$640	\$0	\$640
	069900	Process Equipment-BID CONDITIONING	0.04	%	1.20				\$16,000.00		\$0	\$640	\$0	\$640
Fir	m Price-Jib Cran	es					58	88.63			\$5,105	\$32,250	\$0	\$37,355
	060116	Casting Area-PROCESS EQ Jib Cranes	2	each	1.20	28.80	57.60	\$88.63	\$15,000.00		\$5,105	\$30,000	\$0	\$35,105
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$15,000.00		\$0	\$750	\$0	\$750
	068900	Casting Area-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
Fir	m Price-Marking	Station Item 28					19	88.63			\$1,702	\$12,960	\$0	\$14,662
	060101	Process Equipment-PROCESS EQ Marking Station	1	each	1.20	19.20	19.20	\$88.63	\$12,000.00		\$1,702	\$12,000	\$0	\$13,702
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$12,000.00		\$0	\$480	\$0	\$480
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$12,000.00		\$0	\$480	\$0	\$480
Fir	m Price-Milling	Machines Salt Removal Item 31					43	88.63			\$3,829	\$54,000	\$0	\$57,829
	060101	Process Equipment-PROCESS EQ Milling Machines 31	1	each	1.20	43.20	43.20	\$88.63	\$50,000.00		\$3,829	\$50,000	\$0	\$53,829
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000
Fir	m Price-Milling	Machines Surface Finish 21					480	88.63			\$42,540	\$979,500	\$0	\$1,022,040
	060101	Process Equipment-PROCESS EQ Milling Machines 21	5	each	1.20	96.00	480.00	\$88.63	\$180,000.00		\$42,540	\$900,000	\$0	\$942,540
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$900,000.00		\$0	\$36,000	\$0	\$36,000
	068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500

Location: GREEN FIELD SITE HIP Option Account: 06 Process Equipment Facility: Entire Estimate

Washington Division HIP Option Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

	•										Listinute. 1		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Materia	I Subs	Tota
069900	Process Equipment-BID CONDITIONING	0.04	%					\$900,000.00		\$0	\$36,000	\$0	\$36,000
m Price-MIT/MU	JRR Welding Station Item 32					10	88.63			\$851	\$10,800	\$0	\$11,651
060101	Casting Area-PROCESS EQ Ingot Cleaning Station	1	each	1.20	9.60	9.60	\$88.63	\$10,000.00		\$851	\$10,000	\$0	\$10,851
060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
069900	Casting Area-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
m Price-Plate Cle	eaning System Item C					38	88.63			\$3,403	\$12,300	\$0	\$15,703
060101	Process Equipment-PROCESS EQ Plate Degreaser	1	each	1.20	38.40	38.40	\$88.63	\$10,000.00		\$3,403	\$10,000	\$0	\$13,403
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
068900	Process Equipment-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
069900	Process Equipment-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
m Price-Plate De	greaser System Item 11					38	88.63			\$3,403	\$12,300	\$0	\$15,703
060101	Process Equipment-PROCESS EQ Plate Degreaser	1	each	1.20	38.40	38.40	\$88.63	\$10,000.00		\$3,403	\$10,000	\$0	\$13,403
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
068900	Process Equipment-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
069900	Process Equipment-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
m Price-Polishing	g Wheel					5	88.63			\$425	\$5,250	\$0	\$5,675
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%	1.20				\$5,000.00		\$0	\$250	\$0	\$250
060201	Process Equipment-PROCESS EQ Polishing Wheel	1	each	1.20	4.80	4.80	\$88.63	\$5,000.00		\$425	\$5,000	\$0	\$5,425
m Price-Process l	Equipment ElectronBeam Welder									\$0	\$0	\$4,000,000	\$4,000,000
060101	HIP Area-PROCESS EQ Elcetron Beam Welder S/C	1	each						\$4,000,000.00	\$0	\$0	\$4,000,000	\$4,000,000
060199	HIP Area-DESIGN DEVELOPMENT ALLOW (DDA) SAMPLE-FIRM PRICE MATERIAL	0.04	%							\$0	\$0	\$0	\$0
m Price-Process l	Equipment Hot Isostatic Press					2,592	88.63			\$229,717	\$8,188,000	\$0	\$8,417,717
060101	HIP Area-PROCESS EQ HIP Package	2	each	1.20	1,296.00	2,592.00	\$88.63	\$3,925,000.00		\$229,717	\$7,850,000	\$0	\$8,079,717
060199	HIP Area-DESIGN DEVELOPMENT ALLOW (DDA) SAMPLE-FIRM PRICE MATERIAL	0.04	%					\$7,850,000.00		\$0	\$314,000	\$0	\$314,000
068900	HIP Area-VENDOR REPS SAMPLE-FIRM PRICE MATERIAL	16.00	days					\$1,500.00		\$0	\$24,000	\$0	\$24,000
m Price-Raw Allo	by Wash Station tem 72					38	88.63			\$3,403	\$12,300	\$0	\$15,703
060101	Casting Area-PROCESS EQ Wash Station Item 72	1	each	1.20	38.40	38.40	\$88.63	\$10,000.00		\$3,403	\$10,000	\$0	\$13,403
060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400

Page 34 of 69

Location: GREEN FIELD SITE HIP Option Account: 06 Process Equipment Facility: Entire Estimate

HIP Option

URS

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

		HIP Option				JOD INO:	21989-323	Rev No:	U			Estimate:	FFC	
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Materia	al Subs	Total
	068900	Casting Area-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
	069900	Casting Area-BID CONDITIONING	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
Fir	m Price-Rolling N	Mill w/Tunnel Furnace 25					144	88.63			\$12,762	\$1,087,500	\$0	\$1,100,262
	060101	Process Equipment-PROCESS EQ Rolling Mill W/Tunnel Furnace	1	each	1.20	144.00	144.00	\$88.63	\$1,000,000.00		\$12,762	\$1,000,000	\$0	\$1,012,762
	060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$1,000,000.00		\$0	\$40,000	\$0	\$40,000
	068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
	069900	Process Equipment-BID CONDITIONING	0.04	%					\$1,000,000.00		\$0	\$40,000	\$0	\$40,000
Fir	m Price-Stack						336	88.63			\$29,778	\$19,438	\$0	\$49,216
	060161	Bldg All In-PROCESS EQ Stack 70" diameter by 80' high	1	each	1.20	336.00	336.00	\$88.63	\$17,500.00		\$29,778	\$17,500	\$0	\$47,278
	060199	Bldg All In-DESIGN DEVELOPMENT ALLOW (DDA)	0.03	%					\$17,500.00		\$0	\$438	\$0	\$438
	068900	Bldg All In-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
Fir	m Price-Tanks &	Platework Fire Water Collection Crit tanks					19	88.63			\$1,702	\$21,900	\$0	\$23,602
	060161	Fire Water Collection-PROCESS EQ Pencil Tank Assembly	1	each	1.20	19.20	19.20	\$88.63	\$20,000.00		\$1,702	\$20,000	\$0	\$21,702
	060199	Fire Water Collection-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$20,000.00		\$0	\$400	\$0	\$400
	068900	Fire Water Collection-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
Fir	m Price-Tanks &	Platework Fire Water Collection Tank					19	88.63			\$1,702	\$11,016	\$0	\$12,718
	060161	Fire Water Collection-PROCESS EQ Tank Single Walled Plastic	1	each	1.20	19.20	19.20	\$88.63	\$10,800.00		\$1,702	\$10,800	\$0	\$12,502
	060199	Fire Water Collection-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$10,800.00		\$0	\$216	\$0	\$216
For	klifts and Power						10	88.63			\$851	\$87,750	\$0	\$88,601
	069900	Mechanical Equipment- Front End Loader 6000 lb cap	3	each	1.20	2.40	7.20	\$88.63	\$28,000.00		\$638	\$84,000	\$0	\$84,638
	069900	Mechanical Equipment-Pallet Truck	1	each	1.20	2.40	2.40	\$88.63	\$3,750.00		\$213	\$3,750	\$0	\$3,963
Hea	at Transfer Eq Cı						12	88.63			\$1,064	\$11,700	\$0	\$12,764
	060126	Casting Area-PROCESS EQ Crucible Tilter	1	each	1.20	12.00	12.00	\$88.63	\$10,000.00		\$1,064	\$10,000	\$0	\$11,064
	060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.02	%					\$10,000.00		\$0	\$200	\$0	\$200
	068900	Casting Area-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
HE		ir Handling Sys for Fuel Fabrication Area					4,920	88.63			\$436,037	\$154,017	\$2,654,150	\$3,244,204
	060129	Mechanical Equipment-HVAC EQUIPMENT Process Area Subcontract furnish & install (38900 sqft)	1	each						\$2,654,150.00	\$0	\$0	\$2,654,150	\$2,654,150
	060129	Mechanical Equipment-HVAC EQUIPMENT Process Area HEPA Filter Install Craft Support	1	each	1.20	372.00	372.00	\$88.63			\$32,969	\$0	\$0	\$32,969

Location: GREEN FIELD SITE HIP Option Account: 06 Process Equipment Facility: Entire Estimate

HIP Option

UKS

Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

	HIP Option				Job No:	27989-325	Rev No: 0				Estimate: FF	C	
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
060129	Mechanical Equipment-HVAC EQUIPMENT Process Area craft labor support (38900 sqft)	1	each	1.20	4,548.00	4,548.00	\$88.63	\$154,017.00		\$403,068	\$154,017	\$0	\$557,085
HEPA Filters and A	Air Handling Sys for HIP Area					494	88.63			\$43,816	\$154,017	\$285,600	\$483,433
060129	HIP Area-HVAC EQUIPMENT Process Area craft labor support (4200 sqft)	1	each	1.20	456.00	456.00	\$88.63	\$154,017.00		\$40,413	\$154,017	\$0	\$194,430
060129	HIP Area-HVAC EQUIPMENT Process Area Subcontract furnish & install (4200 sqft)	1	each						\$285,600.00	\$0	\$0	\$285,600	\$285,600
060129	HIP Area-HVAC EQUIPMENT Process Area HEPA Filter Install Craft Support (HIP)	1	each	1.20	38.40	38.40	\$88.63			\$3,403	\$0	\$0	\$3,403
Instron Item O	,					48	88.63			\$4,254	\$64,800	\$0	\$69,054
060101	Casting Area-PROCESS EQ Pull Testor	1	each	1.20	48.00	48.00	\$88.63	\$60,000.00		\$4,254	\$60,000	\$0	\$64,254
060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$60,000.00		\$0	\$2,400	\$0	\$2,400
069900	Casting Area-BID CONDITIONING	0.04	%					\$60,000.00		\$0	\$2,400	\$0	\$2,400
NIST/HIFR Weldin	g Item G					48	88.63			\$4,254	\$105,900	\$0	\$110,154
060101	Process Equipment-PROCESS EQ Welding Station	1	each	1.20	48.00	48.00	\$88.63	\$100,000.00		\$4,254	\$100,000	\$0	\$104,254
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.00	%					\$100,000.00		\$0	\$400	\$0	\$400
068900	Process Equipment-VENDOR REPS	1.00	days					\$1,500.00		\$0	\$1,500	\$0	\$1,500
069900	Process Equipment-BID CONDITIONING	0.04	%					\$100,000.00		\$0	\$4,000	\$0	\$4,000
Nitric Acid Wash Sy	ystem (incl Piping)					94	88.63			\$8,295	\$469	\$0	\$8,764
060101	Mechanical Equipment-Nitric Acid Wash System	1	each	1.20	93.60	93.60	\$88.63	\$469.00		\$8,295	\$469	\$0	\$8,764
Platework Crucible	Cleaning Station Glovebox Item 39					19	88.63			\$1,702	\$55,000	\$0	\$56,702
060161	Casting Area-PROCESS EQ Crucible Cleaning Station Glovebox Item 39	1	each	1.20	19.20	19.20	\$88.63	\$50,000.00		\$1,702	\$50,000	\$0	\$51,702
060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000
068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
Platework Crucible	Loading Station Item 38					19	88.63			\$1,702	\$34,200	\$0	\$35,902
060161	Casting Area-PROCESS EQ Crucible Loading Station Item 38	1	each	1.20	19.20	19.20	\$88.63	\$30,000.00		\$1,702	\$30,000	\$0	\$31,702
060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$30,000.00		\$0	\$1,200	\$0	\$1,200
068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
Platework Entry Glo	ovebox					58	88.63			\$5,105	\$55,000	\$0	\$60,105
060161	Casting Area-PROCESS EQ Casting Mold Entry Glovebox	1	each	1.20	57.60	57.60	\$88.63	\$50,000.00		\$5,105	\$50,000	\$0	\$55,105
060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000
068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000

Page 36 of 69

Location: GREEN FIELD SITE HIP Option Account: 06 Process Equipment Facility: Entire Estimate

HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

	HIP Option				300 110.	21909-323	KCV IVO. U				Estillate. FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Tota
atework Exit Glo	vebox					58	88.63		_	\$5,105	\$55,000	\$0	\$60,105
060161	Casting Area-PROCESS EQ Casting Mold Exit Glovebox	1	each	1.20	57.60	57.60	\$88.63	\$50,000.00		\$5,105	\$50,000	\$0	\$55,105
060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$50,000.00		\$0	\$2,000	\$0	\$2,000
068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
atework Removal	Station Glovebox Item 37					19	88.63			\$1,702	\$13,400	\$0	\$15,102
060161	Casting Area-PROCESS EQ Removal Glovebox Item 37	1	each	1.20	19.20	19.20	\$88.63	\$10,000.00		\$1,702	\$10,000	\$0	\$11,702
060199	Casting Area-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$10,000.00		\$0	\$400	\$0	\$400
068900	Casting Area-VENDOR REPS	2.00	days					\$1,500.00		\$0	\$3,000	\$0	\$3,000
ocess Equipment	Channel Probe Item B					115	88.63			\$10,220	\$871,500	\$0	\$881,720
060101	Process Equipment-PROCESS EQ Channel Probe	1	each	1.20	115.32	115.32	\$88.63	\$800,000.00		\$10,220	\$800,000	\$0	\$810,220
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%	1.20				\$800,000.00		\$0	\$32,000	\$0	\$32,000
068900	Process Equipment-VENDOR REPS	5.00	days	1.20				\$1,500.00		\$0	\$7,500	\$0	\$7,500
069900	Process Equipment-BID CONDITIONING	0.04	%	1.20				\$800,000.00		\$0	\$32,000	\$0	\$32,000
ocess Equipment	HIFR Lathe Item H					67	88.63			\$5,962	\$118,320	\$0	\$124,282
060101	Process Equipment-PROCESS EQ-Lathe Model SL 40	1	each	1.20	67.27	67.27	\$88.63	\$105,000.00		\$5,962	\$105,000	\$0	\$110,962
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%	1.20				\$105,000.00		\$0	\$4,620	\$0	\$4,620
068900	Process Equipment-VENDOR REPS	3.00	days	1.20				\$1,500.00		\$0	\$4,500	\$0	\$4,500
069900	Process Equipment-BID CONDITIONING	0.04	%	1.20				\$105,000.00		\$0	\$4,200	\$0	\$4,200
ocess Equipment	MIT Milling Item I					77	88.63			\$6,806	\$121,320	\$0	\$128,126
060101	Process Equipment-PROCESS EQ-MIlling Mode IVR 8	1	each	1.20	76.80	76.80	\$88.63	\$105,000.00		\$6,806	\$105,000	\$0	\$111,806
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%					\$105,000.00		\$0	\$4,620	\$0	\$4,620
068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500
069900	Process Equipment-BID CONDITIONING	0.04	%					\$105,000.00		\$0	\$4,200	\$0	\$4,200
oller Levelers Ite	m 19					48	88.63			\$4,254	\$40,800	\$0	\$45,054
060101	Process Equipment-PROCESS EQ Roller Levelers	1	each	1.20	48.00	48.00	\$88.63	\$35,000.00		\$4,254	\$35,000	\$0	\$39,254
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.04	%	1.20				\$35,000.00		\$0	\$1,400	\$0	\$1,400
068900	Process Equipment-VENDOR REPS	2.00	days	1.20				\$1,500.00		\$0	\$3,000	\$0	\$3,000
069900	Process Equipment-BID CONDITIONING	0.04	%	1.20				\$35,000.00		\$0	\$1,400	\$0	\$1,400
lt Bath with Loa	ding Equipment & Rolling Mill Item 26					130	88.63			\$11,486	\$532,500	\$0	\$543,986
060116	Process Equipment-PROCESS EQ Loading Equipment	1	each	1.20	129.60	129.60	\$88.63	\$500,000.00		\$11,486	\$500,000	\$0	\$511,486

Page 37 of 69

URS Washington D

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM

Priced By: ADC

Office: Denver

Product Line: Gov
Estimate: FFC

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
060199	Process Equipment-DESIGN DEVELOPMENT ALLOW (DDA)	0.05	%					\$500,000.00		\$0	\$25,000	\$0	\$25,000
068900	Process Equipment-VENDOR REPS	5.00	days					\$1,500.00		\$0	\$7,500	\$0	\$7,500

Tot	als 06-Process Equipment	12,533 \$88.63	\$1,110,740	\$18,771,132	\$6,939,750	\$26,821,622	
	Entire Estimate						

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate



Date: 7/17/2008 11:31AM

Priced By: ADC
Office: Denver
Product Line: Gov
Estimate: FFC

HIP Option Job No: 27989-325 Rev No: 0

					Lab.		Workhours						Totals	
Account No.	Description		Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Tota
11.01 PIPE BY ME														
11***** 1X	Carbon Steel													
Small I	Bore	1.5	1,000.0	0 LF	1.20	1.481	1,481	\$87.01	\$10.97		\$128,873	\$10,965	\$0	\$139,839
		28.60 Ftg	gs & Vlvs/100 LF Pip	e	0.00	LF/	Valve	\$ 140	Total Cost/LF					
11***** 2X	Stainless Steel													
Small I	Bore	1.0	000 300.0	0 LF	1.20	2.219	666	\$87.01	\$55.50		\$57,916	\$16,649	\$0	\$74,565
		63.33 Ftg	gs & Vlvs/100 LF Pip	e	3.49	LF/	Valve	\$ 249	Total Cost/LF					
11***** 5X	Plastic/Fiberglass													
Large l	Bore	3.2	5,615.0	0 LF	1.20	0.681	3,826	\$87.01	\$2.46		\$332,880	\$13,794	\$0	\$346,674
		7.50 Ftg	gs & Vlvs/100 LF Pip	e	0.00	LF/	Valve	\$ 62	Total Cost/LF					
11***** 61(62,	63) Iron													
Large l	Bore	0.0	00	0 LF	1.20		556	\$87.01			\$48,342	\$11,575	\$0	\$59,910
1103****	Specialities						19	\$87.01			\$1,671	\$3,930	\$0	\$5,601
1104****	Hangers & Supports						2,573	\$87.01			\$223,855	\$26,393	\$0	\$250,248
11*****	Unspecified Metallurgy													
110116	Out of Spec - Pipe		1,800.00	lnft				\$87.01			\$0	\$0	\$0	\$0
110102	OVERALL PIPING ALLOWAL WEIGHTED Compressed Air	NCE-A/G	1,844.00	lnft		1.96	3,606.86	\$87.01	\$12.05		\$313,827	\$22,217	\$0	\$336,044
110102	OVERALL PIPING ALLOWAL WEIGHTED Instrument Air	NCE-A/G	3,211.00	lnft		1.96	6,280.72	\$87.01	\$16.43		\$546,475	\$52,757	\$0	\$599,231
110121	Out of Spec Unions		4.00	each				\$87.01			\$0	\$0	\$0	\$0
		0.06 Ftg	gs & Vlvs/100 LF Pip	e e	0.00) LF/	Valve	\$ 136	Total Cost/LF					

Overall Ratios

6.86 Ftgs & Vlvs/100 LF Pipe

105.92 LF/Valve 1.38 Workhours/LF \$131.60 Total Cost/LF

Grand Total: 11: Piping	1.458	13,770	LF	1.20	1.38	19,008	\$87.01	\$1,653,839	\$158,279	\$0 \$1,812,
								\$120.10 /LF	\$11.49 /LF	\$0.00 /LF

Location: GREEN FIELD SITE HIP Option

HIP Option



Job No: 27989-325

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

Account: 11 Piping
Facility: Entire Estimate

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

11.02 PIPE BY SERVICE SYSTEM

1.458 13,770.00 LF 1.20 19,007.82 \$87.01 \$11.49 \$0 \$1,812,118 1.380 \$1,653,839 \$158,279 \$0.00 LF/Valve 105.92 Total Cost/LF Ftgs & Vlvs/100 LF \$ 131.60 6.86

Overall Ratios

6.86 Ftgs & Vlvs/100 LF P

105.92 LF/Valve 1.38 Workhours/LF \$131.60 Total Cost/LF

Grand Total: 11: Piping	1.458	13,770 LF	1.20	1.38	19,008 \$	87.01	\$1,653,839	\$158,279	\$0	\$1,812,118
							\$120.10 /LF	\$11.49 /LF	\$0.00/LF	

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate
HIP Option



Washington Division

27090 225 Pay Mar

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov

н	IP Option					Job No:	27989-325	Rev No: 0			r	Estimate: FFC		
					Lab.		Workhours						Totals	
Account No.	Description		Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
11.04 PIPE BY ASSEM	MBLY - SUMMARY]												
Bldg Plumbir	ng		0.00	LF	1.20	0.00	19	\$87.01	\$0.00	\$0.00	\$1,671	\$3,930	\$0	\$5,601
	(400s Specs) Plumbing 50 Inft per fixture)L	1.500	1,000.00	LF	1.20	1.91	1,908	\$87.01	\$17.05	\$0.00	\$166,043	\$17,047	\$0	\$183,090
Plastic (800s)) Fire Protection Loop		1,800.00	LF	1.20	0.89	1,608	\$87.01	\$10.41	\$0.00	\$139,889	\$18,746	\$0	\$158,635
Plastic (800s) per floor drai) Floor Drain Pipe (100 Inft in)	3.000	2,400.00	LF	1.20	0.72	1,723	\$87.01	\$3.83	\$0.00	\$149,933	\$9,180	\$0	\$159,113
Plastic (800s) per floor drai) Floor Drain Pipe (100 Inft in) HIP Area	3.000	200.00	LF	1.20	0.72	145	\$87.01	\$3.72	\$0.00	\$12,613	\$743	\$0	\$13,356
Plastic (800s) Line) Outside Sanitary Sewer	6.000	475.00	LF	1.20	1.14	540	\$87.01	\$9.30	\$0.00	\$46,985	\$4,416	\$0	\$51,400
Plastic (800s) roof drain)) Roof drain pipe(70 lnft per	3.000	1,400.00	LF	1.20	0.70	986	\$87.01	\$3.79	\$0.00	\$85,762	\$5,304	\$0	\$91,066
Plastic (800s) roof drain) H) Roof drain pipe(70 lnft per IIP AREA	3.000	140.00	LF	1.20	0.73	103	\$87.01	\$4.09	\$0.00	\$8,948	\$573	\$0	\$9,521
Plastic (800s) Inft per fixtur) Sanitary Sewer piping (50 re)	3.000	1,000.00	LF	1.20	1.54	1,538	\$87.01	\$9.20	\$0.00	\$133,801	\$9,204	\$0	\$143,005
Stainless Stee Piping	el (700s) Argon Supply	1.000	150.00	LF	1.20	1.83	275	\$87.01	\$47.21	\$0.00	\$23,946	\$7,081	\$0	\$31,028
Stainless Stee Piping for HI	el (700s) Argon Supply IP Sys	1.000	150.00	LF	1.20	1.83	275	\$87.01	\$47.21	\$0.00	\$23,946	\$7,081	\$0	\$31,028
Utilities			5,055.00	LF	1.20	1.96	9,888	\$87.01	\$14.83	\$0.00	\$860,302	\$74,973	\$0	\$935,275

Overall Ratios

6.86 Ftgs & VLvs/100 LF Pipe

105.92 LF / Valve

1.38 Workhours/LF

\$131.60 Total Cost/LF

Grand Total: 11: Piping	1.458	13,770 LF	1.20	1.38	19,008	\$87.01	\$1,653,839	\$158,279	\$0	\$1,812,118
							\$120.10 /LF	\$11.49 /LF	\$0.00 /LF	

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:31AM

Priced By: ADC Office: Denver Product Line: Gov

	r acı	HIP Option					Job No:	27989-325	Rev No: 0			F	Product Line: Gov Estimate: FF0		
						Lab.		Workhours						Totals	
	Account No.	Description		Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
1	1.03 PIPE BY C	COMMODITY													
1	101 Pip	be, Fittings, Welds, and Shopcosts	13,770.00	lnft	1.46	1.20	1.133	15,601	\$87.01	\$7.66		\$1,357,440	\$105,442		\$1,462,882
1	102 Val	lves	130.00	ea		1.20	6.266	815	\$87.01	\$173.19		\$70,874	\$22,514		\$93,388
1	103 Spe	ecialties				1.20	9.600	19	\$87.01	\$1,965.00		\$1,671	\$3,930		\$5,601
1	104 Hai	ngers & Supports	684.00	ea		1.20	3.761	2,573	\$87.01	\$38.59		\$223,855	\$26,393		\$250,248

Overall Ratios

6.86 Ftgs & Vlvs/100 LF Pipe

105.92 LF / Valve 1.38 Workhours/LF \$131.60 Total Cost/LF

Grand Total: 11: Piping	13,770	LF	1.458	1.20	1.38	19,008	\$87.01	\$1,653,839	\$158,279	\$0	\$1,812,118
								\$120.10 /LF	\$11.49 /LF	\$0.00 /LF	

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate HIP Option



Job No: 27989-325

9.60

2.00 each 1.20

Washington Division

Rev No: 0

\$87.01

\$1,965.00

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov Estimate: FFC

\$3,930

\$0

\$5,601

\$1,671

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

11.05 Pipe by Assembly - Detail

Bldg Plumbing

LB SPECIALTIES - Safety Shower & Eyewash Station W/ Eye & Face Wash 110311

Bldg Plumbing

19

0.00 Ftgs & Vlvs/100 LF Pipe

0.00 LF / Valve 0.00 Workhours/LF

\$0.00 Total Cost/LF

11: Piping	Bldg Plumbing	0.000 0 LI	1.20	0.00	19	\$87.01		\$1,671 \$0.00 /LF	\$3,930 \$0.00 /LF	\$0 \$0.00 /LF	\$5,60
Carbon Sto	eel (400s Specs) Plumbing Water Pipe (50 Inft per	fixture)L									
10111	1.5" PIPE,A106 STD/S40 SMLS	1,000.00 lnft	1.20	0.49	492	\$87.01	\$3.70	\$42,808	\$3,703	\$0	\$46,5
10121	1.5" 90 ELL CS 3000# SW	71.00 each	1.20	1.68	119	\$87.01	\$24.56	\$10,378	\$1,744	\$0	\$12,1
10121	1.5" 45 ELL CS 3000# SW	7.00 eacl	1.20	1.68	12	\$87.01	\$28.44	\$1,023	\$199	\$0	\$1,2
10121	1.5" TEE CS 3000# SW	43.00 eacl	1.20	2.52	108	\$87.01	\$37.02	\$9,428	\$1,592	\$0	\$11,02
10121	1.5" RED CS 3000# SW	29.00 each	1.20	1.68	49	\$87.01	\$35.14	\$4,239	\$1,019	\$0	\$5,25
110121	1.5" CAP CS 3000# SW	7.00 each	1.20	0.84	6	\$87.01	\$16.56	\$512	\$116	\$0	\$62
10121	1.5" CS 150# STD RF SW	129.00 each	1.20	0.96	124	\$87.01	\$20.10	\$10,775	\$2,593	\$0	\$13,36
110132	1.5" FIELD WELD, STD	529.00 eacl	1.20	1.08	571	\$87.01		\$49,710	\$0	\$0	\$49,71
110206	1 1/2" GATEVALVE 63SA 1.50	60.00 eacl	1.20	3.12	187	\$87.01	\$55.21	\$16,288	\$3,313	\$0	\$19,60
110406	1 1/2" Hanger, Standard 1.5"	100.00 each	1.20	2.40	240	\$87.01	\$27.69	\$20,882	\$2,769	\$0	\$23,65
				Carbon Steel (400	Specs) P	lumbing Water	P				
				34.60	Ftgs & V	/lvs/100 LF Pipe	,				
				16.67	LF / Va	lve					
				1.91	Workho	urs/LF					
				\$183.09	Total Co	ost/LF					
							_				
11: Piping	Carbon Steel (400s Specs) Plumbing	1.500 1,000 LI		1.91	1,908	\$87.01		\$166,043	\$17,047	\$0	\$183,09

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

	тт Орион									Estimate. 11C		
			Lab.		Workhours						Totals	
Account No.	Description	Qty UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Plastic (800s) Fire	Protection Loop											
110116	Out of Spec - Pipe	1,800.00 lnft	1.20			\$87.01			\$0	\$0	\$0	\$0
110126	8" 90 ELL S80 PVC SW	28.00 each	1.20	4.08	114	\$87.01	\$64.30		\$9,940	\$1,800	\$0	\$11,740
110126	8" TEE S80 PVC SW	8.00 each	1.20	6.24	50	\$87.01	\$90.98		\$4,343	\$728	\$0	\$5,071
110126	8" FLG SCH 80 SW PVC	50.00 each	1.20	2.04	102	\$87.01	\$38.44		\$8,875	\$1,922	\$0	\$10,797
110126	8" SM. INLINE Tie into existing fire line 8"	1.00 each	1.20	16.44	16	\$87.01			\$1,430	\$0	\$0	\$1,430
110126	8" LG. INLINE Hydrants 8"	6.00 each	1.20	20.52	123	\$87.01			\$10,712	\$0	\$0	\$10,712
110137	8" PLAST FIELD WELD	140.00 each	1.20	2.52	353	\$87.01	\$2.00		\$30,697	\$280	\$0	\$30,977
110146	8" 150# BOLT-UP,PLAST	25.00 each	1.20	3.60	90	\$87.01			\$7,831	\$0	\$0	\$7,831
110211	8" GATEVALVE 11FA 8.00	12.00 each	1.20	20.52	246	\$87.01	\$572.25		\$21,425	\$6,867	\$0	\$28,292
110411	8" Supports, Standard 8"	95.00 each	1.20	5.40	513	\$87.01	\$75.25		\$44,635	\$7,149	\$0	\$51,784

Plastic (800s) Fire Protection Loop

5.44 Ftgs & Vlvs/100 LF Pipe 150.00 LF / Valve 0.89 Workhours/LF \$88.13 Total Cost/LF

11: Piping	Plastic (800s) Fire Protection Loop	0.000	1,800 LF	1.20	0.89	1,608	\$87.01		\$139,889 \$77.72 /LF	\$18,746 \$10.41 /LF	\$0 \$0.00 /LF	\$158,635
Plastic (800	s) Floor Drain Pipe (100 lnft per floor drain)											
110116	3" PIPE, SCH 40 PVC		2,400.00 lnft	1.20	0.31	749	\$87.01	\$0.98	\$65,152	\$2,352	\$0	\$67,504
110126	3" 90 ELL S40 PVC SW		24.00 each	1.20	1.56	37	\$87.01	\$4.39	\$3,258	\$105	\$0	\$3,363
110126	3" 45 ELL S40 PVC SW		12.00 each	1.20			\$87.01	\$5.70	\$0	\$68	\$0	\$68
110126	3" WYE S40 PVC SW		24.00 each	1.20	2.28	55	\$87.01	\$7.03	\$4,761	\$169	\$0	\$4,930
110137	3" PLAST FIELD WELD		144.00 each	1.20	0.96	138	\$87.01		\$12,028	\$0	\$0	\$12,028
110411	3" Supports, Standard 3"		200.00 each	1.20	3.72	744	\$87.01	\$32.43	\$64,734	\$6,486	\$0	\$71,220

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

						Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

| Plastic (800s) Floor Drain Pipe (100 Inft per fl | 2.50 | Ftgs & Vlvs/100 LF Pipe | 0.00 | LF / Valve | 0.72 | Workhours/LF | \$66.30 | Total Cost/LF |

11: Piping	Plastic (800s) Floor Drain Pipe (100 Inft per floor drain)	3.000	2,400 LF	1.20	0.72	1,723	\$87.01		\$149,933 \$62.47 /LF	\$9,180 \$3.83 /LF	\$0 \$0.00 /LF	\$159,113
Plastic (800	os) Floor Drain Pipe (100 Inft per floor drain) I	HIP Area										
110116	3" PIPE, SCH 40 PVC		200.00 Inft	1.20	0.31	62	\$87.01	\$0.98	\$5,429	\$196	\$0	\$5,625
110126	3" 90 ELL S40 PVC SW		2.00 each	1.20	1.56	3	\$87.01	\$4.39	\$271	\$9	\$0	\$280
110126	3" 45 ELL S40 PVC SW		1.00 each	1.20			\$87.01	\$5.70	\$0	\$6	\$0	\$6
110126	3" WYE S40 PVC SW		2.00 each	1.20	2.28	5	\$87.01	\$7.03	\$397	\$14	\$0	\$411
110137	3" PLAST FIELD WELD		16.00 each	1.20	0.96	15	\$87.01		\$1,336	\$0	\$0	\$1,336
110411	3" Supports, Standard 3"		16.00 each	1.20	3.72	60	\$87.01	\$32.43	\$5,179	\$519	\$0	\$5,698
					Plastic (800s)	Floor Drain Pi	pe (100 lnft pe	er fl				

 Plastic (800s) Floor Drain Pipe (100 Inft per fl

 2.50
 Ftgs & Vlvs/100 LF Pipe

 0.00
 LF / Valve

 0.72
 Workhours/LF

 \$66.78
 Total Cost/LF

11: Piping	Plastic (800s) Floor Drain Pipe (100 Inft per floor drain) HIP Area	3.000 200 1	F 1.20	0.72	145	\$87.01		\$12,613 \$63.06 /LF	\$743 \$3.72 /LF	\$0 \$0.00 /LF	\$13,356
Plastic (800	0s) Outside Sanitary Sewer Line										
110116	6" PIPE, SCH 40 PVC	475.00 ln	ft 1.20	0.46	217	\$87.01	\$2.56	\$18,846	\$1,216	\$0	\$20,062
110126	6" 90 ELL S40 PVC SW	6.00 ea	ch 1.20	3.12	19	\$87.01	\$24.97	\$1,629	\$150	\$0	\$1,779
110126	6" 45 ELL S40 PVC SW	2.00 ea	ch 1.20			\$87.01	\$25.26	\$0	\$51	\$0	\$51
110126	6" TEE S40 PVC SW	1.00 ea	ch 1.20	4.68	5	\$87.01	\$39.23	\$407	\$39	\$0	\$446
110126	6" RED S40 PVC SW	1.00 ea	ch 1.20	3.12	3	\$87.01	\$11.80	\$271	\$12	\$0	\$283
110121	Out of Spec Unions	4.00 ea	ch 1.20			\$87.01		\$0	\$0	\$0	\$0
110126	6" FLG SCH 40 SW PVC	31.00 ea	ch 1.20	1.56	48	\$87.01	\$19.79	\$4,208	\$613	\$0	\$4,821
110126	6" LG. INLINE Tie In to Existing Sewer Line 6"	1.00 ea	ch 1.20	14.28	14	\$87.01		\$1,242	\$0	\$0	\$1,242

Page 45 of 69

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate
HIP Option



Job No: 27989-325

Washington Division

Rev No: 0

11:31AM Priced By: ADC

Date: 7/17/2008

Office: Denver
Product Line: Gov
Estimate: FFC

			Lab.		Workhours						Totals	
Accoun	t No. Description	Qty UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
110137	6" PLAST FIELD WELD	30.00 each	n 1.20	2.04	61	\$87.01	\$1.00		\$5,325	\$30	\$0	\$5,355
110211	6" GATEVALVE 11FA 6.00	2.00 each	1.20	14.28	29	\$87.01	\$316.75		\$2,485	\$634	\$0	\$3,118
110411	6" Supports, Standard 6"	28.00 each	1.20	5.16	144	\$87.01	\$59.70		\$12,571	\$1,672	\$0	\$14,243

 Plastic (800s) Outside Sanitary Sewer Line

 9.89
 Ftgs & Vlvs/100 LF Pipe

 237.50
 LF / Valve

 1.14
 Workhours/LF

 \$108.21
 Total Cost/LF

11: Piping	Plastic (800s) Outside Sanitary Sewer Line	6.000	475 LF	1.20	1.14	540	\$87.01		\$46,985 \$98.91 /LF	\$4,416 \$9.30 /LF	\$0 \$0.00 /LF	\$51,400
Plastic (800	s) Roof drain pipe(70 lnft per roof drain)											
110116	3" PIPE, SCH 40 PVC		1,400.00 lnft	1.20	0.31	437	\$87.01	\$0.98	\$38,005	\$1,372	\$0	\$39,377
110126	3" 90 ELL S40 PVC SW		20.00 each	1.20	1.56	31	\$87.01	\$4.39	\$2,715	\$88	\$0	\$2,802
110126	3" 45 ELL S40 PVC SW		3.00 each	1.20			\$87.01	\$5.70	\$0	\$17	\$0	\$17
110137	3" PLAST FIELD WELD		82.00 each	1.20	0.96	79	\$87.01		\$6,849	\$0	\$0	\$6,849
110411	3" Hanger, Standard 3"		118.00 each	1.20	3.72	439	\$87.01	\$32.43	\$38,193	\$3,827	\$0	\$42,020

 Plastic (800s) Roof drain pipe(70 Inft per roof)

 1.64
 Ftgs & Vlvs/100 LF Pipe

 0.00
 LF / Valve

 0.70
 Workhours/LF

 \$65.05
 Total Cost/LF

11: Piping	Plastic (800s) Roof drain pipe(70 lnft per roof drain)	3.000	1,400 LF	1.20	0.70	986	\$87.01		\$85,762 \$61.26 /LF	\$5,304 \$3.79 /LF	\$0 \$0.00 /LF	\$91,066
Plastic (800	s) Roof drain pipe(70 lnft per roof drain) HIP	AREA										
110116	3" PIPE, SCH 40 PVC		140.00 Inft	1.20	0.31	44	\$87.01	\$0.98	\$3,801	\$137	\$0	\$3,938
110126	3" 90 ELL S40 PVC SW		2.00 each	1.20	1.56	3	\$87.01	\$4.39	\$271	\$9	\$0	\$280
110126	3" 45 ELL S40 PVC SW		1.00 each	1.20			\$87.01	\$5.70	\$0	\$6	\$0	\$6
110137	3" PLAST FIELD WELD		8.00 each	1.20	0.96	8	\$87.01		\$668	\$0	\$0	\$668
110411	3" Hanger, Standard 3"		13.00 each	1.20	3.72	48	\$87.01	\$32.43	\$4,208	\$422	\$0	\$4,629

Page 46 of 69

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Plastic (800s) Roof drain pipe(70 Inft per roof

2.14 Ftgs & Vlvs/100 LF Pipe 0.00 LF / Valve 0.73 Workhours/LF \$68.01 Total Cost/LF

11: Piping	Plastic (800s) Roof drain pipe(70 lnft per roof drain) HIP AREA	3.000 1	40 LF	1.20	0.73	103	\$87.01		\$8,948 \$63.91 /LF	\$573 \$4.09 /LF	\$0 \$0.00 /LF	\$9,521
Plastic (800	s) Sanitary Sewer piping (50 lnft per fixture)											
110116	3" PIPE, SCH 40 PVC	1,000.0) lnft	1.20	0.31	312	\$87.01	\$0.98	\$27,147	\$980	\$0	\$28,127
110126	3" 90 ELL S40 PVC SW	50.00	each each	1.20	1.56	78	\$87.01	\$4.39	\$6,787	\$220	\$0	\$7,006
110126	3" 45 ELL S40 PVC SW	6.0	each each	1.20			\$87.01	\$5.70	\$0	\$34	\$0	\$34
110126	3" TEE S40 PVC SW	30.00	each each	1.20	2.28	68	\$87.01	\$7.03	\$5,951	\$211	\$0	\$6,162
110126	3" RED S40 PVC SW	20.00	each each	1.20	1.56	31	\$87.01	\$2.13	\$2,715	\$43	\$0	\$2,757
110126	3" CAP S40 PVC SW	6.0	each each	1.20	0.84	5	\$87.01	\$2.15	\$439	\$13	\$0	\$451
110126	3" FLG SCH 40 SW PVC	91.0	each each	1.20	0.84	76	\$87.01	\$9.95	\$6,651	\$905	\$0	\$7,556
110137	3" PLAST FIELD WELD	389.0	each each	1.20	0.96	373	\$87.01		\$32,492	\$0	\$0	\$32,492
110211	3" GATEVALVE 11FA 3.00	30.00	each each	1.20	9.36	281	\$87.01	\$135.80	\$24,432	\$4,074	\$0	\$28,506
110411	3" Hanger, Standard 3"	84.00	each each	1.20	3.72	312	\$87.01	\$32.43	\$27,188	\$2,724	\$0	\$29,912

 Plastic (800s) Sanitary Sewer piping (50 Inft pe

 23.30
 Ftgs & Vlvs/100 LF Pipe

 33.33
 LF / Valve

 1.54
 Workhours/LF

 \$143.01
 Total Cost/LF

11: Piping	Plastic (800s) Sanitary Sewer piping (50 lnft per fixture)	3.000	1,000 LF	1.20	1.54	1,538	\$87.01		\$133,80 \$133.80 /LF	99,204 \$9.20 /LF	\$0 \$0.00 /LF	\$143,005
Stainless S	iteel (700s) Argon Supply Piping											_
110111	1" PIPE,S40 316L SMLS		150.00 lnft	1.20	0.49	74	\$87.01	\$6.28	\$6,421	\$941	\$0	\$7,363
110121	1" 90 ELL 316L 3000# SW		13.00 each	1.20	0.96	12	\$87.01	\$16.39	\$1,086	\$213	\$0	\$1,299
110121	1" 45 ELL 316L 3000# SW		1.00 each	1.20	0.96	1	\$87.01	\$21.01	\$84	\$21	\$0	\$105
110121	1" TEE 316L 3000# SW		8.00 each	1.20	1.44	12	\$87.01	\$21.70	\$1,002	\$174	\$0	\$1,176
110121	1" RED 316L 3000# SW		5.00 each	1.20	0.96	5	\$87.01	\$11.56	\$418	\$58	\$0	\$475
											Page 4	47 of 69

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate
HIP Option



Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

	<u> </u>											
			Lab.		Workhours						Totals	
Account No.	Description	Qty UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
110121	1" CAP 316L 3000# SW	1.00 each	1.20	0.48	0	\$87.01	\$7.66		\$42	\$8	\$0	\$49
110121	1" SS 316L 600# RF SW	24.00 each	1.20	0.48	12	\$87.01	\$60.00		\$1,002	\$1,440	\$0	\$2,442
110132	1" FIELD WELD, SCH 40	95.00 each	1.20	0.92	88	\$87.01			\$7,638	\$0	\$0	\$7,638
110206	1" GATEVALVE 73SA 1.00	13.00 each	1.20	2.76	36	\$87.01	\$293.35		\$3,122	\$3,814	\$0	\$6,935
110406	1" Hanger, Standard 1"	15.00 each	1.20	2.40	36	\$87.01	\$27.53		\$3,132	\$413	\$0	\$3,545

 Stainless Steel (700s) Argon Supply Piping

 43.33
 Ftgs & Vlvs/100 LF Pipe

 11.54
 LF / Valve

 1.83
 Workhours/LF

 \$206.85
 Total Cost/LF

11: Piping	Stainless Steel (700s) Argon Supply Piping	1.000	150 LF	1.20	1.83	275	\$87.01		\$23,94 6 \$159.64 /LF	\$7,081 \$47.21 /LF	\$0 \$0.00 /LF	\$31,028
Stainless St	eel (700s) Argon Supply Piping for HIP Sys											
110111	1" PIPE,S40 316L SMLS	150	00 lnft	1.20	0.49	74	\$87.01	\$6.28	\$6,421	\$941	\$0	\$7,363
110121	1" 90 ELL 316L 3000# SW	13.	00 each	1.20	0.96	12	\$87.01	\$16.39	\$1,086	\$213	\$0	\$1,299
110121	1" 45 ELL 316L 3000# SW	1.	00 each	1.20	0.96	1	\$87.01	\$21.01	\$84	\$21	\$0	\$105
110121	1" TEE 316L 3000# SW	8.	00 each	1.20	1.44	12	\$87.01	\$21.70	\$1,002	\$174	\$0	\$1,176
110121	1" RED 316L 3000# SW	5.	00 each	1.20	0.96	5	\$87.01	\$11.56	\$418	\$58	\$0	\$475
110121	1" CAP 316L 3000# SW	1.	00 each	1.20	0.48	0	\$87.01	\$7.66	\$42	\$8	\$0	\$49
110121	1" SS 316L 600# RF SW	24.	00 each	1.20	0.48	12	\$87.01	\$60.00	\$1,002	\$1,440	\$0	\$2,442
110132	1" FIELD WELD, SCH 40	95.	00 each	1.20	0.92	88	\$87.01		\$7,638	\$0	\$0	\$7,638
110206	1" GATEVALVE 73SA 1.00	13.	00 each	1.20	2.76	36	\$87.01	\$293.35	\$3,122	\$3,814	\$0	\$6,935
110406	1" Hanger, Standard 1"	15.	00 each	1.20	2.40	36	\$87.01	\$27.53	\$3,132	\$413	\$0	\$3,545

 43:33
 Figs & VIvs/100 LF Pipe

 11.54
 LF / Valve

 1.83
 Workhours/LF

 \$206.85
 Total Cost/LF

							i				
11: Piping		1.000	150 LF 1.20	1.83	275	\$87.01		\$23,946	\$7,081	\$0	\$31,028
	Piping for HIP Sys							\$159.64 /LF	\$47.21 /LF	\$0.00 /LF	

Utilities

Page 48 of 69

Location: GREEN FIELD SITE HIP Option

Account: 11 Piping
Facility: Entire Estimate
HIP Option

URS

Washington Division

Date: 7/17/2008 11:31AM

Priced By: ADC
Office: Denver
Product Line: Gov
Estimate: FFC

Job No: 27989-325 Rev No: 0

			Lab.		Workhours						Totals	
Account No.	Description	Qty UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
110102	OVERALL PIPING ALLOWANCE-A/G WEIGHTED Compressed Air	1,844.00 li	nft 1.20	1.96	3,607	\$87.01	\$12.05		\$313,827	\$22,217	\$0	\$336,044
110102	OVERALL PIPING ALLOWANCE-A/G WEIGHTED Instrument Air	3,211.00 li	nft 1.20	1.96	6,281	\$87.01	\$16.43		\$546,475	\$52,757	\$0	\$599,231

 Utilities

 0.00
 Ftgs & Vlvs/100 LF Pipe

 0.00
 LF / Valve

 1.96
 Workhours/LF

 \$185.02
 Total Cost/LF

11: Piping	Utilities	0.000	5,055 LF 1.2	0	1.96	9,888	\$87.01	\$860,302	\$74,973	\$0	\$935,275
								\$170.19 /LF	\$14.83 /LF	\$0.00 /LF	

Overall Ratios

6.86 Ftgs & Vlvs/100 LF Pipe

105.92 LF / Valve 1.38 Workhours/LF \$131.60 Total Cost/LF

Grand Total	11: Piping	1.458	13,770 LF	1.20	1.96	19,008 \$87.01	\$1,653,839	\$158,279	\$0	\$1,812,118
							\$120.10 /LF	\$11.49 /LF	\$0.00 /LF	

Page 49 of 69

Location: GREEN FIELD SITE HIP Option

Account: 12 Electrical
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

	ніг Ори	on				300 110.	21969-323	KCV IVO. 0				Estillate. FFC		
			_		Lab.		Workhours				·		Totals	
Account	t No. Des	cription	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Tota
2 Electric	al Sum by Commo	dity												
216*	Electrical Equipn	nent			1.20		1,137.96	85.13			\$96,879	\$595,800	\$0	\$692,679
	121602	480/208/120/3P TRANS 300 KVA For HIP Units	2.00	each	1.20	104.40	208.80	\$85.13	\$5,275.00		\$17,776	\$10,550		\$28,326
	121602	15KV/5KV/3PHASE 2000 KVA	2.00	each	1.20	160.08	320.16	\$85.13	\$35,000.00		\$27,257	\$70,000		\$97,257
	121615	Batteries & Chargers	1.00	each	1.20	384.00	384.00	\$85.13	\$159,000.00		\$32,691	\$159,000		\$191,691
	121604	Power Distribution Center #1 (15' X 25')	375.00	sqft	1.20	0.60	225.00	\$85.13	\$950.00		\$19,155	\$356,250		\$375,405
201*	Conduit		17,500		1.20	0.13	2,330.77		2.65		\$198,428	\$46,379	\$0	\$244,807
	120103	1" Conduit Hanger-2Holer	350.00		1.20	0.02	8.40		\$0.35		\$715	\$123		\$838
	120103	1 1/2 PVC CONDUIT	3,500.00	lnft	1.20	0.08	294.00		\$1.40		\$25,029	\$4,900		\$29,929
	120105	2 PVC CONDUIT	2,500.00	lnft	1.20	0.10	240.00		\$1.85		\$20,432	\$4,625		\$25,057
	120105	2 PVC CONDUIT	3,500.00			0.10		\$85.13	\$1.85		\$28,605	\$6,475		\$35,080
	120103	1 RGS CONDUIT	3,500.00		1.20	0.19		\$85.13	\$1.30		\$57,210	\$4,550		\$61,760
	120103	1 RGS ELL	105.00	each	1.20	0.28	28.98	\$85.13	\$4.90		\$2,467	\$515		\$2,982
	120103	1 RGS LB	105.00	each	1.20	0.62	65.52	\$85.13	\$13.15		\$5,578	\$1,381		\$6,959
	120103	1 RGS UNION	140.00	each	1.20	0.79	110.88	\$85.13	\$13.93		\$9,440	\$1,950		\$11,390
	120105	3 PVC COND ALL IN	4,500.00	lnft	1.20	0.12	540.00	\$85.13	\$4.73		\$45,972	\$21,285		\$67,257
	120105	3 PVC ELL	36.00	each	1.20	0.97	34.99	\$85.13	\$16.00		\$2,979	\$576		\$3,555
				\$ / lnft										
203*	Wire & Cable		22,500) Inft	1.20	0.06	1,368.05	85.13	2.79		\$116,468	\$62,695	\$0	\$179,163
	120301	OVERALL WIRE & CABLE ALLOWANCE Power Feeds to Process Equipment	10,500.00	lnft	1.20	0.06	630.00	\$85.13	\$2.74		\$53,634	\$28,770		\$82,404
	120303	3/C - 6 AWG CU THHN-THWN	3,000.00	lnft	1.20	0.04	108.00	\$85.13	\$1.87		\$9,194	\$5,610		\$14,804
	120303	3/C - 6 AWG CU THHN-THWN	4,000.00	lnft	1.20	0.04	144.00	\$85.13	\$1.87		\$12,259	\$7,480		\$19,739
	120303	1/C - 6 AWG - TERMS 600V	90.00	each	1.20	0.41	36.72	\$85.13	\$0.94		\$3,126	\$85		\$3,211
	120317	Coaxial Video Cable	4,000.00	lnft	1.20	0.05	192.00	\$85.13	\$0.40		\$16,346	\$1,600		\$17,946
	120303	1/C - 6 AWG - TERMS 600V	60.00	each	1.20	0.41	24.48	\$85.13	\$0.94		\$2,084	\$56		\$2,140
	120307	1/C - 250 MCM 5KV TERMS	16.00	each	1.20	5.57	89.09	\$85.13	\$18.50		\$7,584	\$296		\$7,880
	120309	3/C - 250 MCM SHIELDED EPR/PVC 15KV CU	1,000.00	lnft	1.20	0.12	120.00	\$85.13	\$18.60		\$10,216	\$18,600		\$28,816
	120314	Coaxial Cable - TERMS	36.00	each	1.20	0.66	23.76	\$85.13	\$5.50		\$2,023	\$198		\$2,221
			\$7.96	\$ / Inft										
204*	Lighting 120401	OVERALL LIGHT FIXTURE ALLOWANCE (incl light fixtures & wire	200.00	each	1.20 1.20	8.00	5,580.41 1,600.80	85.13 \$85.13	\$350.00		\$475,084 \$136,283	\$247,980 \$70,000	\$0	\$723,064 \$206,283

Page 50 of 69

Location: GREEN FIELD SITE HIP Option

Account: 12 Electrical
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

		- Option							_					
					Lab.		Workhours						Totals	
Accoun	it No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	T
	120401	OVERALL LIGHT FIXTURE ALLOWANCE 400W Hi-Bay	100.00	each	1.20	13.00	1,299.60	\$85.13	\$600.00		\$110,640	\$60,000		\$170,64
	120401	OVERALL LIGHT FIXTURE ALLOWANCE 150W Low-Bay	175.00	each	1.20	10.00	1,749.93	\$85.13	\$500.00		\$148,979	\$87,500		\$236,4
	120401	OVERALL LIGHT FIXTURE ALLOWANCE 150W 15' spacing Low Bay (HIP Area)	19.00	each	1.20	10.00	189.92	\$85.13	\$500.00		\$16,169	\$9,500		\$25,60
	120405	MAST ARM 250W	14.00	each	1.20	5.28	73.92	\$85.13	\$450.00		\$6,293	\$6,300		\$12,59
	120405	MAST ARM 400W	8.00	each	1.20	5.28	42.24	\$85.13	\$600.00		\$3,596	\$4,800		\$8,39
	120405	40' POLE, ALUMINUM	14.00	each	1.20	24.00	336.00	\$85.13	\$420.00		\$28,605	\$5,880		\$34,48
	120405	50' POLE, ALUMINUM	8.00	each	1.20	36.00	288.00	\$85.13	\$500.00		\$24,519	\$4,000		\$28,51
1205*	Grounding				1.20		4,157.28	85.13			\$353,926	\$85,239	\$0	\$439,16
	120501	GROUNDING ALLOWANCE	1.00	lsum	1.20	3,578.40	3,578.40	\$85.13	\$72,067.00		\$304,644	\$72,067		\$376,71
	120501	GROUNDING ALLOWANCE (HIP)	1.00	lsum	1.20	180.00	180.00	\$85.13	\$3,606.00		\$15,324	\$3,606		\$18,93
	120502	COPPERWELD GR ROD 3/4"X10"	30.00	each	1.20	3.48	104.40	\$85.13	\$15.55		\$8,888	\$467		\$9,35
	120503	1/C - #4/0 AWG BARE GRND WIRE C	U 4,500.00	lnft	1.20	0.04	162.00	\$85.13	\$1.91		\$13,792	\$8,595		\$22,38
	120503	TERMIN LUGS-CU WIRE 4/0AWG	120.00	each	1.20	1.10	132.48	\$85.13	\$4.20		\$11,279	\$504		\$11,78
1209*	Fire Alarm				1.20		552.05				\$46,998	\$58,156	\$0	\$105,15
	120901	ALARM ALLOWANCE/Emergency Lighting	82,600.00	sqft	1.20	0.01	525.34	\$85.13	\$0.67		\$44,724	\$55,342		\$100,06
	120901	ALARM ALLOWANCE/Emergency Lighting (HIP Area)	4,200.00	sqft	1.20	0.01	26.71	\$85.13	\$0.67		\$2,274	\$2,814		\$5,08
1212*	Lightning F	Protection			1.20		834.00	85.13			\$71,002	\$42,000	\$0	\$113,00
	121201	LIGHTING PROTECTION ALLOWANCE	1.00	lsum	1.20	794.40	794.40		\$40,000.00		\$67,631	\$40,000		\$107,63
	121201	LIGHTING PROTECTION ALLOWANCE (HIP)	1.00	lsum	1.20	39.60	39.60	\$85.13	\$2,000.00		\$3,371	\$2,000		\$5,37
1214*	Security/Co	ommunication			1.20		2,167.20	85.13			\$184,503	\$228,958	\$0	\$413,46
	121404	PAGING System	15.00	each	1.20	18.00	270.00	\$85.13	\$747.00		\$22,986	\$11,205		\$34,19
	121404	PAGING System (HIP)	1.00	each	1.20	18.00	18.00	\$85.13	\$747.00		\$1,532	\$747		\$2,2
	121405	Emergency Telephones	15.00	each	1.20	18.00	270.00	\$85.13	\$850.00		\$22,986	\$12,750		\$35,7
	121405	Emergency Telephones (HIP)	1.00	each	1.20	18.00	18.00	\$85.13	\$850.00		\$1,532	\$850		\$2,3
	121402	SECURITY Card Reader	1.00	each	1.20	480.00	480.00	\$85.13	\$40,000.00		\$40,864	\$40,000		\$80,8
	121403	CCTV System Inside Bldg (50 each)	1.00	lsum	1.20	1,058.40	1,058.40	\$85.13	\$155,626.00		\$90,106	\$155,626		\$245,7
	121403	CCTV System Inside Bldg (HIP)	1.00	lsum	1.20	52.80	52.80	\$85.13	\$7,780.00		\$4,495	\$7,780		\$12,2
Grand Tota	al: 12: Electrical	ı			1.20		18,128	\$85.13	\$34.18	\$0.00	\$1,543,287	\$1,367,206	\$0	\$2,910,49

\$1,367,206 \$0 \$2,910,494 Page 51 of 69

Location: GREEN FIELD SITE HIP Option
Account: 12 Electrical
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov

ra	HIP Option				Job No:	27989-325	Rev No: 0			Pr	roduct Line: Gov Estimate: FFC		
				Lab.		Workhours					-	Totals	
Account No	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12.01 Electric	cal Equipment												
	Elec. EquipTransformers					320	\$85.13			\$27,257	\$70,000	\$0	\$97,257
121602	15KV/5KV/3PHASE 2000 KVA	2	each	1.20	160.08	320.16	85.13	35,000.00		\$27,257	\$70,000	\$0	\$97,257
	Elec. EquipTransformers HIP Area					209	\$85.13			\$17,776	\$10,550	\$0	\$28,326
121602	480/208/120/3P TRANS 300 KVA For HIP Units	2	each	1.20	104.40	208.80	85.13	5,275.00		\$17,776	\$10,550	\$0	\$28,326
	Electrical Equipment					384	\$85.13			\$32,691	\$159,000	\$0	\$191,691
121615	Batteries & Chargers	1	each	1.20	384.00	384.00	85.13	159,000.00		\$32,691	\$159,000	\$0	\$191,691
	ELECTRICAL SUBSTATION					225	\$85.13			\$19,155	\$356,250	\$0	\$375,405
121604	Power Distribution Center #1 (15' X 25')	375	sqfi	1.20	0.60	225.00	85.13	950.00		\$19,155	\$356,250	\$0	\$375,405

|--|

Location: GREEN FIELD SITE HIP Option

Account: 12 Electrical
Facility: Entire Estimate
HIP Option



Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

Job No: 27989-325 Rev No: 0

	HIP Option				Job No:	27989-325	Rev No: 0				Estimate: FFC		
				Lab.		Workhours					,	Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12.01 Electrical Con	nduit												
	AREA FENCE LIGHTING CONDUIT	3,500.00	LF			336				28,605	6,475	0	35,080
120105	2 PVC CONDUIT	3,500.00	lnft	1.20	0.10	336.00	\$85.13	\$1.85		\$28,605	\$6,475	\$0	\$35,080
	Conduit All-In RGS 1" dia For Power	3,500.00	LF			886				75,410	8,518	0	83,928
	Feed to Equipment												
120103	1 RGS CONDUIT	3,500.00	lnft	1.20	0.19	672.00	\$85.13	\$1.30		\$57,210	\$4,550	\$0	\$61,760
120103	1 RGS ELL	105.00	each	1.20	0.28	28.98	\$85.13	\$4.90		\$2,467	\$515	\$0	\$2,982
120103	1 RGS LB	105.00	each	1.20	0.62	65.52	\$85.13	\$13.15		\$5,578	\$1,381	\$0	\$6,959
120103	1 RGS UNION	140.00	each	1.20	0.79	110.88	\$85.13	\$13.93		\$9,440	\$1,950	\$0	\$11,390
120103	1" Conduit Hanger-2Holer	350.00	each	1.20	0.02	8.40	\$85.13	\$0.35		\$715	\$123	\$0	\$838
	Ductbank by Dimension (2.5' X 2.5' X 500')	4,500.00	LF			575				48,951	21,861	0	70,812
120105	3 PVC COND ALL IN	4,500.00	lnft	1.20	0.12	540.00	\$85.13	\$4.73		\$45,972	\$21,285	\$0	\$67,257
120105	3 PVC ELL	36.00	each	1.20	0.97	34.99	\$85.13	\$16.00		\$2,979	\$576	\$0	\$3,555
	ROADWAY LIGHTING CONDUIT	2,500.00	LF			240				20,432	4,625	0	25,057
120105	2 PVC CONDUIT	2,500.00	lnft	1.20	0.10	240.00	\$85.13	\$1.85		\$20,432	\$4,625	\$0	\$25,057
	SECURITY CAMERA CONDUIT	3,500.00	LF			294				25,029	4,900	0	29,929
120103	1 1/2 PVC CONDUIT	3,500.00	lnft	1.20	0.08	294.00	\$85.13	\$1.40		\$25,029	\$4,900	\$0	\$29,929

Overall Ratios:

0.13 Workhours/LF

\$2.65 Material Cost/LF \$13.99 Total Cost/LF

Grand Total: 17,500 LF 1.20 0.13 2,331 \$85.13 \$198,428 \$46,379 \$0 \$244,807 \$11.34 /LF \$2.65 /LF \$0.00 /LF

Location: GREEN FIELD SITE HIP Option
Account: 12 Electrical
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov

	HIP Option				Job No:	27989-325	Rev No: 0			11	Estimate: FFC		
				Lab.		Workhours						Γotals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12.03 Electrical Win	re/Cable												
•	AREA FENCE LIGHTING CABLE	4,000	lnft			168	85.13			\$14,343	\$7,536	\$0	\$21,880
120303	3/C - 6 AWG CU THHN-THWN	4,000	lnft	1.20	0.04	144.00	85.13	1.87		\$12,259	\$7,480	\$0	\$19,739
120303	1/C - 6 AWG - TERMS 600V	60	ach	1.20	0.41	24.48	85.13	0.94		\$2,084	\$56	\$0	\$2,140
	Power Feeds Process Area	10,500	lnft			630	85.13			\$53,634	\$28,770	\$0	\$82,404
120301	OVERALL WIRE & CABLE ALLOWANCE Power Feeds to Process Equipment	10,500	lnft	1.20	0.06	630.00	85.13	2.74		\$53,634	\$28,770	\$0	\$82,404
	ROADWAY LIGHTING CABLE	3,000	lnft			145	85.13			\$12,321	\$5,695	\$0	\$18,015
120303	3/C - 6 AWG CU THHN-THWN	3,000	lnft	1.20	0.04	108.00	85.13	1.87		\$9,194	\$5,610	\$0	\$14,804
120303	1/C - 6 AWG - TERMS 600V	90	ach	1.20	0.41	36.72	85.13	0.94		\$3,126	\$85	\$0	\$3,211
	SECURITY CAMERA CABLE	4,000	lnft			216	85.13			\$18,369	\$1,798	\$0	\$20,167
120314	Coaxial Cable - TERMS	36	ach	1.20	0.66	23.76	85.13	5.50		\$2,023	\$198	\$0	\$2,221
120317	Coaxial Video Cable	4,000	lnft	1.20	0.05	192.00	85.13	0.40		\$16,346	\$1,600	\$0	\$17,946
	Wire & Cable-Medium Voltage (5 & 15kV)	1,000	lnft			209	85.13			\$17,801	\$18,896	\$0	\$36,697
120307	1/C - 250 MCM 5KV TERMS	16	ach	1.20	5.57	89.09	85.13	18.50		\$7,584	\$296	\$0	\$7,880
120309	3/C - 250 MCM SHIELDED EPR/PVC 15KV CU	1,000	lnft	1.20	0.12	120.00	85.13	18.60		\$10,216	\$18,600	\$0	\$28,816

Overall Ratios:

0.06 Workhours/LF \$2.79 Material Cost/LF

\$7.96 Total Cost/LF

Grand Total: Wire & Cable	22,500	lnft	1.20	0.06	1,368	85.13	\$116,468	\$62,695	\$0	\$179,163
							\$5.18 /LF	\$2.79/LF	\$0.00 /LF	

Location: GREEN FIELD SITE HIP Option
Account: 12 Electrical
Facility: Entire Estimate HIP Option



Job No: 27989-325

Washington Division

Rev No: 0

11:31AM Priced By: ADC

Date: 7/17/2008

				Lah		Workhours						Totals	
Account No.	Description	Qty	UM	Lab. Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

1203a Electical Wire/Cable Summary							
High Voltage							
Cable	4.4%	1,000	LF	0.12	120		
Terms		0	EA	0.00	0		
Ratio (LF / Term)		0.00					
Cable + Terms (per LF wire)				0.12	120	Per LF of Wire	
Medium Voltage							
Cable	0.0%	0	LF	0.00	0		
Terms		16	EA	5.57	89		
Ratio (LF / Term)		0.00					
Cable + Terms (per LF wire)				0.00	89	Per LF of Wire	
Low Voltage / Control							
Cable	31.1%	7,000	LF	0.04	252		
Terms		186	EA	0.46	85		
Ratio (LF / Term)		37.63					
Cable + Terms (per LF wire)				0.05	337	Per LF of Wire	
MIsc Wire/Cable							
Cable	64.4%	14,500	LF	0.06	822		
Terms		0	EA	0.00	0		
Ratio (LF / Term)		0.00					
Cable + Terms (per LF wire)				0.06	822	Per LF of Wire	

Cable	100.0%	22,500 LF	0.05	1,194	
Terms		202 EA	0.86	174	
Ratio (LF / Term)		111.39			
Cable + Terms			0.06	1,368	Per LF of Wire

Location: GREEN FIELD SITE HIP Option
Account: 12 Electrical
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver Product Line: Gov

	HIP Option				Job No:	27989-325	Rev No: 0			11	Estimate: FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12.04 Electrical	Lighting												
	AREA FENCE LIGHTING					330	\$85.13			\$28,115	\$8,800	\$0	\$36,915
120405	MAST ARM 400W	8.00	each	1.20	5.28	42.24	\$85.13	\$600.00		\$3,596	\$4,800	\$0	\$8,396
120405	50' POLE, ALUMINUM	8.00	each	1.20	36.00	288.00	\$85.13	\$500.00		\$24,519	\$4,000	\$0	\$28,519
	Finishes Office Area					1,601	\$85.13			\$136,283	\$70,000	\$0	\$206,283
120401	OVERALL LIGHT FIXTURE ALLOWANCE (incl light fixtures & wire)	200.00	each	1.20	8.00	1,600.80	\$85.13	\$350.00		\$136,283	\$70,000	\$0	\$206,283
	Finishes Process Area					3,239	\$85.13			\$275,788	\$157,000	\$0	\$432,788
120401	OVERALL LIGHT FIXTURE ALLOWANCE 400W Hi-Bay	100.00	each	1.20	13.00	1,299.60	\$85.13	\$600.00		\$110,640	\$60,000	\$0	\$170,640
120401	OVERALL LIGHT FIXTURE ALLOWANCE 150W Low-Bay	175.00	each	1.20	10.00	1,749.93	\$85.13	\$500.00		\$148,979	\$87,500	\$0	\$236,479
120401	OVERALL LIGHT FIXTURE ALLOWANCE 150W 15' spacing Low Bay (HIP Area)	19.00	each	1.20	10.00	189.92	\$85.13	\$500.00		\$16,169	\$9,500	\$0	\$25,669
	ROADWAY LIGHTING					410	\$85.13			\$34,898	\$12,180	\$0	\$47,078
120405	MAST ARM 250W	14.00	each	1.20	5.28	73.92	\$85.13	\$450.00		\$6,293	\$6,300	\$0	\$12,593
120405	40' POLE, ALUMINUM	14.00	each	1.20	24.00	336.00	\$85.13	\$420.00		\$28,605	\$5,880	\$0	\$34,485

Grand Total: 12.04 Electrical Lighting	1.20	5,580 S	85.13		\$475,084	\$247,980	\$0	\$723,064
--	------	---------	-------	--	-----------	-----------	-----	-----------

Page 56 of 69

Location: GREEN FIELD SITE HIP Option
Account: 12 Electrical
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov

	HIP Option				Job No:	27989-325	Rev No: 0			r	Product Line: Gov Estimate: FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
12 Electrical Otl	her												
	Electrical Systems					3,758	\$85.13			\$319,968	\$75,673	\$0	\$395,641
120501	GROUNDING ALLOWANCE	1.00	lsum	1.20	3,578.40	3,578.40	\$85.13	\$72,067.00		\$304,644	\$72,067	\$0	\$376,711
120501	GROUNDING ALLOWANCE (HIP)	1.00	lsum	1.20	180.00	180.00	\$85.13	\$3,606.00		\$15,324	\$3,606	\$0	\$18,930
	FENCE GROUND CABLE					294	\$85.13			\$25,070	\$9,099	\$0	\$34,169
120503	1/C - #4/0 AWG BARE GRND WIRE CU	4,500.00	lnft	1.20	0.04	162.00	\$85.13	\$1.91		\$13,792	\$8,595	\$0	\$22,387
120503	TERMIN LUGS-CU WIRE 4/0AWG	120.00	each	1.20	1.10	132.48	\$85.13	\$4.20		\$11,279	\$504	\$0	\$11,783
	FENCE GROUND RODS					104	\$85.13			\$8,888	\$467	\$0	\$9,355
120502	COPPERWELD GR ROD 3/4"X10'	30.00	each	1.20	3.48	104.40	\$85.13	\$15.55		\$8,888	\$467	\$0	\$9,355
1205*	Grounding	4,500.00	lnft	1.20		4,157	\$85.13			\$353,926	\$85,239	\$0	\$439,165
	Alarm Systems					552	\$85.13			\$46,998	\$58,156	\$0	\$105,154
120901	ALARM ALLOWANCE/Emergency Lighting	82,600.00	sqft	1.20	0.01	525.34	\$85.13	\$0.67		\$44,724	\$55,342	\$0	\$100,066
120901	ALARM ALLOWANCE/Emergency Lighting (HIP Area)	4,200.00	sqft	1.20	0.01	26.71	\$85.13	\$0.67		\$2,274	\$2,814	\$0	\$5,088
1209*	Fire Alarm Control	0.00	lnft	1.20		552	\$85.13			\$46,998	\$58,156	\$0	\$105,154
	Electrical Systems					834	\$85.13			\$71,002	\$42,000	\$0	\$113,002
121201	LIGHTING PROTECTION ALLOWANCE	1.00	lsum	1.20	794.40	794.40	\$85.13	\$40,000.00		\$67,631	\$40,000	\$0	\$107,631
121201	LIGHTING PROTECTION ALLOWANCE (HIP)	1.00	lsum	1.20	39.60	39.60	\$85.13	\$2,000.00		\$3,371	\$2,000	\$0	\$5,371
1212*	Lightning Protection	0.00	lnft	1.20		834	\$85.13			\$71,002	\$42,000	\$0	\$113,002
	Access System					480	\$85.13			\$40,864	\$40,000	\$0	\$80,864
121402	SECURITY Card Reader	1.00	each	1.20	480.00	480.00	\$85.13	\$40,000.00		\$40,864	\$40,000	\$0	\$80,864
	Electrical Systems					1,687	\$85.13			\$143,638	\$188,958	\$0	\$332,596
121403	CCTV System Inside Bldg (50 each)	1.00	lsum	1.20	1,058.40	1,058.40	\$85.13	\$155,626.00		\$90,106	\$155,626	\$0	\$245,732
121403	CCTV System Inside Bldg (HIP)	1.00	lsum	1.20	52.80	52.80	\$85.13	\$7,780.00		\$4,495	\$7,780	\$0	\$12,275
121404	PAGING System	15.00	each	1.20	18.00	270.00	\$85.13	\$747.00		\$22,986	\$11,205	\$0	\$34,191
121404	PAGING System (HIP)	1.00	each	1.20	18.00	18.00	\$85.13	\$747.00		\$1,532	\$747	\$0	\$2,279
121405	Emergency Telephones	15.00	each	1.20	18.00	270.00	\$85.13	\$850.00		\$22,986	\$12,750	\$0	\$35,736
121405	Emergency Telephones (HIP)	1.00	each	1.20	18.00	18.00	\$85.13	\$850.00		\$1,532	\$850	\$0	\$2,382
1214*	Security/Communication	0.00	lnft	1.20		2,167	\$85.13			\$184,503	\$228,958	\$0	\$413,461

rand Total: 12.xx Electrical Other Systems 1.20	7,711 \$85.13	3 \$656,429 \$414,353	\$0 \$1,070,781
---	---------------	-----------------------	-----------------

Location: GREEN FIELD SITE HIP Option

Account: 13 Instrumentation Facility: Entire Estimate Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

Entire Estimate

HIP Option Job No: 27989-325 Rev No: 0

				Lab.		Workhours						Totals	
Account N	No. Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
13 Instrumentat	tion Summary				•			•					
1301	Field Instruments	9.00	ea	1.20		64	\$89.78			\$5,764	\$17,880	\$0	\$23,644
131007	Analyzers	25.00	ea	1.20		713	\$89.78			\$63,994	\$4,947,140	\$0	\$5,011,134
13xx	Bulks			1.20		555	\$89.78			\$49,795	\$4,101	\$0	\$53,896
13xxxx	Misc			1.20		163	\$85.13			\$13,894	\$20,400	\$0	\$34,294

Grand Total: Instrumentation 9 Field Inst Count	1.20	0.00	1,495	\$89.27		\$133,447	\$4,989,521	\$0	\$5,122,968	
---	------	------	-------	---------	--	-----------	-------------	-----	-------------	--

Location: GREEN FIELD SITE HIP Option

Account: 13 Instrumentation
Facility: Entire Estimate

Job No: 27989-325 Rev No: 0

Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

	racinty	HIP Option				Job No:	27989-325	Rev No:	0			Product Line: Gov Estimate: FFC	;	
	Account No.	Description	Qty	UM	Lab. Fact.	Per Unit	Workhours Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Totals Subs	Total
	Account Ivo.	Description	Qty	UNI	ract.	rei Ollit	Total	Kate	Mat i Ollit	Subs Clift	Labor	iviateriai	Suos	Total
An	alyzer- w/ Bulks						138	89.78			\$12,368	\$105,428	\$0	\$117,796
	130404	1/4" BALL VALVE WHITEY 43	1	each	1.20	0.48	0.48	\$89.78	\$29.67		\$43	\$30	\$0	\$73
	130404	1/4" BALL VALVE WHITEY 43	1	each	1.20	0.48	0.48	\$89.78	\$29.67		\$43	\$30	\$0	\$73
	130703	3/8" TUBING (SS)	150.00	lnft	1.20	0.22	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
	130703	3/8" TUBING (SS)	150.00	lnft	1.20	0.22	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
	131007	Determinator O N ANALYZER	1	each	1.20	36.00	36.00	\$89.78	\$80,000.00		\$3,232	\$80,000	\$0	\$83,232
	131007	Determinator C S ANALYZER	1	each	1.20	36.00	36.00	\$89.78	\$25,000.00		\$3,232	\$25,000	\$0	\$28,232
Bo	dy Scanners						58	89.78			\$5,171	\$180,000	\$0	\$185,171
	131007	Body Scanner	3	each	1.20	19.20	57.60	\$89.78	\$60,000.00		\$5,171	\$180,000	\$0	\$185,171
Fie	ld Instr Allow - w			,	1.20	2.57	3	89.78	62 000 00		\$231	\$2,000	\$0	\$2,231
-	130101	Scale	1	each	1.20	2.57	2.57	\$89.78	\$2,000.00		\$231	\$2,000	\$0 \$0	\$2,231
rie	130101	/ Bulks Fire Water Collection OVERALL INSTRUMENTS ALLOWANCE	8	each	1.20	7.70	208 61.63	89.78 \$89.78	\$1,985.00		\$18,634 \$5,533	\$17,142 \$15,880	\$0	\$35,776 \$21,413
	130404	1/4" BALL VALVE WHITEY 43	16	each	1.20	0.48	7.68	\$89.78	\$29.67		\$690	\$475	\$0	\$1,164
	130703	3/8" TUBING (SS)	640.00	lnft	1.20	0.22	138.24	\$89.78	\$1.23		\$12,411	\$787	\$0	\$13,198
Flu	orscope Analyzer	- w/ Bulks Item 17					81	89.78			\$7,304	\$200,244	\$0	\$207,548
	130404	1/4" BALL VALVE WHITEY 43	2	each	1.20	0.48	0.96	\$89.78	\$29.67		\$86	\$59	\$0	\$146
	130703	3/8" TUBING (SS) cooling water	150.00	lnft	1.20	0.22	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
	131007	Fluoroscope DO	1	each	1.20	48.00	48.00	\$89.78	\$200,000.00		\$4,309	\$200,000	\$0	\$204,309
Ga	mma Scanner- w/	Bulks					124	89.78			\$11,161	\$1,000,488	\$0	\$1,011,649
	130404	1/4" BALL VALVE WHITEY 43	4	each	1.20	0.48	1.92	\$89.78	\$29.67		\$172	\$119	\$0	\$291
	130703	3/8" TUBING (SS)	300.00	lnft	1.20	0.22	64.80	\$89.78	\$1.23		\$5,818	\$369	\$0	\$6,187
	131007	Gamma Scanner DO	1	each	1.20	57.60	57.60	\$89.78	\$1,000,000.00		\$5,171	\$1,000,000	\$0	\$1,005,171
Ga	mma Spectroscop						36	89.78			\$3,232	\$80,000	\$0	\$83,232
	131007	Gamm Spectroscopy Item M	1	each	1.20	36.00	36.00	\$89.78	\$80,000.00		\$3,232	\$80,000	\$0	\$83,232
Ga	mma Spectroscop	y (PLate) w/ Bulks Item L 1/4" BALL VALVE WHITEY 43	1	each	1.20	0.48	81 0.48	89.78 \$89.78	\$29.67		\$7,261 \$43	\$200,214 \$30	\$0 \$0	\$207,475 \$73
	130703	3/8" TUBING (SS)	150.00	lnft	1.20	0.48	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
	131007		150.00	each	1.20	48.00	48.00	\$89.78	\$200,000.00				\$0	\$204,309
11.	nd & Foot Monito	Gamma Spectroscopy	1	eacn	1.20	48.00	48.00	\$89.78	\$200,000.00		\$4,309	\$200,000 \$145,000	\$0 \$0	\$204,309 \$151,464
па	131007	Hand & Foot Monitor	5	each	1.20	14.40	72.00	\$89.78	\$29,000.00		\$6,464 \$6,464	\$145,000	\$0	\$151,464
На	nd & Foot Monito		,				72.00	89.78	,		\$6,464	\$145,000	\$0	\$151,464
	131007	Hand & Foot Monitor HIP Area	5	each	1.20	14.40	72.00	\$89.78	\$29,000.00		\$6,464	\$145,000	\$0	\$151,464
Ma	ss Spectrometer-	w/ Bulks					62	89.78			\$5,581	\$250,244	\$0	\$255,824
	130404	1/4" BALL VALVE WHITEY 43	2	each	1.20	0.48	0.96	\$89.78	\$29.67		\$86	\$59	\$0	\$146

Location: GREEN FIELD SITE HIP Option

Account: 13 Instrumentation
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC

1 401	HIP Option				Job No:	27989-325	Rev No:	0			Product Line: Gov Estimate: FFC		
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
130703	3/8" TUBING (SS)	150.00	lnft	1.20	0.22	32.40	\$89.78	\$1.23		\$2,909	\$185	\$0	\$3,093
131007	Mass Spectrometer Hook-up & Test	1	each	1.20	28.80	28.80	\$89.78	\$250,000.00		\$2,586	\$250,000	\$0	\$252,586
Optical Microscope	•					10	89.78			\$862	\$2,140	\$0	\$3,002
131007	Microscope 1000X w/Camera & computer	1	each	1.20	9.60	9.60	\$89.78	\$2,140.00		\$862	\$2,140	\$0	\$3,002
Radiography Analy	yzer- w/ Bulks Item 16					184	89.78			\$16,548	\$640,611	\$0	\$657,159
130404	1/4" BALL VALVE WHITEY 43	4	each	1.20	0.48	1.92	\$89.78	\$29.67		\$172	\$119	\$0	\$291
130703	3/8" TUBING (SS) water & gas	400.00	lnft	1.20	0.22	86.40	\$89.78	\$1.23		\$7,757	\$492	\$0	\$8,249
131007	ANALYZER DO	2	each	1.20	48.00	96.00	\$89.78	\$320,000.00		\$8,619	\$640,000	\$0	\$648,619
SECURITY CAME	ERA					163	85.13			\$13,894	\$20,400	\$0	\$34,294
139900	FENCE SECURITY CAMERA (mount on fence lighting poles)	17	each	1.20	9.60	163.20	\$85.13	\$1,200.00		\$13,894	\$20,400	\$0	\$34,294
Ultrasonc Tester- w	v/ Bulks Item 12					204	89.78			\$18,272	\$2,000,611	\$0	\$2,018,882
130404	1/4" BALL VALVE WHITEY 43	4	each	1.20	0.48	1.92	\$89.78	\$29.67		\$172	\$119	\$0	\$291
130703	3/8" TUBING (SS)	400.00	lnft	1.20	0.22	86.40	\$89.78	\$1.23		\$7,757	\$492	\$0	\$8,249
131007	ANALYZER DO	2	each	1.20	57.60	115.20	\$89.78	\$1,000,000.00		\$10,343	\$2,000,000	\$0	\$2,010,343

Totals	13-Instrumentation	9 each	1,495 \$89.27	\$133,447	\$4,989,521	\$0	\$5,122,968
	Entire Estimate	Field Inst Count					

Location: GREEN FIELD SITE HIP Option

Account: 16 Buildings
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

	HIP Option				Job No:	27989-325	Rev No: ()			Estimate: FF	С	
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Bldg Furnishings						144	80.41			\$11,580	\$33,642	\$6,360	\$51,581
161101	SPECIALTIES-LOCKERS	36	each	1.20	2.40	86.40	\$80.41	\$267.82		\$6,948	\$9,642	\$0	\$16,589
161103	OFFICE FURNISHINGS	24	each	1.20	2.40	57.60	\$80.41	\$1,000.00	\$265.00	\$4,632	\$24,000	\$6,360	\$34,992
Bldg Plumbing						19	80.41			\$1,544	\$3,940	\$26,020	\$31,503
160403	SERVICE SINK,PE ON CI,WALL HUNG,22"x18" (Janitor Closet)	1	each	1.20					\$1,424.90	\$0	\$0	\$1,425	\$1,425
160403	WC (Incl Fixture, Water, Vent & Drain Pipe)	10	each	1.20					\$1,000.00	\$0	\$0	\$10,000	\$10,000
160403	URINAL	4	each	1.20					\$700.00	\$0	\$0	\$2,800	\$2,800
160403	SHOWER,STALL,BAKED ENAM,TERRAZZO RECEPTOR,30" Incl Warer, Vent & Drain Pipe	2	each	1.20					\$1,245.30	\$0	\$0	\$2,491	\$2,491
160403	Safety Showers W/Eye wash Incl Waste Vent & Drain Pipe	2	each	1.20	9.60	19.20	\$80.41	\$1,970.00		\$1,544	\$3,940	\$0	\$5,484
160403	LAVATORY W/TRIM WALL HUNG PE ON CI,18"x15"	10	each	1.20					\$930.40	\$0	\$0	\$9,304	\$9,304
Bldg Specialties						3,578	82.16			\$293,954	\$287,891	\$6,006	\$587,851
160501	ALLOWANCE Fire Protection (Wet Pipe Sprinkler Sys)	82,600.00	sqft	1.20	0.03	2,478.00	\$80.41	\$1.25		\$199,268	\$103,250	\$0	\$302,518
160501	ALLOWANCE Fire Protection (Wet Pipe Sprinkler Sys) (HIP Area)	4,200.00	sqft	1.20	0.03	126.00	\$80.41	\$1.25		\$10,132	\$5,250	\$0	\$15,382
161004	CERAMIC TILE Floors Locker & Bathrooms 6" by 6" Thin Set	1,275.00	sqft	1.20	0.10	122.40	\$80.41	\$3.36	\$3.90	\$9,843	\$4,284	\$4,973	\$19,099
161004	CERAMIC TILE Floors Locker & Bathrooms Wainscoting 6" by 4-1/2"	265.00	lnft	1.20	0.21	54.70	\$80.41	\$3.61	\$3.90	\$4,398	\$957	\$1,034	\$6,389
161101	SPECIALTIES-Building Elevator 2 stop	1.00	lsum	1.20	192.00	192.00	\$80.41	\$15,500.00		\$15,440	\$15,500	\$0	\$30,940
161102	SPECIALTIES-ALLOWANCE Furniture Cubicles	1.00	lsum	1.20	28.80	28.80	\$80.41	\$58,650.00		\$2,316	\$58,650	\$0	\$60,966
161199	SPECIALTIES-OTHER Shelving Cans & Fuel	1.00	lsum	1.20	576.00	576.00	\$91.25	\$100,000.00		\$52,558	\$100,000	\$0	\$152,558
Building						17,479	80.41			\$1,405,545	\$958,989	\$0	\$2,364,534
160100	Building Incl Insul Siding, Roofing, & Support Steel	82,500.00	sqft	1.20	0.20	16,632.00	\$80.41	\$11.06		\$1,337,456	\$912,533	\$0	\$2,249,989
160100	Building Incl Insul Siding, Roofing, & Support Steel (HIP Area)	4,200.00	sqft	1.20	0.20	846.72	\$80.41	\$11.06		\$68,089	\$46,456	\$0	\$114,545
CMU-12" wide Con	pressor, MCC Mech & Elec Maint Rooms									\$0	\$0	\$290,738	\$290,738
160203	CONC BLK,REG WT.,HOLLOW,12"THK W/PERLITE INSUL CORE FILL	15,350.00	sqft	1.20					\$18.94	\$0	\$0	\$290,738	\$290,738
Doors & Windows										\$0	\$0	\$56,619	\$56,619
160302	HOLLOW METAL,18GA. STEEL,NO LABEL,3'-0"x7'-0" Interior	20	each	1.20					\$935.30	\$0	\$0	\$18,706	\$18,706
160302	HOLLOW METAL,18GA. STEEL,NO LABEL,3'-0"x7'-0" Exterior	7	each	1.20					\$935.30	\$0	\$0	\$6,547	\$6,547
160302	HOLLOW METAL,18GA. STEEL,NO LABEL,DBL.,6'-0"x7'-0"	4	each	1.20					\$1,890.00	\$0	\$0	\$7,560	\$7,560

Location: GREEN FIELD SITE HIP Option

Account: 16 Buildings
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

	HIP Option				Job No:	27989-325	Rev No: 0				Estimate: FF	С	
				Lab.		Workhours						Totals	
Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
160302	HOLLOW METAL,18GA. STEEL,A LABEL,DBL.,6'-0"x7'-0" (Furnace Area)	1	each	1.20					\$2,145.50	\$0	\$0	\$2,146	\$2,146
160302	sample - Wood Doors	20	each	1.20					\$1,083.00	\$0	\$0	\$21,660	\$21,660
Finishes						3,511	51.59			\$181,139	\$37,660	\$106,745	\$325,544
160402	Roof Drain 3" Diameter	20	each	1.20	1.60	31.92	\$80.41	\$207.00		\$2,567	\$4,140	\$0	\$6,707
160402	3" Floor Drains W/P Trap	24	each	1.20	2.96	71.14	\$80.41	\$220.50		\$5,720	\$5,292	\$0	\$11,012
161004	PAINTING Sealer on Concrete Floor	37,746.50	sqft	1.20	0.00	139.81	\$50.69	\$0.05		\$7,087	\$2,073	\$0	\$9,160
161004	PAINTING Epoxy Paint Coating Floor	41,140.00	sqft	1.20	0.00	152.37	\$54.00	\$0.04		\$8,229	\$1,784	\$0	\$10,013
161004	VCT Lunch/Break Room 12" by 12" by 3/32" Embossed	1,350.00	sqft	1.20	0.02	25.92	\$80.41	\$1.18	\$1.11	\$2,084	\$1,593	\$1,499	\$5,176
161004	CARPET Office Areas	9,600.00	sqft	1.20					\$3.25	\$0	\$0	\$31,200	\$31,200
161004	Rubber Base	2,259.40	lnft	1.20					\$1.61	\$0	\$0	\$3,631	\$3,631
161004	Resilient Flooring	4,052.40	lnft	1.20	0.11	435.23	\$54.00	\$0.57		\$23,504	\$2,301	\$0	\$25,805
161006	PAINTING Sealer on Concrete	8,606.40	sqft	1.20	0.02	173.19	\$49.70	\$0.16		\$8,607	\$1,368	\$0	\$9,976
161006	PAINTING Epoxy Paint on Drywall	40,667.00	sqft	1.20	0.02	818.38	\$49.70	\$0.16		\$40,672	\$6,466	\$0	\$47,137
161006	PAINTING Epoxy Paint on Concrete	26,877.40	sqft	1.20	0.02	540.88	\$49.70	\$0.16		\$26,880	\$4,273	\$0	\$31,154
161006	PAINTING Epoxy Paint on CMU	3,533.20	sqft	1.20	0.02	71.10	\$49.70	\$0.16		\$3,534	\$562	\$0	\$4,095
161006	PAINTING Latex Paint on Concrete	8,382.00	sqft	1.20	0.02	168.68	\$49.70	\$0.16		\$8,383	\$1,333	\$0	\$9,716
161006	PAINTING Latex Paint on CMU	1,993.20	sqft	1.20	0.02	40.11	\$49.70	\$0.16		\$1,993	\$317	\$0	\$2,310
161006	PAINTING Latex Paint on Drywall	38,135.90	sqft	1.20	0.01	411.97	\$49.70	\$0.07		\$20,474	\$2,756	\$0	\$23,230
161006	PAINTING Decon coating on Concrete	21,401.60	sqft	1.20	0.02	430.68	\$49.70	\$0.16		\$21,404	\$3,403	\$0	\$24,807
161006	GYPSUM BD PARTITION (5/8" Gypsum both sides) Office Areas	7,000.00	sqft	1.20					\$5.38	\$0	\$0	\$37,660	\$37,660
161006	GYPSUM BD PARTITION (5/8" Gypsum both sides) Lab, Programmer's & supervisor'sO	1,200.00	sqft	1.20					\$5.38	\$0	\$0	\$6,456	\$6,456
161006	GYPSUM BD PARTITION (5/8" Gypsum ONE sides) Office Areas	6,000.00	sqft	1.20					\$3.55	\$0	\$0	\$21,300	\$21,300
161103	TOILET ACCESSORIES Partitions	10	each	1.20					\$500.00	\$0	\$0	\$5,000	\$5,000
Fire Protection						452	80.41			\$36,377	\$2,775	\$0	\$39,152
160501	Fire Protection Allowance Fire Line From Blgd Exterior to Sprinkler Sys	287.00	lnft	1.20	1.58	452.37	\$80.41	\$9.67		\$36,377	\$2,775	\$0	\$39,152
HVAC Equipment		******	-			3,523	80.41	0.5 #0		\$283,269	\$209,502	\$0	\$492,771
160901	ALLOWANCE Process Area Non Radiological	30,900.00	sqft	1.20	0.11	3,522.60	\$80.41	\$6.78		\$283,269	\$209,502	\$0	\$492,771
	Standard Hvac Office area	10.200.00		1.20	0.12	1,359	80.41	67.00		\$109,255	\$81,396	\$0	\$190,651
160901	Office area	10,200.00	sqft	1.20	0.13	1,358.64	\$80.41	\$7.98		\$109,255	\$81,396	\$0 \$0	\$190,651
Interior Finish						431	80.41			\$34,652	\$32,832	20	\$67,484

Location: GREEN FIELD SITE HIP Option

Account: 16 Buildings
Facility: Entire Estimate
HIP Option



Washington Division

11:31AM Priced By: ADC

Date: 7/17/2008

	raciii	HIP Option				Job No:	27989-325	Rev No: 0				Product Line: Gov Estimate: FFC	:	
Ī					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
	161005	ACT CEILING SYSTEM w/ GRID (2' by 4' by 3/4" panels) Lab, Programmers & Supervi	2,100.00	sqft	1.20	0.03	52.92	\$80.41	\$1.92		\$4,256	\$4,032	\$0	\$8,288
	161005	ACT CEILING SYSTEM w/ GRID (2' by 4' by 3/4" panels) Office & Radiographic Area	15,000.00	sqft	1.20	0.03	378.00	\$80.41	\$1.92		\$30,397	\$28,800	\$0	\$59,197
Me	tal Siding Interio	r Enclosure					2,157	80.41			\$173,488	\$113,572	\$0	\$287,060
	160706	20 GA Metal Panel on metal framing Prduct Prep	26,050.00	sqft	1.20	0.05	1,281.66	\$80.41	\$2.59		\$103,064	\$67,470	\$0	\$170,534
	160706	20 GA Metal Panel on metal framing Interim Storage area	8,430.00	sqft	1.20	0.05	414.76	\$80.41	\$2.59		\$33,352	\$21,834	\$0	\$55,186
	160706	20 GA Metal Panel on metal framing Final Prduct Assembly Area	9,370.00	sqft	1.20	0.05	461.00	\$80.41	\$2.59		\$37,071	\$24,268	\$0	\$61,340
Ove	erhead Coiling Do	oors					148	80.41			\$11,914	\$9,324	\$0	\$21,238
	160203	OVERHEAD,ROLLING,STEEL,ELEC. OPER.,7'-0"x15'-0" Bldg	3	each	1.20	37.04	111.11	\$80.41	\$2,331.00		\$8,935	\$6,993	\$0	\$15,928
	160203	OVERHEAD,ROLLING,STEEL,ELEC. OPER.,7'-0"x15'-0" Warehouse	1	each	1.20	37.04	37.04	\$80.41	\$2,331.00		\$2,978	\$2,331	\$0	\$5,309
Pre	-engineered Bldg	s					2,079	80.41			\$167,182	\$127,586	\$0	\$294,768
	160801	PREFAB BLDGS Warehouse Complete	4,125.00	sqft	1.20	0.50	2,079.00	\$80.41	\$30.93		\$167,182	\$127,586	\$0	\$294,768
Sec	urity Bldg						1,123	80.41			\$90,322	\$67,014	\$0	\$157,336
	160100	ALLOWANCE All-IN Cost	900.00	sqft	1.20	1.25	1,123.20	\$80.41	\$74.46		\$90,322	\$67,014	\$0	\$157,336
ÇI.	Lights			•			513	80.41			\$41,253	\$23,520	\$0	\$64,773
эку	160399	Speciality Items Skylights	50	each	1.20	10.26	513.00	\$80.41	\$470.40		\$41,253	\$23,520	\$0	\$64,773
		. , , , ,	50	cacii	1.20	10.20			3470.40					
Tw		ewall Furnace Room Enclosure					649	80.41			\$52,186	\$13,645	\$0	\$65,831
	161006	DW PARTITIONS Metal Studs NLB 3-5/8" on 16" ctrs Btwn Furnace Area & Process Are	8,320.00	sqft	1.20	0.08	648.96	\$80.41	\$1.64		\$52,186	\$13,645	\$0	\$65,831
Uti	lities						1,232	80.41			\$99,103	\$5,117	\$0	\$104,220
	161101	SPECIALTIES-ALLOWANCE Compressed Air System Compressor	1.00	lsum	1.20	344.40	344.40	\$80.41	\$1,430.00		\$27,695	\$1,430	\$0	\$29,125
	161101	SPECIALTIES-ALLOWANCE Treated Water System Pump	1.00	lsum	1.20	102.00	102.00	\$80.41	\$425.00		\$8,202	\$425	\$0	\$8,627
	161101	SPECIALTIES Wash Down Spray System Pump & Piping	1.00	lsum	1.20	786.00	786.00	\$80.41	\$3,262.00		\$63,206	\$3,262	\$0	\$66,468

Totals 16-Buildings Entire Estimate	38,398 \$77.94		\$2,992,762	\$2,008,403	\$492,487	\$5,493,652
--	----------------	--	-------------	-------------	-----------	-------------

Location: GREEN FIELD SITE HIP Option

Account: 21 Spare Parts
Facility: Entire Estimate
HIP Option



Washington Division

Job No: 27989-325 Rev No: 0

Date: 7/17/2008 11:31AM Priced By: ADC Office: Denver

Product Line: Gov Estimate: FFC

		HIP Option					Job No:	27989-325	Rev No: 0				Estimate: FFC		
			Avg			Lab.		Workhours						Totals	
	Account No.	Description	Diam	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Sv	vaging Item D											\$0	\$15,000	\$0	\$15,000
	210101	SPARE PARTS		2	each					\$7,500.00		\$0	\$15,000	\$0	\$15,000
	210101	SPARE PARTS		2	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each	1.20						\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		2	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
Fir		ling Cleaning Station Item 29										\$0	\$10,000	\$0	\$10,000
	210101	SPARE PARTS		1	each					\$10,000.00		\$0	\$10,000	\$0	\$10,000
	210101	sample-SPARE PARTS		1.00	lsum							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each	1.20						\$0	\$0	\$0	\$0
	210101	SPARE PARTS SAMPLE-FIRM PRICE MATERIAL		1	each	1.20						\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		2	each	1.20						\$0	\$0	\$0	\$0
	210101	SPARE PARTS SAMPLE-FIRM PRICE MATERIAL		1	each	1.20						\$0	\$0	\$0	\$0
	210101	SPARE PARTS SAMPLE-FIRM PRICE MATERIAL		1	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS SAMPLE-FIRM PRICE MATERIAL		1	each	1.20						\$0	\$0	\$0 \$0	\$0
Fir	rm Price-Hydrauli 210101	SPARE PARTS		1	each					\$5,000.00		\$0 \$0	\$5,000 \$5,000	\$0 \$0	\$5,000 \$5,000
	210101	SPARE PARTS		4	each					\$5,000.00		\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each							\$0 \$0	\$0	\$0	\$0
	210101	SPARE PARTS		2	each	1.20						\$0 \$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each	1.20						\$0 \$0	\$0 \$0	\$0 \$0	\$0
E:.	rm Price-Marking			1	cacii							\$0 \$0	\$5,000	\$0 \$0	\$5,000
FII	210101	SPARE PARTS		1	each					\$5,000.00		\$0 \$0	\$5,000	\$0	\$5,000
Fir		Machines Salt Removal Item 31								,		\$0	\$5,000	\$0	\$5,000
	210101	SPARE PARTS		1	each					\$5,000.00		\$0	\$5,000	\$0	\$5,000
	210101	SPARE PARTS		5	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0
	210101	SPARE PARTS		1	each							\$0	\$0	\$0	\$0

Page 64 of 69

210101

SPARE PARTS

Location: GREEN FIELD SITE HIP Option

Account: 21 Spare Parts
Facility: Entire Estimate
HIP Option



11:31AM
Priced By: ADC

Office: Denver

\$0

\$0

\$0

\$0

Product Line: Gov Estimate: FFC

Date: 7/17/2008

Job No: 27989-325 Rev No: 0

Workhours Totals Lab. Avg Diam Account No. Total Subs Unit Mat'l Unit Description Qty UM Per Unit Rate Labor Material Subs Total Fact. 210101 SPARE PARTS 1 each 1.20 \$0 \$0 \$0 \$0 SPARE PARTS SAMPLE-FIRM PRICE 210101 \$0 \$0 \$0 1 each \$0 MATERIAL SPARE PARTS SAMPLE-FIRM PRICE 2 210101 each \$0 \$0 \$0 \$0 210101 SPARE PARTS \$0 \$0 \$0 \$0 \$0 Firm Price-Rolling Mill w/Tunnel Furnace 25 \$0 \$6,000 \$6,000 \$6,000.00 \$0 210101 SPARE PARTS each \$6,000 \$0 \$6,000 210101 SPARE PARTS \$0 1 each \$0 \$0 \$0 210101 SPARE PARTS each \$0 \$0 \$0 \$0 210101 SPARE PARTS each \$0 \$0 \$0 \$0 210101 SPARE PARTS 1 each \$0 \$0 \$0 \$0 SPARE PARTS \$0 \$0 210101 1 each \$0 \$0 SPARE PARTS \$0 \$0 210101 1 each \$0 \$0 210101 SPARE PARTS \$0 \$0 \$0 1 each \$0 210101 SPARE PARTS 1 each \$0 \$0 \$0 210101 SPARE PARTS 1 each \$0 \$0 \$0 \$0 \$0 Process Equipment Channel Probe Item B \$0 \$100,000 \$100,000 \$100,000.00 1 each 1.20 \$0 \$100,000 \$0 \$100,000 210101 SPARE PARTS 210101 SPARE PARTS 2 each 1.20 \$0 \$0 \$0 \$0 210101 SPARE PARTS \$0 \$0 \$0 \$0 2 each Roller Levelers Item 19 \$0 \$3,000 \$0 \$3,000 210101 SPARE PARTS 1 each 1.20 \$3,000.00 \$0 \$3,000 \$0 \$3,000

each

1

Location: GREEN FIELD SITE HIP Option

Account: 22 Freight
Facility: Entire Estimate
HIP Option



Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM

Priced By: ADC
Office: Denver
Product Line: Gov
Estimate: FFC

1					Lab.	Workhours						Totals	
	Account No.	Description	Qty	UM	Fact.	Per Unit Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
Fir	m Price-EB Can	Assy Station HIP Area Item 1								\$0	\$400	\$0	\$400
	220100	BID CONDITIONING SAMPLE-NON FIRM PRICE MATERIAL	0.04	%				\$10,000.00		\$0	\$400	\$0	\$400
	220100	BID CONDITIONING SAMPLE-NON FIRM PRICE MATERIAL	0.04	%						\$0	\$0	\$0	\$0
Fir	m Price-Process I	Equipment Hot Isostatic Press								\$0	\$314,000	\$0	\$314,000
	220100	BID CONDITIONING SAMPLE-NON FIRM PRICE MATERIAL	0.04	%			5	\$7,850,000.00		\$0	\$314,000	\$0	\$314,000

Totals	22-Freight	0 \$0.00	\$0	\$314,400	\$0	\$314,400
1	Entire Estimate					

Location: GREEN FIELD SITE HIP Option

Account: 31 Construction Management Staff & Services
Facility: Entire Estimate



Washington Division

Date: 7/17/2008 11:31AM Priced By: ADC

	,	HIP Option				Job No:	27989-325	Rev No: 0			Pro	duct Line: Go Estimate: FF		
					Lab.		Workhours						Totals	
	Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Sub	s Total
Cor	nstruction Manage	ement - URS					20,984	70.40			\$1,477,274	\$0	\$238,220	\$1,715,494
	310101	Site Manager	24.00	mnth		172.00	4,128.00	\$95.00		\$2,150.00	\$392,160	\$0	\$51,600	\$443,760
	310603	Project Secretary (Local)	24.00	mnth		172.00	4,128.00	\$38.20		\$1,720.00	\$157,690	\$0	\$41,280	\$198,970
	310901	Safety Professional	24.00	mnth		172.00	4,128.00	\$81.00		\$2,150.00	\$334,368	\$0	\$51,600	\$385,968
	310901	Superientendant Elec/I& C (local)	14.00	mnth		172.00	2,408.00	\$65.00		\$1,720.00	\$156,520	\$0	\$24,080	\$180,600
	310901	Project Controls	18.00	mnth		172.00	3,096.00	\$76.00		\$2,150.00	\$235,296	\$0	\$38,700	\$273,996
	310901	Superientendant Civil/Structural (local)	8.00	mnth		172.00	1,376.00	\$65.00		\$1,720.00	\$89,440	\$0	\$13,760	\$103,200
	310901	Superientendant Piping/Mech (local)	4.00	mnth		172.00	688.00	\$65.00		\$1,720.00	\$44,720	\$0	\$6,880	\$51,600
	310901	Superientendant Elec/I& C (local)	6.00	mnth		172.00	1,032.00	\$65.00		\$1,720.00	\$67,080	\$0	\$10,320	\$77,400

Т	otals 31-Construction Management Staff & Services	20,984 \$70.40	\$1,477,274	\$0	\$238,220	\$1,715,494
	Entire Estimate					

Location: GREEN FIELD SITE HIP Option Account: 61 Home Office Services
Facility: Entire Estimate

HIP Option

Job No: 27989-325

Washington Division

Rev No: 0

Date: 7/17/2008 11:31AM

Priced By: ADC Office: Denver

				Lab.		Workhours					Totals			
	Account No.	Description	Qty	UM		Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total
All-In Home Office at 105\$/hr							85,714	105.00			\$8,999,970	\$0	\$0	\$8,999,970
	610000	ALL IN HOME OFFICE w/ Overhead & other costs	85,714.00	mnhr		1.00	85,714.00	\$105.00			\$8,999,970	\$0	\$0	\$8,999,970

Totals	61-Home Office Services	85,714 \$105.00	\$8,999,970	\$0	\$0	\$8,999,970
	Entire Estimate					

Location: GREEN FIELD SITE HIP Option

Account:

Facility: Entire Estimate

HIP Option

URSWashington Division

Job No: 27989-325

Date: 7/17/2008 11:31AM Priced By: ADC

Office: Denver
Product Line: Gov
Estimate: FFC

							Workhours						Totals	
А	Account No.	Description	Qty	UM	Fact.	Per Unit	Total	Rate	Mat'l Unit	Subs Unit	Labor	Material	Subs	Total

Rev No: 0

Grand Total: Entire Estimate	300,809 87.11	\$26,202,011	\$30,226,546	\$7,716,607	\$64,145,165