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INL Site ARG-US Implementation – FY-22 Activities and FY-23 Plans

September 2022

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Idaho National Laboratory

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SUMMARY

The Packaging Certification and Life Cycle Management program at Argonne National Laboratory (ANL) developed a suite of monitoring systems collectively referred to here as ARG-US. ARG-US provides necessary data for nuclear facility and system operation and maintenance, and has been previously demonstrated in hot cells, radioactive material (RAM) storage areas, and RAM shipment trucks. It has also been installed directly on RAM storage and shipment containers. ARG-US offers some unique advantages over other commercially available systems by using wired and wireless data connections, battery power supplies, and customizable monitoring methods.

Idaho National Laboratory (INL) has been tasked with investigating applications for ARG-US at INL site facilities, which are operated by several different contractors. The initial investigation scope centered on CPP-603 Irradiated Fuel Storage Facility in relation to the upcoming Department of Energy (DOE) Spent Nuclear Fuel (SNF) Packaging Demonstration. The investigation has been led by the Used Fuel Management Department in INL's Nuclear Science and Technology (NS&T) directorate. This investigation is expected to recommend INL site processes or facilities in which to implement ARG-US systems.

INL has engaged local site technical and oversight representatives, security, nuclear safeguards, and program management personnel to identify good candidates for ARG-US test implementations. INL has identified the following high-level goals for any INL site implementation of ARG-US: provide unique testing environments, prompt development of new monitoring methods and techniques for the ARG-US suite, and acquire useful monitoring for the user facility. As a result, INL suggests three program areas for further investigation: CPP-603 Fuel Handling Cave (FHC), legacy mixed waste storage systems at Idaho Nuclear Technology & Engineering Center (INTEC) known as the "Tank Farm," and periodic and emergency environmental monitoring.

This progress report relates activities undertaken in this investigation, describes the preliminary areas of interest for limited scope ARG-US testing or implementation, and relays expected actions for completing the task scope. This report offers an opportunity to the program sponsor, technical leads at ANL, and INL site representatives to give feedback on the initial assessment and make recommendations on the forthcoming activities.

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ACRONYMS

ANL	Argonne National Laboratory
CMA	Crane Maintenance Area
CRA	Cask Receiving Area
CTC	Cask Transfer Car
CTP	Cask Transfer Pit
DOE	Department of Energy
FCF	Fuel Conditioning Facility
FHC	Fuel Handling Cave
FSA	Fuel Storage Area
FY	Fiscal Year
HMI	Human-Machine Interface
ICP	Idaho Cleanup Project
IFSF	Irradiated Fuel Storage Facility
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology & Engineering Center
IWTU	Integrated Waste Treatment Unit
MFC	Materials & Fuels Complex
NOAA	National Oceanic and Atmospheric Administration
NS&T	Nuclear Science and Technology
PCS	Permanent Containment Structure
PoE	Power over Ethernet
RAM	Radioactive Material
RAMM	Remote Area Modular Monitoring
RF	Radiofrequency
RFID	Radio Frequency Identification
RTD	Resistance Temperature Detector
SAR	Safety Analysis Report
SNF	Spent Nuclear Fuel
TRA	Test Reactor Area
VOG	Vessel Off-Gas System
WPCS	Waste Processing Computer System

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INTRODUCTION

Argonne National Laboratory (ANL) approached Idaho National Laboratory (INL) to investigate whether there are operational areas at the INL site that would benefit from ARG-US, with funding from the Department of Energy (DOE) Office of Environmental Management Packaging and Certification Program to assess the viability of ARG-US implementation at INL site facilities. Activities during the first half of the fiscal year (FY), as well as an overview of ARG-US systems, were previously reported in reference 1.

This report will elaborate on the INL site program areas selected, describe system hardware to be investigated, and provide a scope of the activities needed to perform the facility scale tests and demonstrations.

Summary of Previous Status Report

Reference 1 served as a midyear status report. It includes detailed descriptions of ARG-US system components and a description of INL facilities considered for ARG-US test implementation.

ARG-US systems that may tested include:

- Radio frequency identification (RFID) surveillance sensor “tag” – A primary component of ARG-US, the RFID tag is a self-contained detector unit consisting of the control and communication computer with both integral and modular solid-state detectors and a battery power source.
- RFID reader – Commercially available RFID readers are used to communicate with the RFID tags and input the collected data to the online database. One configuration of RFID reader is in a mobile test kit (weighing less than 10 lbs), employing a standard RFID reader and an ethernet switch connecting the reader and a laptop, as well as a reader logic board with an external antenna.
- Remote Area Modular Monitoring (RAMM) – A monitoring system suited to facility monitoring, RAMM incorporates numerous sensors with power-over-Ethernet (PoE) and mesh network communication to cover legacy and difficult facility cases.
- RAMM Traveler – These RAMM units are fit with Li-ion batteries or hard-wired to vehicle power systems and have GPS and cellular communications to allow monitoring for shipments even in remote areas.
- Web application human-machine interface (HMI) – Data from both the RFID tags and RAMMs are displayed in a custom web-based interface, configured to the specific monitoring situation.
- Other related hardware currently in development at ANL may be included, such as a new prototype platform for environmental monitoring being developed by ANL and Evigia are based on Evigia’s SensiFlood™ system.

The INL site program areas considered for ARG-US test implementation are:

- CPP-603 Fuel Handling Cave – A spent nuclear fuel (SNF) handling hot cell located at the Idaho Nuclear Engineering and Technology Center (INTEC).

- INTEC Tank Farm – A collection of facilities at INTEC storing, transferring, and monitoring sodium-bearing radioactive wastes from legacy operations.
- Environmental monitoring – Environmental monitoring is needed in both routine and emergency response conditions at facility locations and widespread surrounding areas.

INL FACILITIES FOR ARG-US TEST IMPLEMENTATION

CPP-603

The CPP-603 facility at INTEC has undergone many expansions and facility changes over its several decades of operation. CPP-603 consists of the Irradiated Fuel Storage Facility (IFSF), the decommissioned legacy basin facility, and common truck bays with overhead crane systems. The only current area with active operations is the IFSF. The IFSF primary mission is to receive DOE-managed SNF, condition it for long-term storage, and provide a safe storage location.

The IFSF functional areas include:

- Truck bays (including cask receiving area [CRA], east–west truck bay, and north–south truck bay)
- Cask transfer pit (CTP) and permanent containment structure (PCS)
- Fuel handling cave (FHC)
- Fuel storage area (FSA)
- Control room/instrument room
- Crane maintenance area (CMA)
- Decontamination pad.

Much of the information in this section is found in the facility safety analysis report (SAR) for CPP-603, reference 2. Figure 1 and Figure *2* have photos and plan views of the CPP-603 IFSF.

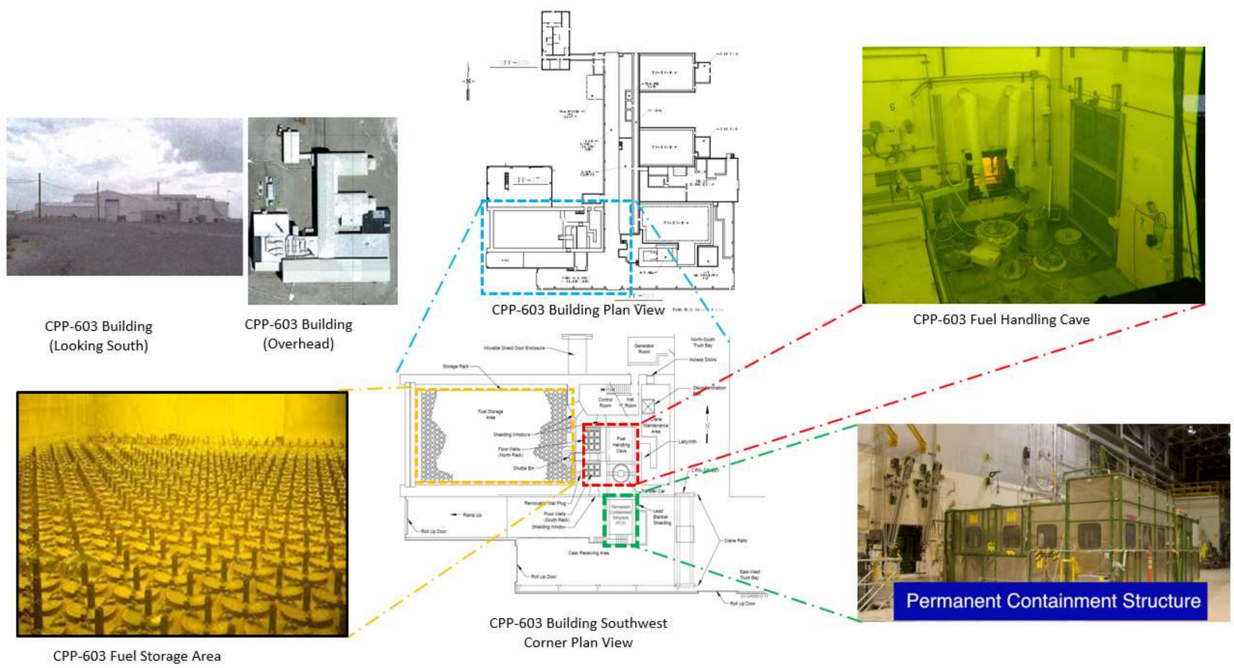


Figure 1. CPP-603 functional areas.

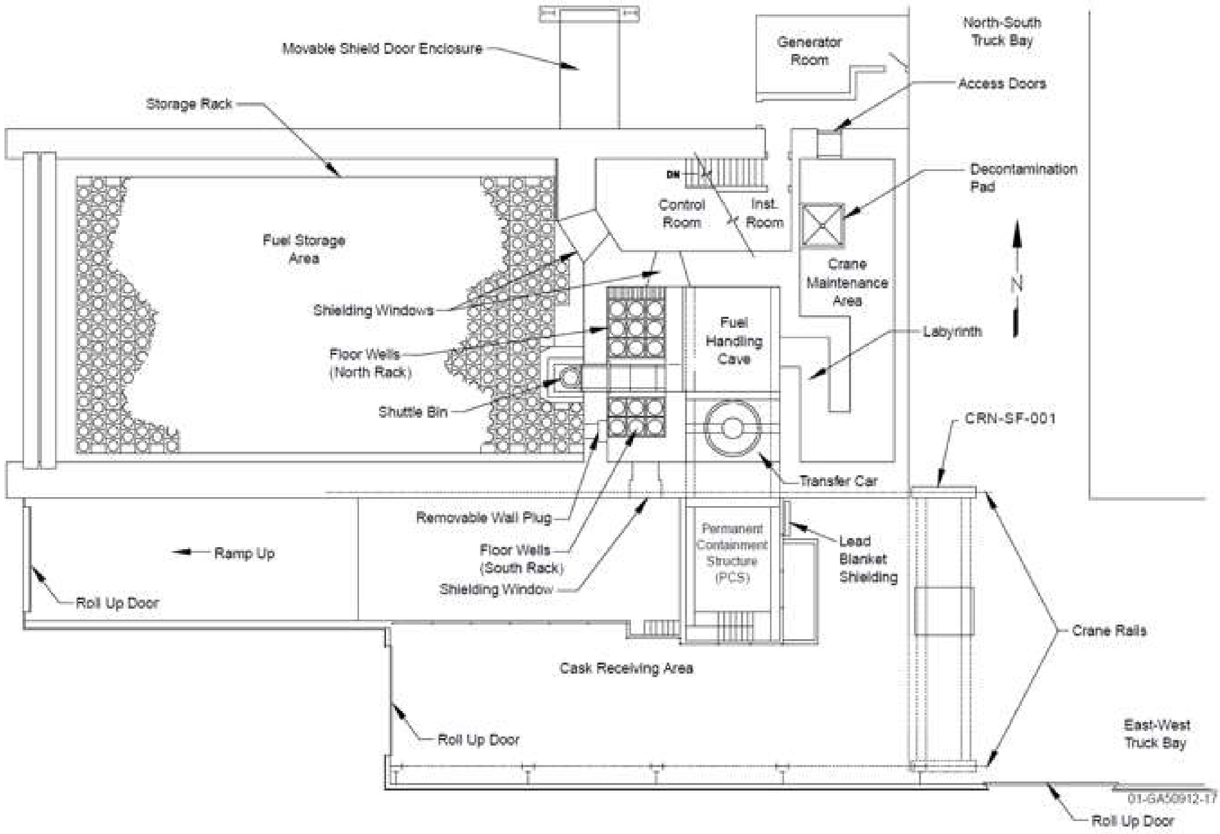


Figure 2. CPP-603 IFSF.

Cask Receiving Area/South Truck Bay

The CPP-603 CRA consists of the east–west truck bay, the north–south truck bay, and the truck ramp. The exterior walls and roof are of steel-frame construction covered with transite panels. Overhead doors are located at each end of the truck bays and at the end of the truck ramp to provide vehicle access. Personnel doors are located near the east overhead door, the south overhead door, and the west overhead door. Figure 3 shows a plan view of CPP-603 with the CRA marked.

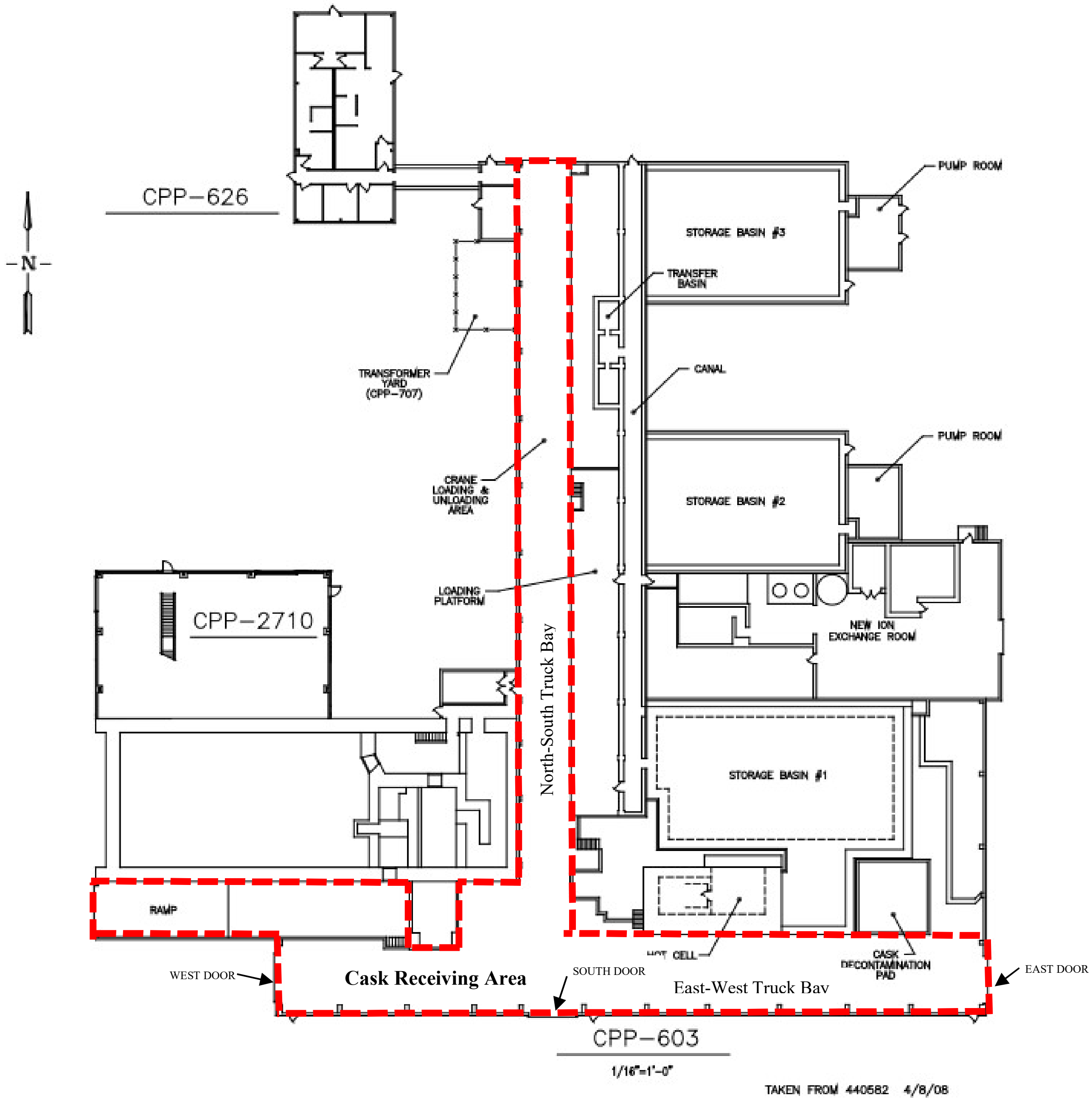
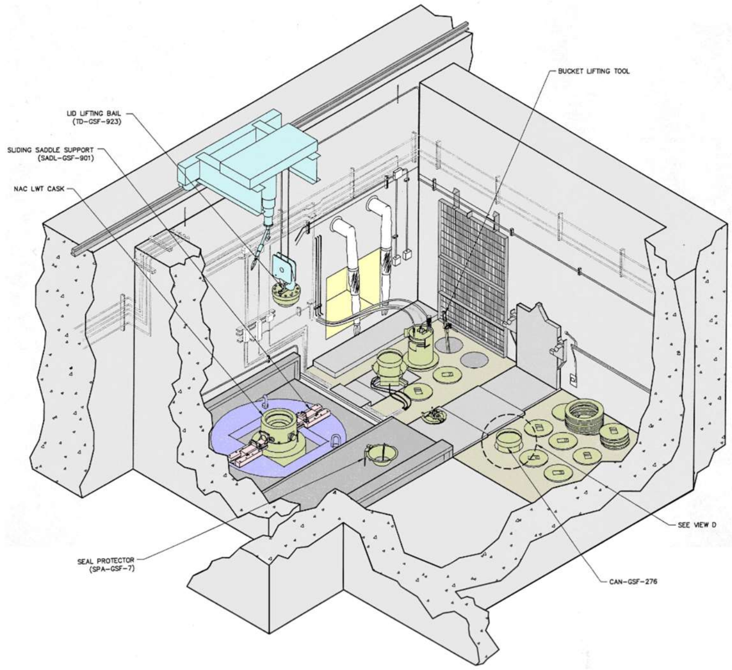


Figure 3. Cask Receiving Area.

Fuel Handling Cave

The FHC is 24-ft wide × 23-ft long. The FHC is equipped with a set of wall-mounted telemanipulators, cranes, a PaR telemanipulator arm on a crane, two shielding windows, video cameras, floor wells for temporarily storing fuel, and a shuttle bin for transferring fuel storage canisters between the FHC and the FSA. In addition, the IFSF is serviced by the cask transfer car (CTC) to move casks and other equipment between the FHC and the PCS/CRA. The FHC is 24-ft wide × 23-ft long. Figure 4 has a diagram and view of the FHC from the shielded window in the control room.



CPP-603 Fuel Handling Cave

View of Fuel Handling Cave from Control Room

Figure 4. Fuel Handling Cave.

Permanent Containment Structure

The CPP-603 PCS is a hard-walled structure that encloses the portion of the CTP in the CRA. The PCS is constructed of stainless-steel sheet and carbon-steel angle. The PCS has top and side panels that can open to provide crane access and allow transfer of equipment to and from the CTC. Walk-through doors on the east side of the PCS are provided for personnel access. Figure 5 has two views of the PCS.

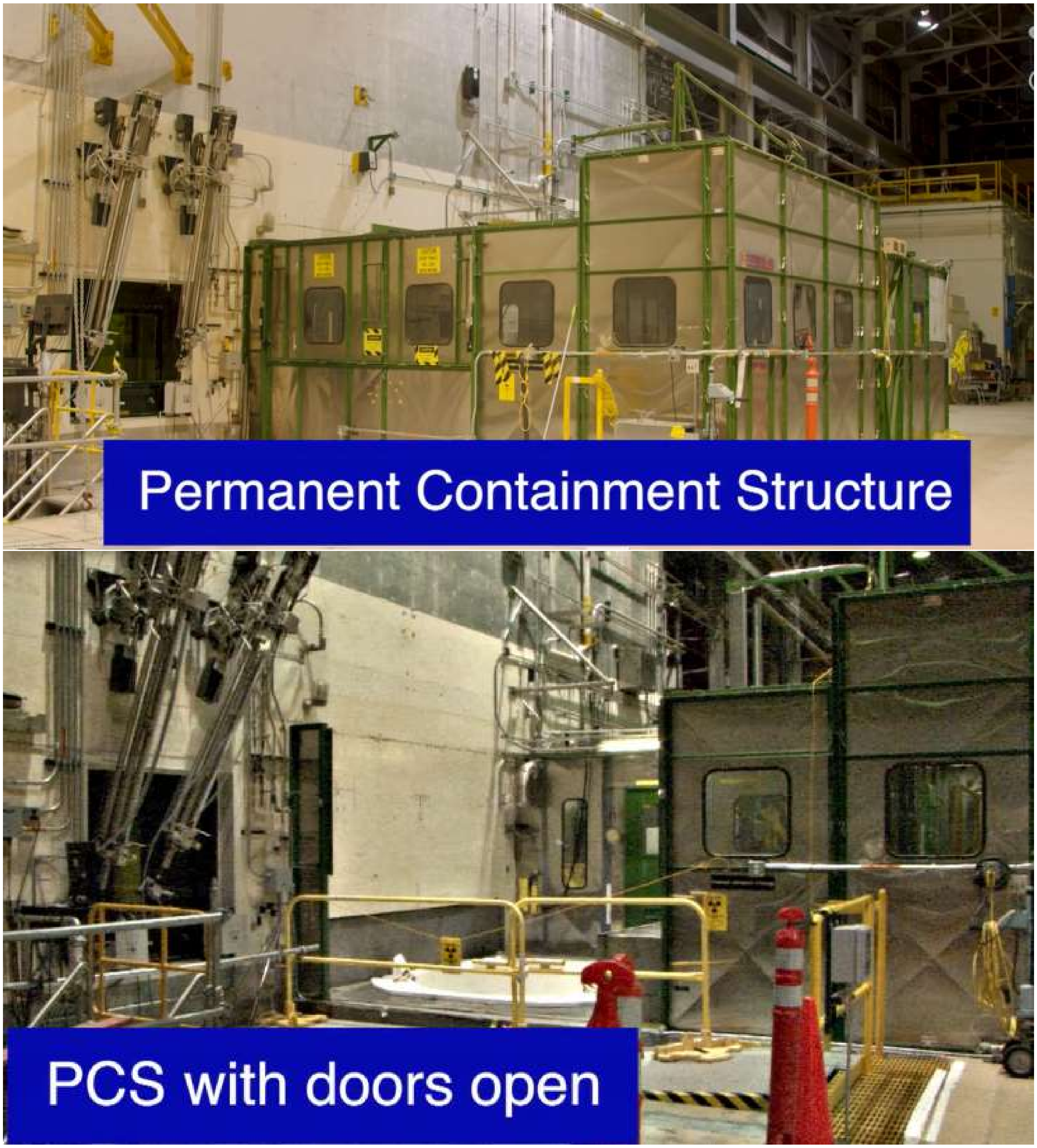


Figure 5. Permanent Containment Structure.

Cask Transfer Pit/ Cask Transfer Car

The CTP floor is 18-ft below grade, measuring 10-ft wide and 48-ft long. The CTP is located under the south wall of the FHC. Approximately one-half of the CTP is under the PCS in CRA; the other half is in the FHC. The CTC is a specially designed car positioned on rails at the top of the CTP, and is used to transfer packages or equipment between the PCS and the FHC. Figure 6 has two top views of the CTC and a CTC 3D model.

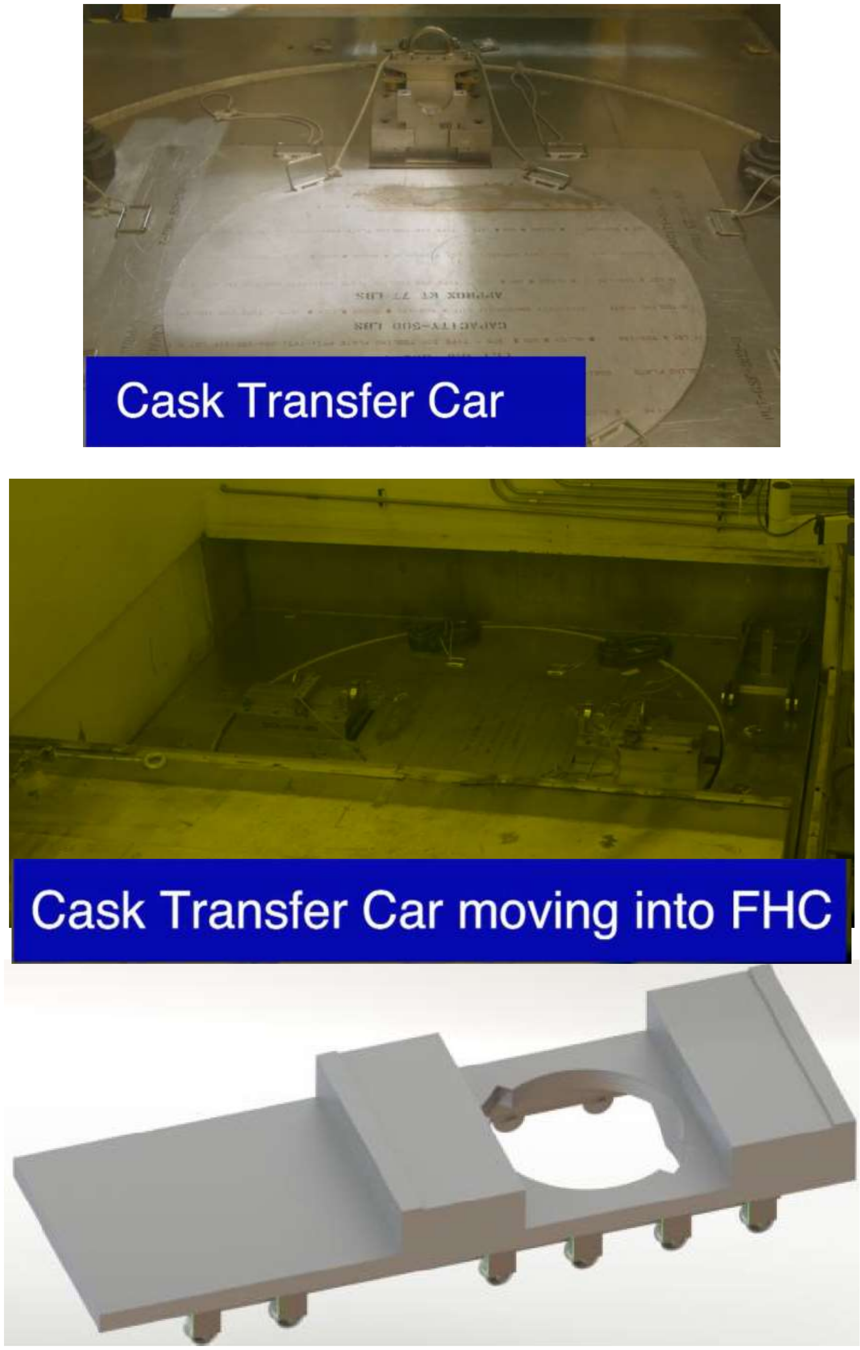


Figure 6. Cask Transfer Car.

Fuel Storage Area

The CPP-603 FSA is 41-ft wide × 71-ft-long and occupies the entire west end of the IFSF. The FSA houses the carbon-steel storage rack, which measures 36-ft wide × 68-ft long × 11-ft tall. The rack supports the 636 fuel storage canisters, each of which is 18-in. in diameter and approximately 11-ft long. The rack has 38 rows of canisters, alternating 17 and 18 canisters per row. Some of the rows do not have the entire width of 17 or 18 canisters, as shorter rack rows exist around the opening for the shuttle bin. The rack sits on the FSA floor, and the storage rack supports the canisters approximately 2-1/2-in. above the facility floor. A view of the rack of fuel storage canisters in the FSA is shown in Figure 7.

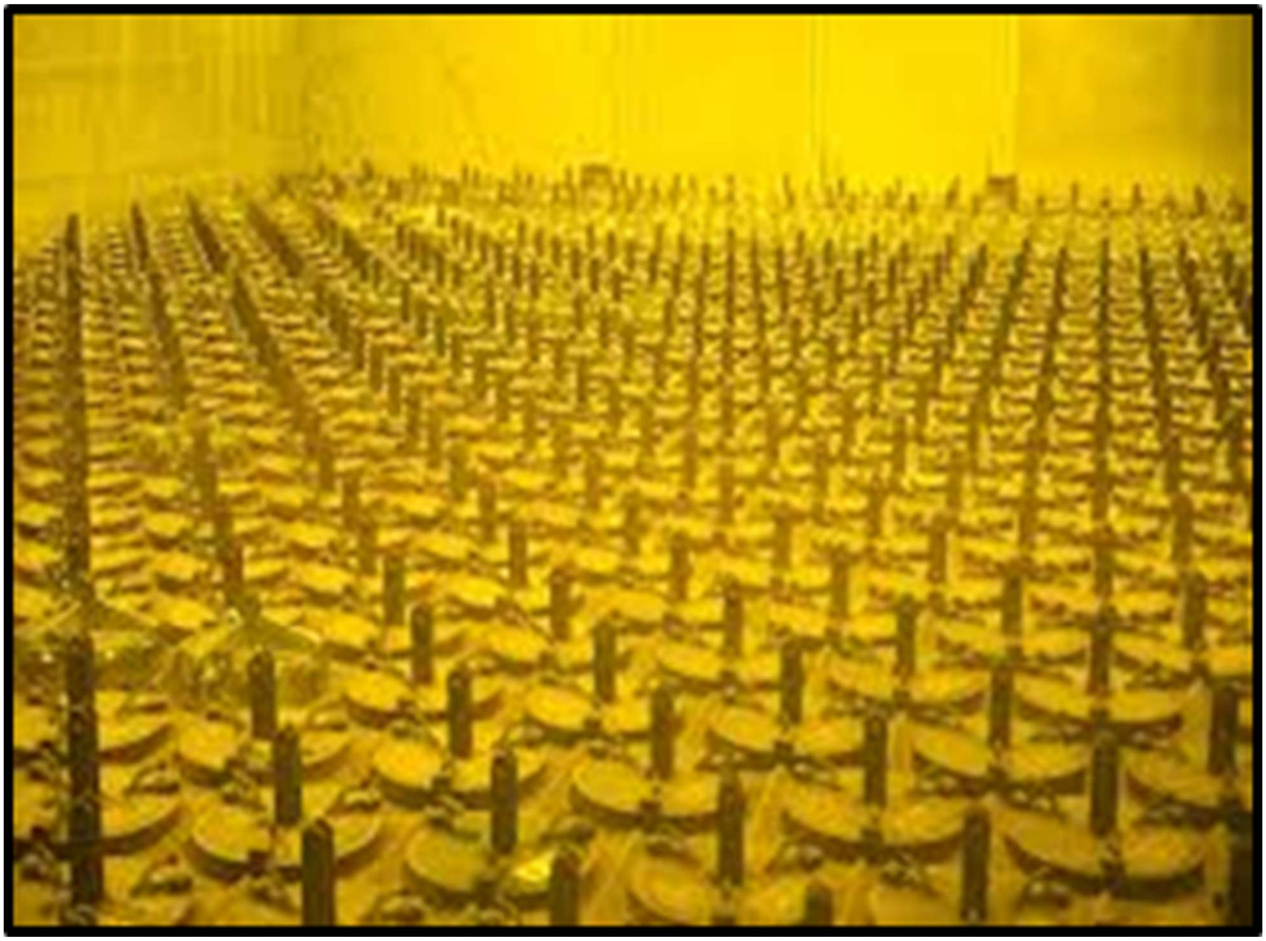


Figure 7. Fuel Storage Area.

INTEC Tank Farm

For many years, INTEC operated SNF reprocessing facilities, storage facilities, and other nuclear industrial operations. These historical operations resulted in large volumes of high-level liquid mixed (radioactive and regulated hazardous) waste. Between 1950 and 1964 a system of large, underground tanks and related hardware including sumps, valve boxes, monitoring enclosures, and control stations was constructed to handle the waste. The tanks, related hardware, control systems, and protective structures are collectively known as the Tank Farm. Information and images in this section are mainly from the facility SAR for the Tank Farm, SAR-107, reference 3.

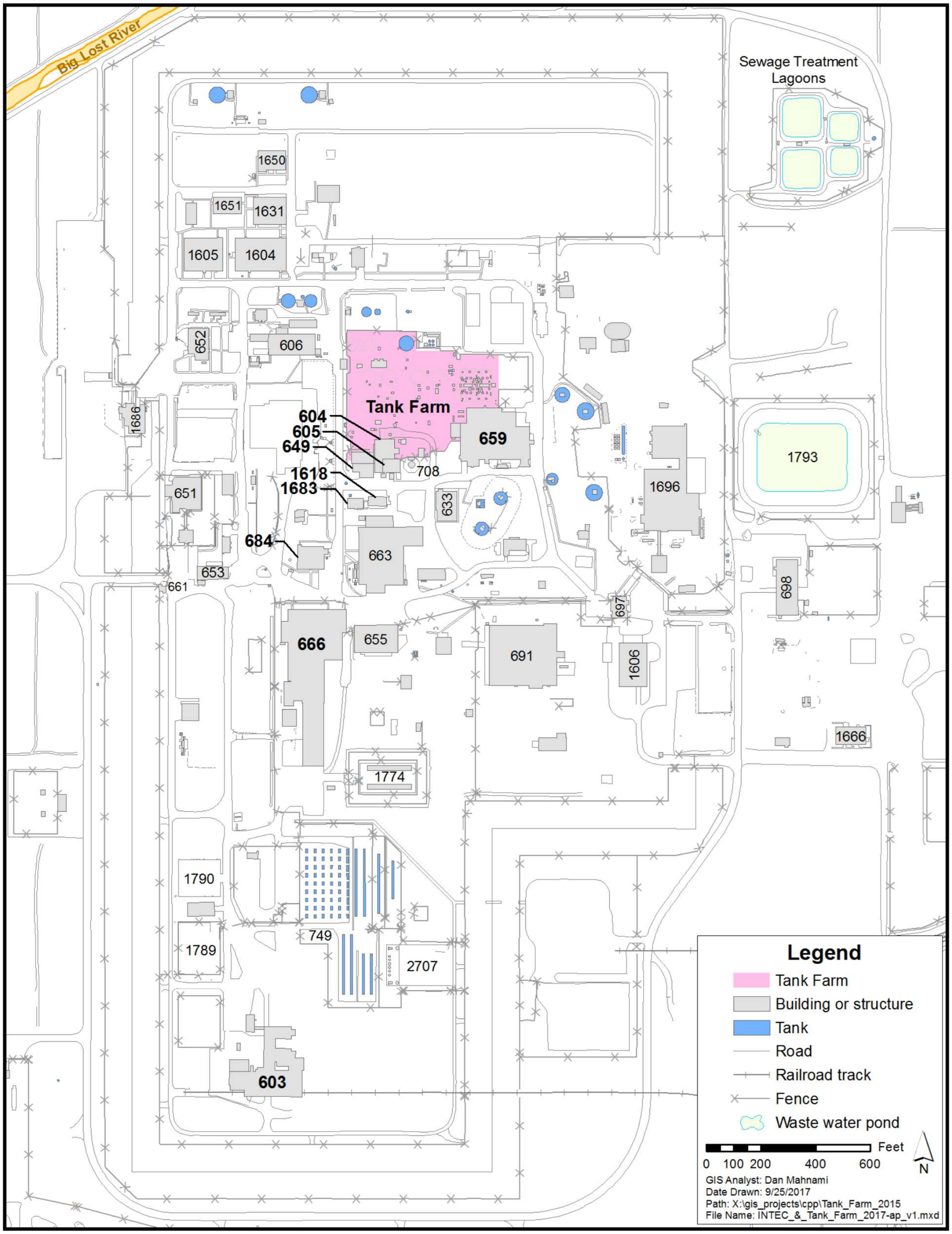


Figure 8. Tank Farm location at INTEC.

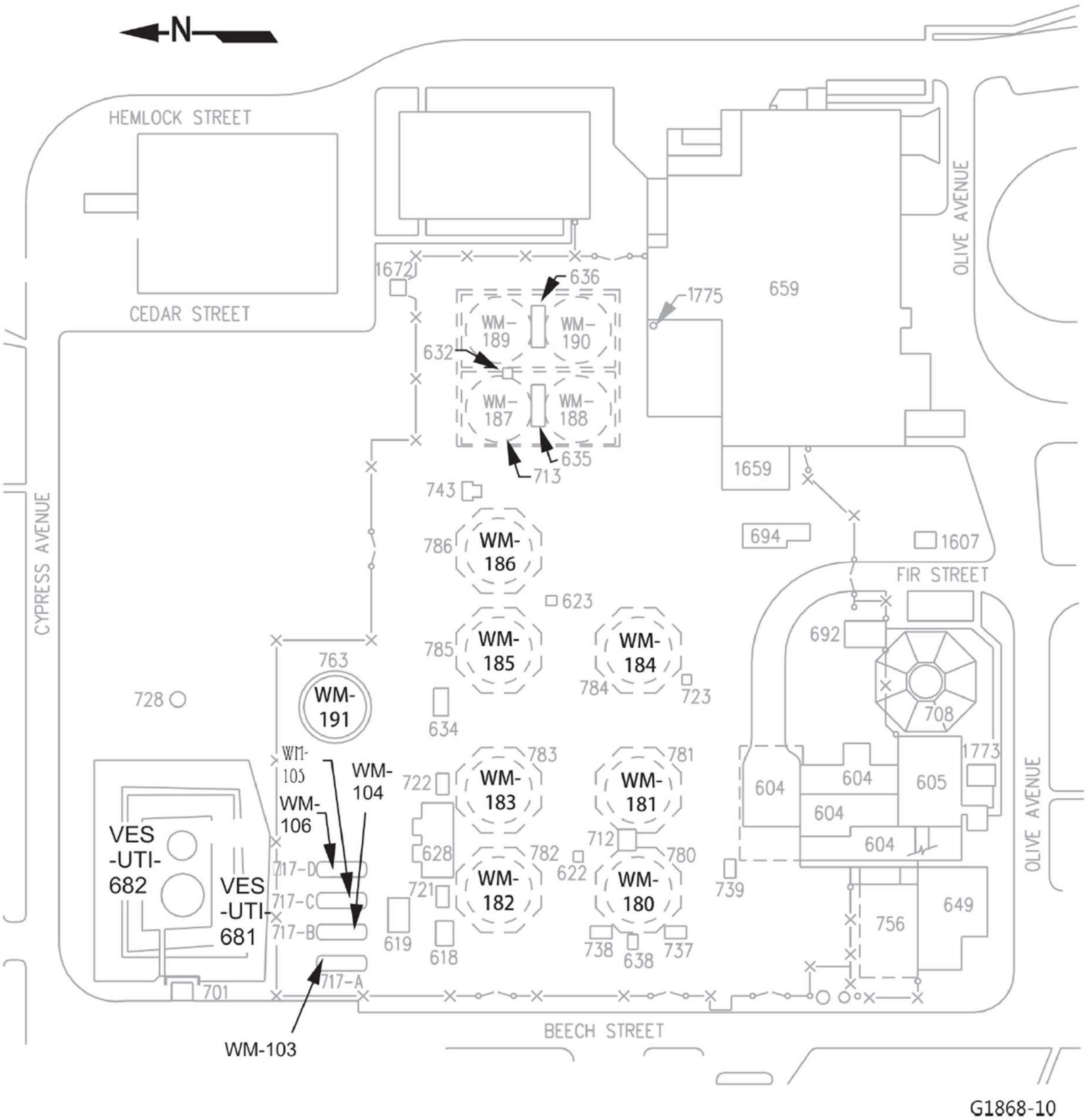


Figure 9. General Tank Farm layout.

The Tank Farm no longer receives new liquid waste and is actively under decommissioning and demolition activities. Most of the underground tanks and associated piping have been emptied, internally grouted, and buried in ground cover. These tanks are “less than hazard category 3” facilities. Following volume reduction and other waste treatment, about 900,000 gallons of highly radioactive and corrosive sodium-bearing waste remain in actively used underground tanks. Most of the remaining facilities are enclosed in tents for weather protection (see Figure 10). The remaining liquid waste will be removed and treated by a new facility at INTEC called Integrated Waste Treatment Unit (IWTU). After IWTU treatment is complete, a Tank Farm closure project will remove solids and wash down residual liquid until environmental closure criteria are met.

Figure 10. Typical Tank Farm weather enclosure.

Underground Storage Tanks

There are four remaining storage tanks in use at the Tank Farm. These are designated WM-187, WM-188, WM-189, and WM-190. These tanks hold large volumes of the original liquid waste form. In a drained condition, the tanks hold minimal residual wash liquid and solids in the heels of the tank. The other tanks shown on Figure 11 (designated with "WM-") were drained and grouted in place.

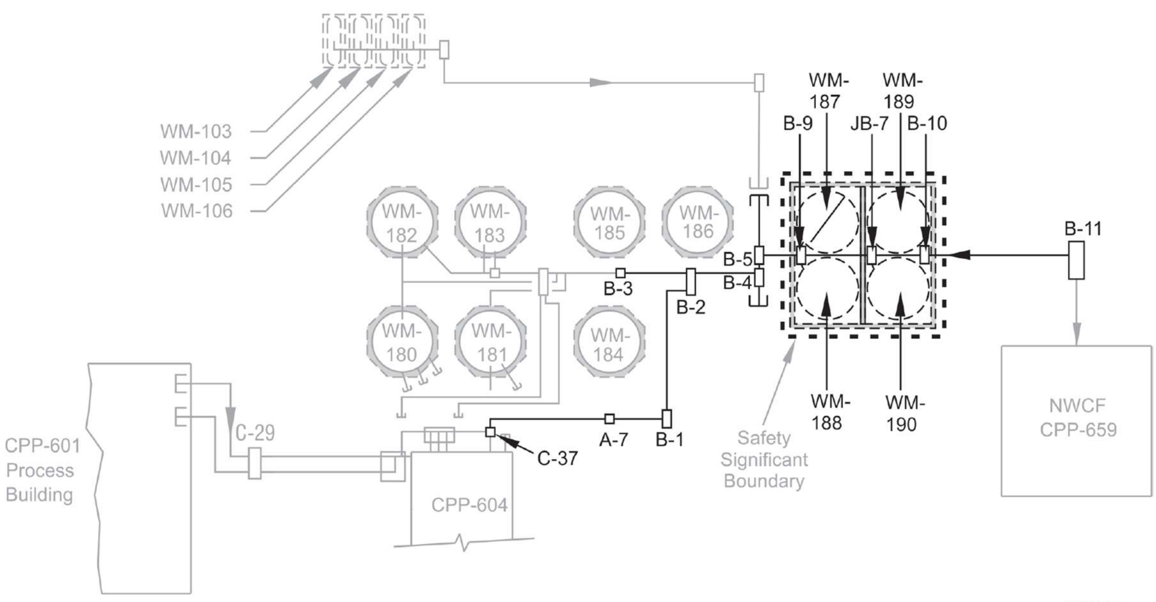


Figure 11. Active underground tanks and systems shown in bold.

These tanks are housed in underground concrete vaults. The tanks themselves are nominal 300,000-gal cylindrical stainless-steel tanks, approximately 50-ft in diameter and 21- to 23-ft in height. The tanks include deactivated cooling systems that were used during active operations for newly added waste. Tank risers provide access for monitoring systems as well as operational systems for liquid transfer, pressure relief, etc. Figure 12 shows a photograph of a typical tank internal during installation. Figure 13 shows an example of the typical tank and vault configuration.

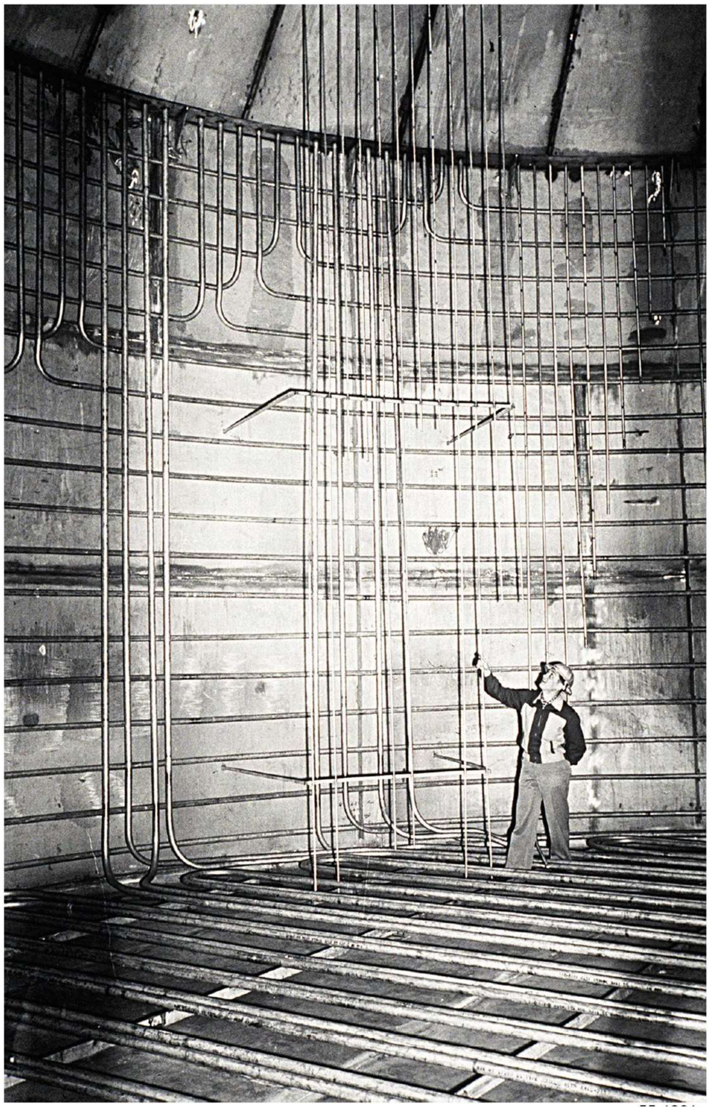


Figure 12. Typical Tank Farm waste storage tank internal.

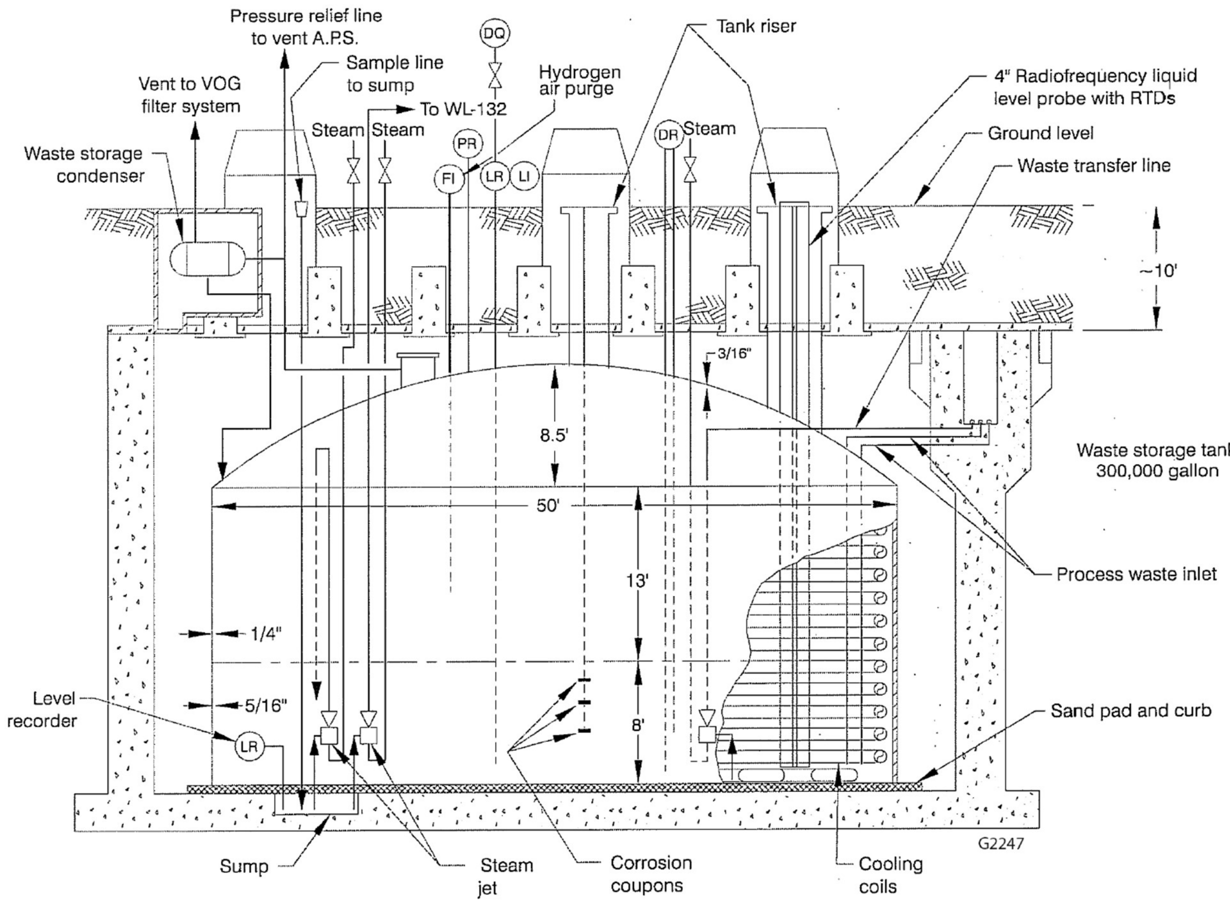


Figure 13. Typical Tank Farm tank configuration.

Existing tank monitoring systems

Tank monitoring systems are a combination of vintage monitoring components originally installed on the tank and newer components that were installed during repairs or upgrades. As tank deactivation proceeds, monitoring systems are cut, capped, and retired in place at certain phases of operation.

Pneumatic liquid level – Tank liquid level is determined by measuring the air pressure required to force air bubbles through a dip tube at the bottom of the tank. A dip tube above the liquid level provides the "vapor space" pressure value to allow the pressure differential to be determined and a liquid height to be calculated. This system transmits readings and alarms to the control system at CPP-628.

Digiquartz liquid level – This monitoring system uses the same dip tube as the pneumatic system described above. Tank liquid level is measured by pressure transducers which output variable frequency signals based on measured pressure. This signal is sent to signal processing systems in CPP-618 and the resulting liquid level determination is displayed at CPP-635 and CPP-636 and in the Waste Processing Computer System (WPCS).

Electronic liquid level and temperature – This multifunction monitoring system is installed on one of the tank risers. A stainless-steel tube extends to within 1-ft of the tank bottom. This tube is slotted to allow tank contents to enter the tube at the same level as within the tank. Loop antennae placed at the top of the tank riser send and receive a radiofrequency (RF) signal. The RF signal is tuned by an RF synthesizer and the received RF signal strength determines the fundamental resonance frequency of the cavity, which directly correlates to the liquid level height. The resulting liquid level determination is displayed in the WPCS. A smaller diameter tube within the larger tube contains resistance temperature detectors (RTD) at

10 heights within the tank. The output from these RTDs is routed through junction boxes at each tank and processed and recorded in CPP-632.

Pneumatic liquid density – Liquid density data are required for two of the liquid level determination methods described above. These data are gathered by measuring the air pressure required to force air bubbles through two dip tubes at a known vertical offset. Pressure values are transmitted to CPP-628 and recorded. A high-density alarm in CPP-628 also uses these values.

Pneumatic tank pressure – An instrument probe in the tank vapor space monitors gauge pressure to outside ambient pressure. This data is transmitted to CPP-628 and recorded, as well as provided input for pressure alarms. There are also Magnahelic pressure gauges for each tank providing direct measurements. WM-187 and WM-188 gauges are located in CPP-635; WM-189 and WM-190 gauges are located in CPP-636.

Secondary liquid temperature – Metal-clad thermocouple temperature sensors provide a backup system for measuring liquid temperature. The thermocouples are within stainless-steel tubes in the tank and are connected to temperature recorders in CPP-628. Due to the long service life of the tanks, many of these thermocouples have failed or are no longer operable.

Other Tank Farm systems and facilities

In addition to the tanks themselves and their condition monitoring systems, there are several other systems and related monitoring instruments that could be relevant to ARG-US implementation.

Vessel Off-Gas System (VOG) – The VOG maintains a negative pressure and vents off-gasses in each storage tank during normal operations. The VOG connects the tanks by underground piping to a condenser system and then to a blower in CPP-604, after which it is filtered through the Atmospheric Protection System and exhausted through the main INTEC stack.

Vacuum and pressure relief valves –A common set of pressure relief valves is connected to the tanks by a shared piping system. These valves operate automatically to relieve excessive tank pressure, either positive or negative.

Vault sumps – Each tank is enclosed in a dedicated concrete vault for structural protection from surrounding soil and secondary containment for tank contents. Each vault includes one or more sumps for collection and removal of tank contents or external water that leaks into the vault. Groundwater seepage is regularly removed from the sumps. The sumps have level-indicating instruments and alarms.

Other sumps – Numerous below-grade buildings and equipment pits include sumps. These include CPP-743, valve boxes, and junction boxes. Some of these sumps include liquid indication sensors and alarms while others do not.

Instrument buildings – Various instrument buildings house auxiliary valves, piping, alarms, and equipment for the storage tanks and transfer lines. These buildings are CPP-618, CPP-623, CPP-628, CPP-632, CPP-635, and CPP-636.

Waste Operations Control Room – CPP-1683 contains the control center for Tank Farm operations.

INL Environmental Monitoring

The majority of INL site environmental monitoring is managed under INL's laboratory-wide manual M-8, Environmental Protection and Compliance. Some monitoring is performed as controlled by emergency response procedures, while other monitoring is directed by facility-specific manuals.

Facility location monitoring

Facility location monitoring options are available at several INL site facilities. INTEC, Test Reactor Area (TRA), and Materials & Fuels Complex (MFC) facilities have systems that require constant monitoring. These systems are not discussed in detail, but in general have similar configurations that draw a limited volume off the main stack flow, route it through sealed sensor systems, and then return the analyzed volume to the main stack flow.

INTEC

INTEC has several facilities with exhaust stacks, including the previously discussed Tank Farm and CPP-603. Other facilities include CPP-666, CPP-692, and IWTU.

TRA

TRA-770 is the designator for the main exhaust stack and is discussed in reference 4, the SAR for the Advanced Test Reactor. The stack system includes radiation monitoring and an isolation system which can secure exhaust based on the radiation monitoring.

TRA also has a liquid effluent monitoring system for liquid output to the industrial waste pond. This system is used periodically to collect composite samples for offsite analysis.

MFC

MFC has several stack monitoring systems for different facilities. These various systems include several common components such alpha monitors, beta particulate monitors, combined alpha-beta monitors, and data recording devices. As an example, reference 5, the SAR of the Fuel Conditioning Facility (FCF), refers to stack monitoring systems and includes the following diagram with stack monitoring dedicated spaces MCF-764.

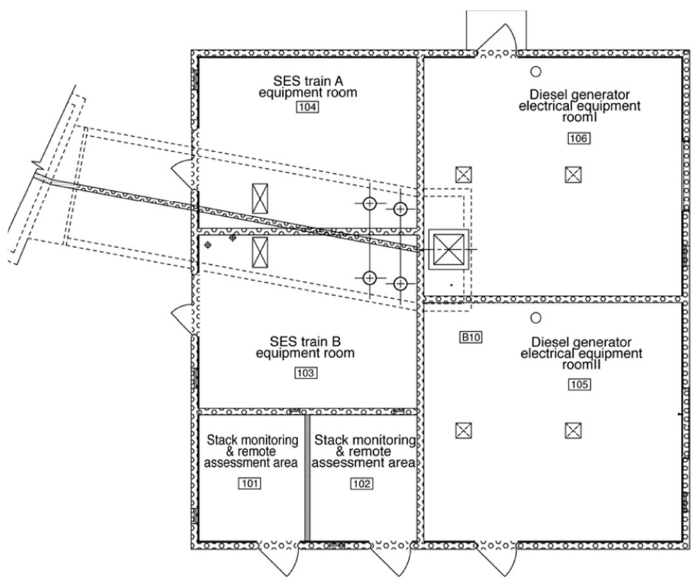


Figure 14. FCF stack monitoring facility layout.

Field monitoring

Environmental field monitoring includes several monitoring techniques that are not well suited to automation, such as radiation, vegetation sampling, and well water sampling. Radiation monitoring is performed by long-term placement of optically stimulated luminescent dosimeters. Vegetation and well water sampling is performed by direct personnel activity. The primary monitoring method which may lend itself to ARG-US adaptation is airborne radioactivity sampling. Low-volume air sampling is performed as described by reference 6. Sampling occurs at populated areas nearby, including Mountain View Middle School in Blackfoot, Idaho, near the Idaho Falls Regional Airport, in Sugar City, Idaho, and near INL research areas in Idaho Falls, Idaho. Sampling also occurs at many desert sites including the

Central Facilities Area, INTEC, Craters of the Moon National Monument, Experimental Breeder Reactor 1, and areas designated only by National Oceanic and Atmospheric Administration (NOAA) data station or location near roadways. Figure 15 and Figure 16 taken from reference 6 show examples of sampler locations.

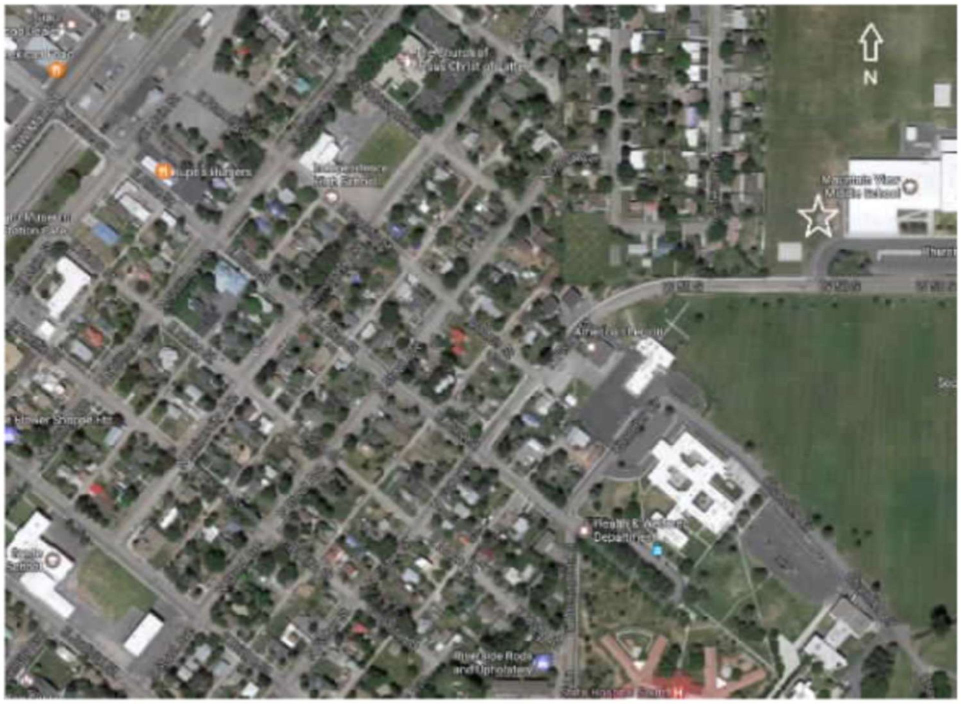


Figure A-1. Low-volume air monitor BLKFT inside NOAA fence at Mountain View Middle School in Blackfoot.

Figure 15. Example low-volume air sampler location [6].

Figure A-7. Low-volume air monitor Gate 4 located at a NOAA tower South of Gate 4

Figure 16. Example low-volume air sampler location [6].

Current air sampling is by low-volume air sampler, which deposits sample material on a fiber filter patch and within charcoal filters.

Emergency response monitoring

INL site emergency response is controlled by reference 7. While facilities include many real-time monitors for external radiation and airborne radioactivity, pre-positioned, broad environmental monitoring during an emergency response is primarily accomplished by high-volume air sampling. This sampling method detects very low levels of airborne radioactive particulate by drawing a large volume of air through a fiber patch, which is then removed from the sample collector and analyzed by portable survey instruments or sent for highly precise laboratory analysis. Similar instruments can be used to collect samples within silver gel or charcoal cartridges for radioiodine analysis. The sampling can be started remotely by signals sent via NOAA data station, but personnel must still physically travel to the collection hardware to retrieve the sample.

For adaptive survey team response, rather than pre-set monitoring locations, surveying is performed by present personnel with typical radiological control instruments for external radiation and airborne radioactivity.

ARG-US TEST CONFIGURATION

CPP-603

ARG-US system testing in CPP-603 will be centered around monitoring within the FHC. This monitoring will serve several purposes:

- Provide early indication of radiological conditions prior to personnel entry
- Gather data of facility conditions during diverse operations and ambient environments
- Further demonstrate ARG-US operation in heavily shielded, high-radiation environment.

Standard RAMM units will be the primary ARG-US hardware operated in the facility. Figure 17 shows expected RAMM locations. RFID surveillance tags may be used for some of the mobile hardware used in the facility, which are not shown on the facility diagram.

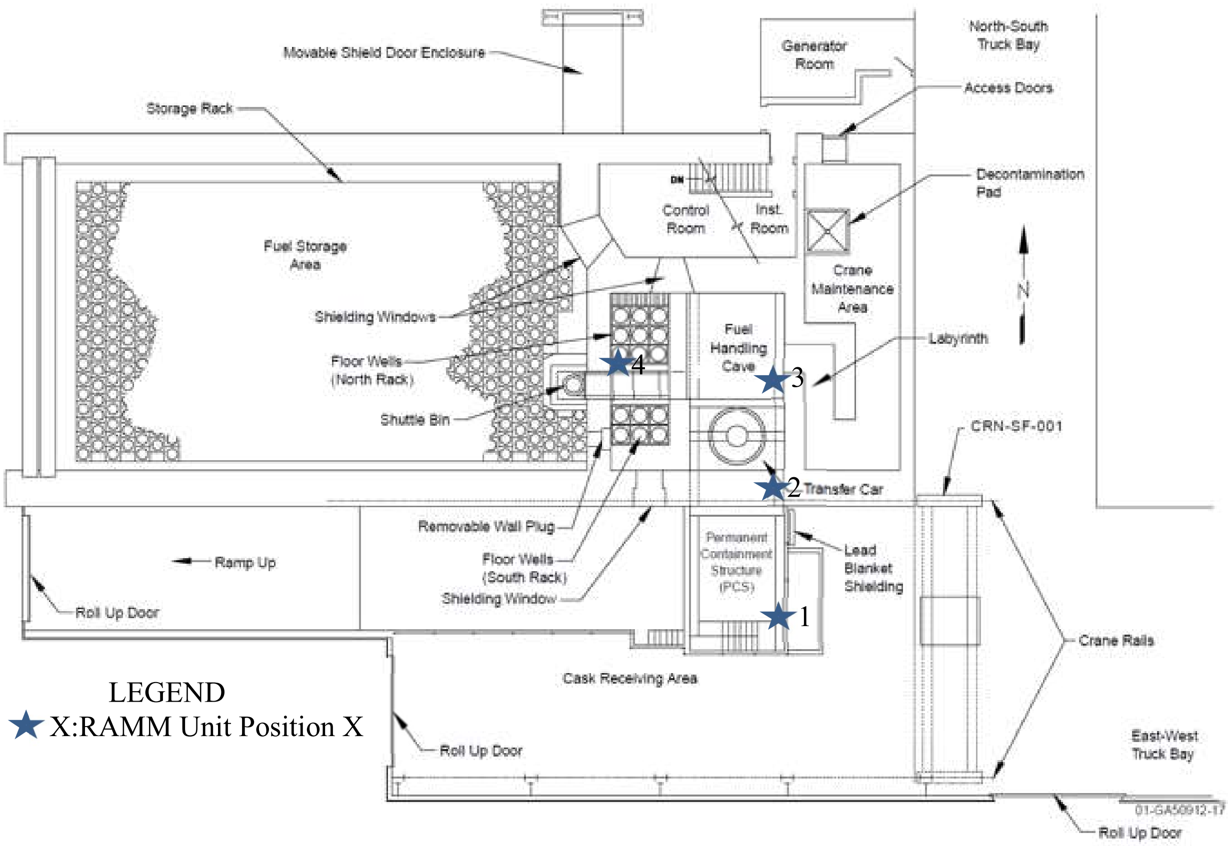


Figure 17. RAMM locations in CPP-603.

Position 1 is in the PCS near the personnel access to CTC. Position 2 is in the CTP at the floor level, likely directly under the FHC shield wall. Position 3 is in the FHC, near the personnel access doorway. Position 4 is in the FHC, near the transfer shuttle to the FSA.

The RAMM monitoring capabilities of primary interest are for gamma radiation dose rate, neutron radiation indication, temperature, and humidity. Other sensor capabilities such as loop seal, accelerometer, and digital camera are not expected to be used, and may warrant deactivation for security purposes in the case of the camera. Positions 1 and 3 provide real-time monitoring at personnel access points to the PCS and FHC. Position 4 provides real-time monitoring at the SNF transfer point between the FHC and FSA. Position 2 is not in a location for regular personnel access but is anticipated as a data connection relay between the heavily shielded points of Positions 1 and 3.

RAMM units are expected to be powered by a combination of PoE and standard 110 VAC facility power. The PoE connection is expected to be available for Position 1, and possibly available for Positions 2 and 3. PoE is not expected to be available for Position 4. Standard 110 VAC outlets are available near all positions but may require extension cords.

The data connection to the ARG-US web application will be made through one or more RAMM units connected to the Idaho Cleanup Project (ICP) intranet by the PoE connection. It is possible that only Position 1 will have an Ethernet connection available. Those RAMM units without an Ethernet connection will communicate through the mesh wireless network built into the RAMM units.

Tank Farm

ARG-US system testing in the Tank Farm will be more physically widespread and diverse than for CPP-603. The system will serve several purposes:

- Supplement or improve current monitoring on Tank Farm systems
- Consolidate monitoring from several physical locations to a single web-based HMI
- Demonstrate ARG-US adaptability to new monitoring hardware and methods.

This test is expected to use a variety of ARG-US hardware. RFID tags will be used in physically confined locations where numerous monitoring points can be served by a single RFID reader, or where external power cannot be supplied. RAMM units will be used where monitoring requirements exceed the low-voltage capability of the RFID tags and to provide data nodes to connect to network. Exact positions and quantities of these components have not yet been identified.

ARG-US monitoring methods of interest in the Tank Farm will vary depending on the specific use. Gamma radiation, temperature, and humidity will be used at all locations. For some applications, such as sump and valve box monitoring, liquid detection will be added to current ARG-US capability. In other applications, valve position, flow rate, and other operational control parameters will be monitored. Additionally, ARG-US may provide the data transmission for existing monitoring devices.

RFID tags will be powered by the onboard batteries. Standalone RFID readers will require regular 110 VAC facility power, which may limit their positioning. The mobile test kit may be used to collect RFID surveillance tag data to supplement the permanently located RFID readers. RAMM units are expected to use a combination of PoE and 110 VAC facility power depending on location.

Data connections will be made through a combination of RFID readers, RAMM mesh network, and RAMM Ethernet connection to the ICP intranet.

Environmental Monitoring

ARG-US system testing for INL site environmental monitoring will fall under two basic categories: facility-based monitoring and routine area monitoring. Emergency monitoring will also be considered. Most ARG-US testing will be implemented in parallel existing, required monitoring systems. Implementing ARG-US in these areas will serve to:

- Simplify or improve current facility monitoring
- Reduce direct access required for routine area monitoring
- Assess potential benefit for emergency monitoring
- Demonstrate ARG-US adaptability to new monitoring and power supply methods.

This test is expected to use RAMM, RAMM Traveler, and prototype ANL-Evigia monitoring units. These units will serve similar monitoring purposes. The difference in selection will depend on available Ethernet connection to INL or ICP intranet and monitoring capability. The number and location of these units will be determined in order to supplement or provide a side-by-side capability comparison to existing monitoring units in accordance with reference 8.

ARG-US capability for environmental monitoring will depend on implementation of significant new hardware. Existing RAMM sensors for temperature, humidity, and digital cameras will be beneficial. The loop seal sensor may be used to provide hardware security in remote or publicly accessible locations. For units in remote locations, low-battery warnings will also be necessary. Current RAMM gamma and neutron radiation sensors are insufficiently sensitive for long term environmental monitoring purposes. New hardware implemented for RAMM that is expected to interface directly to the single-board computer will likely include an anemometer, a precipitation sensor, and an effluent/stack flow rate sensor. Implementing new monitoring hardware needed for ARG-US environmental monitoring is best achieved by using commercially available systems with RAMM or RAMM Traveler for data communication. Examples of this hardware include airborne radioactive gas or particulate monitoring. Some of these functions may also be relevant to the ANL-Evigia prototype systems.

In some locations, PoE or 110 VAC facility power will be available for RAMM power, particularly for facility applications. In most environmental area monitoring applications, the monitoring location will be far removed from regular power distribution. For units designated for emergency response monitoring, it is possible that battery-powered RAMM Traveler units can be pre-positioned in a stand-by condition, then activated only as needed. Other RAMM Traveler units may be configured to use vehicle power and provide monitoring and data transmittal for dispatched emergency response teams. Routine area monitoring will need regular, remotely available power sources. These RAMM Traveler units will be supplied with a battery bank and fitted with a recharging system, such as solar photovoltaic or wind turbine.

Monitoring systems will transmit data by Ethernet connection where available, but most locations are likely too far from regular facilities for Ethernet access. For these locations, RAMM Traveler communication by cellular network or GPS satellite network will be necessary. These data connections may be to both INL and ICP intranets.

IDAHO NATIONAL LABORATORY NECESSARY ACTIVITIES

INL activities for implementing the test configurations described above fall into three categories:

- INL and ICP personnel training
- Hardware modification investigation
- Evaluation and approval documentation
- Hardware installation.

INL and ICP Personnel Training

INL and ICP personnel will require detailed knowledge of ARG-US hardware, web-based HMI, and system interfaces. This knowledge is best provided by hands-on training for small groups with the ANL ARG-US experts. This training will be provided at ANL due to the available systems and facilities there and is expected to be accomplished in 3 days. The personnel requiring training are those involved with hardware investigation, installation, and ongoing monitoring afterwards. Training may be needed for different persons at different stages of activity, before and after implementation at the INL site.

Hardware Modification Investigation

The test configurations described above include several significant hardware modifications or sensor additions to current ARG-US units. Some monitoring capabilities including liquid detection, anemometry, valve position, and pipe flow rate, are expected to be well suited to direct implementation as ARG-US unit sensors. More complex monitoring methods such as airborne radioactivity monitoring and previously installed monitoring will remain as auxiliary systems and use ARG-US units for data transmission. Last, RAMM Traveler units and auxiliary monitoring systems far removed from facility power sources require development of energy harvesting remote power systems.

Lab-scale investigation will be necessary for selecting new hardware, establishing communication methods, setting parameters and calibrations, and testing operation. These investigations will be performed by INL staff in the Used Fuel Management Department (C430) at the INL Engineering Demonstration Facility in Idaho Falls, Idaho. Lab work will start by January 9, 2023. Results of these investigations will provide input to later work for test implementation. Initial Results of these investigations will be documented in the detailed plan for INL ARG-US test implementation, expected April 28, 2023. Some lab-scale investigation is expected to continue through the remainder of the test implementation.

Evaluation and Approval Documentation

There are significant administrative requirements to be satisfied prior to physical work for test implementation. These requirements are driven by the general regulatory and work control environment for working at DOE nuclear research and development facilities. The results of these evaluations and approval will be recorded internal documents. These last of these evaluations are planned to be completed by May 26, 2023. Some evaluations will be completed prior to this date to allow the start of lab-scale testing.

Environmental Evaluation

An evaluation of environmental impacts of project activities is necessary. The evaluation will consider federal and state environmental requirements and direct environmental documentation and mitigation activities. This task will be performed by INL personnel.

Information Security Evaluation

ARG-US hardware will have several interfaces with INL and ICP intranets. Both the hardware and transmission methods will need to meet information security requirements. These requirements will vary based on the nature of the data being transmitted, the facility where the hardware is located, other nearby computer hardware, and the network with which it communicates. These evaluations will be performed by both INL and ICP personnel.

Laboratory Scale Work Control

Prior to commencing hands-on hardware investigations, work controls must be developed. Work scope and hardware selection will be documented. Environmental, safety, and health controls will be developed, documented, and provided to researchers through training and briefings. Work controls will be documented in an internal INL document called a laboratory instruction, and the record of work will be in an INL electronic laboratory notebook. Laboratory instructions will be developed by INL personnel.

Facility Control Documentation

The various facilities for ARG-US testing have configuration control programs, implemented through documents such as safety analysis reports (SARs) or hazard assessment documents. Bringing in new hardware and potentially replacing monitoring methods requires evaluation for compliance with these control documents. In cases where facility modification must be performed the effects of the modifications must be evaluated and approved, which is a significant work effort for hazard category 3 facilities. These evaluations will be performed by both INL and ICP personnel.

Hardware Installation

After all evaluations and approvals have been completed, ARG-US hardware installation may commence. Work orders and instructions must be developed.

The scope of work will vary based on the location. Work performed in radiological areas or on hazardous systems, such as in CPP-603 or on the Tank Farm, will require significant effort. Area monitoring ARG-US implementation is expected to require the least effort as it will not require incorporation to existing systems. Installation will require modifications to ARG-US hardware as determined by the lab-scale investigations, routing power and Ethernet within facilities, hardware placement, and sensor incorporation to existing system.

In addition to ARG-US-specific hardware, commercially available networking hardware must be added to the INL and ICP intranets specifically to connect ARG-US data to the database.

Installation is planned to start by August 14, 2023. The duration of installation activities is uncertain due to the widely varying scope possibilities.

SUMMARY

INL is developing plans for ARG-US testing at INL site facilities. The further investigations of previously identified possible applications (CPP-603 FHC, INTEC Tank Farm, and environmental monitoring) have identified opportunities for ARG-US testing and requirements for implementation.

FY-23 activities to implement ARG-US testing will begin with evaluations and approvals to satisfy significant administrative requirements. Completion of these evaluations is required to start both lab-scale and full-scale testing of ARG-US. The evaluations are expected to be complete by May 26, 2023. Lab-scale investigation of ARG-US hardware modification will select new hardware and incorporate it to the ARG-US suite. These investigations will start by January 9, 2023, and will provide input to the full-scale testing by April 28, 2023. Hardware installation for full-scale testing will start by August 14, 2023. Once ARG-US is installed, ongoing evaluation will be performed regarding system operation, benefits to INL operations, and potential future testing opportunities.

REFERENCES

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3. ICP SAR-107, Safety Analysis Report for the Tank Farm Facilities, Rev. 8, January 2018.
4. INL SAR-153, Upgraded Final Safety Analysis Report for the Advanced Test Reactor, Rev. 27, February 2022.
5. INL SAR-403, Safety Analysis Report for the Fuel Conditioning Facility, Rev. 7, June 2022
6. INL LI-352, Low-Volume Air Sampling using DL-22, Rev. 7, September 2022.
7. INL PLN-114, INL Emergency Plan/RCRA Contingency Plan, Rev. 127, August 2022.
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