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KJRR-FAI Hydraulic Flow Testing Input Package

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R.B. Nielson
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December 2013

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Approved by:

N.E. Woolstenhulme	12/20/13 Date
(N.E Woolstenhulme for R.B. Nielson per email 12/20/13) R.B. Nielson	12/20/13 Date
D.B. Chapman	12/20/13 Date

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1. Introduction

The Korea Atomic Energy Research Institute (KAERI) has initiated the Ki-Jang Research Reactor (KJRR) project to construct a new dedicated radio-isotope production facility in the KiJang province of South Korea. The KJRR will employ a plate-type driver fuel assembly. The fuel meat will consist of uranium 7 wt% molybdenum (U-7Mo) metallic alloy particles dispersed in a blended matrix of pure aluminum and 5 wt% silicon. The uranium enrichment will be 19.75wt% U-235 and considered Low Enriched Uranium (LEU). Aluminum alloy 6061(Al-6061) will be used as the fuel plate cladding material (see Figure 1).

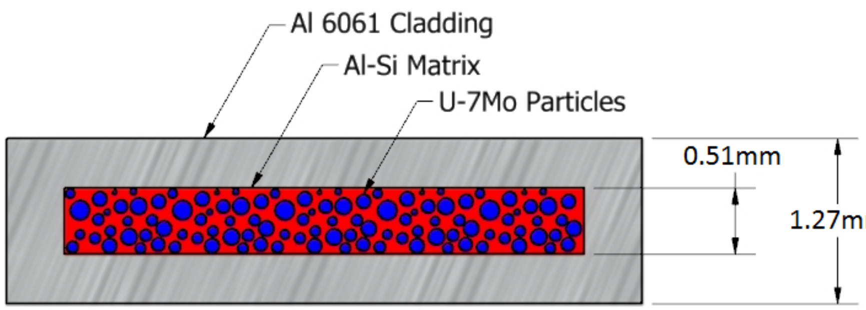


Figure 1: Fuel Plate Cross Section

Two fuel meat uranium densities of 8.0 and 6.5 g-U/cm3 will be used for the 19 interior plates and the 2 exterior plates of the KJRR fuel assembly, respectively. Fuel plate fabrication will be accomplished by hot roll bonding processes. Each of the 21 flat fuel plates will be assembled into a fuel assembly by swaging in the grooves of Al-6061 side plates giving ~620g U-235 for each KJRR fuel assembly (see Figure 2). The KJRR will receive fabricated driver fuel assemblies from a fabrication facility at the KAERI.

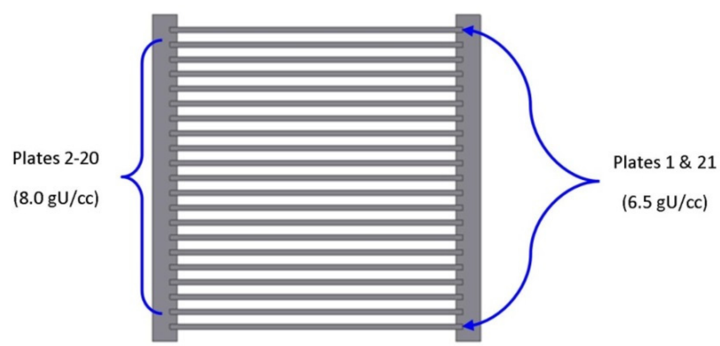


Figure 2: KJRR Fuel Assembly Top View

This fuel assembly design and fabrication technique is similar to other plate-type research reactor fuels, but the use of the U-7Mo dispersed in Al-Si fuel system is not. The U-7Mo dispersion fuel system has long been under development by the international community for its potential use in LEU conversion of existing research reactors [1]. While a large amount of research has taken place for this fuel system, it has not yet received generic qualification through a regulatory agency such as was accomplished for the U_3Si_2 system through the US Nuclear Regulatory Commission [2]. Hence, qualification of the KJRR fuel fabrication process and licensing the use of U-7Mo dispersion fuel in the KJRR environment will require irradiation testing of representative specimens followed by post-irradiation examination (PIE).

A series of small-scale irradiation tests will be performed in the KAERI's existing HANARO research reactor in the HANARO Mini-Plate (HAMP) experiment campaigns and are discussed elsewhere[3]. The KJRR fuel qualification program will also require irradiation of a full-size driver fuel assembly. This will be performed in the North-East Flux Trap (NEFT) of the Advanced Test Reactor (ATR) with PIE in the Hot Fuel Examination Facility (HFEF); both located in the US at the Idaho National Laboratory. This campaign is termed the KJRR Fuel Assembly Irradiation (KJRR-FAI).[4]

1.1 Objectives

The INL, in cooperation with the KAERI via Cooperative Research And Development Agreement (CRADA), undertook an effort in the latter half of calendar year 2013 to produce a conceptual design for the KJRR-FAI campaign. The outcomes of this effort are documented in further detail elsewhere [5]. The KJRR-FAI was designed to be cooled by the ATR's Primary Coolant System (PCS) with no provision for in-pile measurement or control of the hydraulic conditions in the irradiation assembly. The irradiation assembly was designed to achieve the target hydraulic conditions via engineered hydraulic losses in a throttling orifice at the outlet of the irradiation vehicle. The irradiation assembly design is further described in section 2.1.

Since PCS flow will be needed to provide adequate cooling to the KJRR fuel plates, while assuring that the total flow through the irradiation assembly does not exceed the capacity of the PCS and result in driver core starvation, the sizing of this flow orifice is a critical aspect in assuring safety and operability of the design. Physical flow testing of a full-size mock-up irradiation assembly will help confirm proper selection of the orifice design as well as provide empirical data for the expected heat transfer conditions in the assembly. Accordingly, the first phase of flow testing will characterize hydraulic losses for a few orifice designs as described in section 2.2.

Structural calculations and finite element analyses have and will continue to be performed to demonstrate that the KJRR-FAI design is mechanically sound. However, fluid-structure interactions can be difficult to simulate, particularly if dynamic behaviors are involved (e.g. flow-induced vibrations). The second phase of flow testing will include longer term endurance testing in order to help mitigate risk of an unforeseen flow-induced structural failure. This will provide greater confidence that the assembly structure is able to withstand the hydrodynamic forces associated with the ATR flowing water environment. This phase of the flow test program is described further in section 0.

Fabrication of the flow test hardware, hydraulic testing, and post-test data processing will be accomplished by the KAERI with input from the INL irradiation design team. The purpose of this report is to provide these inputs to the KAERI.

2. Flow Test Inputs

2.1 Hardware Design

The KJRR-FAI assembly is described in greater detailed in the KJRR-FAI conceptual design report [5]. This section describes the fundamental features of the hydraulic configuration which consists of four general components, each nested within the other, in the order listed below. A full-size mock-up of each component listed below must be fabricated for use in the hydraulic flow tests.

1. Fuel assembly
2. Inner fuel basket
3. Outer basket
4. NEFT simulator

The ATR is a downflow reactor. The structural arrangement of the KJRR-FAI assembly relies up on gravity and the downward forces of the flow direction to ensure that these components remain seated. Flow testing must be performed with the assembly arranged vertically and water flow direction downwards. The KJRR fuel assembly and flow direction are show in Figure 3 below.

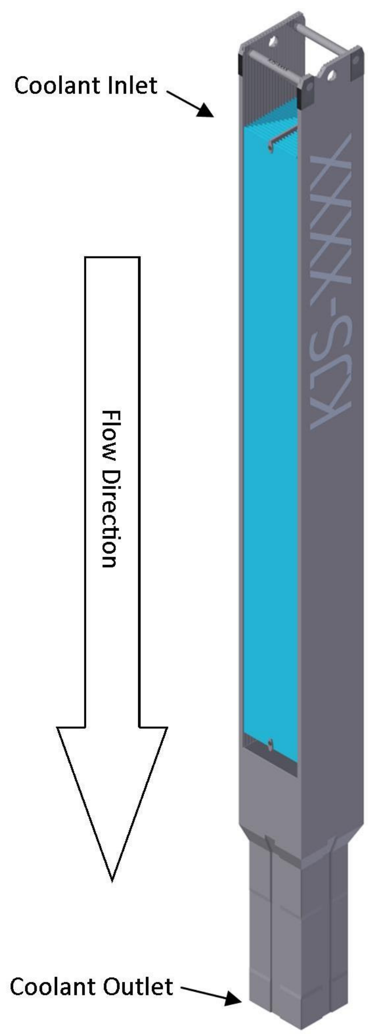


Figure 3: KJRR Fuel Assembly and Flow Direction

The KJRR fuel assembly can be simulated by a non-fueled dummy assembly for the purposes of the flow test. This assembly must be fabricated to the same tolerances as the actual KJRR fuel assemblies in order to assure proper form, fit, and function when installed into the inner fuel basket. The coolant channel gaps, in particular, must be fabricated to the same tolerances as the actual KJRR fuel assemblies. All components of the fuel assembly must be present, constructed of representative stock materials, and installed per KAERI drawings/specifications. Special processing which affects mechanical characteristics such as welding, swaging, and the annealed condition of the plates must be employed to produce a proper assembly for flow testing.

The flow test assembly for the inner fuel basket is depicted in drawing 604407 in Appendix B. The square internal corners of Items -7 and -12 were designed to be fabricated by Wire Electrical Discharge Machine (Wire-EDM). The internal chamfer profile of item -12 was design to be fabricated by Plunge or Sinker EDM. The remainder of the assembly was designed to be fabricated with conventional machine tools (e.g. milling machine, lathe) with welding accomplished by Gas Tungsten Arc Welding (GTAW). The assemblies must be fabricated for flow testing from the specified materials and inspected to the tolerances shown in Appendix B.

The flow test assembly for the outer basket is depicted in drawing 604408 in Appendix B. This design is identical to the current conceptual design for the in-pile irradiation assembly, except that the base of the outer basket (item -10) has an interchangeable orifice plate specifically for flow testing purposes (items -13 through -18). Orifice plates holes must be fabricated with sharp-edges (i.e. no chamfers, fillets) in order to match the hydraulic loss assumptions used in calculating the hole sizes. The as-built orifice hole dimensions must be inspected and reported to the INL. Items -9, -11, and -12 were designed to be fabricated from solid aluminum bar stock, with the inner profiles produced by Wire-EDM. The remainder of the assembly was designed to be fabricated with conventional machine tools (e.g. milling machine, lathe) with welding accomplished by GTAW. The assemblies must be fabricated for flow testing from the specified materials and inspected to the tolerances shown in Appendix B.

The inner profile of the NEFT is made up of an intricate flux trap baffle assembly and lower flux trap support tube constructed from a combination of aluminum and stainless steel alloys. Both the flux trap baffle assembly and lower flux trap support tube are well proven designs currently installed in the ATR. It is not necessary to simulate the entire NEFT assembly for purposes of the KJRR-FAI flow test. However, the inlet geometry, inner profile, and outlet structure must be fabricated and employed during flow testing to provide prototypic boundary conditions. Appendix A contains engineering sketches of the critical hydraulic features of the NEFT. The materials from which the flow test NEFT simulator is constructed are unimportant. The dimensions, however, depicted in Appendix A are important features and must be replicated in the flow test NEFT simulator. The lower flux trap support tube must be fabricated and rigidly affixed so that the flow test assembly can be located and supported by it. See Figure 4.

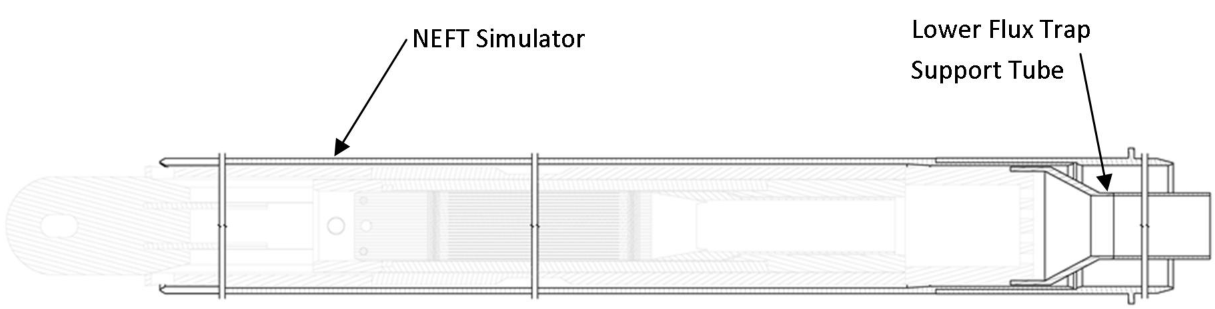


Figure 4: NEFT Simulator Layout

2.2 Characterization of Hydraulic Losses

The first phase of hydraulic flow testing will commence after the following have been accomplished:

- KAERI flow test facility configured for downflow testing
- Fabrication and inspection complete for the following
    - Fuel assembly
    - Inner fuel basket
    - Outer basket
    - NEFT simulator
- INL Quality Assurance completes supplier evaluation and qualification of the KAERI for providing flow test services

The flow test should be conducted with a water temperature range between 20-60˚C, the temperature of the water must be measured and recorded throughout the tests. ATR's nominal inlet temperature is 52˚C. The flow test should be conducted through a range of flowrates starting at relatively low conditions up to slightly beyond ATR's coolant conditions to determine the relationship between volumetric flow and pressure drop through the vehicle. Flow rates and pressure drops through the assembly must be measured. Simulating the absolute inlet pressure in the ATR vessel 2.5 MPa (360 psi) is not necessary unless cavitation occurs in the flow test assembly. Care should be taken to avoid extreme coolant channel velocities which could cause plate damage. The critical coolant parallel flow velocity, below which a fuel plate should not collapse, was calculated to be 16.6 m/sec in the expected KJRR-FAI conditions in the ATR.[5]

The first flow test should be performed with the complete irradiation assembly mock-up installed with item -13 on dwg 604408 (no holes) orifice plate installed. This will effectively block all flow through the vehicle's internal channels. The flow rates measured in this test will characterize the hydraulic losses through the "bypass" channel between the NEFT and the outer profile of the outer basket. The results of this test can be subtracted from subsequent tests to determine volumetric flowrates through the vehicle's internal channels.

The target flow rate through the fuel coolant channels is 7.2 m/s. This corresponds to a pressure drop through the irradiation assembly of 0.53 MPa (77 psi). The primary orifice plate design predicted to meet this flow rate is item -16 on dwg 604408 (12X holes at 11.43mm diameter) in Appendix B. Accordingly, the next flow test should be performed with item -16 installed. It is preferable to continue flow testing with orifice plate items -14, -15, -17, and -18 (in no particular order) to better characterize the assembly. However, if the data are processed and the appropriate orifice plate design is found, then this phase of flow testing can be terminated. Following these tests all hardware should be visually inspected for signs of fretting, chatter, fracture, material yielding, and other evidence of structural problems during the flow test. The INL should be notified immediately if any problems are observed.

Testing conditions performed with the orifice plate which most closely achieves the 7.2 m/s flow rate should exhibit a total volumetric flow through the total assembly (including fuel plate coolant and bypass channels) of ~1720 liters/min. If this measured value exceeds 1830 liters/min, then KAERI should contact the INL for further direction as this total flow rate could exceed the capacity of the ATR PCS.

2.3 Endurance Testing

The orifice plate which most closely achieved the 7.2 m/s flow rate at ATR conditions must be installed on the outer basket. The assembly must then receive long term steady state flow testing at conditions which produce the same 7.2 m/s flow velocities in the coolant channels. The minimum duration of this test must be a cumulative time of 10 days. Data logging from temperature, flow rate, and pressure instruments can be much less frequent than the previous hydraulic characterization testing, but should be frequent enough to ensure that the equipment is operating properly in maintaining the desired flowrate. Following these tests all hardware should be visually inspected for signs of fretting, chatter, fracture, material yielding, and other evidence of structural problems during the flow test. The INL should be notified immediately if any problems are observed.

2.4 Finalization

The findings of these flow tests and the detailed flow characterization data for the orifice plate configurations must be documented by the KAERI for transmittal to the INL. The irradiation hardware mock-up used in the flow tests should not be discarded. This hardware should be maintained in a clean environment as the INL could envision requesting that this hardware be shipped to the INL for in-canal handling practice or similar prototyping work.

3. References

[1] Dennis D. Keiser Jr., Jan-Fong Jue, Bo Yao, Emmanuel Perez, Yongho Sohn, and Curtis R. Clark, "Microstructural characterization of U–7Mo/Al–Si alloy matrix dispersion fuel plates fabricated at 500 ˚C", Journal of Nuclear Materials 412 (2011) 90–99.

[2] "Safety Evaluation Report related to the Evaluation of Low-Enriched Uranium Silicide-Aluminum Dispersion Fuel for Use in Non-Power Reactors", NUREG-1313, U.S. Nuclear Regulatory Commission, July 1988.

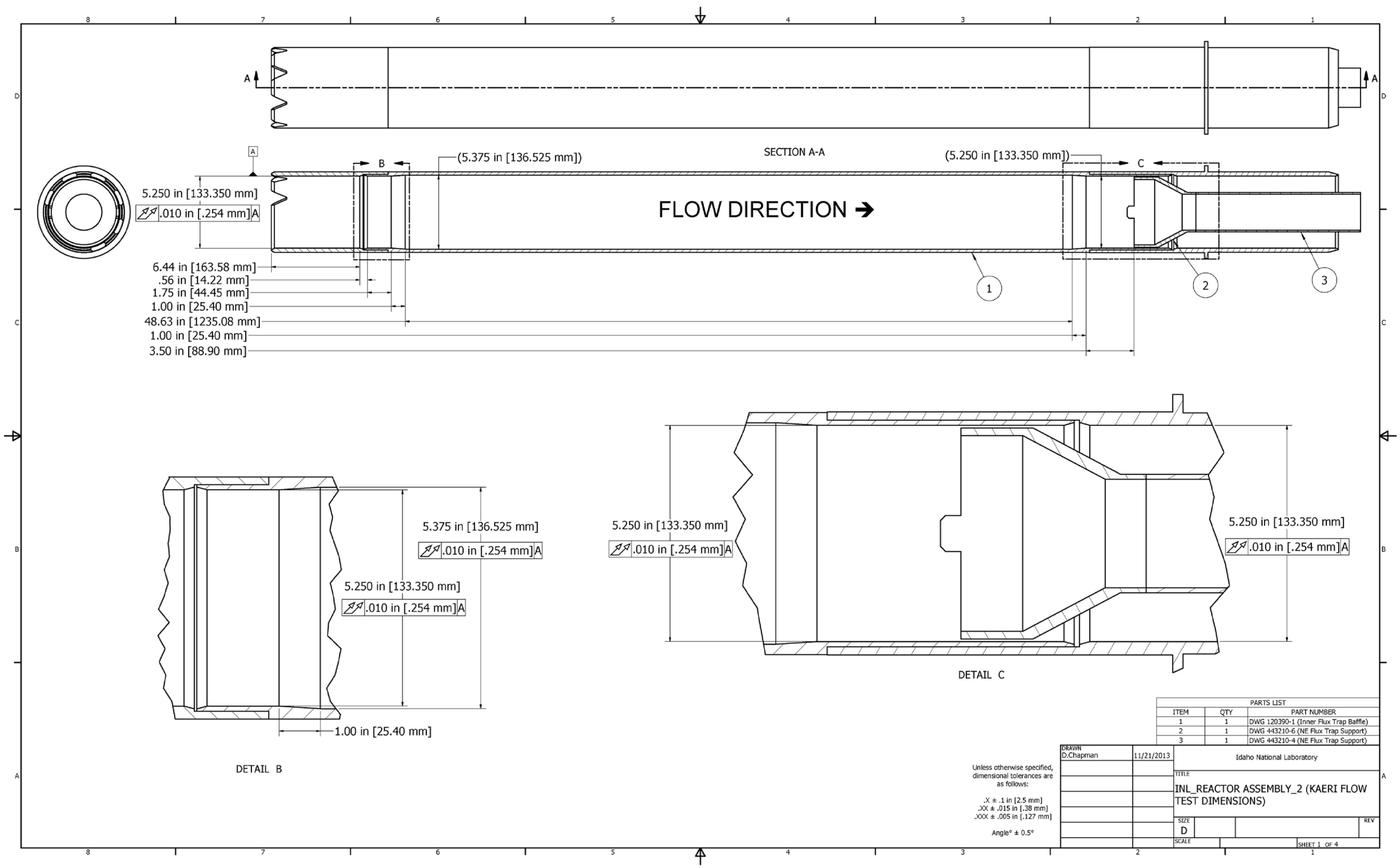
[3] "LEU UMo Dispersion Fuel Tests at KAERI", INL Document Statement of Work SOW-110099, rev 2, 8-6-2013.

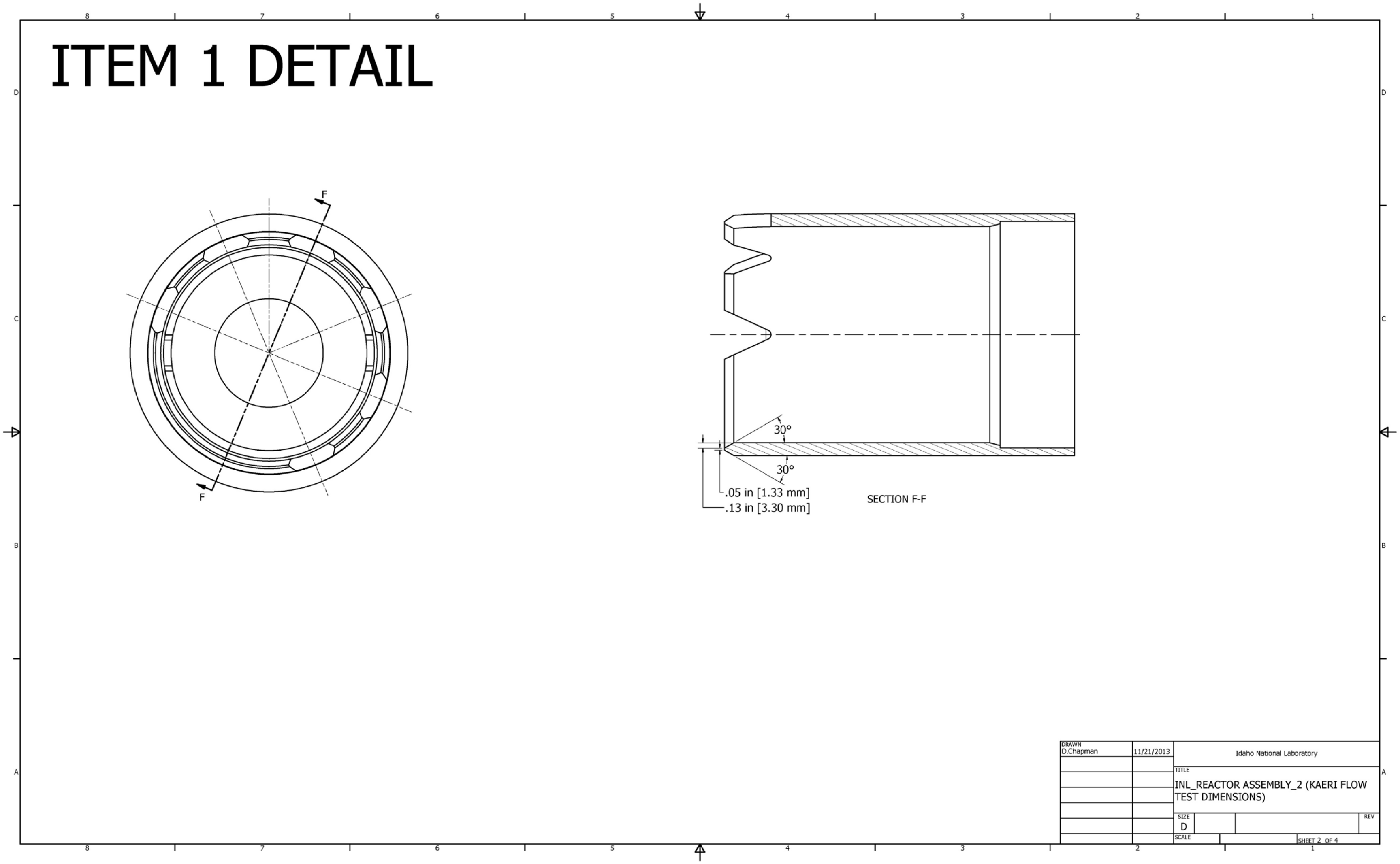
[4] INL Document PLN-4584, "Ki-Jang Research Reactor Fuel Assembly Irradiation in the ATR", rev 0, 12/18/2013.

[5] N.E. Woolstenhulme, R.B. Nielson, D.B. Chapman, J.W. Nielsen, P.E. Murray, D.S. Crawford, and S.D. Snow, "KJRR-FAI Status Report of Conceptual Design Activities", INL external report INL/EXT-13-30857, December 2013.

[6] INL Document FOR- 169, "Ki-Jang Research Reactor Fuel Assembly Irradiation Campaign", rev 0, Draft December 2013.

Appendix A (NEFT Hydraulic Features and Dimensions)

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D.Chapman
11/21/2013
Idaho National Laboratory
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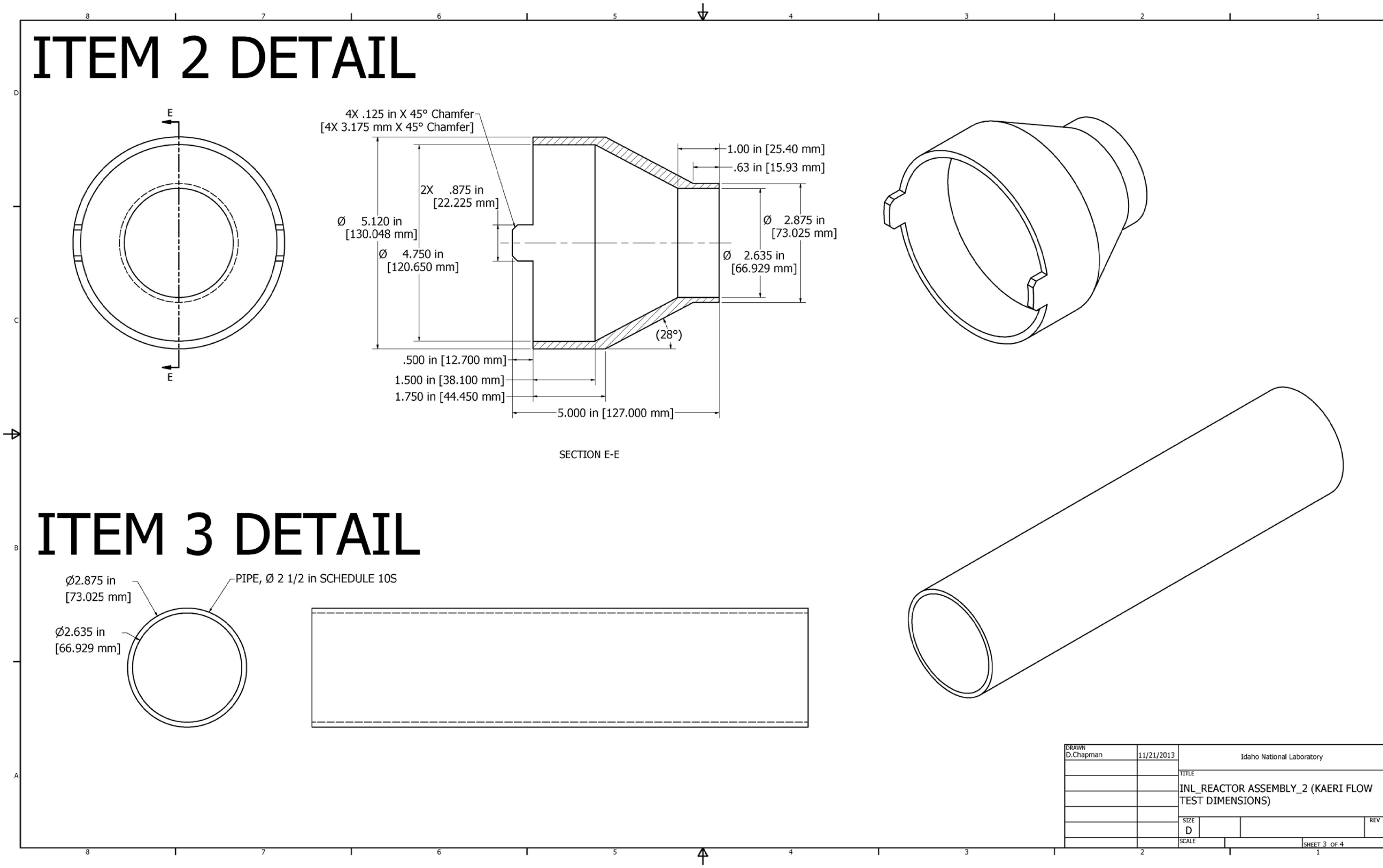
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Ø 4.750 in
[120.650 mm]
1.00 in [25.40 mm]
.63 in [15.93 mm]
Ø 2.875 in
[73.025 mm]
Ø 2.635 in
[66.929 mm]
(28°)
.500 in [12.700 mm]
1.500 in [38.100 mm]
1.750 in [44.450 mm]
5.000 in [127.000 mm]
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Ø2.635 in
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D.Chapman
11/21/2013
Idaho National Laboratory
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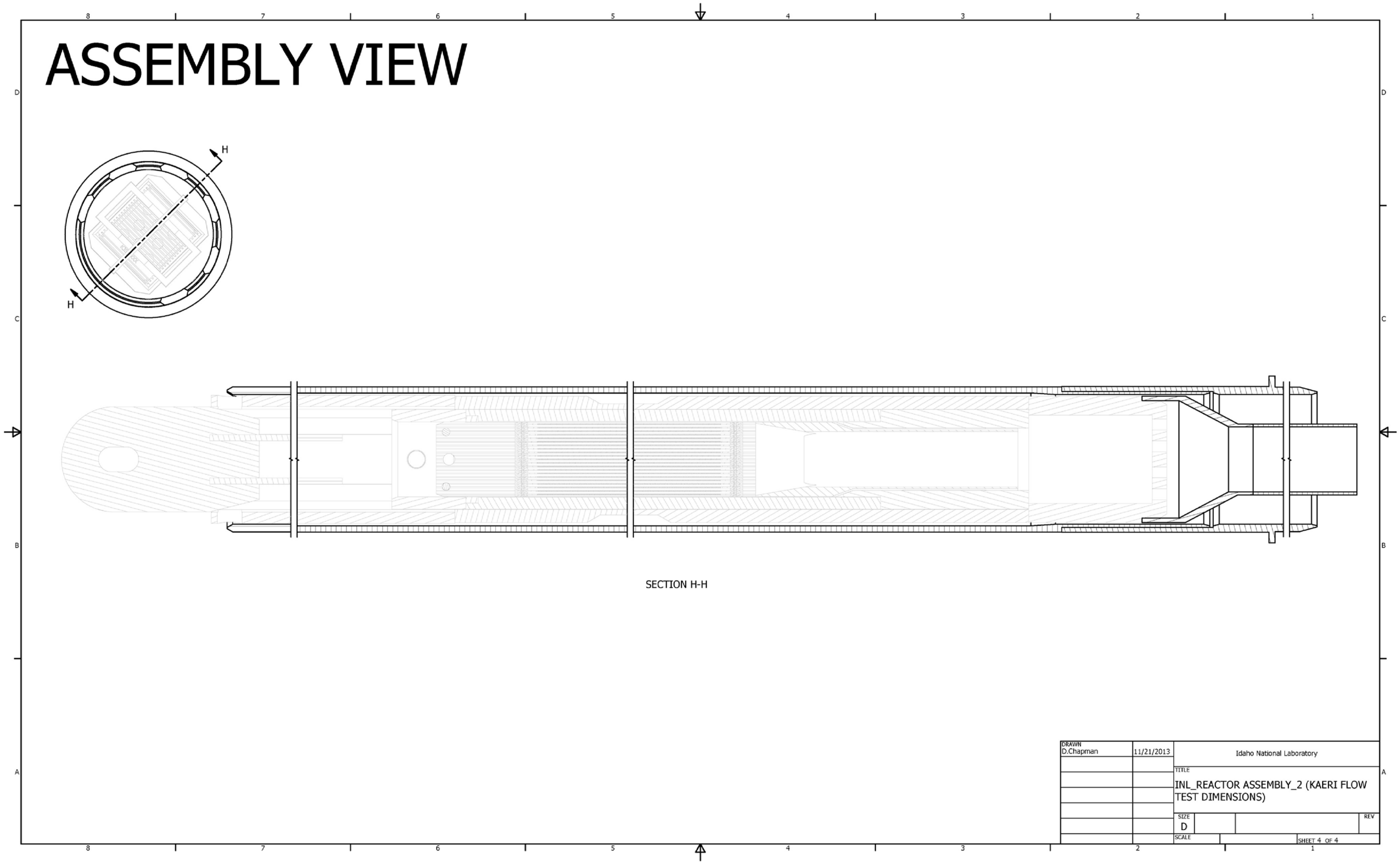

ASSEMBLY VIEW
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D.Chapman
11/21/2013
Idaho National Laboratory
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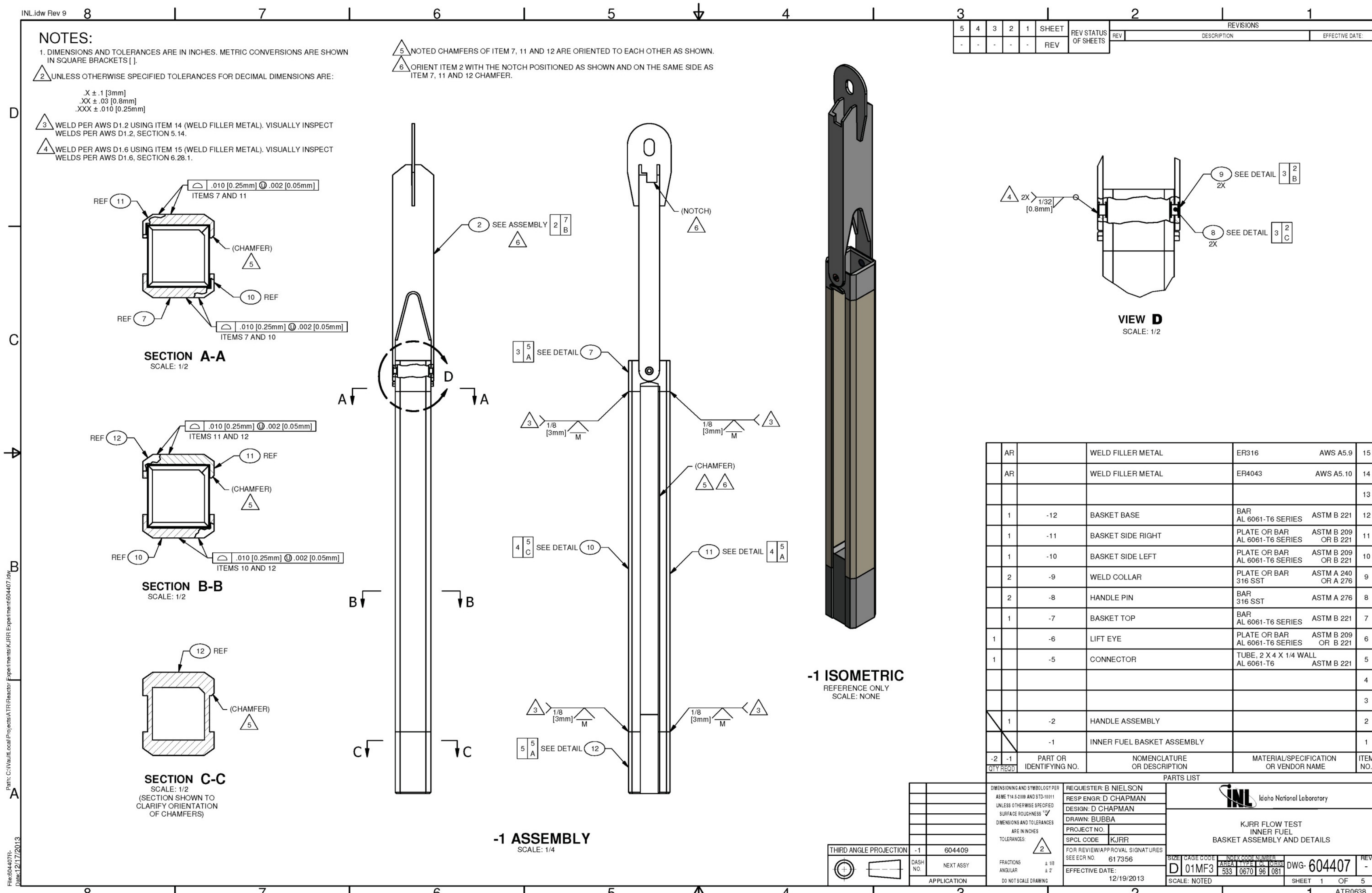

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1		-6	LIFT EYE	PLATE OR BAR AL 6061-T6 SERIES ASTM B 209 OR B 221	6
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					4
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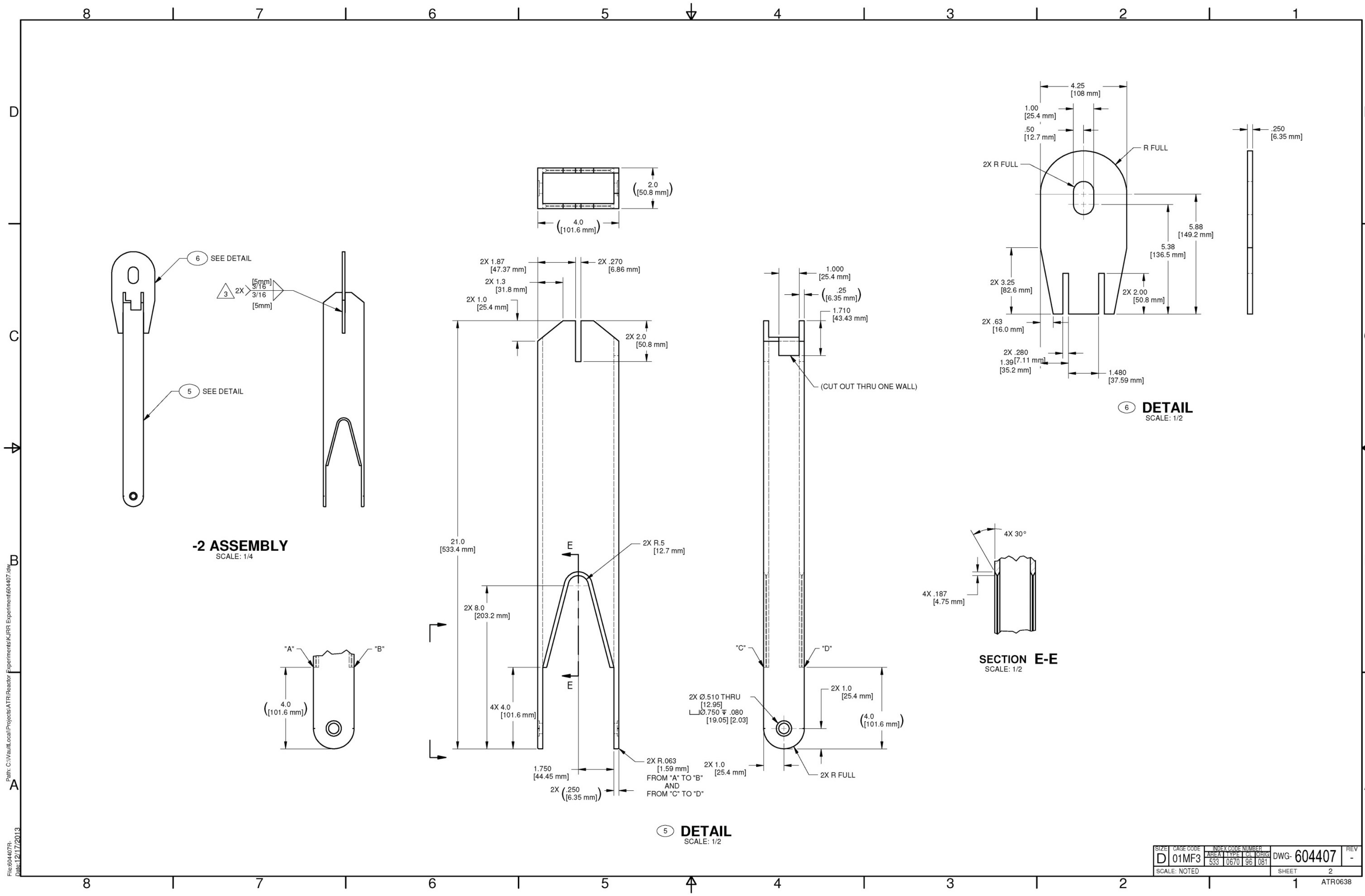
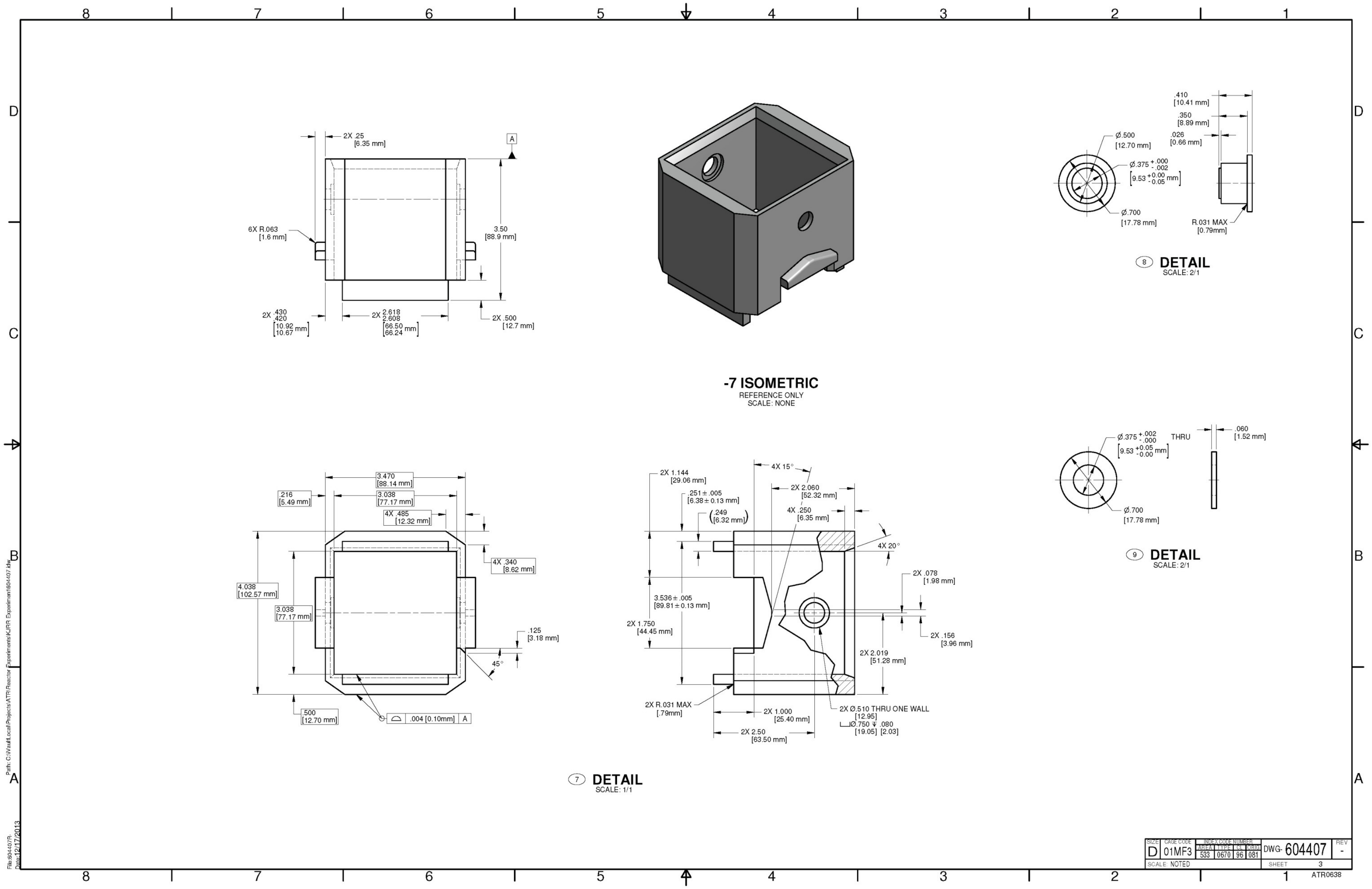
Appendix B (Irradiation Hardware Design for Flow Testing)

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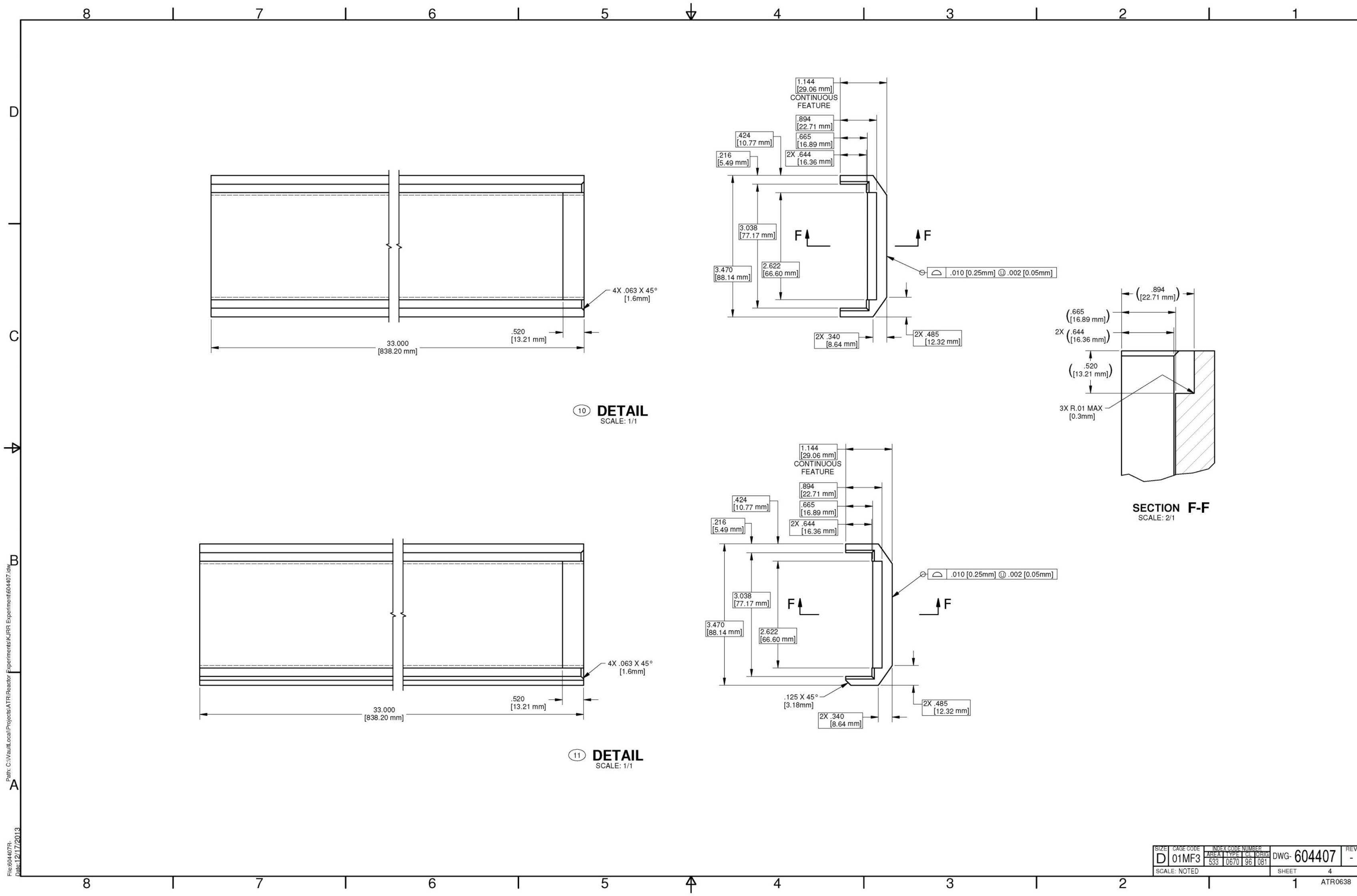
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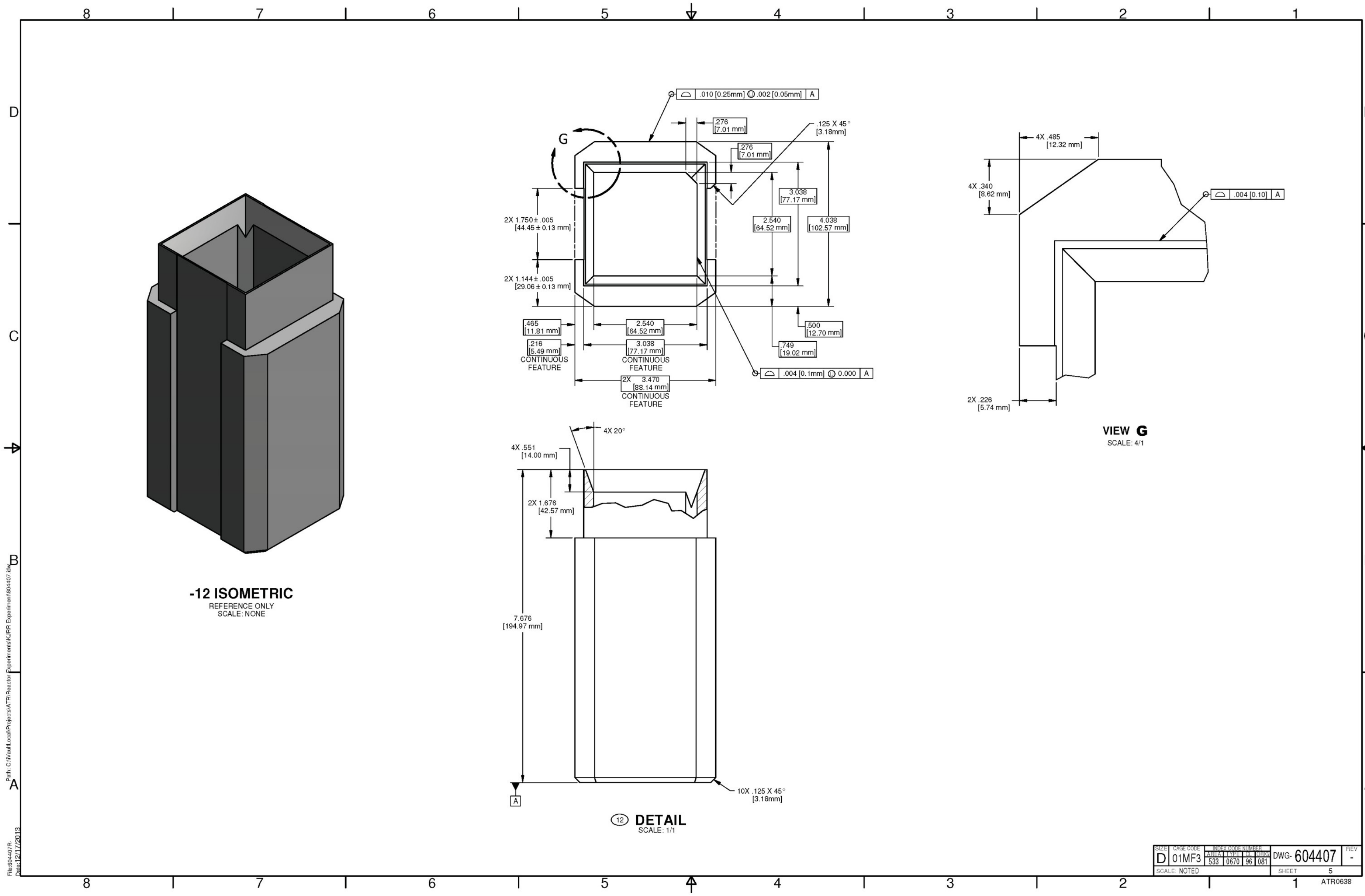
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INL.idw Rev 9

NOTES:

1. UNLESS OTHERWISE SPEDIFIED, DIMENSIONS AND TOLERANCES ARE IN INCHES WITH METRIC CONVERSIONS SHOWN IN SQUARE BRACKETS [ ].
2. UNLESS OTHERWISE SPECIFIED, TOLERANCES FOR DECIMAL DIMENSIONS ARE:

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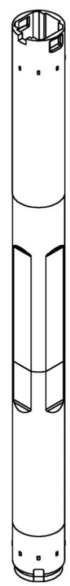

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									19

PARTS LIST

-6	-5	-4	-3	-2	-1	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL/SPECIFICATION OR VENDOR NAME	ITEM NO.
1						-18	Ø.550 ORIFICE PLATE	BAR OR PLATE AL 6061-T6 SERIES ASTM B209 OR B221	18
	1					-17	Ø.500 ORIFICE PLATE	BAR OR PLATE AL 6061-T6 SERIES ASTM B209 OR B221	17
		1				-16	Ø.450 ORIFICE PLATE	BAR OR PLATE AL 6061-T6 SERIES ASTM B209 OR B221	16
			1			-15	Ø.400 ORIFICE PLATE	BAR OR PLATE AL 6061-T6 SERIES ASTM B209 OR B221	15
				1		-14	Ø.350 ORIFICE PLATE	BAR OR PLATE AL 6061-T6 SERIES ASTM B209 OR B221	14
					1	-13	BLANK PLATE	BAR OR PLATE AL 6061-T6 SERIES ASTM B209 OR B221	13
1	1	1	1	1	1	-12	OUTER BASKET LOWER BODY	BAR AL 6061-T6 SERIES ASTM B211 OR B221	12
1	1	1	1	1	1	-11	OUTER BASKET UPPER BODY	BAR AL 6061-T6 SERIES ASTM B211 OR B221	11
1	1	1	1	1	1	-10	OUTER BASKET BASE	BAR AL 6061-T6 SERIES ASTM B211 OR B221	10
1	1	1	1	1	1	-9	OUTER BASKET TOP	BAR AL 6061-T6 SERIES ASTM B211 OR B221	9
									8
									7
						-6	OUTER BASKET WITH Ø.550 ORIFICE PLATE ASSEMBLY		6
						-5	OUTER BASKET WITH Ø.500 ORIFICE PLATE ASSEMBLY		5
						-4	OUTER BASKET WITH Ø.450 ORIFICE PLATE ASSEMBLY		4
						-3	OUTER BASKET WITH Ø.400 ORIFICE PLATE ASSEMBLY		3
						-2	OUTER BASKET WITH Ø.350 ORIFICE PLATE ASSEMBLY		2
						-1	OUTER BASKET WITH BLANK PLATE ASSEMBLY		1

SHEET	6	5	4	3	2	1
REV	-	-	-	-	-	-

REV STATUS OF SHEETS

REVISIONS

REV	DESCRIPTION	EFFECTIVE DATE

APPLICATION

DASH NO.	NEXT ASSY
-6	604409
-5	604409
-4	604409
-3	604409
-2	604409
-1	604409

THIRD ANGLE PROJECTION

DIMENSIONING AND SYMBOLOGY PER ASME Y14.5-2009 AND STD-10011. UNLESS OTHERWISE SPECIFIED SURFACE ROUGHNESS 125. DIMENSIONS AND TOLERANCES ARE IN INCHES. TOLERANCES: 2. FRACTIONS ± 1/8. ANGULAR ± 2°. DO NOT SCALE DRAWING

REQUESTER: B NIELSON
RESP ENGR: D CHAPMAN
DESIGN: D CHAPMAN
DRAWN: BUBBA
PROJECT NO.:
SPCL CODE: KJRR
FOR REVIEW/APPROVAL SIGNATURES SEE ECR NO. 617356
EFFECTIVE DATE: 12/19/2013

INL Idaho National Laboratory

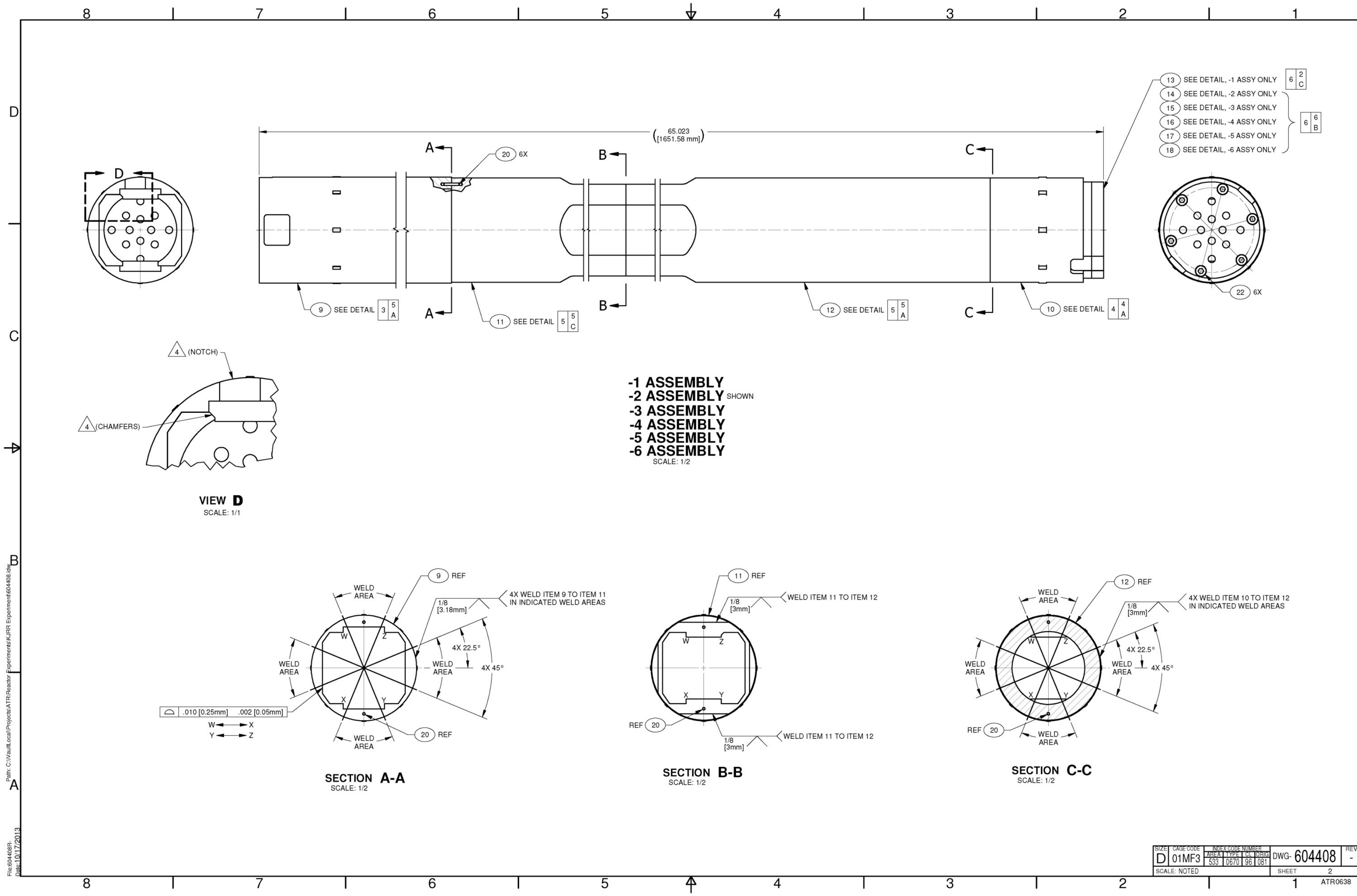
KJRR FLOW TEST
OUTER BASKET
ASSEMBLIES AND DETAILS

SIZE D | CAGE CODE 01MF3 | INDEX CODE NUMBER: AREA 533, TYPE 0670, CL 96, DRAW 081 | DWG- 604408 | REV -
SCALE: 1/2 | SHEET 1 OF 6

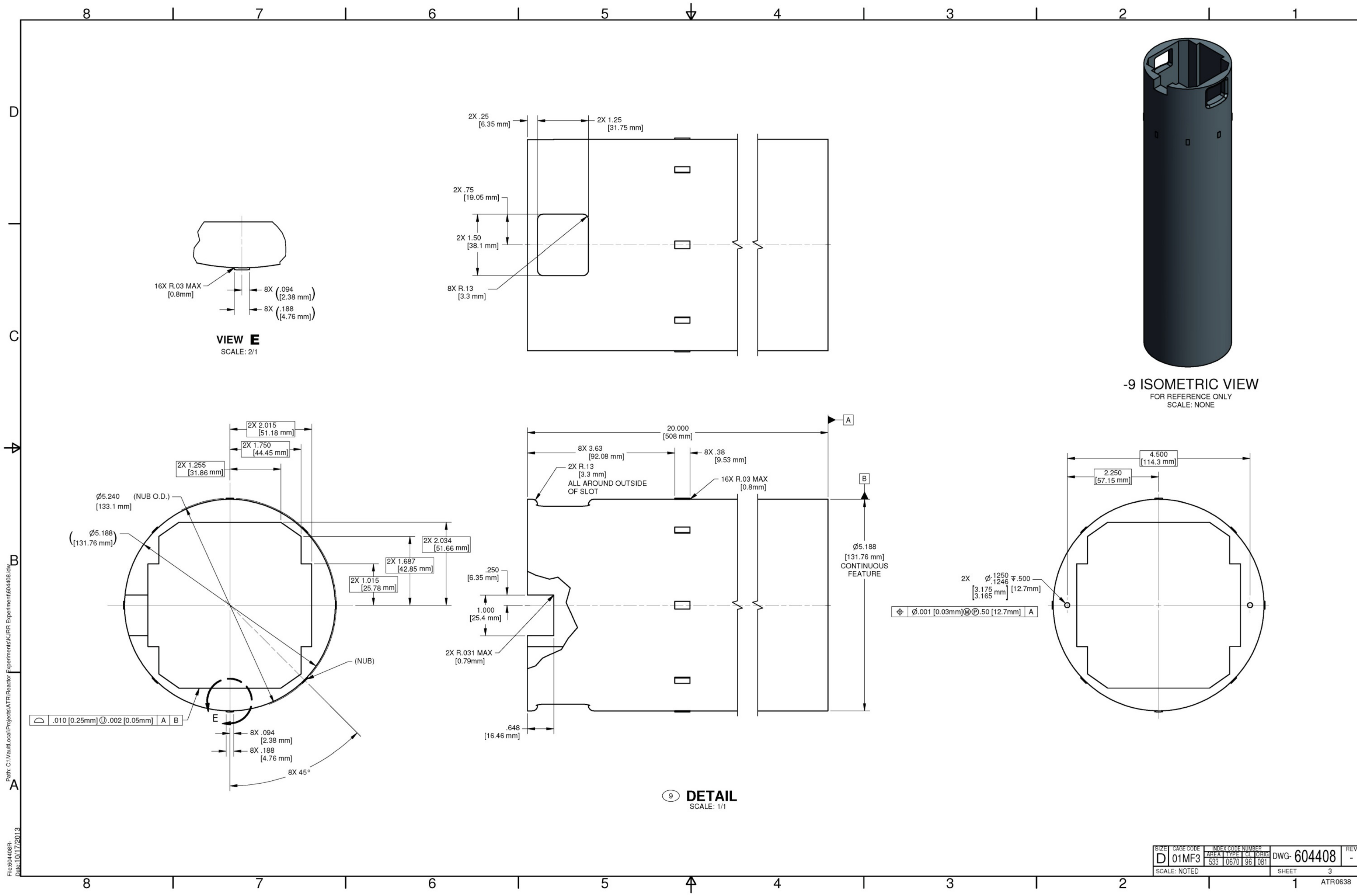
ATR0638

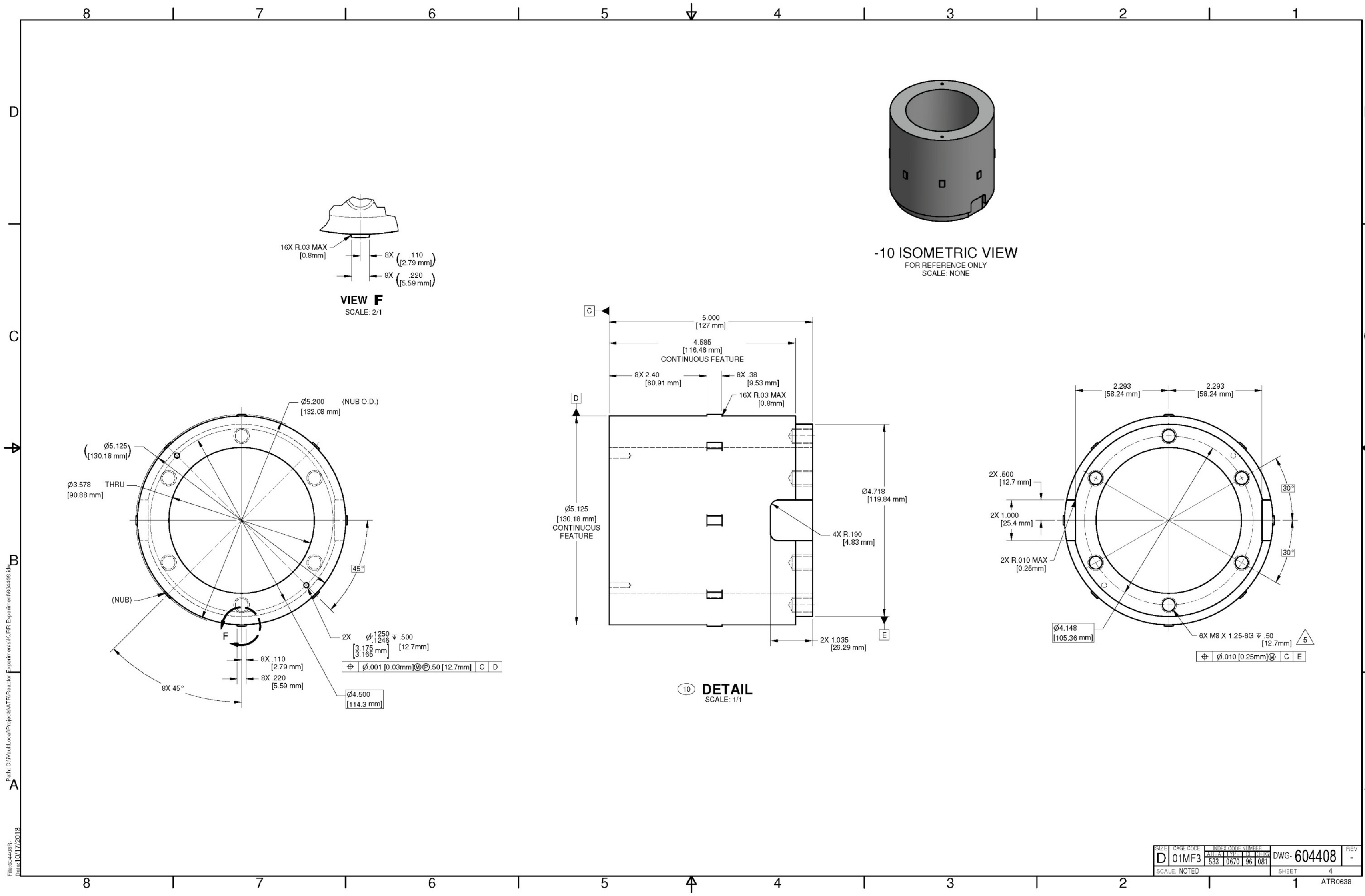
Path: C:\VaultLocal\Projects\ATR\Reactor Experiments\KJRR Experiment\604408.idw

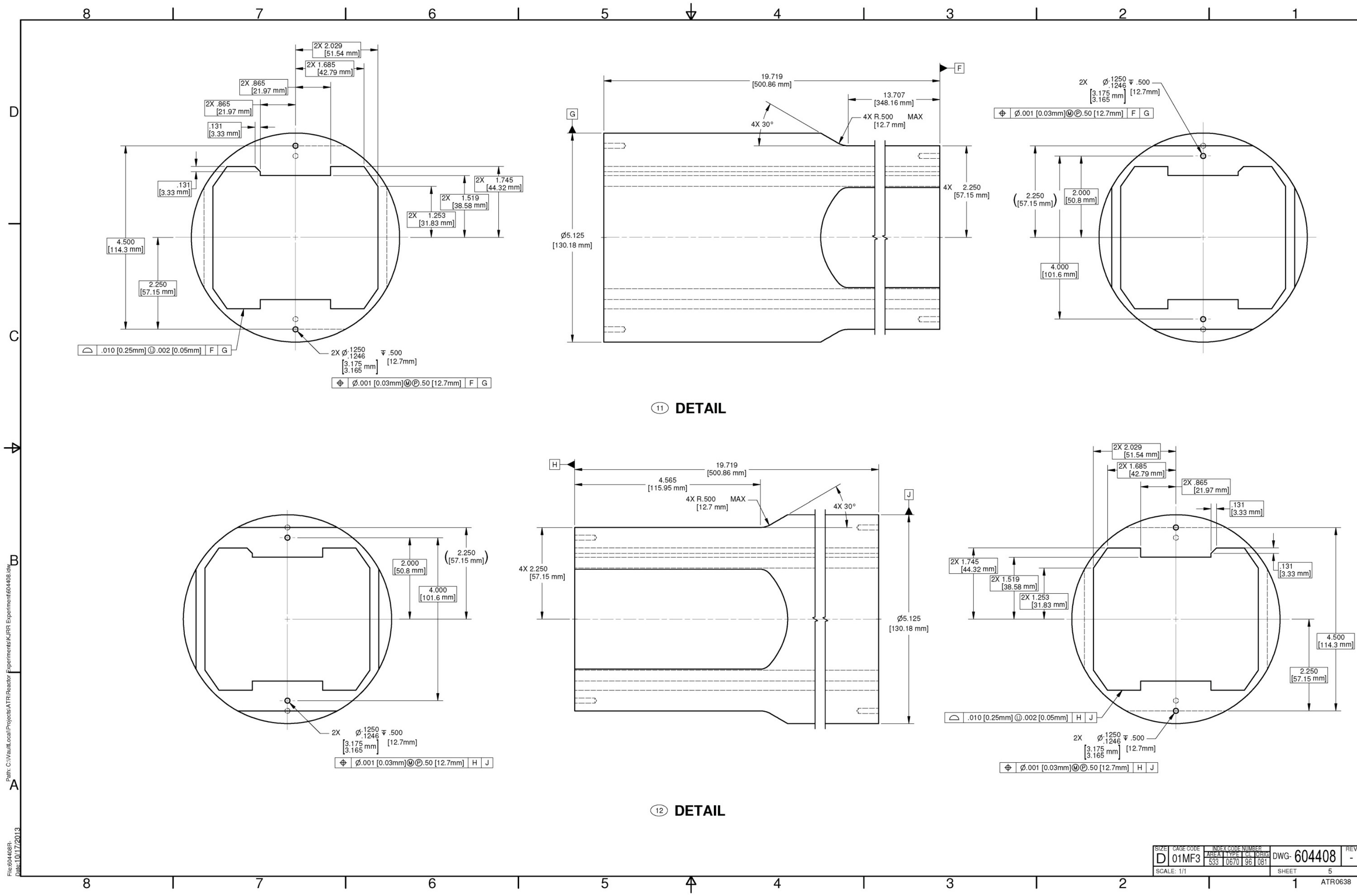
File:604408R-
Date:10/17/2013



65.023 [1651.58 mm]
13 SEE DETAIL, -1 ASSY ONLY
14 SEE DETAIL, -2 ASSY ONLY
15 SEE DETAIL, -3 ASSY ONLY
16 SEE DETAIL, -4 ASSY ONLY
17 SEE DETAIL, -5 ASSY ONLY
18 SEE DETAIL, -6 ASSY ONLY
20 6X
22 6X
9 SEE DETAIL
11 SEE DETAIL
12 SEE DETAIL
10 SEE DETAIL
4 (NOTCH)
4 (CHAMFERS)
VIEW D
SCALE: 1/1
-1 ASSEMBLY
-2 ASSEMBLY SHOWN
-3 ASSEMBLY
-4 ASSEMBLY
-5 ASSEMBLY
-6 ASSEMBLY
SCALE: 1/2
9 REF
4X WELD ITEM 9 TO ITEM 11 IN INDICATED WELD AREAS
1/8 [3.18mm]
WELD AREA
4X 22.5°
4X 45°
.010 [0.25mm] .002 [0.05mm]
W X
Y Z
20 REF
SECTION A-A
SCALE: 1/2
11 REF
WELD ITEM 11 TO ITEM 12
1/8 [3mm]
REF 20
SECTION B-B
SCALE: 1/2
12 REF
4X WELD ITEM 10 TO ITEM 12 IN INDICATED WELD AREAS
SECTION C-C
SCALE: 1/2
SIZE D
CAGE CODE 01MF3
INDEX CODE NUMBER AREA 533 TYPE 0670 C.L. 96 DISC 081
DWG- 604408
REV -
SCALE: NOTED
SHEET 2
ATR0638
File:604408R-
Date:10/17/2013
Path: C:\VaultLocal\Projects\ATR\Reactor Experiments\KJRR Experiment\604408.idw


VIEW E
SCALE: 2/1
16X R.03 MAX [0.8mm]
8X (.094 [2.38 mm])
8X (.188 [4.76 mm])
2X .25 [6.35 mm]
2X 1.25 [31.75 mm]
2X .75 [19.05 mm]
2X 1.50 [38.1 mm]
8X R.13 [3.3 mm]
-9 ISOMETRIC VIEW
FOR REFERENCE ONLY
SCALE: NONE
2X 2.015 [51.18 mm]
2X 1.750 [44.45 mm]
2X 1.255 [31.86 mm]
Ø5.240 (NUB O.D.) [133.1 mm]
(Ø5.188 [131.76 mm])
2X 2.034 [51.66 mm]
2X 1.687 [42.85 mm]
2X 1.015 [25.78 mm]
(NUB)
.010 [0.25mm] .002 [0.05mm] A B
E
8X .094 [2.38 mm]
8X .188 [4.76 mm]
8X 45°
20.000 [508 mm]
A
8X 3.63 [92.08 mm]
8X .38 [9.53 mm]
2X R.13 [3.3 mm] ALL AROUND OUTSIDE OF SLOT
16X R.03 MAX [0.8mm]
B
Ø5.188 [131.76 mm] CONTINUOUS FEATURE
.250 [6.35 mm]
1.000 [25.4 mm]
2X R.031 MAX [0.79mm]
.648 [16.46 mm]
9 DETAIL
SCALE: 1/1
4.500 [114.3 mm]
2.250 [57.15 mm]
2X Ø.1250 .1246 ↧.500 [3.175 mm 3.165] [12.7mm]
Ø.001 [0.03mm] Ⓜ Ⓟ .50 [12.7mm] A
SIZE D
CAGE CODE 01MF3
INDEX CODE NUMBER
AREA 533
TYPE 0670
CL 96
DRWR 081
DWG- 604408
REV -
SCALE: NOTED
SHEET 3
ATR0638
File:604408R-
Date:10/17/2013
Path: C:\VaultLocal\Projects\ATR\Reactor Experiments\KJRR Experiment\604408.idw


16X R.03 MAX
[0.8mm]
8X .110 [2.79 mm]
8X .220 [5.59 mm]
VIEW F
SCALE: 2/1
-10 ISOMETRIC VIEW
FOR REFERENCE ONLY
SCALE: NONE
Ø5.200 (NUB O.D.)
[132.08 mm]
Ø5.125
[130.18 mm]
Ø3.578 THRU
[90.88 mm]
(NUB)
45°
F
2X Ø.1250/.1246 ↧ .500
[3.175/3.165 mm] [12.7mm]
Ø.001 [0.03mm] Ⓜ Ⓟ .50 [12.7mm] C D
8X .110
[2.79 mm]
8X .220
[5.59 mm]
8X 45°
Ø4.500
[114.3 mm]
5.000
[127 mm]
4.585
[116.46 mm]
CONTINUOUS FEATURE
8X 2.40
[60.91 mm]
8X .38
[9.53 mm]
16X R.03 MAX
[0.8mm]
Ø5.125
[130.18 mm]
CONTINUOUS
FEATURE
Ø4.718
[119.84 mm]
4X R.190
[4.83 mm]
2X 1.035
[26.29 mm]
10 DETAIL
SCALE: 1/1
2.293
[58.24 mm]
2.293
[58.24 mm]
2X .500
[12.7 mm]
2X 1.000
[25.4 mm]
2X R.010 MAX
[0.25mm]
30°
30°
Ø4.148
[105.36 mm]
6X M8 X 1.25-6G ↧ .50
[12.7mm]
5
Ø.010 [0.25mm] Ⓜ C E
SIZE D
CAGE CODE 01MF3
INDEX CODE NUMBER 533 0670 96 081
DWG- 604408
REV -
SCALE NOTED
SHEET 4
ATR0638
Date:10/17/2013



11 DETAIL
12 DETAIL
2X 2.029 [51.54 mm]
2X 1.685 [42.79 mm]
2X .865 [21.97 mm]
.131 [3.33 mm]
4.500 [114.3 mm]
2.250 [57.15 mm]
2X 1.745 [44.32 mm]
2X 1.519 [38.58 mm]
2X 1.253 [31.83 mm]
19.719 [500.86 mm]
13.707 [348.16 mm]
4X R.500 MAX [12.7 mm]
4X 30°
Ø5.125 [130.18 mm]
4X 2.250 [57.15 mm]
4.565 [115.95 mm]
2.000 [50.8 mm]
4.000 [101.6 mm]
2X Ø.1250 .1246 ↧ .500 [3.175 3.165 mm] [12.7mm]
.010 [0.25mm] Ⓤ .002 [0.05mm] F G
.010 [0.25mm] Ⓤ .002 [0.05mm] H J
Ø.001 [0.03mm]Ⓜ️Ⓟ.50 [12.7mm] F G
Ø.001 [0.03mm]Ⓜ️Ⓟ.50 [12.7mm] H J
SIZE D CAGE CODE 01MF3 INDEX CODE NUMBER AREA 533 TYPE 0670 CL 96 DRWG 081 DWG- 604408 REV -
SCALE: 1/1 SHEET 5
ATR0638
File:604408R- Date:10/17/2013
Path: C:\VaultLocal\Projects\ATR\Reactor Experiments\KJRR Experiment\604408.idw

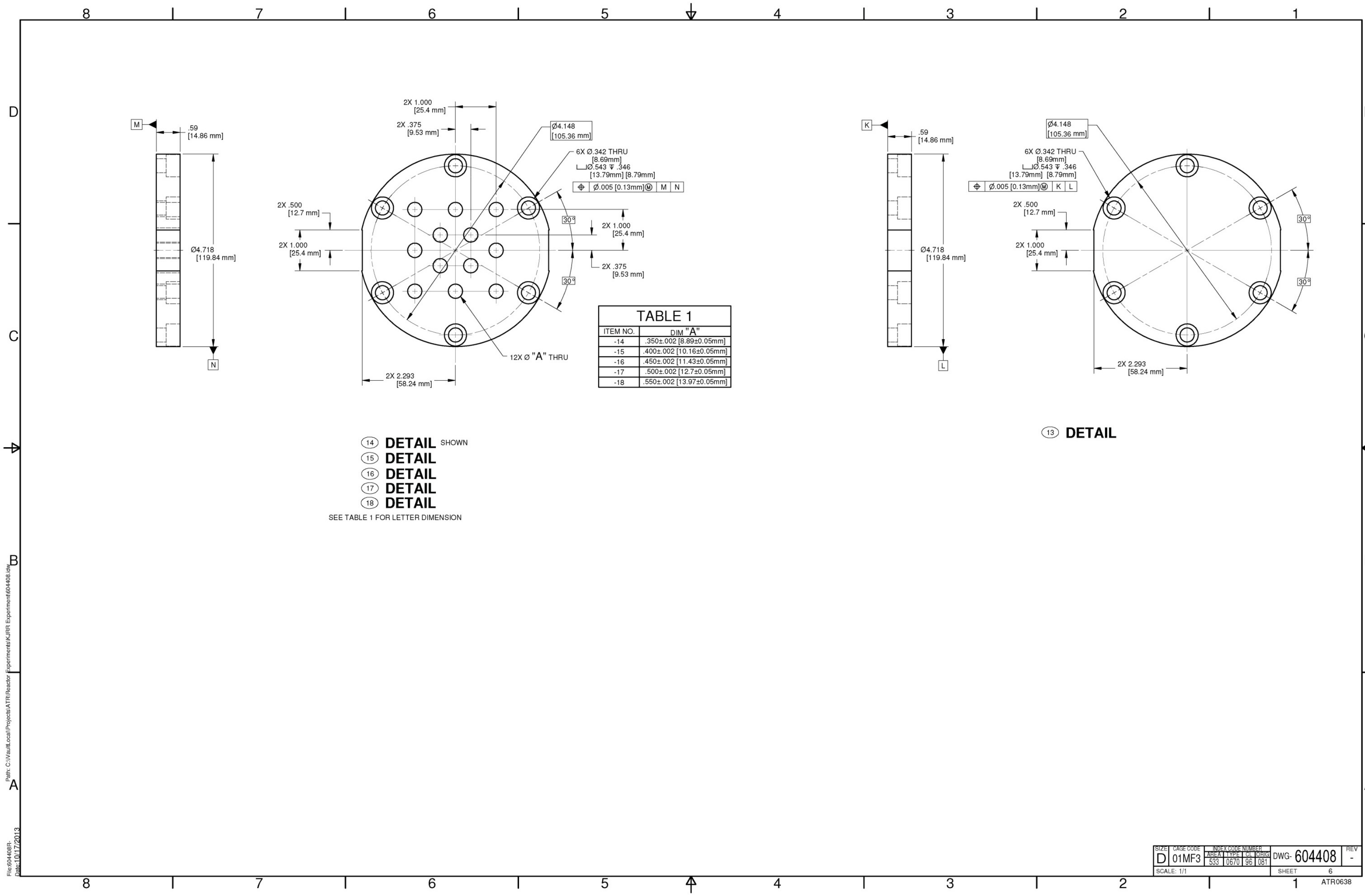


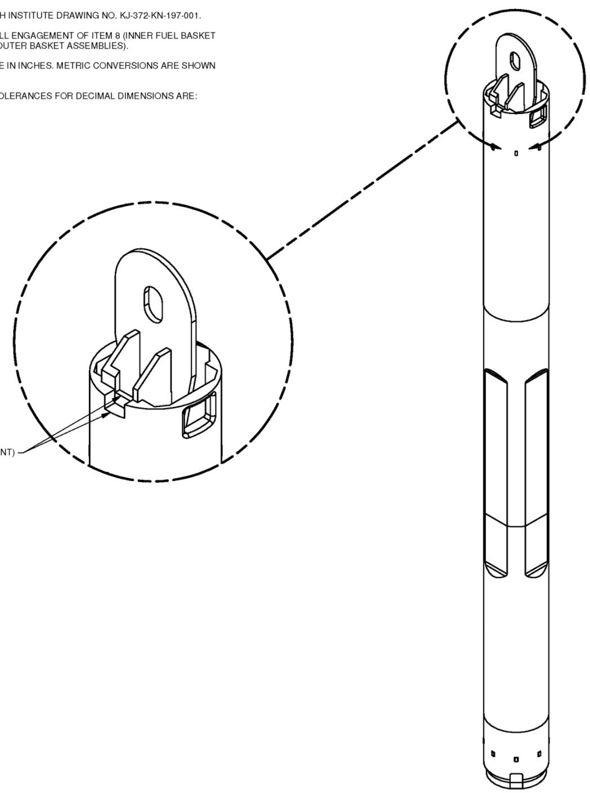
TABLE 1

ITEM NO.	DIM "A"
-14	.350±.002 [8.89±0.05mm]
-15	.400±.002 [10.16±0.05mm]
-16	.450±.002 [11.43±0.05mm]
-17	.500±.002 [12.7±0.05mm]
-18	.550±.002 [13.97±0.05mm]

NOTES:

1. KOREA ATOMIC ENERGY RESEARCH INSTITUTE DRAWING NO. KJ-372-KN-197-001.
2. THIS DIMENSION ENSURES THE FULL ENGAGEMENT OF ITEM 8 (INNER FUEL BASKET ASSEMBLY) TO ITEMS 9 THRU 14 (OUTER BASKET ASSEMBLIES).
3. DIMENSIONS AND TOLERANCES ARE IN INCHES. METRIC CONVERSIONS ARE SHOWN IN SQUARE BRACKETS [ ].
4. UNLESS OTHERWISE SPECIFIED TOLERANCES FOR DECIMAL DIMENSIONS ARE:

.X ± .1 [3mm]
.XX ± .03 [0.8mm]
.XXX ± .010 [0.25mm]



-1 THRU -6 ISOMETRIC VIEW

SCALE: NONE

REV	DESCRIPTION	EFFECTIVE DATE

SHEET	2	1
REV	-	-

REV STATUS OF SHEETS

PARTS LIST

-6	-5	-4	-3	-2	-1	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL/SPECIFICATION OR VENDOR NAME	ITEM NO.
1	1	1	1	1	1	1	STANDARD FUEL ASSEMBLY		15
1						604408-6	OUTER BASKET WITH Ø.550 ORIFICE PLATE ASSEMBLY		14
	1					604408-5	OUTER BASKET WITH Ø.500 ORIFICE PLATE ASSEMBLY		13
		1				604408-4	OUTER BASKET WITH Ø.450 ORIFICE PLATE ASSSEMBLY		12
			1			604408-3	OUTER BASKET WITH Ø.400 ORIFICE PLATE ASSEMBLY		11
				1		604408-2	OUTER BASKET WITH Ø.350 ORIFICE PLATE ASSEMBLY		10
					1	604408-1	OUTER BASKET WITH BLANK PLATE ASSEMBLY		9
1	1	1	1	1	1	604407-1	INNER FUEL BASKET ASSEMBLY		8
									7
						-6	FLOW TEST Ø.550 ORIFICE PLATE BASKET ASSEMBLY		6
						-5	FLOW TEST Ø.500 ORIFICE PLATE BASKET ASSEMBLY		5
						-4	FLOW TEST Ø.450 ORIFICE PLATE BASKET ASSEMBLY		4
						-3	FLOW TEST Ø.400 ORIFICE PLATE BASKET ASSEMBLY		3
						-2	FLOW TEST Ø.350 ORIFICE PLATE BASKET ASSEMBLY		2
						-1	FLOW TEST BLANK PLATE BASKET ASSEMBLY		1

QTY REQD

DASH NO.	NEXT ASSY	
-6	FINAL	
-5	FINAL	
-4	FINAL	
-3	FINAL	
-2	FINAL	
-1	FINAL	

APPLICATION

THIRD ANGLE PROJECTION

DIMENSIONING AND SYMBOLOGY PER ASME Y14.5-2009 AND STD-10011
UNLESS OTHERWISE SPECIFIED SURFACE ROUGHNESS
DIMENSIONS AND TOLERANCES ARE IN INCHES
TOLERANCES: 4
FRACTIONS ± 1/8
ANGULAR ± 2°
DO NOT SCALE DRAWING

REQUESTER: B NIELSON
RESP ENGR: D CHAPMAN
DESIGN: D CHAPMAN
DRAWN: BUBBA
PROJECT NO.:
SPCL CODE: KJRR
FOR REVIEW/APPROVAL SIGNATURES SEE ECR NO. 617356
EFFECTIVE DATE: 12/19/2013

Idaho National Laboratory

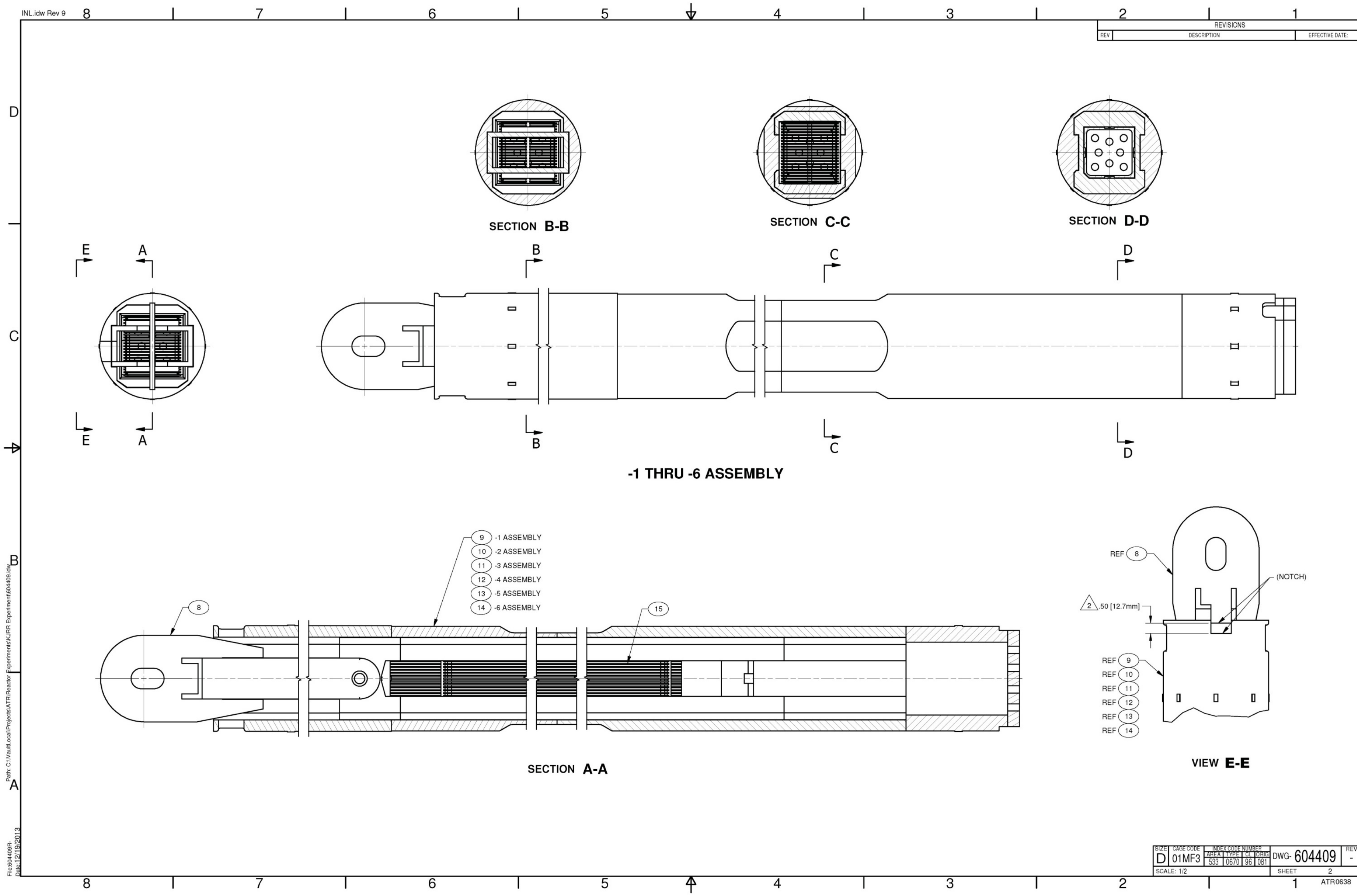
KJRR FLOW TEST BASKET ASSEMBLIES

SIZE: D | CAGE CODE: 01MF3 | INDEX CODE NUMBER: AREA 533, TYPE 0670, CL 96, DRGN 081 | DWG- 604409 | REV -

SCALE: NOTED | SHEET 1 OF 2

ATR0638

File:604409R-
Date:12/19/2013
Path: C:\VaultLocal\Projects\ATR\Reactor Experiments\KJRR Experiment\604409.idw


INL.idw Rev 9
REVISIONS
REV
DESCRIPTION
EFFECTIVE DATE:
SECTION B-B
SECTION C-C
SECTION D-D
-1 THRU -6 ASSEMBLY
9 -1 ASSEMBLY
10 -2 ASSEMBLY
11 -3 ASSEMBLY
12 -4 ASSEMBLY
13 -5 ASSEMBLY
14 -6 ASSEMBLY
SECTION A-A
REF 8
(NOTCH)
2 .50 [12.7mm]
REF 9
REF 10
REF 11
REF 12
REF 13
REF 14
VIEW E-E
SIZE D
CAGE CODE 01MF3
INDEX CODE NUMBER
AREA 533 TYPE 0670 CL 96 DRW 081
DWG- 604409
REV -
SCALE: 1/2
SHEET 2
ATR0638
File:604409R-
Date:12/19/2013
Path: C:\VaultLocal\Projects\ATR\Reactor Experiments\KJRR Experiment\604409.idw