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Characterization of the 309 Fuel Examination Facility

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Abstract: This document identifies radiological, chemical and physical conditions inside the Fuel Examination Facility. It is located inside the Plutonium Recycle Test Reactor containment structure (309 Building.) The facility was a hot cell used for examination of PRTR fuel and equipment during the 1960's. Located inside the cell is a PRTR shim rod assembly, reported are radiological conditions of the sample. The conditions were assessed as part of overall 309 Building transition.

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CHARACTERISTICS OF THE 309 FUEL EXAMINATION FACILITY

EXECUTIVE SUMMARY

The Fuel Examination Facility (FEF), located inside the Plutonium Recycle Test Reactor (PRTR) containment has been characterized in order to meet 309 Building needs for transition to the Environmental Restoration Contractor. The assessment concludes that the FEF is stable and does not appear to be changing. Additional stabilization work inside the FEF is not needed to meet facility transition requirements. Minor work is required in plugging a drain into B-Cell sump from FEF.

In a period of 10 to 20 years radiological conditions will allow for additional cleanout of the facility with low worker radiological exposure. The peak dose in the FEF is 6.7 R/hr from an activated PRTR shim rod assembly, which contains an estimated 0.9 Ci of Co⁶⁰. Dose from the 23.3 μ Ci total smearable contamination is negligible in comparison. The smearable content is 99.9% beta/gamma. Neutron counts inside the FEF are consistent with background, implying no transuranic (TRU) material. The shim rod assembly did have an estimated 48 pCi of smearable TRU.

Lead (est. 2,680 kg {5,910 lbs}) in the FEF is the only known regulated material. Lubricating oils in the fuel manipulator may also be regulated. Air quality in the cell was found to be near normal.

The FEF Cell remains essentially the same as when it was operational, except for some removed equipment. FEF equipment which was original on the containment floor and in the B-Cell have been removed. The main FEF control console outside the cell is completely removed. The periscope viewing equipment is gone. Ventilation equipment is no longer operable, external fans and ducting has been removed. Lighting equipment is intact, but is not powered. Cooling water sprays headers have no water supply, and the B-Cell sump pump has been removed. The fuel manipulator appears to be intact, as well as the water spray risers and the lighting banks. Mounted in the manipulator is a portion of a PRTR Shim Rod Assembly. Observations show the cell has a dried material on the floor. Among the equipment is the fuel manipulator and its associated cooling ducting. Also seen are portion of the wide angle viewer, and a small instrument package.

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APPENDIX B: Radiological Measurement Reports/Surveys/Analyses
APPENDIX C: Smearable Radiological Contamination Estimate
APPENDIX D: MSDS Sheets
APPENDIX E: 309 FEF Fuel Manipulation Machine CVI Excerpts

ABBREVIATIONS

CP	Cutie Pie (radiation instrument)
CVI	Certified Vendor Information
GM	Geiger-Mueller (detector tube)
FEF	Fuel Examination Facility
HEW	Hanford Engineer Works
MSDS	Material Safety Data Sheet
PRTR	Plutonium Recycle Test Reactor
RCT	Radiation Control Technician
RSR	Radiation Survey Report

CHARACTERISTICS OF THE 309 FUEL EXAMINATION FACILITY

1. INTRODUCTION

The 309 Building has been declared surplus and is in the transition process to surveillance and maintenance, pending ultimate decontamination and decommissioning. The transition process requires that existing conditions be identified and stabilization performed. Transition requirements are identified by the facility Transition requirements check sheets (WHC-SD-NEL-RD-001). The Fuel Examination Facility (FEF) characterization and stabilization needs are addressed by this document.

This report constitutes the final report on the status and condition of the FEF Cell. This report describes the results of the physical, radiological, and chemical characterization of the 309 FEF Cell. The purpose of the report is to document the present status of the FEF cell and its contained equipment. The characterization work is done to provide information to best protect workers, the environment, and provide information for use in future restoration, and cleanup work activities. The characterization work is primarily directed toward determining the Cell content and radiological and chemical conditions.

2. Characterization Process

The FEF characterization process includes: (1) background information search, (2) radiological characterization, (3) chemical characterization, (4) cell equipment identification and condition review, and (5) generate FEF Cell status report.

2.1. General Approach and Philosophy

The FEF background information search included a review of 309 drawings, published reports, manuals, construction specifications, radiological survey reports, and certified vendor information.

The radiological conditions in the FEF are determined by monitoring radiation dose rates, gaseous and particulate contamination, smearable contamination levels, and neutron radiation. Dose rate measurements provide an indication of potential exposure and equipment radiological activation. Smearable contamination levels provide release potential information and radiological contamination stability. Neutron radiation measurement provide evidence of transuranics. Air samples quantify the particulate contamination directly available for release and for controlling personnel exposure.

The chemical characterization identifies hazardous materials and conditions for planning maned entries. For this reason, the cell atmosphere is monitored for oxygen, and visually examined for evidence of chemicals or oils.

A video search of the cell is made to identify equipment, assess structural conditions and look for chemical indications. Remote video equipment is used to record and monitor conditions. Video provides easy access for observation and isolation from radiation. A video survey establishes what equipment is installed and an indication of the physical condition/status of the cell and equipment. Pictures are easily obtained from video tape and can readily be include in reports.

2.2. Work Description

The FEF field work characterization procedures are given in Work Package 3B-96-00144. Process highlights and difficulties are presented below.

Access into the FEF may be achieved from the containment floor by removing plugs or cover blocks, and from the shield door in B-Cell at the -32 ft. level. Entry through a plug in the cover blocks was selected for the initial entry. This provided easy access and minimized radiological exposures potential.

The first step was to expose access plugs and attach rigging equipment. A layer of sheet metal was removed. The sheet metal provided protection to the painted floor when the containment was used as a shop. Next paint and a material resembling an epoxy grout were removed from around several access plugs. The plug drop anchors were exposed and cleaned. A radiological control area was then set up around the work area.

Cell entry was attempted through five separate plugs. The Fuel Access Plug (center plug) was pulled first, since it was the plug normal entry during operations. Full cell access was blocked by the fuel examination manipulator and a piece of equipment identified as a part of a PRTR Shim Rod Assembly. Attempts to lift plugs on either side of the fuel Access Plug were not successful. The Viewing Plug was then removed, providing a triangular access area which was open to the FEF floor. The accessible FEF area was bounded by the lighting fixture in each of the northern corners and the fuel handling machine mounted on the cell south wall. Sufficient access was provided, eliminating the need for entry at the -32 ft level.

Sampling was performed through the view plug opening. Radiological dose rate measurements were made at the opening and at 30.5 cm (one Ft.) increments. An air sample was obtained to determine airborne contamination. Air quality measurements were made for explosive gases and oxygen level. A remote operated video camera was used to observe and record conditions and equipment inside the cell. Smear samples were taken from representative surfaces and equipment in the cell. A six meter telescoping pole was used to reach down into the cell and take smears from equipment and walls. Floor samples were obtained from material on the protective sleeving placed around radiological instrumentation, which was scraped across the cell floor. A standard size smear was taken, read by the RCTs, and the results recorded. Smear samples were analyzed by the PNNL Analytical Chemistry Laboratory, located in the 325 building. Sampling and analysis result are located in Appendix B.

Following a review of the data the FEF was reentered and the radiological dose rate measurements at 30.5 cm increments repeated. The instrument used was not responding correctly to conditions above 800 mR/hr. While the FEF was open a neutron counter was also inserted and measurements taken at three levels. Neutron data were analyzed by PNNL NDA System personnel.

After all data was gathered the viewing plug was replaced. The temporary radiation area was surveyed and dismantled. The FEF was left in a state to easily access the view plug in the future.

3. CELL AND EQUIPMENT BACKGROUND

3.1. Facility History

The original 309 building mission was to provide an operating test reactor in the Hanford Engineer Works (HEW) Plutonium Fuels Utilization Program whose purpose was to research and develop nuclear fuel technology. This test reactor was known as the Plutonium Recycle Test Reactor (PRTR). A General Layout of the facility and its various features are shown in Figure 1.

In 1963, Fuel Element Rupture Test Facility, (hereafter called the Rupture Loop) operations began in one channel of the PRTR. The Rupture Loop itself was a pressurized, light-water-cooled loop within the main, heavy-water-cooled PRTR. The Rupture Loop was used as a pilot irradiation facility to test new fuel element designs and new operating regimes. Many of its tests involved pre-defecting fuel elements with pinhole breaks to study the stability of various pre-defected materials under irradiation. The FEF was used to examine fuel from the rupture loop as well as the PRTR.

Such Rupture Loop tests continued until a serious (Type A) operating accident occurred on September 29, 1965 (fuel rod failure). After the subsequent cleanup, the PRTR resumed critical experiments, known as the Batch Core Experiment. This experiment ran for only about half of its planned duration before a flaw was discovered in the P-4 valve (the main valve in the primary coolant inlet system). The PRTR was shut down in order to replace the valve in early 1969. The U.S. Atomic Energy Commission (AEC) decided not to refuel the PRTR. The PRTR was laid away in 1969 and subsequently decommissioned. By 1975 the PRTR had been deactivated, all fuel removed and the fuel storage basin decontaminated.

In the late 1970's, the ground floor level inside the PRTR containment dome was emptied and converted into a "clean shop" (i.e., one using no radioactive materials and no sodium) to fabricate sodium test loops used in the 324, 335 and 337 buildings. This conversion removed the fuel handling machine and FEF control equipment at the 0 Ft. level.

Figure 1. Fuel Examination Facility Location and Configuration

In 1986-87 a space technology development program known as SP-100 was assigned to the 309 Building. This program immediately undertook an extensive clean-out of the PRTR facilities in the building. The clean-out included removal of all PRTR process equipment from the containment floor, A, B, and C cells. Among the equipment removed were the FEF ventilation and cooling equipment and the B Cell sump pump equipment.

In 1991, the SP-100 program was placed on a 5-yr "hold," thus ceasing any further clean-out. The SP-100 program was terminated by DOE in November 1993, which has brought about the transition of the facility.

3.2. Fuel Examination Facility Description

The FEF cell was an experimental hot cell used to exam PRTR fuel and process tubes. The FEF functioned as a hot cell where personnel conducted remote manipulation of fuel elements or process tubes. The FEF was used for making observations, preliminary gamma scans, and other tests on irradiated and sometimes breached fuel. (Gerber, 1992) The type of fuel characteristics studied included: warpage, swelling, cladding anomalies, and other defects.

The FEF physical description and equipment are described below. The general layout and configuration is depicted in Figure 2 through 6. A more detailed FEF description, operation and maintenance requirements are found in the FEF Operating Manual (Kelly, 1961). The construction specification is HWS-6340.

3.2.1. Physical Description

The FEF Cell is located inside containment in the radial wall between B-Cell and A-Cell. A control console for the facility was located on the ground floor level of the containment dome (north side). Ventilation supply and exhaust equipment, process water connection, drain equipment and cell access were in B-Cell.

Air was normally for cooling sample, provided by the FEF heating and ventilation system. But, the cell also contained a vertical set of water spray riser units that served two purposes, back up cooling or cell decontamination and cell wash down. The cell contains a 10 cm (4 in.) floor drain, discharging into the B-Cell sump. In the B-Cell sump were a solenoid valve and pump, operated from the control console. This equipment removed waste water to the 309 Tank Farm hold-up tanks. The valve, pump and waste lines in B-Cell have been removed, waste lines capped, and the tank farm shut down.

The FEF Cell viewing and fuel handling equipment were operated from a Control Console. It sat between the containment north wall and FEF shielding blocks. The control console, periscope, fuel handling vehicle, and equipment protruding above the containment floor were removed during facility conversion to the sodium test loop fabrication shop. Portions of the periscopes may still be in the FEF. The control console and wiring into the FEF are removed. The connecting trench is empty, and portions filled with concrete.

Figure 2. Fuel Exam Facility Cover Block Arrangement

RG97020185.4

Figure 3. General Construction of Fuel Examination Facility

RG97020185.5

Figure 4. Fuel Examination Facility Access and Penetrations

Figure 5. Fuel Examination Facility Utilities and Lighting

RG97020185.7

Figure 6. Fuel Examination Facility Viewing and Manipulation Equipment

The cell is a 1.8 m by 1.2 m by 8.5 m (6 ft by 4 ft by 30 ft) structure with a stainless steel liner. The A-Cell side wall is constructed of 1.1 m (3.5 ft) heavy aggregate (high density) concrete (bulk density 4,325 kg/m³ (270 lbs/ft³.) The north and south walls are structural concrete. The B-Cell side wall is constructed of 0.56 m (22 in.) thick, tightly fitting, cast iron blocks (Meehanite). The overall cell is lined with 16 gauge stainless steel. The Cell is covered with three 0.6 m (24-inch) deep shielding plugs, which form portions of the containment floor. A 15 cm (6 in.) vertical steel plate is mounted in the top half of the FEF near the north wall, providing shielding for the periscope and optical viewing equipment.

Access into the cell is through ports, plugs and a door. In the shield plugs are eight 32 cm (12.75 in.) diameter access and equipment plugs. These plugs provided for sample insertion, cell viewing, and cell lighting. A manned entry into the bottom of the cell is provided through a heavy metallic bank vault type door located in B-Cell at the -32 ft level. Observation ports and access plugs are also available at various levels into the side of the cell. Characterization work performed was accomplished through the Sample Access Plug (fuel entry) and the Viewing Plug located in the containment floor (0 foot level).

3.2.2. Principal Equipment

Equipment used for the FEF included sample handling and viewing, and cell support equipment. Sample handling and observation was provided by two remote controlled periscopes, the fueling vehicle, and in cell manipulators. Support equipment included the ventilation and cooling system, two light fixtures, water cooling and decontamination, and liquid drain equipment.

Fuel Manipulator

The manipulator is essentially a 9.1 m (30 foot) long vertical lathe bed with two translatable carriages on each is a mounted a rotatable universal chuck. The manipulator is designed to handle 8.9 cm (3.5 in) cylindrical specimens weighing up to 137 Kg (300 lbs.) The only engineering drawings located for the fuel handling machine were: manipulator assembly, SK-3-1161.; Upper manipulator head SK-3-11509; lower manipulator head SK-3-11511 and SK-3-11508.

The manipulator heads were translated either up or down by electrically driven screws. A PRTR fuel assembly was 4.4 m (14 ft. 5 in.) long, the active core was 2.2 m (7-1/3 ft.) long, and a shim rod assembly is 7.7 m (15-1/2 ft) long. Shorter fuel rod lengths were also tested at PRTR, but longer lengths were undoubtedly rare and nothing in the 30 foot range would be expected. The vertical drive motor for the manipulator is listed as a 5 h.p., 3500 rpm, 240 volt D.C., General Electric totally enclosed, non-ventilated piece of equipment. (Additional information is in CVI file No. 15449, portions are in Appendix E.) The chuck motor is a variable 0.5 to 2.0 h.p. 1750 rpm, 72 volt D.C. motor. The equipment was connected to controls outside the cell and is not operational.

Ventilation and Cooling Equipment

There were two ventilation systems, a $0.12 \text{ m}^3/\text{s}$ (250 CFM) and a $0.68 \text{ m}^3/\text{s}$ (1500 CFM) System. The two supply fans and one exhaust fan were located in B-Cell. The smaller system used 4 inch Schedule 40 pipe, and the larger 25.4 cm (10 in.) inside diameter tubing. Ducting into the cell is at the -5.8 ft level. Inside the cell the ventilation systems supplied air through specially designed ducts attached to the fuel manipulator. The 250 CFM system provided axial cooling through the chuck. The 1500 CFM system provided cooling along the length of the sample. The 38 cm (15 in.) inside diameter exhaust duct intake was located in the north cell wall. After passing through a HEPA filter the exhaust entered the containment exhaust system. The B-Cell ventilation equipment has been removed.

In the event of a power failure, reduction of cooling airflow or specimen overheating during FEF operation, water spray cooling was available. The cooling air system was shut off and an automatic water spray rinse system was energized. Water jets were located inside the cell directing coolant onto the sample. The spray cooling was shut off if the water level in the cell reached the -8 ft. level.

Optical Equipment

Optical equipment used in the FEF included periscopes and a boroscope. Two optical periscopes, operated from the control console, were used for observation, measurement and photographing irradiated specimens. One periscope had a two headed wide angle viewer providing a 70° field view at the -2 ft 6 in level and the -19 ft level. The other periscope was dual purpose providing a 5X magnifier and a profilometer. The profilometer functioned at the -19 ft level. A boroscope was also used for viewing the inside of process tubes and disassembled elements. The boroscope operated through the fuel element loading plug. The optical equipment outside the cell is no longer present.

4. FEF CELL RADIOLOGICAL CONDITIONS

4.1. Radiation Dose Rates

Measured dose as a function of depth for the FEF Cell is given in Table 1. These values have been plotted and are shown in Figure 7. Note that the graph shows a sharp maximum dose rate value that corresponds to the location of the lower fuel handling chuck mechanism.

The FEF shield plug was effective in eliminating any appreciable dose rate with the FEF closed. A dose rate of 2 mR/hr was measured after the fuel Access Plug was removed in the first characterization attempt. However, hardware that prevented the access port from being useful, probably also kept the dose rate down to 2 mR/hr. Dose rates in the FEF were measured via the fuel Access Plug port. The dose rate values measured from the Access Plug port were later found to be inaccurate above 0.800 mR/hr. The instrument calibration was rechecked and measurements repeated through the view port.

A dose rate of 7 mR/hr was measured later when the Viewing Plug was removed. Dose rate values varied with depth up to a maximum of 6700 mR/hr. The depth of the maximum dose rate was about 12 feet. This is in the vicinity of the manipulator lower chuck and the shim rod assembly Inconel shims. Dose rate dropped sharply as the lower in the cell, to roughly 5 mR/hr at the bottom. The Cell has very little equipment in the lower half which probably explains the low dose. The Radiological Survey Reports are provided in Appendix B.

A PRTR shim rod assembly is the primary radiation source. Based upon the shim rod geometry, materials and radiation dose rate profile; the shim rod Co⁶⁰ source is estimated at 0.9 Ci. The shim rod assembly is the principal contributor to the FEF dose.

4.2. Smearable Contamination

Radioactive dose rate and contamination smear results show the FEF cell contamination to be fixed (almost non-smearable). Smearable contamination summaries are presented in Table 2. Samples were taken from the readily accessible surfaces in the FEF, and are representative of the vault conditions. The smears taken were standard 100 cm² samples. Radiation survey report and assay reports are located in Appendix B.

Radiological contamination smear results listed in Table 2 indicate the highest smear level to be 90,000 dpm. Typical Geiger Muller (GM) beta/gamma instruments used at Hanford exhibit about a 350,000 dpm reading for a 1 mR/hr Cutie Pie (CP) or RO-7 instrument reading. This means the highest smearable contamination reading is less than 0.3 mR/hr compared with the highest dose rate reading of 6,700 mR/hr. The radioactively contaminated material at the (-)12 foot level of the FEF cell is therefore primarily fixed, it is in an encapsulated form, or not readily accessible.

Table 1. FEF Cell Dose Rate Readings

Depth Meters (feet)	Cell Feature at Location	Dose Rate (mR/hr)	
		Low Range	High Range
0	Floor Level	5	--
0.31 (1)		14	--
0.61 (2)	Bottom of Cover Block	29	--
0.91 (3)	Upper end of PRTR Fuel Handling Chuck	50	--
1.22 (4)	Top of Upper Manipulator Spindle	85	100
1.52 (5)	Top of Upper Manipulator Chuck	160	200
1.83 (6)		325	400
2.13 (7)		570	700
2.44 (8)		1000	1200
2.74 (9)		--	2500
3.05 (10)		--	5000
3.35 (11)		--	6400
3.66 (12)		--	6700
3.96 (13)		--	4900
4.27 (14)		--	3200
4.57 (15)		1800	1800
4.88 (16)		900	800
5.18 (17)	Top of Lower Manipulator Chuck	480	400
5.49 (18)	Est. Position of Shim Rod End	270	300
5.79 (19)	Lowest Periscope Position	159	200
6.10 (20)		90	100
6.40 (21)		60	--
6.71 (22)		36	--
7.01 (23)		28	--
7.32 (24)		20	--
7.62 (25)		10	--
7.92 (26)		7	--
8.23 (27)		4	--
8.53 (28)		3	--
8.84 (29)		3	--
9.14 (30)		3	--
9.45 (31)		3	--
9.75 (32)	Bottom of Cell	5	--

[note: Measurements were made using an RO-7 Instrument ID no. ICEB2-0036 with a DTEB7-0030 low range (LR) probe (0 - 2R) and a DTEB7-0047 medium range (MR) probe (0 - 200R)]

Figure 7. Dose Rate Profile in FEF

The greatest source of contamination is the fuel manipulator lower chuck and the surrounding area. Analysis of the smears show high beta and Co^{60} which account in part for the sharp dose rate. Total alpha is comparatively low indicating little or no nuclear fuel residues.

The smearable contamination inventory is estimated at 23.3 μCi total for the FEF. The smearable content is 99.9% beta/gamma. Details for this estimate are presented in Appendix C. The inventory is based upon a surface area estimated and isotopic smear averages for horizontal and vertical surfaces. The surface areas are estimated because detailed component drawings were unavailable, from which exact dimensions could be obtained. Smear samples are expected to be representative of the FEF conditions.

The shim rod assembly, mounted in the manipulator, is the only item with Am^{241} . Am^{241} is a decay product of Pu^{241} which indicates a PRTR fuel presents. During PRTR operation the shim assembly was cooled with heavy water. Smearable contamination on the shim rod are comparable to those found in the reactor moderator system (Ref. HNF-SD-ER-008). Shim Rod estimates surface area is 11,400 cm^2 (1,771.40 in^2) which will yield the following isotopic estimates: Total Alpha, 7.65 nCi; Total Beta, 18.4 nCi; Co^{60} , 5.28 nCi; Cs^{137} , 13.8 nCi; Am^{241} , 3.15 nCi (For PRTR this is equivalent to 0.297 μg TRU;) Total Ci, 48.2 pCi.

4.3. Neutron Monitoring

Neutron probe measurements were taken to determine if appreciable PRTR reactor fuel is located in the FEF. A neutron probe was lowered into the FEF Cell and measurements were made just above the Cell, the top of the Cell -0.91 m (-3 ft.), -3.7 m (-12 ft.), and -5.5 m (-18 ft.). The measurements indicate the neutron count is consistent with background levels. The uncertainty of the measurement supports the claim that less than 0.5 of TRU can be present in the FEF. This number is conservative because of the potential multiple counting of neutrons due to a neutron cavity effect in the FEF. The sample report is located in Appendix B. No fuel was detected in the FEF.

Table 2. Radiological Sampling Summary

Sample Information		Field Radiation Survey Results		Laboratory Analysis Results. pCi/Sample (100 cm ² for smear)						
				(Note. Results below detection limit are not included see appendix for complete report.)						
Sample No.	Sample Location	Beta/Gamma (dpm)	Alpha (dpm)	Total Alpha	Total Beta	Co ⁶⁰	Cs ¹³⁷	Am ²⁴¹	Ag ^{108m}	Ba ¹³³
PRTR-FX-01	Floor #1 sample	4000	<20	2.88	867	1150	*	*	*	*
PRTR-FX-02	Floor #2 sample	200	<20	<0.9	352	449	7	*	*	*
PRTR-FX-03	Lower Manipulator Chuck (west side)	20,000	<20	60.7	17,700	33,100	153	*	*	120
PRTR-FX-04	Wall @ -15' (east side)	2000	<20	0.822	212	269	*	*	*	*
PRTR-FX-05	Bottom of east light bank (horizontal surface)	30,000	<20	28.7	12,600	16,200	*	*	*	*
PRTR-FX-06	Lower Manipulator Chuck (east side)	90,000	<20	55.9	24,000	34,900	*	*	*	*
PRTR-FX-07	Shim Rod inside Chuck	2000	<20	67.1	161	46.3	121	27.6	*	*
PRTR-FX-08	Upper Manipulator Chuck	15,000	<20	83.2	1970	3000	34.6	*	45.0	*
PRTR-FX-09	Wall @ -15' (west side)	2000	<20	0.546	186	254	*	*	*	*
PRTR-FX-10	Bottom of west light bank	600	<20	10.8	1570	2210	*	*	*	*
PRTR-FX-11	Air Sample	7,000	*	<0.5	9.77	6.26	*	*	*	*
PRTR-FX-12	Air Filter Charcoal Cartridge	1,000	*	*	*	*				

* Isotopes below detection limit.

5. CHEMICAL CHARACTERIZATION

5.1. Oxygen Monitoring

The FEF Cell has not been opened for approximately 25 years. Before entry there was concern that the oxygen level might have decreased, constituting a potential confined space issue. An oxygen monitor no. 9308101-049 using sampling pump no. 9309069-106, calibrated Feb. 4, 1997 was used to monitor the oxygen levels at 5 foot depth intervals on the 2/4/97. Table 3 shows the results, oxygen levels are normal or very nearly normal being 20.9% oxygen versus 20.9 to 21.0% for the reference level measurement.

Table 3. Oxygen Monitoring	
Depth/Location	Oxygen Monitoring Results (% Oxygen)
Outside Cell (Reference)	20.9 to 21.0
1.5 m (5 ft)	20.9
3.0 m (10 ft)	20.9
4.6 m (15 ft)	20.9
6.1 m (20 ft)	20.9
7.6 m (25 ft)	20.9
9.1 m (30 ft)	20.9

5.2. Regulated Materials

Materials in the cell which may be potentially regulated include the following.

- The FEF structure and components FEF contain an estimated 2,680 kg (5,910 lbs) of lead. See Table 4 for location details and quantities.
- During sampling there were indications of oily film on lower manipulator. A review of the operations manual and procurement specification provides information on two oils and a grease. A review of the available documentation did not indicate equipment listed nor observed as being hydraulic driven, therefore, no hydraulic oil is expected in the FEF.

There is an oil in upper gear box on the upper drive head and lower drive head fuel handling machine manipulator, the oil used is not stated in the operating manual.

A lubricant was routinely applied to manipulator guide rods. The lubricant is Nuclear Grade Radiation Resistant Grease #335 (NLGI #0 Grade) produced by Standard Oil of California 225 Bush Street San Francisco, CA.

Each air motor (Gardner-Denver,) spline connected to the chuck jaws, holds approximately 4 lbs of grease. The reference materials did not state what type of grease was used

- A small amount of penetrating type oil (Aerokroil) was added with a dropper to the seal plug seams to make it easier to remove the cell plug. The MSDS no. is 10231, residual material is not regulated. There might remain some residual oil on the Access Plug and the Viewing Plug. Oily rags and waste are regulated, but we did not generate any and would not expect there would be sufficient residual oil to generate any regulated waste in the future.
- Glyptal (MSDS no. 14680) paint on the nuts and bolts that one can see looking back up the cell towards the bottom of the upper chuck in Figure 16.
- There is also the Anti-Seize lubricant (MSDS no. 12828) residue on the seal plugs, but none of these (Aerokroil, Glyptal, or Anti-seize) should present any appreciable cleanup problems.

In cell FEF equipment is designed for decontamination with water, solvents (xylene or acetone) or acids (dilute nitric.) However, these materials are not expected to be present. If Water rinse was inadequate the solvents and acids in limited quantities could be used. (Ref. HW-70880 page 26)

5.3. Glyptal

A chemical condition was noticed when the cell was video taped. It was noted that the bolts and nuts were painted with a reddish colored material. Based upon prior experience with similar material the material is Glyptal insulating paint. Glyptal was used extensively in the 1960 and 1970's. The nuts, bolts, fittings, and similar items were painted with Glyptal to inhibit rust and prevent bolted joints from freezing, but, could be easily removed. The MSDS for Glyptal is 14680 (see Appendix D). Glyptal residues are not regulated. Glyptal product and coated rags are regulated due to volatile constituents. The removal of Glyptal treated bolts, nuts, or fittings should not result in the generation of a hazardous or mixed waste.

5.4. Anti-Seize

The Viewing Plug was very difficult to remove initially, requiring approximately 2 tons of force to remove a 660 lb plug. Rust, sand, and other foreign materials were found to be on the outside of the plug. Anti-Seize lubricant (MSDS No 12828) was applied to the outside of the plug to make it easier to remove in the future. The Anti-Seize lubricant residues are not regulated, but the product and rags are regulated similarly. No hazardous or mixed waste was generated in coating the View Plug with Anti-Seize lubricant.

Table 4. FEF Lead Inventory Estimate

Location	Component	Estimate Source Drawing/Zone	Material/quantity
Containment, 0 ft Level	Floor Plugs	H-3-11985/G9	Lead/ 501 Kg (1,106 lbs)
Fuel Examination Facility (FEF), Cell	1500 CFM Air Duct Adapter	H-3-13372, sheet 3/G10	Asbestos Gasket/131 cm ³ (8 in ³)
FEF, Cell	Corner Shields	H-3-11987/D10	Lead Wool/1,704 cm ³ (104 in ³)
FEF, Cell	Air Supply and Exhaust System	H-3-11975/F3,G4; H-3-11990/H2	Asbestos Cloth/574 cm ³ (35 in ³) (REMOVED)
FEF, Cell	Wide Angle Viewer	H-3-9100, sheet 1/B3; H-3-9100, sheet 4/C7	Lead/108 Kg (239 lbs)
FEF, Cell	250 CFM Air Duct Adapter	H-3-13384/E7	Asbestos Gasket/66 cm ³ (4 in ³) (REMOVED)
FEF,	Service Entry Plug	H-3-11985/D3	Lead/304 Kg (672 lbs)
FEF, Cover Block El 0'-0"	Viewing Plug	H-3-11981/B6; H-3-11979	Lead Glass/27,550 cm ³ (1,681 in ³)
FEF, Cover Block El 0'-0"	Viewing Plug	H-3-11981/B6; H-3-11979	Lead Wool/737 cm ³ (45 in ³)
FEF, Cover Blocks	Cover Block Plugs	H-3-11978, sheet 1/D4; H-3-11978, sheet 2	Lead/1,215 Kg (2,681 lbs)
FEF, Light Fixture	Light Fixture Plugs	H-3-11982, sheet 1/B2; H-3-11982, sheet 2/D2	Lead/550 Kg (1,214 lbs)
FEF, Wall Block El(-)26'-5"	Viewing Plug	H-3-11981/H6; H-3-11979	Lead Wool/672 cm ³ (41 in ³)
FEF, Wall Block El(-)26'-5"	Viewing Plug	H-3-11981/H6; H-3-11979	Lead Glass/24,840 cm ³ (1,516 in ³)
Total Estimated Lead			2,681 Kg (5,912 lbs)
Total Estimated Lead Wool			3,100 cm ³ (190 in ³)
Total Estimated Lead Glass			52,400 cm ³ (3,197 in ³)
Total Estimated Asbestos			none

6. FEF CELL VISUAL OBSERVATION

6.1. General Observations

The FEF is stable and in good condition. Equipment in the cell appears to be intact with little or no signs of deterioration. There is a PRTR shim rod assembly mounted in the fuel manipulation machine. A thin layer of dried material is on the FEF floor. A light coating of oil was observed on the fuel manipulator lower chuck. There is very little loose equipment found in the cell. There appears to be some equipment inside the shielded periscope area that was not identified. Appendix A contains pictures captured from the video tape and a reference listing of archived photographs.

The port hardware shows indications of rust spots, because of this the viewing plug was lightly coated with an Anti-Seize lubricant (MSDS 12828) before replacing the plug. The bottom section of the plug port was clean as shown in Appendix A Figure 1. As far as working space, the south end of the sample port has limited access due to the Fuel Manipulation Machine and Shim Rod Assembly, but otherwise is clear. Access through the viewing plug provides ready access to the FEF.

6.2. Fuel Manipulation Machine

The first piece of equipment visible in the cell from the view port is the fuel manipulation machine upper chuck. (See Appendix A Figures 2 through 10.) At present the upper chuck is just below the cell block at about the -5 foot level, with the lower chuck at the -16 foot level. A PRTR fuel core was 2.2 m (7-1/3) ft long, and a shim rod assembly is 7.7 m (15-1/2 ft) long. Shorter fuel rod lengths were also tested at PRTR, but longer lengths were undoubtedly rare and nothing in the 30 foot range would be expected.

The carriages are translated either up or down by electrically driven screws. The screw drive mechanism for the lower chuck of the fuel handling machine can be observed in Appendix A Figure 10. Hidden behind the center drive is another screw drive which is readily observed. The chuck jaws are spline-coupled to air motor drives shown in Appendix A Figure 10. (SK-3-11512 is an isometric drawing of the air motor.)

6.3. FEF Samples or Specimens

The FEF examination revealed that there was a piece of equipment mounted in the manipulator. Appendix A Figures 13 through Figure 18 show the specimen. People familiar with PRTR operations recognized it as a PRTR Shim Rod Assembly. Neutron monitor established that it was very unlikely there are any appreciable fuel material (fuel pieces) in the FEF Cell.

Shim Rod Assembly drawings are H-3-14913 for a Mark III design and H-3-13484 for an earlier design. The actual shim was three 0.9 M (36 in) long Inconel "half rods." (Wittenbrock, 1959) The shims were used to balance the reactor neutron flux by absorbing

some of the neutrons, thus changing the neutron flux profile. The shim rods became radioactive (Co-60) in the process and are responsible for the bulk of the FEF cell dose rate. The shim rods are estimated to contain 0.89 Ci of Co⁶⁰ the activated nickel produces an X-Ray.

6.4. FEF Lighting and Cooling

FEF lighting is provided by two vertical fixtures, containing eight flood lights each. The fixtures are located on either sides of the view port. Protection is provided for the flood light bulbs by a ladder like structure. The light fixtures are shown in Appendix A Figures 8, 9 and 13. The light fixture drawing is H-3-11982.

Also, observable in the figures are the two water spray risers adjacent to each light fixture. Appendix A Figure 12 shows a typical spray nozzle. Water spray could be used for washing the FEF down or as back up fuel element cooling.

6.5. FEF Cell Floor

The FEF Cell floor is shown in Appendix A Figures 2 and 3. The FEF floor is easily visible below the lower chuck and light fixture. Magnification of the floor in Appendix A Figure 4 shows a dried solids material. The material appears to be a wash-down residue. These solids were sampled via a contamination smear and were submitted for analysis. Smear contamination levels were low compared with other smear samples. Since radiation dose rates were also low near the bottom, the cell access door in B-Cell could potentially be used for monitoring purposes, or manned entry. Near the floor is an instrument bundle with connecting cable, and two metal plates which appear to have gone around a pipe, such as the floor drain.

6.6. External Observation

Portions of the FEF and related equipment can be visually observed without cell entry. The operational configuration had equipment in the B-Cell and on the containment floor. Drawings for the various parts are as follows: air supply and exhaust, H-3-11975; water cooling and decontamination, H-3-11976; and electrical equipment, H-3-11999.

The process water cooling supply piping in B-Cell has been removed and the pipe entering the cell structure capped (See Appendix A Figure 21.) The Air Cooling supply and exhaust fans, duct, dampers and instrumentation are no longer present. The ducting to and from the cell have been capped. The two duct inlets are visible in Appendix A Figure 20.

The FEF control console, external periscope equipment were removed in the 1970's. along with the control console, electrical power, control cable, and tubing. The south half of the cable trench was filled with concrete. The trench going back into the motor control center is empty.

7. CELL STATUS

The FEF Cell remains essentially the same as when it was operational, except for some removed equipment. The main FEF control console outside the cell is completely removed. The periscope viewing equipment is gone, the ventilation equipment is no longer operable, the lighting equipment is intact, but no power is available, the cooling water sprays headers have no water supply, and the B-Cell sump pump has been removed. The FEF utilities have been removed. The fuel handling machine manipulator appears to be intact, as well as the water spray risers and the lighting banks.

Cell Structure - The stainless steel lined cell appears to be in sound condition. The cell walls are all present and all access plugs are in place. No cracks or leaks in the system were apparent. There is smearable low level contamination on the cell walls and cell floor. The cell floor is painted white. The bottom part of the cell is empty except for one piece of instrumentation and connecting cable and some residual dried solids on the floor. The cell door at the -32 ft level is locked and bolted closed. On the door is High Radiation Area posting.

Control Console/Optical Equipment - The control console is no longer present. The FEF control console was located inside containment on the north center side at the 0 ft level. All ties to equipment inside the cell have been removed. The cable trench is empty it contains no pipe tubing or wiring. Portions of the trench have been filled with concrete. This concrete may be why some of access plugs in the containment floor could not be removed.

Sample - Shim rod Assembly - Portions of a PRTR Shim Rod Assembly are mounted in the manipulator. The shim rod is held in position by the manipulator chuck. Attached to the top of the shim rod assembly is a fuel handling chuck. This chuck may have been used to insert the shim rod into the cell with the fuel handling machine, (which is no longer present.) The shim rod dose is 6.7 R/hr from activated Inconel contains an estimated 0.89 Ci of Co⁶⁰, and activated nickel which emits X-Rays on decay. The shim rod assembly has smearable contamination similar to the PRTR Primary Cooling system.

Manipulator - The FEF manipulator assembly is in place and undisturbed from the time the PRTR was shut down. There is an oily film on lower manipulator head top surfaces. The film is believed to be from the manipulator gear box and/or guide lubricants.

Optical Viewing Equipment - The optical viewing equipment outside the cell has been removed. Inside the FEF the optical equipment was located behind shielding. A video tape review showed one item resting on the lower shelf of the shielded space. The item was not identified but it may be a portion of the optical equipment, perhaps the wide angle viewer.

Lighting Equipment - The two lighting fixtures used in the FEF are present. Eight flood lights are mounted in each assembly. Power and electrical connections to the lights have been removed.

Cooling Equipment - The 250 cfm and 1500 cfm air cooling assemblies are present inside the FEF. Interfacing supply and exhaust fans, ducting, dampers and instrumentation which were in B-Cell have been removed (See H-3-11975 for a layout of the original installation.) The ducts have been covered at the cell structure surface (This work was accomplished in 1986 clean-out activities.)

Water Supply and Drain - Cooling water supply to the FEF spray system has been removed (See H-3-11976 for a description of the original installation.) The spray headers inside the FEF are still present. The cooling water pipe in B-Cell have been cut and capped. The containment process water systems have been drained.

The FEF floor drain was connected to equipment in the B-Cell Sump. The pump, valves and pipe were removed during the 1986 clean-out. At present the cell drain pipe extends approximately 7 cm (3 in) into the B-Cell sump, and is not plugged.

8. RECOMMENDATIONS

The FEF is stable and does not require significant work to meet transition requirements. The only stabilization work needed is to plug the floor drain in B-Cell. Any further equipment removal or deactivation should be delayed until the FEF dose will allow contact handling of the equipment. This is expected to be 10 to 20 years. At that time the fuel manipulator could be removed through the containment floor shield blocks, using methods described in the operating manual. With the manipulator removed the shim rod assembly could be removed. As the FEF is now configured the air motors on the upper and lower carriage can not be opened to remove the shim rod assembly.

9. REFERENCES

- Gerber, M. S., 1992, *Past Practices Technical Characterization Study-300 Area-Hanford Site*, WHC-MR-0388, Westinghouse Hanford Company, Richland, Washington.
- Kelley, W. S., Straley, R. L., 1961, *PRTR Fuel Element Examination Facility Operations Manual*, HW-70880, General Electric, Richland, Washington.
- Wittenbrock, N. G., Walkup, P. C., Anderson, J. K., 1959, *Plutonium Recycle Test Reactor Final Safeguards Analysis*, HW-61236, General Electric, Richland, Washington.
- HWS-6340, *Specification for Fuel Element Examination Facility Plutonium Recycle test Reactor 309 Building*, Hanford Atomic Products Operation, General Electric Company February 5, 1959
- CVI File No. 15449, Vendor Information File, 309 FEF Fuel Manipulation Machine

REFERENCE DRAWING LIST

<u>Drawing No.</u>	<u>Title</u>
H-3-09113 Sheet 1	PRTR FUEL EXAM CELL WIDE ANGLE VIEWER ASSY
H-3-11970 Sheet 1	STRUCT CONCRETE FUEL EXAM PIT PLANS, SECTS
H-3-11971 Sheet 1	SHIELDING WALLS FUEL EXAM PIT PLNS, SECT
H-3-11975 Sheet 1	F.E. EXAM FACILITY MECH. COOLING AIR SUPPLY & EX
H-3-11976 Sheet 1	FUEL EXAMINATION WATER COOLING & DECONTAMINATION SYSTEM
H-3-11977 Sheet 1-6	FUEL EXAM FACILITY WALL BLOCK ASSY & DETS
H-3-11978 Sheet 1-3	FUEL EXAM FACILITY COVER BLOCKS ASSEMBLY & DETAILS
H-3-11979 Sheet 1	FUEL EXAM FACILITY VIEWING PLUG DETAIL
H-3-11980 Sheet 1	FUEL EXAM FACILITY ACCESSPLUG DETAIL
H-3-11981 Sheet 1	FUEL EXAM FACILITY BLOCKS ARRANGEMENT
H-3-11982 Sheet 1-2	FUEL EXAM FACILITY LIGHT FIXTURE & PLUG ASSEMBLY
H-3-11985 Sheet 1	FUEL EXAMINATION FACILITY SERVICE & FLOOR PLUG DETAIL
H-3-11987 Sheet 1	FUEL EXAM FACILITY CORNER SHIELDS
H-3-11990 Sheet 1	F.E. EXAM FAC.COOLING AIR EXH. FILTER BOX ARRANG
H-3-13373 Sheet 1-3	250 CFM PRTR FUEL EXAM DUCT ASSY
H-3-13374 Sheet 1-3	250 CFM PRTR FUEL EXAM DUCT TROLLEY
H-3-13412 Sheet 1	FUEL EXAM FAC EQPT ARRGT
H-3-13412 Sheet 1	FUEL EXAM FAC EQPT ARRGT
H-3-11999 Sheet 1	ELECTRICAL - FUEL ELEMENT EXAMINATION FACILITY CND. PLAN ELEV -32'-0"
SK-3-07909 Sheet 1	F.E. EXAMINATION FACILITY
SK-3-09393 Sheet 1-3	1500 CFM PRTR FUEL EXAMINATION DUCT ASSY
SK-3-09394 Sheet 1-3	1500 CFM PRTR FUEL EXAMINATION DUCT TROLLEY ASSY
SK-3-11508 Sheet 1-2	LOWER GEAR HEAD PRIMARY MANIPULATOR
SK-3-11509 Sheet 1-2	UPPER GEAR BOX PRIMARY MANIPULATOR
SK-3-11510 Sheet 1	SPLICE PLATE DETAILS-SHIPING BEAM
SK-3-11511 Sheet 1	LOWER DRIVE HEAD PRIMARY MANIPULATOR
SK-3-11512 Sheet 1	AIR MOTOR FEEF MANIPULATOR
SK-3-11513 Sheet 1	UPPER GEAR BOX LIMITS + CYLINDERS
SK-3-11514 Sheet 1	BALL NUT ASSEMBLY FEEF
SK-3-11516 Sheet 1	UPPER AND LOWER CHUCK FEEF MANIPULATOR
SK-3-11661 Sheet 1-3	PRIMARY MANIPULATOR ASSY
SK-3-11662 Sheet 1	ROLLER WAY CARTRIDGE ASSY
SK-3-11663 Sheet 1	TROLLEY WIRE DETAILS

Appendix A

Fuel Examination Cell Photographs and Images

Fuel Examination Cell Photographs and Images

Presented in this appendix are images of the Fuel Examination Facility. The figures shown in this appendix are from two sources. The first source is images captured from video surveillance performed in the Fuel Examination Facility. This document is the only place where these images are available. The other source is from still photograph. Not all photos are include, however the photographs may be obtained from Photograph Archive. A listing of applicable photos is at the end of this appendix.

There are other pictures available that may be useful in D&D planing, they were not included with this document, because they are found in other documents under configuration control (HW-70880, PRTR Fuel Element Examination Facility Operations Manual, and CV1 #15449, FEF Fuel Manipulation Machine.)

Below is a listing of the figures and their page numbers.

<u>Figure Number</u>	<u>Subject</u>	<u>Page</u>
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Figure 2.	View From -5 ft. Level Showing Manipulator and Light Fixture	A-3
Figure 3.	View of Cell Floor.....	A-4
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Figure 8.	Light Fixture and Lower Manipulator Head	A-6
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Figure 11.	Light Fixture Plug - Bottom View	A-8
Figure 12.	Auxiliary Cooling and Decontamination Spray Nozzle.....	A-8
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Figure 20.	Fuel Exam Celt Wall in B-Cell.....	A-13
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Figure 1. View into Fuel Examination Facility Through Access Plug Hole.

Figure 2. View From -5 ft. Level Showing Manipulator and Light Fixture

Figure 3. View of Cell Floor

Figure 4 Cell Floor and Drain, Enlarged View

Figure 5. Upper Manipulator Top View

Figure 6. Manipulator Connections View

Figure 7. Upper Manipulator Head Guide Rods

Figure 8. Light Fixture and Lower Manipulator Head

Figure 9. Lower Manipulator and Light Fixture

Figure 10. Lower Manipulator Head Equipment Detail

Figure 11. Light Fixture Plug - Bottom View

Figure 12. Auxiliary Cooling and Decontamination Spray Nozzle

Figure 13. Upper Manipulator and Shim Rod Lifting Fixture

Figure 14. Shim Rod Assembly Passing Through Upper Guide Cone

Figure 15. Shim Rod Assembly Passing Through Upper Manipulator

Figure 16. Shim Rod Detail Showing Lead Screw

Figure 17. Shim Rod Passing Trough Lower Manipulator

Figure 18. Shim rod Assembly Passing Through Lower Manipulator

Figure 19 Replacing View Plug into FEF
(REF Photo # 97020291 -4CN)

Figure 20 Fuel Exam Cell Wall in B-Cell
(REF Photo # 97040252 -31CN)

Figure 21 Fuel Exam Cell Process Water Isolation Valve
(REF Photo # 97040252 -27CN)

Figure 22 Fuel Exam Cell Duct Interface to Containment Exhaust System
(REF Photo # 97040252 -28CN)

Subject of Reference Photographs.....	Picture No.
Upper FEF West Wall from B-Cell (Covered Cell Inlet Duct)	97040252 31CN
Note: Covered 4 and 10 inch pipe for Cooling Air Supply is shown	
Mid FEF West Wall from B-Cell.....	97040252 30CN
FEF Vault Door in B-Cell -32 Ft Level.....	97040252 29CN
Note: Cell Door is bolted and Locked.	
FEF Air Exhaust Ducting Inlet to Containment Exhaust	97040252 28CN
FEF Process Cooling Water Shutoff Valve	97040252 27CN
Note: Pipe from valve to FEF is removed.	
Preparation for Removing Paint Accessing	97020291 45CN
Contamination Control Bull Pen Setup	97040291 41CN
Rigging Crew For Plug Removal	97020291 39CN
Fuel Plug Rigged for Removal, With Tension on Rigging.....	97020291 37CN
Fuel Plug Rigged for Pulling	97020291 36CN
Fuel Plug Being Raised (Note, Doubled Rigging).....	97020291 35CN
Fuel Plug Being Raised, RCT Checking Smears	97020291 34CN
RCT Performing Direct Radiation Measurements on Plug.....	97020291 33CN
Attempting to Shrink Stuck Plugs with Dry Ice.....	97020291 32CN
Fuel Access Plug.....	97020291 31CN
Fuel Access Plug - Showing Rust	97020291 30CN
Fuel Access Plug - Showing Identification Markings.....	97020291 29CN
RCT Performing Survey Through Fuel Access Plug	97020291 28CN
Lighting Plug Shown with Cover Removed.....	97020291 27CN
Cover Plate Tack Welded in Place over View Plug.....	97020291 26CN
View Plug Being Lifted	97020291 06CN
Containment Configuration while Pulling Air Sample	97020291 05CN
View Plug Being Inserted, Note Silver Anti-Sieve Coating	97020291 04CN

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APPENDIX B: Radiological Measurement Reports/Surveys/Analyses

Contents

Radiation Survey Report R00081, Fuel Exam Cell 02/04/1997	B-3
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Radiation Survey Report R00094, Fuel Exam Cell 02/24/1997	B-8
Fuel Examination Cell Neutron Counting Report	B-11

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Westinghouse Hanford Company - Radiological Control RADIOLOGICAL SURVEY REPORT				Survey No. R 000081					
Date <u>02/04/1997</u>		Time <u>0800-1500</u>		RWP No.(s) <u>R-188 REV 001</u>					
Area/Bldg./Room/Location (Code) <u>500 ALCA / 509 ALB6 / CONTAINMENT DOME / FUEL EXAM CELL</u>				Page <u>1</u> of <u>4</u>					
Job Description <u>PERFORM CHARACTERIZATION</u> <u>SURVEY OF FUEL EXAM CELL TO</u> <u>DETERMINE CONDITIONS.</u> <u>-1a</u>				Purpose of Survey (check appropriate box(es)): Contamination Incident: ☐ Skin, ☐ Clothing, ☐ Spill Alarm Response: ☐ CAM, ☐ ARMIRAM, ☐ PSD ☐ HRA/VHRA Work ☐ Job Coverage ☒ Other ☐ Exposure Incident ☐ Material Release ☐ RM Transfer/Shipment ☐ Required, Task No.					
Map/Sketch									
<div style="position: relative; width: 100%; height: 100%;"> <div style="position: absolute; top: 0; left: 0; right: 0; bottom: 0; border: 1px solid black; transform: rotate(45deg); transform-origin: center;"></div> <div style="position: absolute; top: 50%; left: 50%; transform: translate(-50%, -50%); font-weight: bold; font-size: 1.2em;">INFORMATION ONLY</div> </div>									
No.	Description	Dist.	DOSE RATES			CONTAMINATION LEVELS			
			S (non-pen) mrad/h	Y (pen) mR/h	g mrem/h	Total (/100 cm ²)		Removable (/100cm ²)	
			S (dpm)	g (dpm)	g (dpm)	g (dpm)	g (dpm)	mrad/h	
1	PLUG REMOVED @ FLOOR	C	1/2	7	1/2				1/2
2	MAX IN CELL DOSE	C	1/2	1400	1/2				1/2
3	MAX IN CELL SMEAR	1/2					90000	1/2	1/2
4	BULK PEN	1/2					1/2	1/2	1/2
5	BULK ZONE PLUG REPLACED	1/2					1/2	1/2	1/2
6	TOOLS & EQUIPMENT	1/2				1/2	1/2	1/2	1/2
7	PERSONNEL	1/2				1/2	1/2	1/2	1/2
			1/2						

Continued on page 2

Air Sample Results (uCi/ml)				Legend
BZ	GA	Initial	Decay	
#1	1/2			(S) - Smear Location (A) - Air Sample Location (F) - Large Area Smear * - Contact Reading Other <u>1/2</u>
#1				
#2				
#2				

BD-6000-010 (06/96)

BEST AVAILABLE COPY

BD-6000-010R (06/96)

J-4A	RESOLUTION/RETEST (Continuation)	Page 9 of 10	PTS NUMBER 38-96-00144/W
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ATTACHMENT: DATA Sheets

View Port Plug w/ 660#
BCL

1. Top port radiation levels:

1.1. Before plug removed: 01.2. After plug removed: 7 mrem/hr C, 4 mrem/hr R-7
0.001 24-472. Radiation Monitor Readings (units mrem/hr):

0 -	4		
1 ft.	- 12		17 ft. - 200
2 ft.	- 19		18 ft. - 125
3 ft.	- 35		19 ft. - 30
4 ft.	- 66		20 ft. - 50
5 ft.	- 105		21 ft. - 28
6 ft.	- 154		22 ft. - 16
7 ft.	- 270		23 ft. - 8
8 ft.	- 400		24 ft. - 7
9 ft.	- 625		25 ft. - 5
10 ft.	- 980		26 ft. - 3
11 ft.	- 1100	max 11400 1400	27 ft. - 3
12 ft.	- 1050		28 ft. - 3
13 ft.	- 930		29 ft. - 2
14 ft.	- 710		30 ft. - 2
15 ft.	- 495		31 ft. - 2
16 ft.	- 318		32 ft. - 4

Comments: R-7 A 6042 cal exp. 7/25/97

3. Air Sampling and Oxygen Monitoring:

Depth/Location	Continuous Air Sample Data	Oxygen Monitoring Data
Outside Cell		
-5 ft	Not Applicable	
-10 ft		
-15 ft	Not Applicable	
-20 ft		
-25 ft	Not Applicable	
-30 ft		

INFORMATION ONLY

R000091
PAGE 3 of 4

G-12 - 2/1/97

FUEL EXAM CELL TECH SMEARS
& AIR SAMPLE

FOR ANALYSIS AT 325 LAB

Perform GROSS ALPHA, GROSS BETA, GEA on smears

PRTR-FX-01	FLOOR #1	4000 DPM $\beta\gamma$	<20 DPM α
PRTR-FX-02	FLOOR #2	2000 DPM $\beta\gamma$	<20 DPM α
PRTR-FX-03	CHUCK LOWER WESTSIDE	20000 DPM $\beta\gamma$	<20 DPM α
PRTR-FX-04	WALL @ 15" EAST	2000 DPM $\beta\gamma$	<20 DPM α
PRTR-FX-05	LIGHT TREE BOTTOM EAST	30000 DPM $\beta\gamma$	<20 DPM α
PRTR-FX-06	CHUCK LOWER EAST	90000 DPM $\beta\gamma$	<20 DPM α
PRTR-FX-07	CHUCK ROD	2000 DPM $\beta\gamma$	<20 DPM α
PRTR-FX-08	CHUCK TOP	15000 DPM $\beta\gamma$	<20 DPM α
PRTR-FX-09	WALL @ 15' WEST	2000 DPM $\beta\gamma$	<20 DPM α
PRTR-FX-10	WEST LIGHT BOTTOM	6000 DPM $\beta\gamma$	<20 DPM α

		READINGS AFTER REMOVAL
PRTR-FX-11	AIR SAMPLE	7000 DPM $\beta\gamma$
PRTR-FX-12	CHARCOAL CARTRIDGE	1000 DPM $\beta\gamma$

Several of the smears are on whatman 5 filter papers. While others were taken on stickly backed smear papers and stuck to a whatman 5 filter paper.

AIR SAMPLE RUN FOR 4 HOURS AT 2 CFM

Readings were taken with a EGM and a PAM for reference only.

Contact RCT Chuck Wildman at 376-5115 for any questions about the smears.

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2/4/97

INFORMATION ONLY

97-1696
3/4/97.

Battelle Pacific Northwest Laboratory
Analytical Chemistry Laboratory
Radioanalytical Group - 325 Bldg.
Client : B. Cornwell
W/P# : K76103

Wp#: K76103

Client: B. Cornwall

Cognizant Scientist:

Concur :

M. K. Jolly
I Trang-6

Date :

Date :

$$\begin{array}{r} 3497 \\ \hline 3497 \end{array}$$

Measured Activities (uCi/sample)

ALO ID	Client ID	97-1760	97-1761	97-1762	97-1763	97-1764	97-1765	97-1766	97-1767	97-1768	97-1769	97-1770	97-1771	Standard	Blank												
		PATR-FX-01	PATR-FX-02	PATR-FX-03	PATR-FX-04	97-1764	PATR-FX-05	97-1765	PATR-FX-06	97-1766	PATR-FX-07	97-1767	PATR-FX-08	PATR-FX-09	PATR-FX-10	PATR-FX-11	PATR-FX-12	Standard	Blank								
		2.88E-6	<9.E-7	6.07E-6	8.22E-7	2.87E-6	1.26E-2	1.62E-2	5.5E-5	2.40E-2	4%	1.01E-4	4%	1.97E-3	3.00E-3	2.54E-4	5%	1.57E-3	2.1E-3	5%	6.25E-6	9.77E-6	9%	1.03E-6	5.79E-7	103%	20%
		26%	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%	4%	5%	4%
		97-1760	97-1761	97-1762	97-1763	97-1764	97-1765	97-1766	97-1767	97-1768	97-1769	97-1770	97-1771	97-1772	97-1773	97-1774	97-1775	97-1776	97-1777	97-1778	97-1779	97-1780	97-1781	97-1782	97-1783	97-1784	97-1785
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Westinghouse Hanford Company - Radiological Control RADIOLOGICAL SURVEY REPORT						Survey No. R 000094																																																																																																																																											
Date 02/24/1997		Time 0800 - 1100		RWP No.(s) R-123 REV 001		Page 1 of 4																																																																																																																																											
Area/Bldg./Room/Location (Code) 300 AREA / 302 BLDG / CONTAINMENT / FUEL EXAM CELL						F.C. R																																																																																																																																											
Job Description PERFORM CHARACTERIZATION OF FUEL EXAM CELL				Purpose of Survey (check appropriate box(es)):																																																																																																																																													
<div style="border: 1px solid black; padding: 5px;"> -1A </div>				Contamination Incident: ☐ Skin, ☐ Clothing, ☐ Spill Alarm Response: ☐ CAM, ☐ ARM(RAM), ☐ PSD ☐ HRA/VHRA Work ☐ Job Coverage ☒ Other ☐ Exposure Incident ☐ Material Release ☐ RM Transfer/Shipments ☐ Required, Task No.																																																																																																																																													
Map/Sketch -1A				<div style="border: 1px solid black; padding: 20px; width: 100%;"> INFORMATION ONLY -1A </div>																																																																																																																																													
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">No.</th> <th rowspan="2">Description</th> <th rowspan="2">Dist.</th> <th colspan="3">DOSE RATES</th> <th colspan="4">CONTAMINATION LEVELS</th> </tr> <tr> <th>$\dot{S}$ (non-pen) mrad/h</th> <th>$\dot{\gamma}$ (pen) mR/h</th> <th>$\dot{q}$ mrem/h</th> <th colspan="2">Total (/100 cm²)</th> <th colspan="2">Removable (/100cm²)</th> </tr> <tr> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>$\dot{S}$ (dpm)</th> <th>$\dot{\alpha}$ (dpm)</th> <th>$\dot{S}$ (dpm)</th> <th>$\dot{\alpha}$ (dpm)</th> <th>mrad/h</th> </tr> </thead> <tbody> <tr><td>1</td><td>PLUG</td><td></td><td></td><td></td><td></td><td></td><td></td><td><D</td><td><D</td><td>—</td></tr> <tr><td>2</td><td>PLUG PORT</td><td>F</td><td></td><td>8</td><td></td><td></td><td></td><td><D</td><td><D</td><td>—</td></tr> <tr><td>3</td><td>BULL PEN</td><td>F</td><td></td><td><0.5</td><td></td><td></td><td></td><td><D</td><td><D</td><td>—</td></tr> <tr><td>4</td><td>CELL (MAX) DOSE RATE -12" LUG F</td><td></td><td></td><td>6700</td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>5</td><td>RO-7 DETECTOR</td><td></td><td></td><td></td><td></td><td><D</td><td><D</td><td><D</td><td><D</td><td>—</td></tr> <tr><td>6</td><td>NEUTRON DETECTOR</td><td></td><td></td><td></td><td></td><td><D</td><td><D</td><td><D</td><td><D</td><td>—</td></tr> <tr><td>7</td><td>HOUSE ALARM</td><td></td><td></td><td></td><td></td><td></td><td></td><td><D</td><td><D</td><td>—</td></tr> <tr><td>8</td><td>PLUG REPLACED</td><td>F</td><td></td><td><0.5</td><td></td><td></td><td></td><td><D</td><td><D</td><td>—</td></tr> <tr><td>9</td><td>BULL PEN</td><td></td><td></td><td></td><td></td><td></td><td></td><td><D</td><td><D</td><td>—</td></tr> <tr><td></td><td></td><td>-1A</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>								No.	Description	Dist.	DOSE RATES			CONTAMINATION LEVELS				$\dot{S}$ (non-pen) mrad/h	$\dot{\gamma}$ (pen) mR/h	$\dot{q}$ mrem/h	Total (/100 cm ²)		Removable (/100cm ²)								$\dot{S}$ (dpm)	$\dot{\alpha}$ (dpm)	$\dot{S}$ (dpm)	$\dot{\alpha}$ (dpm)	mrad/h	1	PLUG							<D	<D	—	2	PLUG PORT	F		8				<D	<D	—	3	BULL PEN	F		<0.5				<D	<D	—	4	CELL (MAX) DOSE RATE -12" LUG F			6700							5	RO-7 DETECTOR					<D	<D	<D	<D	—	6	NEUTRON DETECTOR					<D	<D	<D	<D	—	7	HOUSE ALARM							<D	<D	—	8	PLUG REPLACED	F		<0.5				<D	<D	—	9	BULL PEN							<D	<D	—			-1A								
No.	Description	Dist.	DOSE RATES			CONTAMINATION LEVELS																																																																																																																																											
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2	PLUG PORT	F		8				<D	<D	—																																																																																																																																							
3	BULL PEN	F		<0.5				<D	<D	—																																																																																																																																							
4	CELL (MAX) DOSE RATE -12" LUG F			6700																																																																																																																																													
5	RO-7 DETECTOR					<D	<D	<D	<D	—																																																																																																																																							
6	NEUTRON DETECTOR					<D	<D	<D	<D	—																																																																																																																																							
7	HOUSE ALARM							<D	<D	—																																																																																																																																							
8	PLUG REPLACED	F		<0.5				<D	<D	—																																																																																																																																							
9	BULL PEN							<D	<D	—																																																																																																																																							
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Air Sample Results (uCi/ml)						Legend																																																																																																																																											
BZ GA		Initial		Decay		☒ - Smear Location ☒ - Air Sample Location ☒ - Large Area Smear * - Contact Reading Other -1A																																																																																																																																											
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BD-6000-010 (06/96)

BEST AVAILABLE COPY

WHC - Radiological Survey Report					F.C. <u>R</u> Page <u>2</u> of <u>4</u>		Survey No. <u>R000094</u>			
Description			DOSE RATES			CONTAMINATION LEVELS				
			8 (non-pen) mrad/h	γ (pen) mR/h	α mrem/h	Total (1/100 cm ²)		Removable (1/100cm ²)		
No.		Dist.				g (dpm)	α (dpm)	g (dpm)	α (dpm)	mrad/h
1										
<div style="display: flex; justify-content: space-between;"> * ALL EMPHAS WERE LARGE AREA W/DPS / NO REMOVABLE CONTAMINATION DETECTED DURING PERFORMANCE OF JOB. * SEE ATTACHED DATA SHEET FOR ONE FOOT DOSE RATE READINGS WITHIN CELL USING A RO-7, WITH 50' CABLE </div> <div style="display: flex; justify-content: space-between;"> * CAMS WERE SET TO ALARM AT 10% OF DAC FOR PL-239, AND SC-50 BEINGS WERE * AFTER 309 BULLPEN WAS MOVED TO OVER REACTOR CASITY FOR NEXT JOB. </div>										
Comments: <u>None</u>										
Total <D = <u>2</u> inches / sec REMOVABLE <D = <u>1</u> inches / sec										
<u>0.25</u> inches from item <u>0.25</u> inches from item										
<u>50</u> % of item surveyed <u>100</u> % of item surveyed										
No audible counts above background No audible counts above background										
Samples Counted with portable instruments for _____ minutes.										
Instr./Probe Model	RO-3B (CP)	E-140/Pancake (GM/Probe)	Surveyor-X w/ZnS probe (PAM)	RO-7	RO-7	RO-7	RO-7	RO-7	RO-7	RO-7
Serial No.	1C63-048L	CMF66-031F DTMC-0103	ACH27-0217	1C63-003L	DT68L-0030	DT68L-0030	DT68L-0030	DT68L-0030	DT68L-0030	DT68L-0030
Efficiency	100%	10%	14%	100%						
Correction Factor	1	10	7	1						

ADDITIONAL REPORTS

RPR No. 1 Sample Counter Log(s) _____
RSR No. 1 ... Contamination - Skin _____
... Contamination - Clothing 1 Other(s) _____

Date: _____ Procedure: 1

HPT: _____
Payroll No.: 95539
Name (Print): C. WILSON
Signature: [Signature]

First-Line HP Manager: _____
Date: _____ Payroll No.: _____
Name (Print): INFORMATION ONLY
Signature: _____

8D-6000-01QR (Q6/96)

BEST AVAILABLE COPY

HNF-SD-NEL-ER-007, Rev. 0

LEVEL	FUEL EXAM CELL REPEAT DOSE RATE SURVEY	SURVEY 2/24/97	
		LR Probe	MR Probe
FLOOR 0'	INSTRUMENT RO-7 ICEB2-0036; RO-7 DTEB6-0030; LR Probe DTEB7-0047; MR Probe LR=LOW RANGE PROBE 0-2R MR=MID RANGE PROBE 0-200R	5 mr/hr	--
1'		14	--
2'		29	--
3'		50	--
4'		85	100 mr/hr
5'		160	200
6'	Instrument Information (--)= Beyond Probe Scale LR Probe 1 mr/hr increments MR Probe 100 mr/hr increments	325	400
7'		570	700
8'		1000	1200
9'		--	2500
10'		--	5000
11'		--	6400
12'	~1/2	--	6700
13'		--	4900
14'		--	3200
15'		1800	1800
16'		900	800
17'		480	400
18'	~1/2	270	300
19'		159	200
20'		90	100
21'		60	--
22'		36	--
23'		28	--
24'	~1/2	20	--
25'		10	--
26'		7	--
27'		4	--
28'		3	--
29'		3	--
30'	SURVEY R000094 PAGE 3 OF 4 02/24/1997 C. WILDMAN <i>C. Wildman</i> INFORMATION ONLY	3	--
31'		3	--
CELL FLOOR 32'		5	--

Note: Page #4 of 4 is Blank

Brent Hannon
6/17/97

Battelle

Pacific Northwest Laboratories
Battelle Boulevard
P.O. Box 999
Richland, Washington 99352
Telephone (509) 376-0405

June 18, 1997

Bruce C. Cornwell
BWMC
Mail Stop L5-70
Richland, WA 99352

Dear Mr. Cornwell:

PNNL DOWN-HOLE ASSAYER RESULTS: FUEL ELEMENT EXAMINATION FACILITY

Enclosed is a set of data for work performed on February 24, 1997, using the PNNL Down-Hole Assayer System inside the sample chamber of the Fuel Element Examination Facility. The assay was performed at the request of Mr. Wilbur Greenhalgh (decd.) to provide positive confirmation that no fuel elements or fragments were stuck inside the chamber.

The PNNL Down-Hole Assayer System is a non-destructive assay (NDA) system that employs high-resolution (HPGe) gamma-ray spectrometry and/or passive neutron counting to characterize a local radiological environment with confined space or where physical access is restricted. Only the passive neutron counter was deemed necessary for achieving the requested radiological characterization.

Alpha-Particle Activity Measured via Passive Neutron Counting

The neutron count for the PNNL Down-Hole Assay System is performed with a single $^{10}\text{BF}_3$ neutron counting tube with 5-cm diameter and 1.83 m length. The neutron count was taken with a bare tube (i.e., no polyethylene wrap to provide moderation for higher energy neutrons in the source term.)

The neutron tube counts ambient neutrons that are low enough in energy to be captured by the ^{10}B . The counting model assumes two sources of neutrons: one from natural background and one from transuranic (TRU) isotopes. The natural background source of neutrons consists mostly of spallation products caused by cosmic-ray bombardment of surrounding structures, which in this case was depressed because of the shielding effects of the massive concrete overburden. The other source of neutrons is transuranic materials, which has two components associated with it: 1) alpha-particle activity results in neutron emissions via (α, n) reactions, predominantly with oxygen and other light elements of the matrix and 2) spontaneous fission of various transuranic isotopes (typically even-numbered isotopes) releases several neutrons.

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In cases where no process knowledge is provided or available, the TRU value determined from the neutron count is based on the specific alpha-particle activity of weapons-grade PuO_2 , a conservative estimate since weapons-grade plutonium yields the lowest alpha-particle activity (hence, the lowest neutron emission rate) of any TRU material that can reasonably be expected in Hanford waste. This assumption is appropriate in this instance because of available process knowledge.

Data were collected at 3 depths inside the sample chamber to profile the entire length. Counting intervals were at 1.8 m, which is the length of the neutron counting tube used. The table summarizing the upper-limit levels of weapons-grade PuO_2 at the 3 depths is presented in Exhibit 1. Computer printouts from the code NANAL, used to document the neutron-count data, are provided in Appendix A.

Passive Neutron Counter Efficiency Calibration

Direct efficiency calibrations were previously performed on several the passive neutron counter using the same configuration that was used for acquiring counts in the sample chamber of the Fuel Element Examination Facility. The neutron source used is the M-710 $^{239}\text{PuBe}$, whose neutron emission rate corresponds to a 953-g weapons-grade $^{239}\text{PuO}_2$ source. This neutron emission rate is relative to the PNNL NIST-traceable 100-g weapons-grade PuO_2 standard, 19B14B. Calibration consists of a series of counts with the standard centered on the length of the neutron counting tube, as specified in the PNNL Technical Procedure SGS-001. A count is taken with the standard moved back in 1 ft increments. Five such counts were performed as part of the calibration. The results of the calibration are provided in Appendix B.

The observed passive neutron data and the corresponding efficiency are used in the PNNL NANAL Neutron Analysis Code to determine TRU levels or gram-quantity values. The resulting hardcopy outputs are enclosed for each of the corresponding depths. An arbitrary net sample weight of 1 g was used; consequently, the TRU activity ratios, expressed as $\text{nCi-}\alpha/\text{g}$ are artificially high and should be ignored -- the "Total grams of TRU" portion of the printout provides the appropriate upper-limit values.

Please note that the stated upper-limit values are conservative since the concrete walls of the sample chamber provide an adequate neutron cavity that allows a given neutron multiple chances of detection before being absorbed by materials in the walls; this effect has not been taken into account in this

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study, but would, in practice, lower the amount of plutonium that could be present and still escape detection.

Field Calibration Source Check

The passive neutron counting tube was checked before use by counting the background (ambient) level inside the facility. The counts were compared to previous background counts taken both inside the same room and taken when the tube was calibrated against a known source of neutrons.

No accuracy or precision noncompliance issues exist for this report.

Recommendations and Conclusions

The data show that the observed neutron count inside the sample chamber of the Fuel Element Examination Facility is consistent with background levels. The data supports the claim that less than 0.5 g TRU can be present inside the sample chamber and still avoid detection. As mentioned previously, the 0.5 g value is conservative, since the concrete of the sample chamber would allow an emitted neutron multiple chances for detection so that detection would actually occur with a smaller amount of TRU.

Hard copies of the data are enclosed for you to maintain as record copies. The hard copies are a documented summary of data contained in the paginated PNNL Assay Systems Log Book. Any questions may be directed to me at Mail Stop P8-08, by cc:Mail, by FAX at 376-2329, or by phone at 376-0405.

Sincerely,

Richard J. Arthur
Sr. Research Scientist

Attachments

cc w/attachments:
MD Winterrose, P8-01
File /LB

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Exhibit 1

Results of PNNL Down-Hole Assayer System
(Passive Neutron Count) on the Sample Chamber of
the Fuel Element Examination Facility

Depth (ft.)	TRU Upper Limit (1 σ)
6	± 0.498 g
12	± 0.405 g
18	± 0.366 g

Appendix A

Computer Printout of NANAL Code Used to
Process and Document Neutron-Count Results.

HNF-SD-NEL-ER-007, Rev. 0

***** 97022408.nan ***
 ANAL: Neutron Analysis Code (Version 2.00) Date Analyzed -- (12:59:07 on 02/26/97)

Neutron ANALYSIS file: \DATA\97022408.NAN
 Segment CountTime NeutronCount Discard Sigma from Median
 1 200.00 36. .00
 2 200.00 36. .00
 3 200.00 37. .17
 4 200.00 32. -.67
 & 800.00 141. 4-Sample Median 36.00

BARREL: Sample Chamber @ 18'
 SITE: Fuel Element Exam Facil.

OPERATOR: ndw
 Statistics on 4 counts (Differences in Sigma units)
 CenMoment Calc Value Poisson Value Diff/CalcSD Diff/PoissonSD
 2 3.687500E+00 3.525000E+01 -15.40 -1.26
 3 -7.031250E+00 3.525000E+01 -15.13 -1.16
 4 3.039453E+01 3.762938E+03 -458.23 -.58
 Mean 35.25 35.25
 SDofMEAN 1.11 2.97
 Std Dev 2.22 5.94 -6.97 -1.76
 SD of SD .53 2.11
 Skewness -.992966 .168430 -1.01 -.94
 Kurtosis -.764723 .028369 -.30 -.29
 Median 36.00 35.00 .72 .27
 SDof MED 1.39 3.72

***** WARNING! *****
 ** NO NET NEUTRON COUNT ** NEGATIVE NET NEUTRON COUNT
 ***** INCONSISTENT WITH ZERO! *****

 ** Measurement error dominates detection efficiency error
 ** Can profitably increase measurement time by factor of 2.84D+00 **

EFFNEU= 5.25D-04 2.62D-05 5.00%
 Y1= 28.287330 Y2= 16.794670

Only the 4 GOOD neutron counts used in TRU calculations
 Measured Neutron Count Rate = 1.76250E-01 c/s +/- 1.48429E-02 [8.42%]
 Estimated Bkgd N Count Rate = 6.21875E-01 c/s +/- 1.97148E-02 [3.17%]
 Net Est Neutron Count Rate = 1.00000E-20 c/s +/- 2.46776E-02 [*****]
 Measured N Source Strength = 1.90578E-17 n/s +/- 4.70301E+01 [*****]

PRELIMINARY TRU activity 1.3122E-11 nCi +/- 3.2382E+07 nCi [*****]
 LESS THAN 5.3268E+07 nCi (1.64-sigma threshold)
 TRU activity Density 1.3120E-14 nCi/gram +/- 3.2376E+04 nCi/gram [*****]
 LESS THAN 5.3259E+04 nCi/gram based on GROSS Wt= 1000. grams
 TRU activity Density 1.3122E-11 nCi/gram +/- 3.2382E+07 nCi/gram [*****]
 LESS THAN 5.3268E+07 nCi/gram based on NET Wt= 1. grams
 Total grams of TRU in barrel 1.4818E-19 gram +/- 3.6568E-01 gram [*****]
 LESS THAN 6.0155E-01 gram

CALCULATIONS BASED ON: 1.000 kg Net barrel weight 1 N-tubes
 Neutron Efficiency = 5.2472E-04 (2.6236E-05) [cts/s]/[n/s] [5.00%]
 Calibration Factor = 6.8854E+05 (3.4427E+04) nCi/[n/s] [5.00%]
 Specific Activity = 8.8552E+07 (4.0000E+06) nCi/gram [4.52%]
 Meas Bkg Count Rate= 6.2187E-01 (1.9715E-02) cps [3.17%]
 Bkg Gross Barrel Wt= 3.202 # BkgAdjFactor= 1.000000 CFERR= 0.0000E+00
 TRU material assumed to be: Weapons grade Pu oxide

***** 97022403.nan ***
 NANAL: Neutron Analysis Code (Version 2.00) Date Analyzed -- (12:58:52 on 02/26/97)

Neutron ANALYSIS file: \DATA\97022403.NAN
 Segment CountTime NeutronCount Discard Sigma from Median
 1 200.00 93. .42
 2 200.00 84. -.53
 3 200.00 89. .00
 & 600.00 266. 3-Sample Median 89.00

BARREL: Sample Chamber @ 6'
 SITE: Fuel Element Exam Facil.

OPERATOR: mdw
 Statistics on 3 counts (Differences in Sigma units)
 CerMoment Calc Value Poisson Value -Diff/CalcSD Diff/PoissonSD
 2 1.355556E+01 8.866666E+01 -13.57 -1.03
 3 -6.740637E+00 8.866666E+01 -2.21 -.08
 4 2.756296E+02 2.367400E+04 -207.94 -.51
 Mean 88.67 88.67
 SDofMEAN 2.60 5.44
 Std Dev 4.51 9.42 -6.53 -1.27
 SD of SD .75 3.86
 Skewness -.135059 .106199 -.27 -.17
 Kurtosis -1.500000 .011278 -2.17 -.51
 Median 89.00 88.00 .31 .15
 SDof MED 3.26 6.81
 ***** WARNING! *****
 ** NO NET NEUTRON COUNT ** NEGATIVE NET NEUTRON COUNT
 ***** INCONSISTENT WITH ZERO! *****

 ** Measurement error dominates detection efficiency error **
 ** Can profitably increase measurement time by factor of 1.50D+00 **

 EFFNEU= 5.25D-04 2.62D-05 5.00%
 Y1= 51.803840 Y2= 42.244750

Only the 3 GOOD neutron counts used in TRU calculations
 Measured Neutron Count Rate = 4.43333E-01 c/s +/- 2.71825E-02 [6.13%]
 Estimated Bkgd N Count Rate = 6.21875E-01 c/s +/- 1.97148E-02 [3.17%]
 Net Est Neutron Count Rate = 1.00000E-20 c/s +/- 3.35792E-02 [*****%]
 Measured N Source Strength = 1.90578E-17 n/s +/- 6.39945E+01 [*****%]

PRELIMINARY TRU activity 1.3122E-11 nCi +/- 4.4063E+07 nCi [*****%]
 LESS THAN 7.2483E+07 nCi (1.64-sigma threshold)
 TRU activity Density 1.3120E-14 nCi/gram +/- 4.4055E+04 nCi/gram [*****%]
 LESS THAN 7.2470E+04 nCi/gram based on GROSS WT= 1000. grams
 TRU activity Density 1.3122E-11 nCi/gram +/- 4.4063E+07 nCi/gram [*****%]
 LESS THAN 7.2483E+07 nCi/gram based on NET WT= 1. grams
 Total grams of TRU in barrel 1.4818E-19 gram +/- 4.9759E-01 gram [*****%]
 LESS THAN 8.1853E-01 gram

CALCULATIONS BASED ON: 1.000 kg Net barrel weight 1 N-tubes
 Neutron Efficiency = 5.2472E-04 (2.6236E-05) [cts/s]/[n/s] [5.00%]
 Calibration Factor = 6.8854E+05 (3.4427E+04) nCi/[n/s] [5.00%]
 Specific Activity = 8.8552E+07 (4.0000E+06) nCi/gram [4.52%]
 Meas Bkg Count Rate = 6.2187E-01 (1.9715E-02) cps [3.17%]
 Bkg Gross Barrel Wt = 3.202 # BkgAdjFactor = 1.0000000 CFERR = 0.0000E+00
 TRU material assumed to be: Weapons grade Pu oxide

HNF-SD-NEL-ER-007, Rev. 0

***** 97022406.nan *****

NANAL: Neutron Analysis Code (Version 2.00) Date Analyzed -- (12:59:00 on 02/26/97)

Neutron ANALYSIS file: \DATA\97022406.NAN

Segment	CountTime	NeutronCount	Discard	Sigma from Median
1	200.00	45.		.15
2	200.00	44.		.00
3	200.00	40.		-.60
8	600.00	129.	3-Sample Median	44.00

BARREL: Sample Chamber @ 12'

SITE: Fuel Element Exam Facil.

OPERATOR: mdw

Statistics on 3 counts

(Differences in Sigma units)

Stat	Calc Value	Poisson Value	Diff/CalcSD	Diff/PoissonSD
CerMoment	4.666667E+00	4.300000E+01	-20.12	-1.09
2	-6.000000E+00	4.300000E+01	-5.61	-.12
3	3.266667E+01	5.590000E+03	-416.71	-.51
Mean	43.00	43.00		
SDofMEAN	1.53	3.79		
Std Dev	2.65	6.56	-8.87	-1.45
SD of SD	.44	2.69		
Skewness	-.595170	.152499	-.63	-.52
Kurtosis	-1.500000	.023256	-.96	-.49
Median	44.00	43.00	.52	.21
SDof MED	1.91	4.75		

WARNING!

** NO NET NEUTRON COUNT **

NEGATIVE NET NEUTRON COUNT

INCONSISTENT WITH ZERO!

** Measurement error dominates detection efficiency error **

** Can profitably increase measurement time by factor of 3.100+00 **

EFFNEU= 5.25D-04 2.62D-05 5.00%

Y1= 36.075800 Y2= 20.487120

Only the 3 GOOD neutron counts used in TRU calculations

Measured Neutron Count Rate = 2.15000E-01 c/s +/- 1.89297E-02 [8.80%]

Estimated Bkgd N Count Rate = 6.21875E-01 c/s +/- 1.97148E-02 [3.17%]

Net Est Neutron Count Rate = 1.00000E-20 c/s +/- 2.73314E-02 [*****%]

Measured N Source Strength = 1.90578E-17 n/s +/- 5.20876E+01 [*****%]

PRELIMINARY TRU activity 1.3122E-11 nCi +/- 3.5864E+07 nCi [*****%]

LESS THAN 5.8997E+07 nCi (1.64-sigma threshold)

TRU activity Density 1.3120E-14 nCi/gram +/- 3.5858E+04 nCi/gram [*****%]

LESS THAN 5.8986E+04 nCi/gram based on GROSS WT= 1000. grams

TRU activity Density 1.3122E-11 nCi/gram +/- 3.5864E+07 nCi/gram [*****%]

LESS THAN 5.8997E+07 nCi/gram based on NET WT= 1. grams

Total grams of TRU in barrel 1.4818E-19 gram +/- 4.0501E-01 gram [*****%]

LESS THAN 6.6624E-01 gram

CALCULATIONS BASED ON: 1.000 kg Net barrel weight 1 N-tubes

Neutron Efficiency = 5.2472E-04 (2.6236E-05) [cts/s]/[n/s] [5.00%]

Calibration Factor = 6.8854E+05 (3.4427E+04) nCi/[n/s] [5.00%]

Specific Activity = 8.8552E+07 (4.0000E+06) nCi/gram [4.52%]

Meas Bkg Count Rate= 6.2187E-01 (1.9715E-02) cps [3.17%]

Bkg Gross Barrel Wt= 3.202 # BkgAdjFactor= 1.000000 CFERR= 0.0000E+00

TRU material assumed to be: Weapons grade Pu oxide

Appendix B

Spreadsheet Printout Showing Values and Data Used
to Establish the Efficiency Calibration for
the PNNL Passive Neutron Counter

Date: 2/26/97 12:25 PM

File: 97022503.XLS

2.00'H x 2.00'D x 6.00'W Waste Container
 97022503 counted: 02/25/97

H 24 "
 W 72 "
 D 24 "

Container ID: M-710 PuBe w/ single BF-3 Tube

Gross: 1 lb 0.5 kg
 Tare: 0 lb 0.0 kg
 Net: 1 lb 0.5 kg

Type of Count: 4-sided

Detector Placement: 0 ft away

Count of Container at Specified Detector Placement

Side A Side B Side C Side D

114	126	114	126
138	121	138	121

200 s 124.8
 ± 9.4

Calibration information

97800.0 n/s on: 02/25/97

Distance (ft)	Count Time (s)	Gross Count (c)	Distance (ft)	Net Rate (c/s)	Net Rate (c/s)	ln(ft.)	ln(rate)
0 ft away							
1 ft	600 s	30196 c	1	49.70 c/s	50.66	0.000	3.906
2 ft	600 s	22094 c	2	36.20 c/s	34.89	0.693	3.589
3 ft	400 s	11508 c	3	28.15 c/s	28.05	1.099	3.337
4 ft	400 s	9658 c	4	23.52 c/s	24.03	1.386	3.158
5 ft	400 s	8206 c	5	19.89 c/s	21.31	1.609	2.990
			6		19.31		

Expected count rate using neutron standard

Type

Calibration Factor (c/n): 5.2472E-04 ± 2.6236E-05
 Calibration Factor (c/n): 2.4866E-04 ± 1.2433E-05
 Calibration Factor (c/n): 2.6622E-04 ± 1.3311E-05
 Calibration Factor (c/n): 3.5446E-04 ± 1.7723E-05
 Calibration Factor (c/n): 4.3127E-04 ± 2.1563E-05

1.00	51.32
3.74	24.32
3.32	26.04
2.00	34.67
1.41	42.18

Homogenous
 1-Sided
 2-Sided
 3-Sided
 4-Sided

File: 97022503.XLS

Date: 2/26/97 12:25 PM

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APPENDIX C: Smerable Radiological Contamination Estimate

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Smearable Contamination Estimate.

The smearable contamination is estimated for use in release calculations. The releasable quantity of material is obtained from surface area estimates in the FEF. Vertical and horizontal surfaces are considered separately. Smear survey results are averaged for horizontal and vertical surfaces samples. The results should only be considered as an estimate because the cell surface areas are approximated and quantified smearable contamination from all surfaces were not available.

Surface area calculations are shown in C-1. Detailed drawing of several of the cell components were unavailable. Internal surface area is considered for duct assemblies and components. Smearable contamination estimates from horizontal and vertical surfaces are shown in C-3. Contamination levels on all surfaces were not available, however the samples taken are expected to represent the conditions inside the FEF.

Table C-1. Total Smearable Isotopic Content Summary					
Isotopes	Average Vertical Surface Ci/100 cm ²	Calculated Vertical Surface Curies	Average Horizontal Surface Ci/100 cm ²	Calculated Horizontal Surface Curies	Total Curie Estimate
Total Alpha	6.84E-01	8.88E-09	3.46E+01	2.48E-08	3.37E-08
Total Beta	1.99E+02	2.58E-06	1.10E+04	7.88E-06	1.05E-05
Co-60	2.62E+02	3.40E-06	1.30E+04	9.32E-06	1.27E-05
Cs-137			2.68E+01	1.92E-08	1.92E-08
Ag-108m			6.43E+00	4.61E-09	4.61E-09
Ba-133			1.71E+01	1.23E-08	1.23E-08
Total Curies					2.33E-05

Table C-2. FEF Area Estimates		
Component/Area	Vertical Area m ² (Ft ²)	Horizontal Area m ² (Ft ²)
Cell Walls	624	24
Radiation Shield	129.8	
Cooling Pipe	45.9	
250 CFM Duct	250	12.5
Light Fixtures	127	0.75
1500 CFM Duct	126.5	6.3
Fuel Manipulator	51.4	13.1
Ducting Inside Concrete	42.3	20.5
Totals	130 m ² (1396.9 ft ²)	7.17 m ² (77.15 ft ²)

Unless otherwise noted units = pCi/100 cm²

Table C-3. Average Smear Sample Results

Sample	Location	Total Alpha	Total Beta	Co-60	Cs ¹³⁷	Am ²⁴¹	Ag ^{108m}	Ba ¹³³
PRTR-FX-01	Floor #1 sample	2.88E+00	8.67E+02	1.15E+03	--	--	--	---
PRTR-FX-02	Floor #2 sample	---	3.52E+02	4.49E+02	--	--	--	---
PRTR-FX-03	Lower Manipulator Chuck (west side)	6.07E+01	1.77E+04	3.31E+04	1.53E+02	--	--	1.20E+02
PRTR-FX-06	Lower Manipulator Chuck (east side)	5.59E+01	2.40E+04	3.49E+04	--	--	--	---
PRTR-FX-08	Upper Manipulator Chuck	8.32E+01	1.97E+04	3.00E+03	3.46E+01	--	4.50E+01	---
PRTR-FX-05	Bottom of east light bank (horizontal surface)	2.87E+01	1.26E+04	1.62E+04	--	--	--	---
PRTR-FX-10	Bottom of west light bank	1.08E+01	1.57E+03	2.21E+03	--	--	--	---
	Horizontal Surface Average	3.46E+01	1.10E+04	1.30E+04	2.68E+01	0.00E+00	6.43E+00	1.71E+01
PRTR-FX-09	Wall @ -15' (west side)	5.46E-01	1.86E+02	2.54E+02	--	--	--	---
PRTR-FX-04	Wall @ -15' (east side)	8.22E-01	2.12E+02	2.69E+02	--	--	--	---
	Vertical Surface Average	6.84E-01	1.99E+02	2.62E+02				
PRTR-FX-07	Shim Rod Assembly	6.71E+01	1.61E+02	4.63E+01	1.21E+02	2.76E+01	--	---

1. Samples are grouped into horizontal, vertical and misc. categories. --- Below detection limit
2. Calculated surface average is calculated on the number of sample represented by the surface (7 for horizontal, 2 for vertical)
3. Below detection limits are include as 0.0 in the average, because the average will be applied to the bulk area for isotope estimation purposes.

APPENDIX D: MSDS Sheets

MSDS #010231, Aerokroil D-3

MSDS #11219, Glyptal, Air Drying Enamel D-5

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PAGE:01

SCOTT

MSDS # 010231

 4 = EXTREME
 3 = HIGH
 2 = MODERATE
 1 = SLIGHT
 0 = NONSIGNIFICANT

FLAMMABILITY

HEALTH

REACTIVITY

MATERIAL SAFETY DATA SHEET

SECTION I

HMIS RATING

PRODUCT NAME OR NUMBER (as it appears on label) AEROKROIL		EMERGENCY TELEPHONE NO. 615-833-4101	
MANUFACTURER'S NAME KANO LABORATORIES, INC.		MANUFACTURER'S DUN-8 NO. N/A	
ADDRESS (Number, Street, City, State and Zip Code) 1000 S. Thompson Lane, Nashville, TN 37211-2627			
HAZARDOUS MATERIAL DESCRIPTION, PROPER SHIPPING NAME, HAZARD CLASS, HAZARD ID NO. (49 CFR 172.101) N/A, Petroleum Distillate, N/A, N/A			
ADDITIONAL HAZARD CLASSES (as applicable) N/A			
CHEMICAL FAMILY Petroleum Lubricant		FORMULA Proprietary	

SECTION II—INGREDIENTS

CAS REGISTRY NO.	%V	CHEMICAL NAME(S)	OSHA/ACGIH PEL/TLV PPM	Used as a Carcinogen in NTP, IARC or OSHA 1916(c) (Specify)
64742-46-7	301-501	Petroleum Base Oil	5.0 mg/m ³ TWA	No
78-92-2	11-101	Aliphatic Petroleum Distillate	50 TWA	No
64742-95-6	11-101	Petroleum Solvent	50 TWA	No
111-76-2	11-101	Aliphatic Hydrocarbon Solvent	50 TWA	No
—	11-201	Non-Hazardous Proprietary Mixture	—	No
64742-47-8	201-401	Petroleum Naptha	100 TWA	No
123-42-2	11-101	Hydrocarbon Solvent	75 STEL	No
115-10-6	11-151	Dymel A (Propellant)	1000 TWA	No
All ingredients in Aerokroil are listed in the TOSCA inventory list.				
TOTAL		1001		

SECTION III—PHYSICAL DATA

BOILING POINT 250°F	SPECIFIC GRAVITY (H ₂ O=1) .88	
VAPOR PRESSURE (OF LIQUID) 0.2 mm Hg	PERCENT VOLATILE BY VOLUME (%) 60	PERCENT SOLD BY WEIGHT (%) 0
VAPOR DENSITY (AIR=1) N/A	EVAPORATION RATE (But. Acet. less than 1) pH.	
SOLUBILITY IN WATER NIL	6.0-7.0	
APPEARANCE AND ODOR Aerokroil, liquid, slight reddish color, pleasant odor		IS MATERIAL: LIQUID SOLID GAS PASTE POWDER

SECTION IV—FIRE AND EXPLOSION HAZARD DATA

FLASH POINT N/A °C	method used Not applicable to aerosols	FLAMMABLE LIMITS LFL UFL
EXTINGUISHING MEDIA CO ₂ , Dry Chemical, Foam		
SPECIAL FIRE FIGHTING PROCEDURES Usual procedure for solvents. Treat as combustible material. Do not use water.		
UNUSUAL FIRE AND EXPLOSION HAZARDS Store at room temperature. Exposure to direct sunlight and/or temperatures over 120° may cause cans to burst. Keep away from ignition sources and open flame.		

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SECTION V—HEALTH HAZARD DATA

Aerokroll—Page 2

SYMPTOMS & EFFECTS OF OVEREXPOSURE: EYE—burning & irritation. SKIN—dryness. Prolonged exposure may cause dermatitis. INHALATION may cause headache, dizziness, anesthesia, nausea & upper respiratory irritation. INGESTION may cause lung irritation, nausea, vomiting & diarrhea. Harmful or fatal if swallowed.		THRESHOLD LIMIT VALUE PERMISSIBLE EXPOSURE LIMIT	OTHER LIMIT
PRIMARY ROUTES OF ENTRY Inhalation ☒ Skin Contact ☐ Other (Specify)			N/A
EMERGENCY AND FIRST AID PROCEDURES EYE—Immediately flush with large amounts of water for 15 minutes. SKIN—wash with mild soap and water, apply skin cream. INHALATION —remove to fresh air. If breathing is difficult administer oxygen, if breathing stops give artificial respiration. Get medical attention. INGESTION —Contains hydrocarbon solvents and petroleum oil. Do not induce vomiting, call physician immediately. Minute amount aspirated into lungs during ingestion may cause severe pulmonary damage. Do not administer epinephrine or adrenaline.			

SECTION VI—REACTIVITY DATA

MSDS # 010231

STABILITY	UNSTABLE	CONDITIONS TO AVOID
	STABLE	Heat. Sparks, Open Flame. Strong Oxidants.
INCOMPATIBILITY (materials to avoid) Strong Oxidizing Agents.		
HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition in the presence of air may yield carbon monoxide and/or carbon dioxide.		
HAZARDOUS POLYMERIZATION	MAY OCCUR	CONDITIONS TO AVOID
	WILL NOT OCCUR	N/A

SECTION VII—SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED	Wipe up immediately with absorbent rags, sweeping compound or other absorbent material. Remove or extinguish all flames and sparks. Do not flush into sewer.
WASTE DISPOSAL METHOD	Bury saturated absorbent in approved landfill. Dispose of as any combustible fuel in accordance with local, state and federal regulations.
CERCLA (Superfund) REPORTABLE QUANTITY (in lbs)	N/A
RCRA HAZARDOUS WASTE NO. (40 CFR 261.33)	N/A
VOLATILE ORGANIC COMPOUND (VOC) (as packaged, minus water)	N/A
☐ Theoretical 7.8 lb/gal	☐ Analytical 7.8 lb/gal

SECTION VIII—SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (specify type)		
NIOSH approved respirator for vapors if desired.		
VENTILATION	LOCAL EXHAUST (Specify Rate)	SPECIAL
	MECHANICAL (General) (Specify Rate)	OTHER
PROTECTIVE GLOVES	Chemically resistant gloves if needed to protect skin.	EYE PROTECTION If splash potential exists wear chemical splash goggles.
OTHER PROTECTIVE EQUIPMENT	None needed.	

SECTION IX—SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE	
Keep away from excessive heat, sparks and open flame. Do not take internally. Do not leave container open. Store in cool area. Other Precautions: Use with proper ventilation. Wearing contact lenses is not advisable. If swallowed can enter lungs and may cause chemical pneumonia. Do not administer epinephrine or adrenaline. Keep away from children and animals. Do not puncture containers.	
The above information is based on information available at this time and is believed to be accurate. However, the data is provided without warranty, expressed or implied. It is the user's responsibility to determine safe conditions for use of this product. We expressly disclaim all liability for reliance thereon, and assume no liability in connection with any use of this information.	
Title	Name (print)
Chairman	P.R. Zimmerman
Date	Signature
1/1/96	<i>P.R. Zimmerman</i>

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MSDS # 11217

MATERIAL SAFETY DATA SHEET

DATE OF PRINTING: 03/09/92

SECTION I

MANUFACTURER: GLYPTAL, INC.
 305 EASTERN AVE
 CHELSEA, MA 02150
 TELEPHONE: 617-884-6318
 PRODUCT CLASS: AIR DRY ENAMEL
 CODE IDENTIFICATION: 1201
 TRADE NAME: GLYPTAL

HMIS 2 3 0

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENT	PERCENT BY WEIGHT	ACGIH TLV PPM	OSHA PEL mg/cu.m. PPM	OSHA PEL mg/cu.m.
XYLENE	34.3	100		100
CAS NUMBER 1330-20-7				
HMIS HEALTH=1 FLAMMABILITY=3 REACTIVITY=0				
XYLOL				
VM&P NAPHTHA	5.6	300		300
CAS NUMBER 8030-30-6				
HMIS HEALTH=2 FLAMMABILITY=3 REACTIVITY=0				
ALIPHATIC HYDROCARBON				
STODDARD SOLVENT	0.2	500		
CAS NUMBER 64741-41-9				
HMIS HEALTH=2 FLAMMABILITY=2 REACTIVITY=0				
HYDROCARBON MIXTURE				
IRON OXIDE	8.2			
CAS NUMBER 1309-382				
HMIS HEALTH=0 FLAMMABILITY=1 REACTIVITY=1				
FERRIC OXIDE				
HYDRATED MAGNESIUM SILICATE	17.0	20		
CAS NUMBER 14807-96-6				
HMIS HEALTH=2 FLAMMABILITY=0 REACTIVITY=0				
TALC				

Remaining 34.7 % is a non-hazardous alkyd resin.
 VM & P (CASH 8030-30-6). AGENCY OSHA TYPE STEL EXPOSURE LIMIT 400 PPM
 N/A MEANS NOT AVAILABLE N/EST MEANS NOT ESTABLISHED
 NOT EST. means NOT ESTABLISHED
 NOT EST. means NOT ESTABLISHED
 N/A MEANS NOT AVAILABLE NOT EST MEANS NOT ESTABLISHED

SECTION III - PHYSICAL DATA

BOILING RANGE: 250.0 TO 345.0 F VAPOR DENSITY: HEAVIER THAN AIR
 EVAPORATION RATE: SLOWER THAN ETHER
 PERCENT VOLATILE BY VOLUME: 56.3 VOC (less water): 3.98 LBS/GAL
 WEIGHT PER GALLON: 9.92 POUNDS
 V.O.C. Is determined per EPA Reference Method 24 using ASTM procedures D2369
 ,D1475 and D3960.
 VAPOR PRESSURE: 5.79 mm/hg MELTING POINT: NOT APPLICABLE

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SOLUBILITY IN WATER: NEGLIGIBLE
APPEARANCE AND ODOR: RED LIQUID WITH PAINT ODOR

MSDS # 11219

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

OSHA CATEGORY: FLAMMABLE LIQUID

FLASH POINT : 72 F PENSLEY MARTIN LEL: 1.0 UEL: N/A
EXTINGUISHING MEDIA:

Carbon dioxide, dry chemical or foam

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Pressure may build up in closed containers that are exposed to heat.

Solvent vapors are heavier than air and may travel a considerable distance along the ground to an ignition source and "flash back".

SPECIAL FIRE FIGHTING PROCEDURES:

Water may be ineffective, however, water may be used to cool closed containers that are exposed to heat. Firefighting personnel should wear self-contained breathing apparatus.

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE: SEE SECTION II

PRIMARY ROUTE(S) OF ENTRY:

Inhalation and skin contact

EFFECTS OF OVEREXPOSURE:

Headache, nausea, dizziness, confusion, irritability.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE:

Respiratory difficulties or preexisting skin sensitization.

CARCINOGENICITY:

None of the components of this product are reported carcinogens in A/C with OSHA, NTP, IARC and NIOSH.

EMERGENCY FIRST AID PROCEDURES:

INHALATION: Remove to fresh air. Administer artificial respiration or oxygen if breathing is difficult.

SKIN: Wash affected area with soap and water. Remove and launder contaminated clothing. Consult a physician if irritation persists.

EYES: Flush immediately with large amounts of water for at least 15 minutes. Take to a physician for medical treatment.

INGESTION: Call a physician immediately.

ACUTE: Skin and eye contact: Primary irritation.

CHRONIC: Xylene contained in this material has been found to cause the following effects in laboratory animals: anemia, liver abnormalities, liver and eye damage.

Pre-Existing liver and/or kidney disorders may be aggravated by exposure to xylene. Reports have associated repeated and prolonged occupational overexposure to xylene with permanent brain and nervous system damage.

SECTION VI - REACTIVITY DATA

STABILITY: NORMALLY STABLE

CONDITIONS TO AVOID:

None known

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INCOMPATIBILITY (Materials to avoid)

Strong acids and bases

HAZARDOUS DECOMPOSITION PRODUCTS:

BY FIRE: Normal products of incomplete combustion.

HAZARDOUS POLYMERIZATION: DOES NOT OCCUR

CONDITIONS TO AVOID:

None known

MSDS #11219

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

Provide adequate ventilation. Remove all possible ignition sources.

Absorb and dispose using non-sparking tools.

Eliminate all sources of ignition. Evacuate unprotected personnel. Water spray may be used. To contain run-off, cover with an absorbent material and place in containers for proper disposal. Flush area with water to remove residue.

WASTE DISPOSAL METHOD:

Dispose in accordance with local applicable regulations.

Dispose of using an approved incineration process or in accordance with local, state, and federal regulations regarding health and pollution.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

In outdoor or open areas use Bureau of Mines approved mechanical filter respirator to remove solid airborne particulates of overspray.

Indoors, where ventilation is inadequate, use Bureau of Mines approved chemical-mechanical respirators designed to remove both particulate and vapor.

VENTILATION:

PROTECTIVE GLOVES:

Recommended if skin contact is likely.

EYE PROTECTION:

Chemical splash goggles recommended if potential for splash or eye contact is likely.

OTHER PROTECTIVE EQUIPMENT:

Recommended as needed to avoid contact.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING OR STORING:

Store in a cool dry place away from heat, sparks and open flame. Keep containers closed and upright to prevent leakage. Outside or detached storage is preferred. Inside storage should be in a standard flammable liquid storeroom or cabinet. Metal containers should be grounded when transferring material from one container to another. Do not reuse product container for any purpose.

OTHER PRECAUTIONS:

MSDS: 1201
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PREPARED BY: TECHNICAL STAFF

MSDS # 11219

REFERENCE DATE: 01/26/89

ACCORDING TO STATE OF CALIFORNIA'S LIST OF CHEMICALS KNOWN TO CAUSE CANCER OR REPRODUCTIVE TOXICITY, THERE ARE NONE PRESENT IN THIS PRODUCT.

MSDS # 11219

TO WHOM IT MAY CONCERN: EFFECTIVE JAN 1, 1989, WE ARE REQUIRED BY SARA TITLE III SECTION 313 OF THE RIGHT TO KNOW LEGISLATION, TO INFORM YOU OF THE PERCENTAGE OF ANY INGREDIENT IN A PRODUCT WHICH IS IN THE 313 LIST OR AS AN LISTING AS A COMPONENT OF A MATERIAL WHICH IS IN A CATEGORY OF CHEMICAL LIST.

PRODUCT: 1201 GLYPTAL

34.3% XYLENE (CAS NUMBER 1330-20-7)

IF YOU WILL MULTIPLY YOUR TOTAL PURCHASES FROM US AS WELL AS FROM OTHER SUPPLIERS BY THE PERCENTAGE OF EACH INGREDIENT FOUND IN EACH PRODUCT AND IF THE TOTAL QUANTITY EXCEEDS THE REPORTABLE QUANTITY FOR THAT INGREDIENT YOU ARE REQUIRED TO FILE FORM R REPORTS.

**APPENDIX E: 309 FEF Fuel Manipulation Machine CVI
Excerpts**

(CVI File No. 15449)

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SECTION I

PURPOSE AND GENERAL DESCRIPTION

The Primary Manipulator is designed and built for remote controlled manipulation of fuel elements, or process tubes, during examination by remote optical means. In this manual, unless otherwise noted, the expression "fuel elements", or "elements" will include fuel elements with hangers and process tubes.

The Manipulator will be installed in a vertical position in a shielded cell. Fuel elements, suspended from one end, will be lowered into the manipulator by an overhead device (juggernaut), while the manipulator is either operated at an adjustable vertical travel rate, or held stationary.

After an element is lowered into the cell it will be chucked by the manipulator for the scanning operation.

The scanning motions of the manipulator will permit selective 2 direction, 2 speed, rotation of the element on its own axis, and for 2 direction, 2 speed vertical travel along the axis.

Other functions of the manipulator will include:

- (a) Selective operation of 2 drive heads
- (b) Chucking and releasing, during rotation.
- (c) Adjustable vertical rapid traverse rate for loading and unloading.
- (d) Tail support adjusting and pivot operation.
- (e) Cooling air baffle opening and closing.
- (f) A numerical read out, at the operator's console, of the vertical position of the upper drive head.

SECTION IV

INSTALLATION

1 - PREPARATION FOR INSTALLATION

- (a) Remove covering and attachments to timber skid, letting the beam continue to rest on the skid.
- (b) Examine manipulator for any possible damage in shipment, checking in particular air line tubes, trolley rods, and electrical and air fittings. If desired, after removing any interfering blocks, or straps, the manipulator may be operated over a short travel (1" or 2"), at scan speed only, by temporary connections. Other functions may also be tested thru short motions.
- (c) Remove any beam attachment clamps which will interfere with the installation of the air ducts (furnished by customer). Also, remove any beam attachment clamps which would be inaccessible after installation of the air ducts.
Do not disturb the (B) wedge type jacks on the shipping beam.
- (d) Installation of air ducts:

- 1 - Upon examination of the cooling air transitions it will be found they are designed to fit inside of the traveling air duct carriage members.

The air ducts are to be attached to the vertical track frame by a series of three dovetailed support blocks and strips. The strips will be found mounted in line, numbered and attached to the sides of the vertical track frame.

Taking full advantage of the edge of the "in line" surface of the leveling jacks, as found attached to the "shipping beam", by placing the proper air ducts in place on the edge of the leveling jacks and the end of the duct against the bottom support brackets, the dovetailed support blocks (H-37750) can be spotted for attachment to the duct proper, after being first placed in position between their support strips for lengthwise location.

SECTION IV

INSTALLATION (Continued)

1 - PREPARATION FOR INSTALLATION

(d) Installation of air ducts (continued):

When this is being done the traveling duct carriage and flexing sealing strip should not be in place on the duct since it will be required to drill four clearance holes from the inside of the duct into the surface of the support blocks (four 3/8 N.C.-16 x 5/8 long head stainless steel screws per block should suffice).

After the holes are spotted through the duct wall into the support blocks, the blocks should be numbered, slid out of their support strips, drilled and tapped for the 3/8 N.C. support screws, then attached to the duct wall with the 3/8 round head machine screws, taking care so the screws will not project thru the blocks.

After the blocks are attached to the duct wall the flexing sealing strip or band and traveling duct carriage should be assembled with the duct.

The next step will be to place this assembly adjacent to the vertical track frame with the bottom of the duct again resting on the edge of the leveling jacks. However, the duct must be placed with the bottom end far enough away from its end support brackets to allow the support dove tail blocks to be slid together after first bringing the traveling duct carriage to the position where the air transition extensions can be inserted into same. It will be found the duct can then be slid into position (Providing the duct is straight; otherwise a sheet metal shim may be required) (Also it may be wise to provide for some internal strengthening strips to the duct wall, depending on its inherent strength)

After the duct assembly is in place the only thing remaining is the attachment of the carriage clevis plates (H-37715) to the traveling duct carriages and connecting the R. and L. hand side drag rods.

SECTION IV

INSTALLATION (Continued)

1 - PREPARATION FOR INSTALLATION

(d) Installation of air ducts (continued)

Once the above assembly steps have been followed the ducts can be quickly removed, or reinstalled with the aid of the shipping beam as a guide, after removing the clevis pin (H-37712). The duct can be slid forward to disengage the dovetail support blocks thereby freeing the duct assembly.

2 - INSTALLATION

- (a) Check to make sure that the manipulator is attached to the "shipping beam" at each end and at least one point near the middle. The hooks provide attachment at each end. After duct installation, it may be necessary to add a timber clamping arrangement near the middle. This should bear on the main vertical track, not on any shaft or lead screw, or telescoping air lines.

Previous to these precautions the support brackets should be checked for having been properly attached to the cell wall, as to squareness of their mounting relative to the plumbness of the cell walls.

Likewise, all air lines attachable with their respective manifolds, as well as electrical plug jacks, should be separated at their respective mating sections and all lines should be free of the manipulator proper so as not to become fouled on the beam when lowering or removing the manipulator.

(b) Erecting

Move the manipulator and shipping beam assembly into the position desired for erecting, depending on which of two methods is used for erecting.

For the first method, the location of the beam and manipulator assembly at the time of lifting to vertical is not important.

For the second method, the assembly is located fairly accurately with respect to the cell chambers.

SECTION IV
INSTALLATION (Continued)

2 - INSTALLATION (Continued)

(b) Erecting (Continued)

For either method a separate provision must be made to hold the beam after tilting to the vertical position, so that the crane can be released from the beam, and attached to the manipulator lifting eyes. Guy wires or ropes are suggested, with blocks to restrain the lower end.

FIRST METHOD: Block the lower end of the shipping beam to prevent its shifting while tilting. For this purpose, a bar can be inserted thru the lower lifting cross member, and supported in blocks high enough so that the lower end of the beam will clear the floor as it pivots.

Attach the sling to one or two bars thru the upper lifting cross member. Use bars long enough so that the sling will not bear against the manipulator. Lift the beam and manipulator assembly to a vertical position in such a manner that the manipulator is resting on the beam on the way up.

Avoid tilting past the vertical.

Attach guy wires to the beam, or lock it into position if facilities permit.

Unhook the crane from the beam and attach to the manipulator lifting eye bolts, using a suitable sling. One lifting eye-bolt will have to be temporarily screwed into the provided hexagonal extension and removed after the manipulator is in position in the cell, due to crowded conditions.

Remove beam attachment clamps from the manipulator and remove the retaining straps (H-38129) from the lower hooks on the shipping beam.

Adjust the sling so that the manipulator will hang close to a vertical position. This can be done by lifting the manipulator slightly off the beam support hooks to check the sling adjustment, and hanging it back on the hooks while adjusting the sling.

SECTION IV

INSTALLATION (Continued)

- 2 - INSTALLATION (Continued)
 - FIRST METHOD (Continued)
 - (b) Erecting (Continued)

After adjusting and setting the sling, the manipulator can be lifted out of the hooks, and lowered into the cell chamber to rest in the upper support brackets and be retained by the lower support brackets.

The traveling crane, after having raised the manipulator from the cradling of the shipping beam, should be inched away from the hook supporting wall in such a direction so as to allow the manipulator assembly to be lowered, clearing the air duct connections in the cell wall, after which the crane should return the manipulator towards the cell wall thereby allowing the manipulator to come to its position with the cross pins in their respective support hook brackets. It will be noted the hooks cause a coming action of 1/8 inch towards the support brackets from their point of entry, this action acting to seal the air ducts relative to their joint faces with the duct outlets in the cell wall. For this reason some form of stainless steel bellows should be provided by the customer between the in cell wall duct outlets and duct inlets, so as to properly seal the connections air tight.

NOTE: Before removing the sling from the manipulator, record information on the sling adjustment, so that it can be arranged the same way for any subsequent service removal from the cell, or lock the sling adjustments with cable clamps.

SECOND METHOD:

This method permits using the shipping beam as a guide when lowering the manipulator into the cell. The manipulator and beam assembly is positioned vertically so that the centerline of the hooks on the beam is slightly back of the centerline of the hooks in the cell chamber. For this purpose, either

- (a) Provide a jig plate, with dowels to match the holes in the bottom end of the shipping beam, and mount the jig plate in proper location on the floor. After erecting to vertical as in the First Method, and before proceeding further, move the beam and manipulator assembly, steadying the lower end, to location on the dowels.

SECTION IV

INSTALLATION (Continued)

3 - INSTALLATION (Continued)

SECOND METHOD (Continued)

- (b) After erecting to vertical as in the First Method and before proceeding further, move the beam and manipulator assembly, steadying the lower end to a measured location above the cell chamber and back the lower end in position.

After proceeding as in (a) or (b), adjust the beam and manipulator assembly so that it is true vertical in a front view, and slightly tilted back (1" or 2" in the height of the beam) so the manipulator leans against the beam.

Attach guy wires to the beam, lash it into position if facilities permit, or if the crane is equipped with an auxiliary hook use it for supporting the beam.

Unhook the crane from the beam and attach to the manipulator lifting eyes, after installing the one temporary eye bolt in its extension, using a suitable sling.

Remove beam attachment clamps from the manipulator, and remove the retaining straps (H-38129) from the lower hooks on the shipping beam.

Adjust the sling so that the manipulator will hang close to a vertical position. This can be done by lifting the manipulator slightly off the bottom of the hooks on the beam, to check the sling adjustment take up, and hanging it back on the hooks while adjusting the beam.

After adjusting the beam, raise the crane just enough to take up the weight of the manipulator. Then remove the hooks from the sides of the beam.

The manipulator can now be lowered into the cell chamber onto the hooks in the cell, using the beam as a rough starting guide.

CAUTION: While lowering the manipulator keep jogging the crane forward to maintain the manipulator in a vertical position, so as to avoid an undue bending movement due to the portion of the manipulator length which extends below the end of the beam; likewise so the ducts will not be fouled on the upper hooks.

SECTION IV

INSTALLATION (Continued)

DISPOSITION OF THE SHIPPING BEAM

For the reasons given elsewhere, the manufacturer urgently recommends that the manipulator never be tilted from vertical to horizontal, or vice versa, without the use of the shipping beam. Any attempt to do so shall automatically absolve the manufacturer from any responsibility due to twist of any components. This includes service removal from the pit, although the beam need not be used if the manipulator is removed for inspection but not laid in a horizontal plane.

For machine assembly, testing, and shipping purposes, the shipping beam has been fabricated as one piece. In the event it is impossible, because of space limitations, to store and reuse the beam in one piece, it can be cut into sections in the following manner:

- (a) Machine off section of suitable length for storage purposes (3 or 4 sections are preferred), in such a manner that the joints will not occur at the cross braces, or at the wedge jacks. Do not cut yet.
- (b) For each joint, provide (2) splice plates not less than 14" wide by 54" long for the sides of the channels, and (4) splice plates 2-1/2" wide by 24" long for the channel flanges. All the splice plates are to be not less than 1/2" thick (one 14" and (2) 2-1/2" plates are used on each channel at each joint).
- (c) Drill splice plates in position for a generous distribution of bolts. Provide at least (4) dowels in each plate, one near the joint on each side of the joint, and one near each end of the plate. Stamp splice plates as to joint and location.
- (d) Remove all splice plates, and cut beam into the sections as marked.

After cutting "shipping beam" apart and reassembling, the wedge jacks should be checked for being flat and in the same plane as previously using it for handling the manipulator.

One way the jacks can be set level is to employ a music wire stretched taut between the top and lower hook centerline, and measuring 2.625 from this center line to the top of the wedge jack shims.

SECTION V

MECHANICAL DESCRIPTION

EMERGENCY MANUAL ACTUATIONS

CAUTION:

To prevent damage to the manipulator consider the following facts before using the emergency vertical travel actuation:

- 1 - The positions of the three air shifted jaw clutches in the vertical travel drive determine the results of turning the motor shaft.

The position of the three clutches are as indicated by their respective selectors, as described below, when the green lamp is lit. (When in the "disassembly" condition - tail support open and baffles open - the amber "disassembly" lamp takes the place of the green lamp). If the green (or amber) lamp is not lit, turn the selector to a position that lights the green (or amber) lamp, if possible. If this is not possible, (and the indicating power is on, and properly functioning) it indicates that the clutch is in an intermediate, and possibly, a partially engaged position. Under this condition, it might be possible to strip or damage the clutch.

To correct the clutch ambiguity, alternately turn the motor shaft and shift the selector until the green lamp lights. Unless the carriage (or carriages) is at the lower limit, turn the motor counterclockwise, thus putting less load on the clutch. The amount of rotation required will vary widely, according to the pitch of the clutch teeth and the mechanical advantage involved.

- 2 - The two speed clutch provides two different mechanical advantages from the motor shaft to the lead screws.
 - (a) When in the "load" position of the speed selector switch (with green lamp lit), one revolution of the motor shaft provides .08" of vertical travel - 12.5: 1 (approximate) mechanical advantage to the lead screws.
 - (b) When in the 15" or 7.5" positions, one revolution of the motor shaft provides .0045" of vertical travel - 220 : 1 (approximate) mechanical advantages to lead screws.

The particular mechanical advantage in use should be considered to avoid exerting undue force.

SECTION VMECHANICAL DESCRIPTIONEMERGENCY MANUAL ACTUATIONS (Continued)CAUTION (Continued)

- 3 - The "vertical motion" selector shifts the other two clutches to drive either "upper carriage", "lower carriage", or both. If the green indicating lamp is lit, it verifies the clutches are in the position indicated on the "vertical motion" selector.
- 4 - Under normal (power) operating conditions, the vertical travel motions of the two carriages are limited with respect to the ends of the manipulator, and to each other, by proximity limit switches.

When manually actuating the vertical travel it is possible to overtravel the switches, and jam the saddles against mechanical end limits, or to each other. Unless excessive force is applied, the anti-friction characteristics of the ball screws should make it possible to easily release the jammed condition. Before that point is reached, however, it may be possible to set up undue strains.

For this reason, manual vertical travel should be backed off if a substantial rise in torque load is noticed.

The following table gives crude estimates of the torque required at the motor shaft for various conditions of vertical travel upwards:

Torque (Pound Inches)

Speed Selector:	"Load" (High Speed)	15" or 7½" (Low Speed)
Both Carriages	52	3
Upper Carriage (only)	17	1
Lower Carriage (only)	35	2

Torque required for downward travel is too light for a realistic estimate.

NOTE: These estimates were made at the engineering stage, and may vary widely from experimental values, due to varying frictional factors.

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