Collection and Preservation of ANL ZPR/ZPPR Materials Inventory Records

J. A. Morman
R. D. McKnight
Nuclear Engineering Division
Argonne National Laboratory

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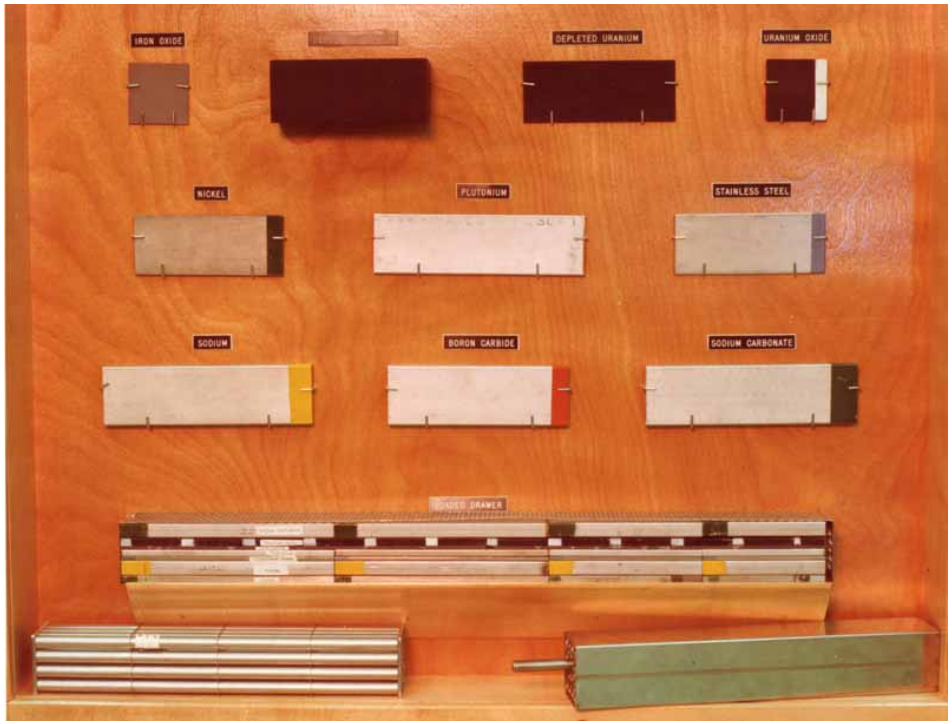
Task Statement

Collect and preserve the inventory records (size, composition, construction, etc.) of the ANL Zero Power Reactor (ZPR)/Zero Power Physics Reactor (ZPPR) materials.

This is important because some portion of these ZPR materials are planned to be retained and used at the Critical Experiment Facility in Nevada.



Records Identification

- Recon Mission, Idaho Falls, March 2010
  - B. Briggs, A. Garcia, D. McKnight, J. Morman, R. Schaefer
  - Records are tagged and in storage boxes
  - No detailed lists of box contents
  - Group selected random boxes to inventory
  - Subset of boxes sent for scanning
  - Scanned files returned to Argonne

Search Results (Example 1)

Box 173164

Date	Subject
	Periodic Surveys; correspondence, graphs
1971	Contaminated ZPR Fuel Plates; photos, correspondence, graphs
1973-1975	Hot Weld corners during fuel inventory Correspondence, charts, with fuel element weights and isotopic, analytical sample records, photos.
1968-1982	Fuel Swelling Experiments (correspondence, reports, data, and photos)
1972	Packing Fissile Materials for Shipment (correspondence.)
1979-1980	Contaminated Plates; (correspondence , data, and diagrams)
1967-1969	Atlantic Richfield Hanford Company Correspondence and date of metal buttons to be used in the fabrication of ZPR fuel; isotopic composition and weights; ZZPR Plutonium Analytical data sheets; ZPPR ingoting, analytical data sheets, specifications
1967	ISOCHEM Ave. isotopic content of Up ZPPR fuel used for FFTF measurements in ZPR-3 (data). Pu ingoting correspondence, sample data (isotopic analyses); more analytical data used for figuring average isotopic content of PU and Am to 9-29-67; packing details for ZPPR ingots, photos, Pu-240 results from the first three ingots blended (1967)

Search Results (Example 2)

Box 173160

No Folder

Technical specifications and drawings for DU blocks

Chemical analysis of DU; Miscellaneous specifications for U and Pu fuel

Procurement correspondence

ANL 6955 (process for manufacturing ZPR-III Pu-U-Mo elements)

ANL 7313 (development of design and fabrication method for Pu bearing ZPR elements)

ZPPR Fuel Development

Specifications and drawings for ZPR-III SEFOR fuel

ANL-FF-672, “Process Summary for Manufacture of SS Jacketed U-Pu-Mo Fuel Elements”

Bids for fabrication of NUMEC, DOW and SEFOR plates

Development of Initial ZPPR Materials Inventory (Fuel and non-Fuel)

FY68 material needs; chemical analysis of DOW and NUMEC plates; preliminary inventory records (1970)

Material Mass Statistics

Program output analyzing weight distribution of fuel pieces

Miscellaneous Info. on Fuels

Data for Spent Nuclear Fuels database; materials inventory summaries

Search Results (Example 2 cont'd)

Box 173160 (cont'd)

No Folder (pink sheet - Oxide Pu Information)

- Chemical analysis of Pu oxide pins
- Drawings and specifications for Pu-UO2 rods, DUO2 rods, enriched UO2 rods, PuO2 and aqueous Pu nitrate solution
- PF-1600, specifications for U-Pu-Mo alloy ZPPR fuel elements
- RF-B2b,c (ZPR) reactor fuel specifications for U-Pu dioxide fuel rods for ZPRs
- RF-B3a,b (ZPR) reactor fuel specifications for EU dioxide fuel rods for ZPRs

Pu0H Fuel Rods

- High-Pu240 fuel specifications; weight analysis of High-Pu240 rods

Oxide Fuel Pu0G

- Analysis of MOX fuel

Pu0F Thorium Contamination

- Correspondence on Th contamination of Pu fuel rods

PuO2 Enriched UO2 / 4.1.2 Pins/Calandria

- Specifications for PuO2-UO2 rods and calandria
- Composition data on PuO2-UO2 rods and calandria, and UO2 pins

Oxide Fuels (Rods or Pins)

- Miscellaneous correspondence on Pu contamination, Th contamination and procurement

Organization of Scanned Documents

Log Books

Directory	File Name	Summary of Contents	Start Date	End Date	Key 1	Key 2	Key 3
\ZPR_Records\ZPR-3\Logbooks	1908F Logbook.pdf	ZPR-3 Assembly 56 reactor startup and operations log, loadings 1-49 (184 pages) [duplicate file in \ZPR_Records\ZPR-3\ZPR3-56\Logbook]	12/19/1968	4/2/1969	ZPR-3	Assembly 56	logbook
\ZPR_Records\ZPR-3\Logbooks	ArgonneNationalLaboratory696E.pdf	ZPR-3 Assembly 7H reactor startup and operations log, loadings 1-32 (pages 6-50 of 206 pages total)	11/28/1956	12/28/1956	ZPR-3	Assembly 7H	logbook
\ZPR_Records\ZPR-3\Logbooks	ArgonneNationalLaboratory696E.pdf	ZPR-3 Assembly 6F reactor startup and operations log, loadings 1-14 (pages 52-68 of 206 pages total)	1/3/1957	1/14/1957	ZPR-3	Assembly 6F	logbook
\ZPR_Records\ZPR-3\Logbooks	ArgonneNationalLaboratory696E.pdf	ZPR-3 Assembly 8 reactor startup and operations log, loadings 1 through 78 (continued on p. 100 of logbook 697E) (pages 69-163 of 206 pages total)	6/6/1957	7/12/1957	ZPR-3	Assembly 8	logbook
\ZPR_Records\ZPR-3\Logbooks	ArgonneNationalLaboratory696E.pdf	ZPR-3 Assembly 8 reactor startup and operations log, loadings 236-267 (continuation from p. 46 of logbook 698E) (pages 166-203 of 206 pages total)	11/25/1957	12/18/1957	ZPR-3	Assembly 8	logbook
\ZPR_Records\ZPR-3\Logbooks	ArgonneNationalLaboratory698E.pdf	ZPR-3 Assembly 8 operations log, loadings 205-236 (continued from logbook 646E and continued on p. 161 of logbook 696E) (pages 5-50 of 205 pages total)	10/24/1957	11/13/1957	ZPR-3	Assembly 8	logbook
\ZPR_Records\ZPR-3\Logbooks	ArgonneNationalLaboratory698E.pdf	ZPR-3 Assembly 8 operations log, loadings 268-276 (continued from p. 198 of logbook 696E) (pages 51-67 of 205 pages total)	12/18/1957	12/23/1957	ZPR-3	Assembly 8	logbook

Organization of Scanned Documents (cont'd)

Materials Records

Directory	File Name	Summary of Contents	Start Date	End Date	Key 1	Key 2	Key 3
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPPR-III-Numer-Rec-Mat-Analysis.pdf	Miscellaneous chemical analyses of NUMEC plates, including trace elements (68 pages, many blank)	10/14/1964	8/16/1965	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Cert-Mat-Shipped.pdf	Certificate of conformance, including weights, for individual NUMEC wafers (123 pages, many blank)	5/7/1965	8/17/1965	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Jacket-Panel-Metall-Form.pdf	NUMEC Jacket Panel Metallography Form (thickness by serial number) (157 pages, many blank)	4/6/1965	7/6/1965	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Jacket-Panl-Insp-Form.pdf	NUMEC Jacket Panel Inspection Form (by jacket serial number) (165 pages, many blank)	3/17/1965	3/17/1965	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Pu-Fuel-Wafers-Pt-I.pdf	Detailed NUMEC Pu stainless steel can inspection results (41 pages, many blank)	May-65	May-65	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-PU-Fuel-Wafers-Pt-II.pdf	Detailed NUMEC Pu stainless steel can inspection results (51 pages, many blank)	May-65	May-65	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Pu-Fuel-Wafers-Pt-III.pdf	Detailed NUMEC Pu stainless steel can inspection results (53 pages, many blank)	May-65	May-65	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-PU-Fuel-Wafers-Pt-IV.pdf	Detailed NUMEC Pu stainless steel can inspection results (49 pages, many blank)	May-65	May-65	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Qual-Dum-Wafer-Insp-Forms.pdf	Detailed NUMEC dummy fuel can inspection and leak test qualification reports (165 pages, many blank)	2/17/1965	7/21/1965	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Qual-Pu-Homo-Ternary.pdf	Analysis reports for NUMEC Pu homogeneity in ternary fuel (141 pages, many blank)	3/6/1965	6/25/1965	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Tern-Mast-Alloy-Rec-Sht.pdf	NUMEC alloy master sheets and chemical analysis reports (77 pages, many blank)	2/23/1965	7/14/1965	ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Tern-Melt-Chem-Pt-I.pdf	NUMEC alloy melt record sheets and chemical analysis reports (187 pages, many blank)			ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Tern-Melt-Chem-Pt-II.pdf	NUMEC alloy melt record sheets and chemical analysis reports (205 pages, many blank)			ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Tern-Melt-Chem-Pt-III.pdf	NUMEC alloy melt record sheets and chemical analysis reports (227 pages, many blank)			ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Tern-Melt-Chem-Pt IV.pdf	NUMEC alloy melt record sheets and chemical analysis reports (241 pages, many blank)			ZPR-3	NUMEC	materials
\ZPR_Records\\Materials\ZPR-3_Numec_Pu	ZPR-III-Numec-Rec-Weld-Oper-Qual.pdf	Welding operators qualification forms for NUMEC plate manufacture (41 pages, many blank)	3/1/1965	3/1/1965	ZPR-3	NUMEC	materials

Examples : Chemical Analysis Records

MASS SPECTROGRAPHIC SERVICES LABORATORY
AVCO/TULSA

REPORT FORM

To: NUMEC

ISOTOPIC STANDARD INFORMATION*

Standard Identification	ISOTOPES						
NBS 948	239	240	241	242			
Accepted Values	91.35	7.94	0.680	0.0335			
Observed Values	91.37±.01	7.92±.01	0.681 ±.001	0.0333 ±.0002			

Sample Identification: Pu Oxide

WEIGHT PERCENT

Sample Number	239	240	241	242	Approx. U-238*	Approx. U-235*	Others*
24-11-01	90.54±.02	8.49±.02	0.93±.00	0.04±.00	.8	.8	Traces 23
24-11-05	90.53±.03	8.50±.03	0.93±.00	0.04±.00	.4	.04	
24-11-15	90.45±.03	8.49±.01	1.02±.03	0.04±.00	.1	.01	
24-11-20	90.54±.02	8.48±.03	0.94±.00	0.04±.00	.2 - .3	.005	
24-11-30	90.4±.01	8.50±.01	1.02±.01	0.04±.00	.4	.01	Trace 233

*These values are rough estimates only.

Weight Fraction _____
% U^{235} Depleted _____
% U^{235} Fissioned _____
Alpha _____

Other Elements Present _____

Analysis Checked By _____ Approved By: _____

* Isotopic standard analyzed in parallel with this group of samples

Examples: Chemical Process Flowcharts

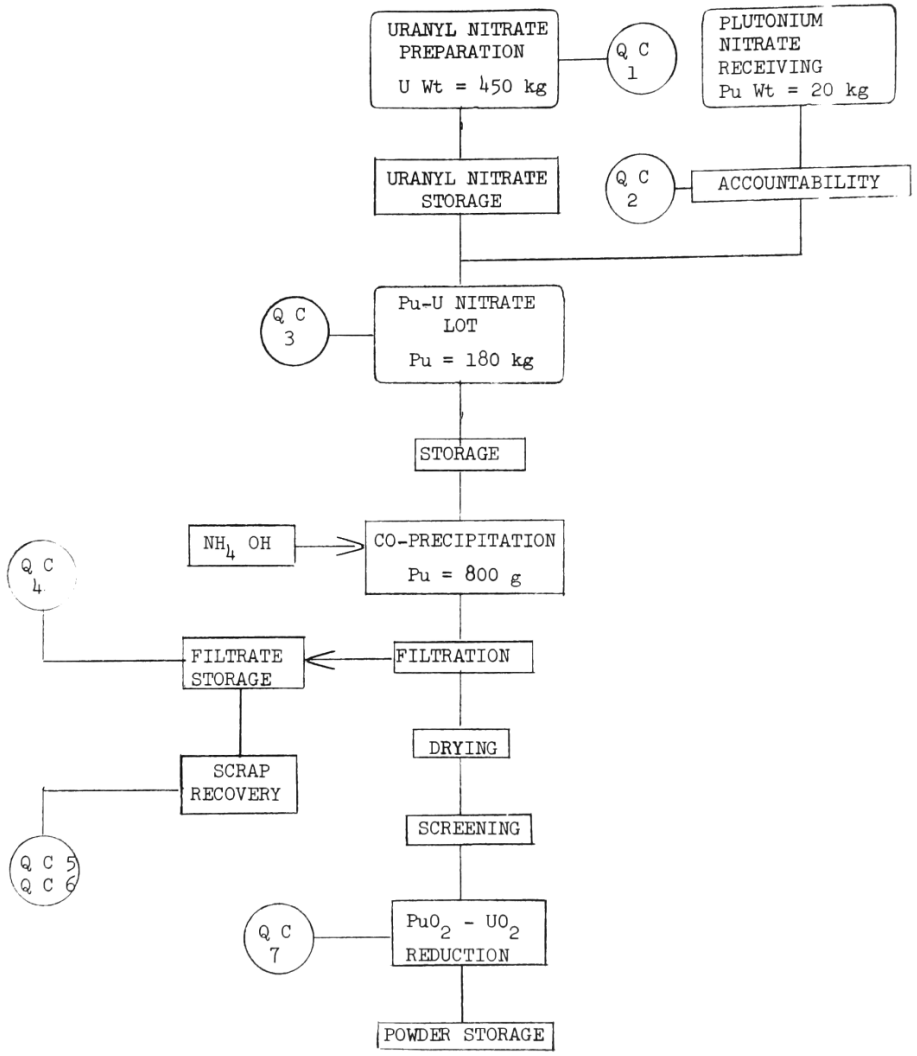
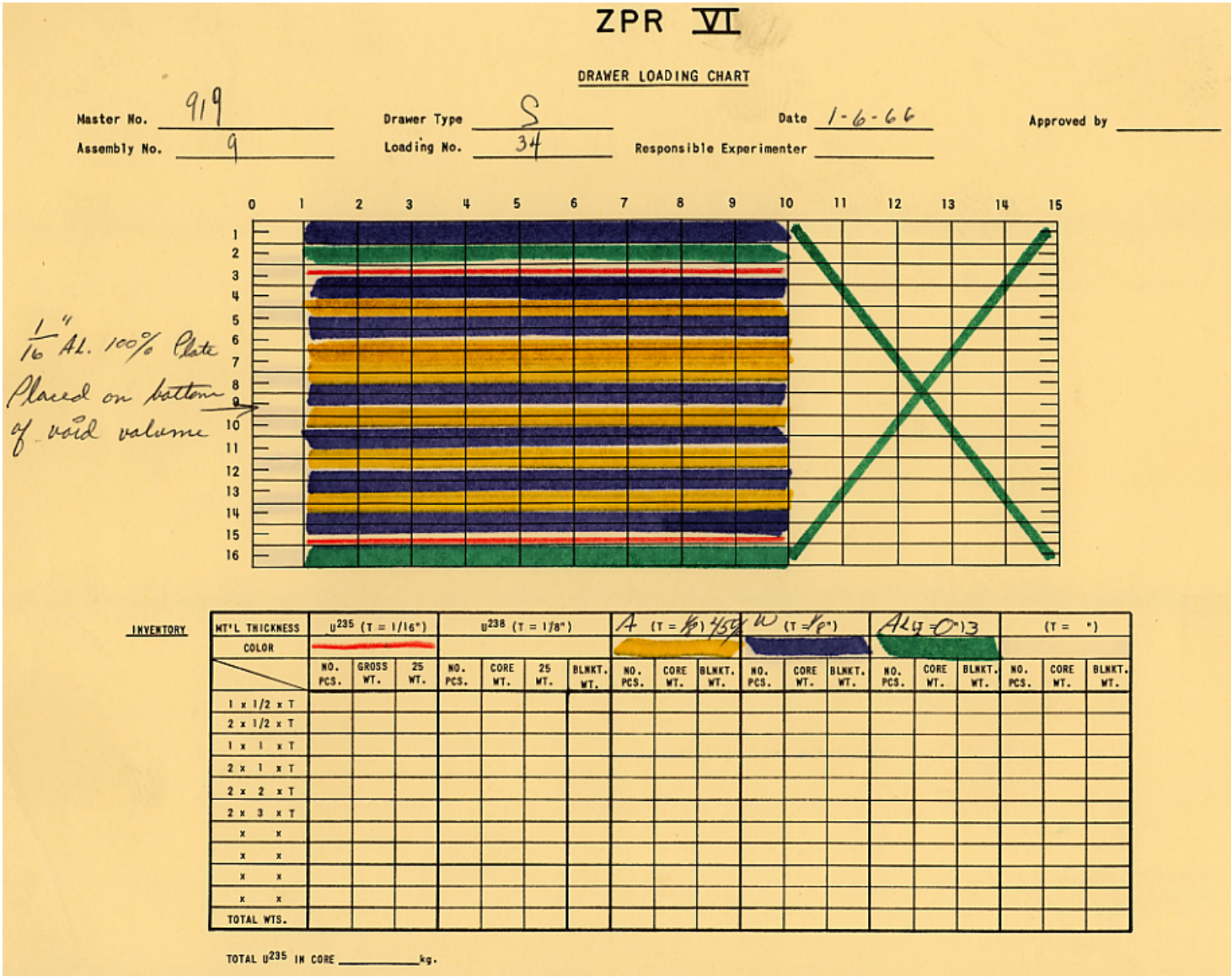


FIGURE 4-1. FUEL PELLET FABRICATION FLOW CHART

Examples: Drawer Masters



ZPR VI

DRAWER LOADING CHART

Master No. 919 Drawer Type S Date 1-6-66 Approved by _____

Assembly No. 9 Loading No. 34 Responsible Experimenter _____

1/16" AL. 100% Plate Placed on bottom of void volume

INVENTORY

MT'L THICKNESS	U^{235} (T = 1/16")			U^{238} (T = 1/8")				A (T = 1/8") 45%			W (T = 1/8")			AL (T = 0") 3			(T = ")		
COLOR																			
	NO. PCS.	GROSS WT.	25 WT.	NO. PCS.	CORE WT.	25 WT.	BLNKT. WT.	NO. PCS.	CORE WT.	BLNKT. WT.	NO. PCS.	CORE WT.	BLNKT. WT.	NO. PCS.	CORE WT.	BLNKT. WT.	NO. PCS.	CORE WT.	BLNKT. WT.
1 x 1/2 x T																			
2 x 1/2 x T																			
1 x 1 x T																			
2 x 1 x T																			
2 x 2 x T																			
2 x 3 x T																			
x x																			
x x																			
x x																			
x x																			
TOTAL WTS.																			

TOTAL U^{235} IN CORE _____ kg.

Examples: Pu Plate Fabrication Notes and Photos

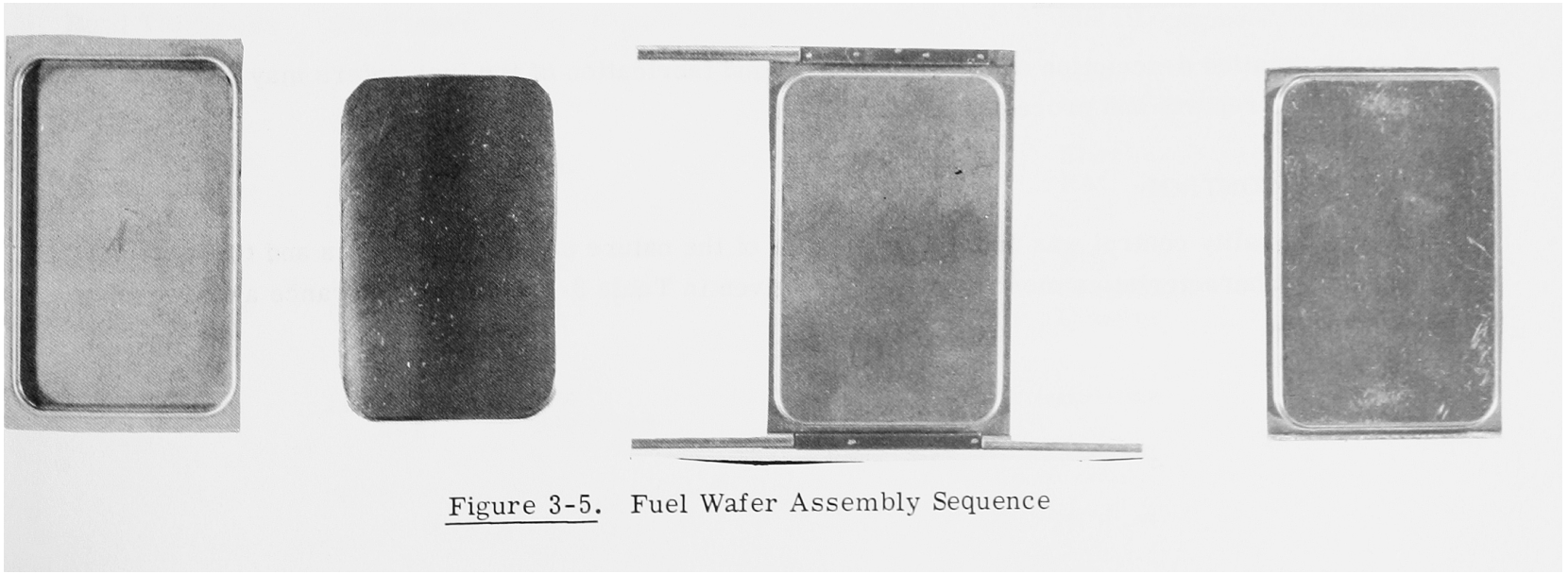
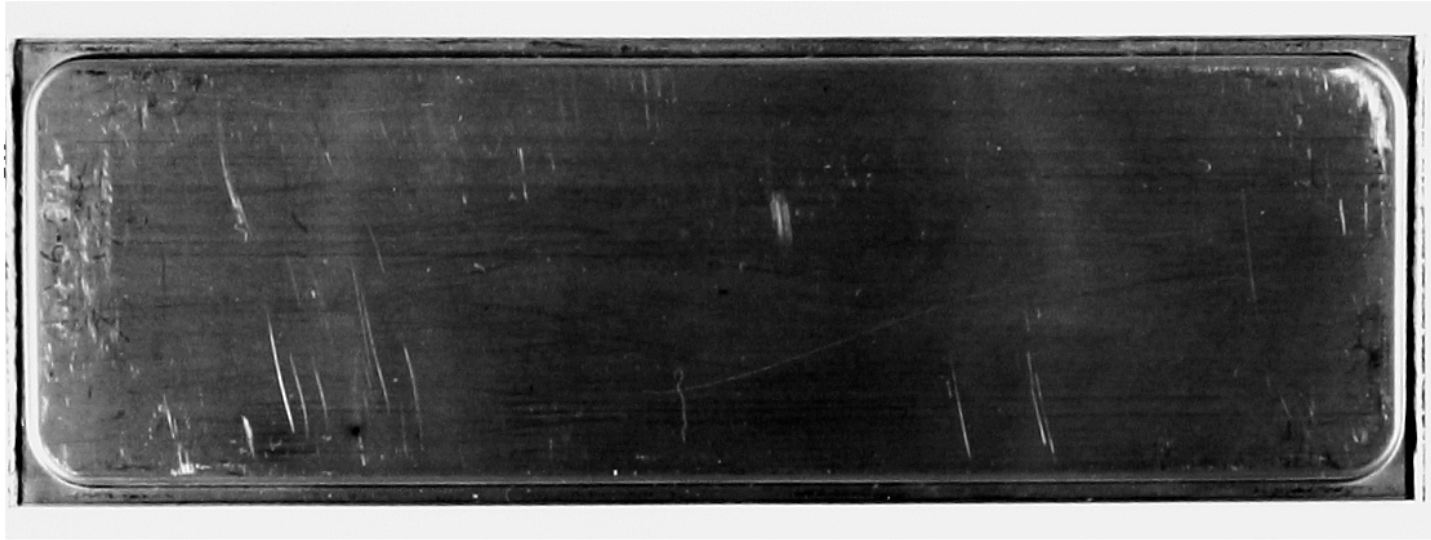


Figure 3-5. Fuel Wafer Assembly Sequence

Examples: NUMEC Pu Plate Photos



Summary

Many of the ANL ZPR/ZPPR experiments have been benchmarked and evaluated to have acceptably small uncertainties – including uncertainties related to masses, dimensions, and compositions of the constituent materials.

Some of these materials could not be manufactured today.

The good characterization of these materials is intrinsic to their unique value.

The activity to catalog and preserve this information will continue in FY11.