AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 JO 1

HW-73111

DAVE

June 1, 1964

DECLASSIFIED

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

XX

RESTRICTED

THIS DOCUMENT CONTAINS UNCLASSIFIED INFORMATION
 TRANSMITTED IN THE ENERGY AREA BY THE
 U.S. TRANSMISSION SYSTEM. THE DISCLOSURE OF ITS
 CONTENTS IN ANY MANNER TO AN UNAUTHORIZED
 PERSON IS PROHIBITED.

TITLE

SUPPLEMENTAL SPECIFICATIONS OF
LABORATORY HOT PRESS PROCESS - FOR
CV SIZE SELF-SUPPORTED I&E
FUEL ELEMENTS

10

OTHER OFFICIAL CLASSIFIED INFORMATION

THIS MATERIAL CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U. S. C. , SECS. 793 AND 794, THE TRANSMISSION OR REVELATION OF WHICH IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

AUTHOR

C. A. Burgess
and
G. M. Schweikhardt

CIRCULATING COPY
RECEIVED 300 AREA
SEP 15 1964
RETURN TO
TECHNICAL INFORMATION FILES

THIS DOCUMENT IS NOT TO BE LEFT UNATTENDED OR WHERE AN UNAUTHORIZED PERSON MAY HAVE ACCESS TO IT. WHEN IN USE, IT MUST REMAIN IN AN APPROVED LOCKED STORAGE DRY WITHIN AN APPROVED GUARDIANSHIP WHILE IT IS IN POSSESSION AND UNTIL IT IS OBTAINED A SIGNATURE FROM CLEARED FILES, IT IS THE RESPONSIBILITY TO MAINTAIN AND ITS CONTENTS ARE THE LIMITS OF THE PROJECT AND REMAIN UNAUTHORIZED PERSONS TRANSMITTAL TO ANY STORAGE AT YOUR PLACE OF RESIDENCE IS PROHIBITED. IT IS NOT TO BE DUPLICATED. IF ADDITIONAL COPIES ARE REQUIRED, OBTAIN THEM FROM THE RELATED OFFICE. ALL PERSONS REQUESTING THIS DOCUMENT ARE REQUESTED TO SIGN IN THE SPACE PROVIDED BELOW.

[illegible]

THIS DOCUMENT HAS BEEN SCANNED
AND IS STORED ON THE OPTICAL DISK DRIVE

DECLASSIFIED

54-3000-340 (3-57) AEC-GE RICHLAND, WASH

(CLASSIFICATION)

DECLASSIFIED

HW-73111

This document consists of
41 pages. Copy No. 2
of 17 copies. ~~Series A~~

SUPPLEMENTAL SPECIFICATIONS OF LABORATORY
HOT PRESS PROCESS - FOR CV SIZE SELF-SUPPORTED
I&E FUEL ELEMENTS

by

C. A. BURGESS
and
G. M. SCHWEIKHARDT

June 1, 1964

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of W.A. Snyder

PR-24 3-8-94

By J. E. Savely 3-21-94

Verified By DK Hansen, 3-29-94

DISTRIBUTION

1. W. A. Blanton	9. V. P. Thomas
2. C. A. Burgess	10. G. M. Schweikhardt
3. G. A. Huff	11. C. A. Strand
4. G. F. Jacky	12. J. T. Stringer
5. J. T. Knight	13. Records Center
6. W. N. Mobley	14. 300 Files
7. E. V. Padgett	15-17. Extra
8. H. F. Tew	

[REDACTED]
The Atomic Energy Act of 1946, as amended, or the
disclosure of its contents in any manner to
or person is prohibited.

MASTER

DECLASSIFIED

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

87D

SUPPLEMENTAL SPECIFICATIONS OF LABORATORY
HOT PRESS PROCESS - FOR CV SIZE SELF-SUPPORTED
I&E FUEL ELEMENTS

DECLASSIFIED

SYNOPSIS

Some refinements have been introduced into the hot press canning of internally and externally cooled fuel elements. This report outlines the specifications for the process including these refinements. Specifications cover components, dies, and punches, furnace condition, nickel plating, component cleaning, component assembly, sizing, hot pressing and inspection.

DECLASSIFIED

INTRODUCTION

Hot press canning at Hanford and the incentives for this process have been described in detail in a number of reports. (1), (2), (3), (4), (5), (6), (7). This report upgrades the original specifications (7) by including modifications and improvements made since that time (September, 1959).

All previous work on hot press canning at Hanford was carefully reviewed and analyzed to define areas for improvement. One such area was that of nickel plating. First, new plating racks were designed to give the cores a continuous Ni plate. Also, the Ni plating process was modified to produce a more adherent as-plated Ni plate. The can component was of the integral spire type and consequently eliminated one worked end closure. With these modifications and by using a different pressing time, temperature and pressure, a high quality fuel element was produced. No attempt was made to restrict the design of the nickel plating facility or the furnace, but rather allow for maximum flexibility in any future design.

This report shall follow the same format as the original specifications (7) for comparative purposes only.

PROCESS SPECIFICATIONS

1.0 Uranium Core (Figure 1)

- 1.1 Standard hot press cores are made from normal uranium with an isotopic content of .71 w/o U-235.
- 1.2 Each core shall be beta heat treated to assure random orientation and small grain size. The core shall meet all the requirements of HW-37677 Rev. 5, "Producer-Site Specifications for Uranium Fuel Element Cores," J. T. Stringer, July 22, 1959.
- 1.3 Cores shall be machined according to General Electric Company Drawing H-3-16992, Model CDB1N.
- 1.4 All surfaces shall have a maximum roughness of 250 maximum per ASA Std. B 46.1 - 1955.
- 1.5 Core I.D. shall pass a .422 inch diameter full-length mandrel, but a .432 inch diameter mandrel shall not enter.
- 1.6 The core I.D. shall be concentric with the O.D. within 0.003 inch, total indicator reading.
- 1.7 The following impurities, maximum, can be tolerated:

DECLASSIFIED

1.7.1 Determined by chemical analysis

- 1.7.1.1 Carbon - 100 ppm
- 1.7.1.2 Nitrogen - 100 ppm
- 1.7.1.3 Hydrogen - 3 ppm

1.7.2 Determined by spectrographic analysis:

- 1.7.2.1 Boron - 0.25 ppm
- 1.7.2.2 Chromium - 0.65 ppm
- 1.7.2.3 Iron - 185 ppm
- 1.7.2.4 Magnesium - 25 ppm
- 1.7.2.5 Manganese - 25 ppm
- 1.7.2.6 Nickel - 100 ppm
- 1.7.2.7 Silicon - 140 ppm

1.8 Minimum core density shall be 18.82 grams per cubic centimeter.

2.0 Aluminum Can (Figure 2)

2.1 Standard hot press cans are made of 8001-F aluminum alloy.

2.2 Composition of this aluminum alloy is as follows:

- 2.2.1 Aluminum - 97.51 percent minimum.
- 2.2.2 Nickel - 0.90 to 1.30 percent.
- 2.2.3 Iron - 0.45 to 0.70 percent.
- 2.2.4 Silicon - 0.17 percent maximum.
- 2.2.5 Copper - 0.15 percent maximum.
- 2.2.6 Lithium - 0.008 percent maximum.
- 2.2.7 Cadmium - 0.003 percent maximum.
- 2.2.8 Cobalt - 0.001 percent maximum.
- 2.2.9 Boron - 0.001 percent maximum.

2.3 The spire-cans shall be made according to General Electric Company Drawing Number H-3-16991, Revision 2, dated September 27, 1960.

2.4 Outside wall scratches shall not exceed 0.001 inches in depth and surface shall be free of stains, galled and checked areas; inside tube wall scratches and die marks shall not exceed 0.003 inches in depth and surface shall be free of galled and checked areas.

2.5 All spire tubes must pass a .348 inch full-length mandrel.

2.6 The 0.375 inch diameter to be concentric with the .417 inch diameter within .010 inch total indicator reading, all other diameters concentric within .010 inch total indicator reading except at the open end.

2.7 All cans shall pass a 1.432 inch full-length mandrel and a 1.511 inch full-length tube gage.

2.8 Bevel is optional - corner may be square or round.

3.0 Aluminum Cap (Figure 3)

3.1 The cap shall be made of 8001-F aluminum alloy within the composition limits listed in section 2.2 of this specification.

3.2 The cap shall be made according to General Electric Company Drawing Number H-3-16993, Revision 3, dated September 26, 1960.

3.3 The outside wall and internal wall surface scratches shall not exceed 0.001 inch in depth and the surfaces shall be free of stains, galled and checked areas.

3.4 The 1.432 diameter and the .437 diameter shall be concentric to 0.006 inches. The 1.432 and 1.232 diameters concentric within .010 TIR. The .428 inch diameter and .628 inch diameter concentric within .010 total indicator reading.

4.0 Furnace Construction Details

The four unit furnace is illustrated in Figure 4. In this illustration, the circled numbers represent the following items: 1) die block, 2) die insert, 3) fuel assembly, 4) insulation, 5) thermocouple, 6) heating element, 7) cap punch, 8) heater block, 9) breaking blocks.

4.1 Die Block

4.1.1 Construction shall be of "Inconel-X" or other high temperature-high-strength material to provide strength at operating temperatures of 650°C and pressures up to 20 tons per square inch.

4.1.2 The interior of the die block shall be machined to match the solid die insert (See Section 6.0, Figure 5). The taper of this hole shall be one inch per foot for an approximate included angle of 4° 16' 15". Also, the die insert and die block shall mate with 90 percent contact as determined by standard blueing methods.

4.2 Heater Block

4.2.1 Construction shall be of 1020 steel.

- 4.2.2 Heating elements shall be placed in the heater block in a symmetrical pattern (H-3-8328, Rev. 1, Sheet 3).

4.3 Heating Elements

- 4.3.1 The type of furnace will determine the choice of heaters. A four-unit furnace will require 20,000 watts minimum supplied by cartridge type heating elements.

4.4 Insulation

- 4.4.1 Insulation shall be of sufficient thickness so that there will be no more than a 100°F temperature rise in the furnace shell after 50 hours of continuous operation.

4.5 Instrumentation

4.5.1 Temperature Control

- 4.5.1.1 The instrument should be a recording unit of the potentiometer type with proportioning control or saturable core reactor control.

- 4.5.1.2 The instrument shall be able to control within $\pm 5^{\circ}\text{C}$ at 600°C (1112°F).

4.5.2 Over-temperature Control

- 4.5.2.1 The instrument should be of the multi-volt meter type (current meter) and shall operate in the control circuit so as to interrupt the current to the contactor holding coil or saturable core reactor in the event of a temperature over-shoot.

- 4.5.2.2 The over-temperature control shall operate in the 600°C (1112°F) region within $\pm 10^{\circ}\text{C}$ ($\pm 50^{\circ}\text{F}$).

4.5.3 Thermocouples

- 4.5.3.1 Thermocouples shall be chromel-alumel type K chosen to operate in conjunction with the temperature control instruments.

- 4.5.3.2 The thermocouple wells shall extend into the die block. Tight contact of the thermocouples against the well base shall be maintained.

5.0 Presses

5.1 Press for Hot Pressing

- 5.1.1 Operating capacity shall be a minimum of 20 tons per square inch.
- 5.1.2 Ram speed shall be a minimum of ten inches per minute.
- 5.1.3 Press travel should be a minimum of twelve inches.
- 5.1.4 Pressure indicators may be either electronic or mechanical gages with a range from 0 to 20 tons per square inch.

5.2 Presses for Sizing and Expanding

- 5.2.1 Press type shall be double acting with opposed action rams.
- 5.2.2 Operating capacity shall be a minimum of ten tons.
- 5.2.3 Ram speeds shall be a minimum of ten inches per minute.
- 5.2.4 Press travel shall be a minimum of twelve inches.
- 5.2.5 Pressure indicators shall have a range from 0 to 10 tons.

6.0 Solid Die Insert (Figure 5)

- 6.1 Material for construction shall be any H-21 tool steel such as Formite-2 tool steel (Columbia Tool Steel Corporation) or CLW tool steel (Latrobe Steel Corporation) or equal.
- 6.2 The dies shall be hardened and double drawn at $600^{\circ}\text{C} \pm 50^{\circ}\text{C}$ ($1110^{\circ}\text{F} \pm 80^{\circ}\text{F}$). Rockwell "C" scale hardness shall be 50 - 55.
- 6.3 Die inserts shall be made according to General Electric Company Drawing Number H-3-8328, Rev. 1, dated April 1962.
- 6.4 Exterior taper of the die shall be one inch per foot with an included angle of $4^{\circ} 46' 16''$. This die shall mate with the die block with 90 percent contact as determined by standard bluing methods.
- 6.5 Surface finish on the tapered and working surfaces of the die shall be a maximum of 16 micro inches. Maximum roughness of the ends shall be 63 micro inches.

7.0 Cap Punch (Figure 6)

- 7.1 Material for construction shall be any H-21 tool steel such as Formite-2 tool steel (Columbia Tool Steel Corporation) or equal.
- 7.2 These punches shall be hardened and drawn to 45-55 Rockwell "C" scale and ground to final dimensions.
- 7.3 Maximum surface roughness shall be 16 micro inches except where noted.
- 7.4 Cap punches shall be made according to General Electric Drawing Number H-3-8328, Rev. 1, dated April 1962.

8.0 Base Support Punch (Figure 7)

- 8.1 Material for construction shall be any H-21 tool steel such as Formite-2 tool steel (Columbia Tool Steel Corporation) or equal.
- 8.2 Hardness of punches shall be 45-55 Rockwell "C" scale.
- 8.3 Maximum surface roughness shall be 16 micro inches except where noted.
- 8.4 Base punches shall be made according to General Electric Drawing H-3-8328, Rev. 1, dated April 1962.

9.0 Cap Punch Ring (Flash Ring - Figure 8)

- 9.1 An expendable flash ring shall be used in conjunction with the outer cap punch (Figure 6c).
- 9.2 Material for construction shall be Shelley seamless mechanical steel tubing, cold drawn, C-1015, finish annealed, 1-1/2 O.D. x 16 BWG.
- 9.3 Cap punch rings shall be made according to General Electric Company Drawing Number H-3-8328, Rev. 1, dated April 1962.

10.0 Fuel Element Pin (Figure 9)

- 10.1 Fuel element pins shall be made of any H-21 tool steel such as Formite-2 (Columbia Tool Steel Corporation) or equal.
- 10.2 Pins shall be hardened and drawn to 50-55 Rockwell "C" scale and ground to final size.
- 10.3 Surface finish shall be 16 micro inches or better except where noted.

- 10.4 Pin body shall have a taper of 0.001 inches per inch of length.
- 10.5 The fuel element pin shall be made according to General Electric Company Drawing Number H-3-8328, Rev. 1, April 1962.
- 11.0 Sizing Die (Figure 10)
- 11.1 Material of construction shall be any 0-2 tool steel such as Stentor (Carpenter Steel Corporation), Ketos (Crucible Steel Corporation) or equal.
- 11.2 Hardness shall be 60-64 Rockwell "C" scale. The die shall be ground to final size.
- 11.3 Surface finish shall be 16 micro inches or better unless specified otherwise.
- 11.4 Sizing dies shall be made according to General Electric Company Drawing Number H-3-8527.
- 11.5 During the sizing operation this die shall be mounted within a recess placed on ball bearings so as to permit free movement of the die during sizing.
- 12.0 Tube Expander (Figure 11)
- 12.1 Material of construction shall be drill rod, hardened and drawn to Rockwell "C" hardness of 45-55.
- 12.2 Surface finish shall be 16 micro inches or better on the working area and 63 micro inches maximum on all other surfaces.
- 12.3 The tube expander shall be made according to General Electric Company Drawing Number H-3-8582, Part 1, dated April 6, 1956.
- 13.0 Pad Pressure Punch
- 13.1 The pad pressure punch shall be used to tightly hold together the can core and cap assembly during the sizing operation.
- 13.2 The middle closure punch listed in this specification under 7.4 can be used for this operation.
- 14.0 Stacking Punch (not used)
- 15.0 Die Seating, Pressing and Breaking Blocks

No detailed illustration is presented for the block design as the furnace type will dictate the design. A schematic

-10- **DECLASSIFIED**

HW-73111

diagram illustrating die seating, pressing and breaking is presented in (Figure 12).

- 15.1 These blocks should be made of TK (Carpenter Steel Corporation) Formite-2 (Columbia Tool Steel Corporation), Potomac (Allegheny Ludburn) or equal. Blocks should be hardened to a Rockwell "C" scale hardness of 40-55, but do not need to be ground.
- 15.2 Alignment of the pressing, seating and breaking dies with the die insert is important. Incorrect alignment can cause back extrusion of the can components. Alignment has been provided as shown on Hanford Drawing Number H-3-8328, Rev. 1.

16.0 Uranium Core Inspection

16.1 Dimensional

- 16.1.1 Each core shall pass the dimensional requirements set forth in section 1 of this specification.
 - 16.1.2 Core length shall be a maximum of 8.410 inches and a minimum of 8.390 inches.
 - 16.2 The cores shall weigh 8.44 pounds $\pm$ 0.01 pound.
 - 16.3 Each core shall pass the standard transformation test.
 - 16.4 Statistical Inspection
 - 16.4.1 Random grain orientation shall be verified by X-ray analysis.
 - 16.4.2 High quality of metal shall be verified by metallographic analysis.
 - 16.4.3 Chemical purity shall be verified by chemical and spectrographic analysis.
 - 16.5 Each core shall be inspected after etching for three minutes in hot (80°C) 50% nitric acid. Any cores indicating inclusions or stringers shall be rejected.
 - 16.6 Each core shall be inspected after nickel plating. Any imperfections in the plate or core will be cause for rejection.
 - 16.7 Maximum allowable time between plating and pressing shall be eight hours in air. By storing in a vacuum of 10^{-3} mm of mercury or sizing the assembly, this time limit may be extended to twenty hours.
-

DECLASSIFIED

-11-

HW-73111

17.0 Aluminum Can Inspection

17.1 Aluminum cans shall pass the inspection requirements outlined in Section 2 of this specification. The statistical inspection shall include the following:

- 17.1.1 Warp
- 17.1.2 Concentricity
- 17.1.3 Wall thickness
- 17.1.4 Base tolerance

17.2 Aluminum cans shall pass the quality requirements outlined in Section 2 of this specification. This quality check shall include the following:

- 17.2.1 Inclusions or defects
- 17.2.2 Surface depressions or marks
- 17.2.3 Finish
- 17.2.4 Material composition

18.0 Aluminum Cap Wafer

18.1 Aluminum caps shall pass the inspection requirements outlined in Section 3 of this specification. The statistical inspection shall include the following:

- 18.1.1 Concentricity
- 18.1.2 Wall thickness
- 18.1.3 Base tolerance

18.2 Aluminum caps shall pass the quality requirements outlined in Section 3 of this specification. This quality check shall include the following:

- 18.2.1 Inclusion or defects
- 18.2.2 Surface depression or marks
- 18.2.3 Finish
- 18.2.4 Material composition

19.0 Vacuum Outgassing (not used)

20.0 Nickel Plating of the Uranium Core

20.1 Plating Racks (Figure 13)

20.1.1 The dual core plating racks shall be made according to General Electric Company Drawing Number H-3-17278, dated May 1, 1961.

20.2 Equipment

20.2.1 Nickel Plating Tank

DECLASSIFIED

-12-

HW-73111

- 20.2.1.1 The present tank is 48 inches in length, 20-1/2 inches in depth and 20 inches wide. Construction is of sheet metal suitably reinforced and protected from corrosion by a heavy coating of Unichrome 218 X.
- 20.2.1.2 Commercial plating tanks made of boiler plate with bonded Neoprene, PVC or natural rubber are satisfactory.

20.2.2 Plating Rack Agitator

- 20.2.2.1 The reciprocating motion of the cathode bar shall be supplied by an agitator.
- 20.2.2.2 Stroke shall be a minimum of four inches at a speed of 34 strokes per minute.
- 20.2.2.3 Drive mechanism and tank shall be insulated from the cathode bar by means of a plastic roller or bearings.

20.2.3 Cathode Bar

- 20.2.3.1 Cathode bar shall be made of stainless steel to minimize corrosion and facilitate cleaning.
- 20.2.3.2 The cathode bar shall be designed with sufficient structural strength to prevent excessive deflection.

20.2.4 Anodes

- 20.2.4.1 Anodes shall be rolled, depolarized nickel metal bars, oval shaped with an anode hook screwed into the anode. These anodes should be approximately three inches in the greater dimension by 1-1/2 inches thick and should extend two inches above the plating solution operating level and within two inches of the tank bottom.
- 20.2.4.2 The anodes shall be spaced as close as possible along the anode bar and three inches from the tank wall.

DECLASSIFIED

-13-

HW-73111

20.2.4.3 Each anode shall be enclosed within a closely woven nylon or glass cloth anode bag. This bag will retain the sludge sloughed off the anode.

20.2.5 Direct Current Source

20.2.5.1 Direct current shall be supplied from a rectifier with a minimum capacity of 200 amperes in the 0 - 8 volt range. This current shall be controllable in a range of ± 3 percent.

20.2.5.2 Direct current ripple shall not exceed five percent.

20.2.6 Filters

20.2.6.1 The nickel plating solution shall be equipped with a continuous filter to remove suspended particles and provide agitation to minimize temperature gradients.

20.2.6.2 Solutions are pumped from a manifold on one side of the tank, through a pH cell, into the pump, through the filter and returned to the tank. The design of any future tank should provide an overflow weir from the main solution tank to the pH cell and pump.

20.2.6.3 Complete filtration shall occur every 1/2 hour for a tank of the type described in paragraph 20.2.1 of this specification.

20.2.7 Heaters and Temperature Control

20.2.7.1 Quartz sheathed immersion type heaters are recommended. These heaters should be placed in a protective guard with a baked-on plastisol. Unichrome 218 X compound is satisfactory.

20.2.7.2 Temperature control from a resistance bulb thermometer operating through a temperature controller. Accuracy shall be $\pm 0.5^{\circ}\text{C}$ in the 30 to 70 $^{\circ}\text{C}$ range.

20.2.8 Deionized Water

20.2.8.1 Deionized water shall be available in sufficient quantity to provide an abundance of water for solution make-up, rinsing, etc.

- 20.2.8.2 A minimum capacity of 200 gallons per hour is recommended for the system described in this specification.

20.3 Solution Make-up

- 20.3.1 Electrolytic etch solution (light etch)
Orthophosphoric Acid (H_3PO_4) 5.4M
Hydrochloric Acid (HCl) 0.12M

20.3.2 Nickel Plating Solution

20.3.2.1 Composition

$\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$	0.426M
$(\text{NH}_4)_2 \cdot \text{SO}_4$	0.159M
KCl	0.107M
pH	5.4 - 5.6

- 20.3.2.2 C. P. Grade chemicals and deionized water shall be used to make the plating solutions.

- 20.3.2.3 Chemical purification shall be by the method recommended by International Nickel Corporation.

- 20.3.2.3.1 Adjust pH to 4.5 by addition of ammonium hydroxide.

- 20.3.2.3.2 Add iron as 0.75 grams of ferrous sulfate per liter, then add 0.8 ml of hydrogen peroxide per liter to oxidize the iron to the ferric state.

- 20.3.2.3.3 Digest with agitation for 16 hours at 50°C.

- 20.3.2.3.4 Allow solution to settle for one hour.

- 20.3.2.3.5 Filter into clean container.

- 20.3.2.3.6 Add charcoal (12 grams per liter) and agitate at room temperature for two hours.

- 20.3.2.3.7 Allow to settle for two hours, then filter.

DECLASSIFIED

-15-

HW-73111

20.3.2.3.8 This purification will remove Fe (II), Fe (III), Cu (II), Zn (II), Cr (III), Al (III). The charcoal will also remove organic impurities such as oil, faulty acids, etc. Lead ion must be removed by electrolytic purification.

20.3.2.4 Electrolytic purification

20.3.2.4.1 A corrugated rack shall be used.

20.3.2.4.2 A current density of two amperes per square foot will remove copper, lead and peroxide. A density of five amperes per square foot will effectively remove iron and zinc.

20.3.2.5 Anti-pitting agent

20.3.2.5.1 Hydrogen peroxide shall be added as a prevention to gas pitting.

20.3.2.5.2 Approximately 0.5 cc per liter of 30 percent hydrogen peroxide will be required; however, this must be determined for each case.

20.3.2.6 Hydrogen Ion Concentration (pH = 5.4 - 5.6)

20.3.2.6.1 The pH shall be decreased with a mixture of hydrochloric and sulfuric acid in the same proportion as the plating bath. This ratio is 15 grams of sulfate ion per liter to one gram of chloride ion per liter.

20.3.2.6.2 The pH shall be increased to the operating range by adding ammonium ion.

DECLASSIFIED

-16-

HW-73111

20.3.2.6.3 In the event that an inert anode is used which decreases the nickel concentration of the bath, the nickel concentration shall be adjusted by the addition of nickel hydroxide.

20.3.2.7 Chemical analysis shall be made once a month, and the following limits must be maintained:

Ni ⁺⁺	25 g/l	0.426M $\pm$.021M
NH ₄ ⁺	5.74 g/l	0.319M $\pm$ 0.80M-0.20M
K ⁺	4.19 g/l	0.107M $\pm$ 107M -0.054M
SO ₄ ⁼	57.25 g/l	0.585M $\pm$ 0.029M
Cl ⁻	3.81 g/l	0.107M $\pm$ 0.011M

20.3.3 Nitric Acid Baths

20.3.3.1 Nitric acid baths shall be used as a deoxidizer and for electrolytic etch coat removal.

20.3.3.2 Composition of these baths shall be 6 - 10M nitric acid.

20.4 Ni Plating Process (Figure 14)

20.4.1 Vapor Degrease

20.4.1.1 Vapor degreasing shall be done in Trichlorethylene vapors heated by steam coils. The top of the tanks shall be cooled to prevent release of trichlorethylene vapors into the room.

20.4.1.2 Time in the degreaser shall be sufficient to raise the core temperature to 35 to 40°C. Three minutes shall be the minimum time.

20.4.2 Place degreased cores on the plating rack to eliminate further handling of the uranium.

20.4.3 Place the racked elements in the nitric acid deoxidizer held at 60 to 65°C for approximately three minutes or until all the black uranium oxide film is removed.

20.4.4 Thoroughly rinse in process water to remove all traces of nitric acid.

- 20.4.5 Electrolytically etch at a current density of 70 amperes per square foot with the bath at 55°C (131°F) for five minutes.
- 20.4.6 Thoroughly rinse in process water.
- 20.4.7 Remove anodic film by immersion in warm (30 - 35°C) (86 - 95°F) nitric acid for three to five minutes.
- 20.4.8 Thoroughly rinse in process water.
- 20.4.9 Complete the removal of the anodic film by immersion in hot (60 - 65°C) (140 - 150°F) nitric acid for two minutes.
- 20.4.10 Thoroughly rinse in process water.
- 20.4.11 Immerse in warm (30 - 35°C) (86 - 95°F) nitric acid for two minutes to permit the formation of a unique uranium surface condition.
- 20.4.12 Thoroughly rinse in process water.
- 20.4.13 The neutralization of any remaining nitric acid is accomplished by immersion in sodium bicarbonate for two to three minutes.
- 20.4.14 Thoroughly rinse in process water.
- 20.4.15 Spray rinse in deionized water.
- 20.4.16 Immerse in the nickel plating bath at 45 amperes per square foot for 26 minutes with a bath temperature of 50°C (122°F). This will deposit a nominal 0.0008 inch of nickel on the core.
- 20.4.17 Remove from bath and dip rinse in tap or process water.
- 20.4.18 Spray rinse in deionized water.
- 20.4.19 Dip rinse in hot (60 - 70°C) (140 - 158°F) deionized water.
- 20.4.20 Warm air dry.
- 20.4.21 Wrap in parchment. Any subsequent handling of the cores shall be with cotton gloves.
- 20.4.22 Deliver to the hot press assembly operation.

DECLASSIFIED

-18-

HW-73111

21.0 Aluminum Component Preparation (Figure 15)

21.1 Inspected aluminum components shall be subjected to the following cleaning treatment:

21.1.1 Degreasing

21.1.1.1 Degrease in trichlorethylene by submerging or spraying with hot solution (86 - 95°C) for a minimum of 50 seconds.

21.1.1.2 Submerge or spray with cold trichlorethylene (35°C max.) for a minimum of 50 seconds.

21.1.1.3 Vapor degrease in hot trichlorethylene vapor condensing on the surface and draining freely at 86 to 95°C for a minimum of 50 seconds.

21.1.2 Cold process water rinse by spray or dipping.

21.1.3 Alkaline clean by soaking in a solution of Wyandotte altrex at 4 to 5 oz./gal., 75 ± 5°C for 9 to 15 minutes.

21.1.4 Hot process water rinse by dipping.

21.1.5 Cold process water rinse by dipping.

21.1.6 Deoxidize with Diversy 514 (Diversy Corporation), 32 ± 3 oz./gal. for 7 to 15 minutes at 10 to 30°C. The etchant life shall be from .25 sq. ft./gal. hr. to 8 sq. ft./hr.-gal for X-8001 alloy. The pH shall be controlled between .1 and .3.

21.1.7 Rinse in flowing cold process water, 30°C maximum for 50 seconds minimum.

21.1.8 Rinse in methanol by dipping with a maximum of 18 percent H₂O, maximum specific gravity of .842 at 18°C.

21.1.9 Completely dry in forced warm air at 70°C maximum for 30 minutes maximum.

22.0 Pressing Component Preparation

22.1 Oxidize any new punches or components in an open air furnace at 450°C for six hours, then air cool.

DECLASSIFIED

-19-

HW-73111

- 22.2 Spray coat surface of each fuel element pin with a mixture consisting of the following:

31% clear lacquer
58% lacquer thinner
7% Molykote (Alpha Corporation)
4% Mica (100 mesh)

Pins must be sprayed after each pressing cycle.

- 22.3 Coat die inserts with 40% oil dag, graphite in oil, and place in open air furnace at 600°C for a minimum of twenty minutes prior to component assembly.

23.0 Assembly (Figure 16)

- 23.1 No contamination of the bonding surfaces can be tolerated.
- 23.2 Place nickel plated core in the previously cleaned and completely dried spire-can components.
- 23.3 Place the cap in the can on the end of the core.
- 23.4 Coat the O.D. of the can and the I.D. of the spire with Johnson's 150 drawing wax (SC Johnson and Son, Inc.) and dry.

24.0 Sizing

- 24.1 Place fuel element in the sizing press.
- 24.2 Apply pad pressure of 1000 psi.
- 24.3 Push element through a $1.490 \pm .001$ inch diameter die for air removal. Release pad pressure and remove element from press.
- 24.4 Place element in expansion press and place 0.376 inch diameter expander into I.D. of spire can and attach to press ram.
- 24.5 Pull expander through tube.
- 24.6 Remove from press.
- 24.7 Trim excess aluminum metal from the can and spire top in a lathe.

25.0 Assembly for Pressing (Figure 17)

- 25.1 Place the base support punch (Part A) over the coated fuel element pin.

DECLASSIFIED

-20-

HW-73111

- 25.2 Insert pin into fuel element core and drive into position so that the inner base punch is in contact with can base and the pin is inserted into the punch as far as possible.
- 25.3 Coat outside of the can with anti-seize compound, consisting of a mixture of water, drawing wax and pulverized (100-mesh) mica. Allow to dry completely.
- 25.4 Place the cap punch flash ring in position.
- 25.5 Place the cap closure assembly punches in position.
- 25.6 Insert coated fuel assembly into the preheated die insert.
- 25.7 Place an upper seating block on top of each heated assembly.
- 26.0 Hot Pressing (Figures 4, 12, and 17)
- 26.1 Place hot inserts with fuel assembly into the hot die block. Start timing.
- 26.2 Place the lower seating block under the heater block.
- 26.3 After 5 minutes preheat time, seat the dies at 8500 psi. This value will vary with die design and will depend upon the amount of prestressing necessary for the insert.
- 26.4 Release the pressure and remove the lower seating block. Leave the upper seating blocks in place until pressing time. (Minimizes heat losses).
- 26.5 Remove upper seating blocks after a total time lapse of 13 minutes from 26.1. Extend pressing blocks to predetermined position to assure uniform pressing pressure on all 4 fuel elements.
- 26.6 Press elements at 600°C ($\pm 5^{\circ}\text{C}$) for two minutes (± 5 sec.) at a pressure of 18 tons per square inch (± 500 psi). (Apply pressure after a total elapsed time of 15 minutes from Step 26.1 of this specification.)
- 26.7 Place breaking blocks in position and break die inserts from die block.
- 26.8 Quench in 20°C ($\pm 5^{\circ}\text{C}$) water.
- 27.0 Die Disassembly
- 27.1 Remove element from die insert. The element should fall out with a slight tapping action.

DECLASSIFIED

-21-

HW-73111

- 27.2 Drive out pin.
- 27.3 Remove cap punches as a unit. These punches will be held together by aluminum flash.
- 27.4 Remove flash ring and throw away.
- 28.0 Punch, Pin and Die Recycling
- 28.1 Separate the inner, middle and outer punches by pressing.
- 28.2 Place punches in a 30 percent hot (70°C - 158°F) sodium hydroxide to dissolve the aluminum flash. Rinse and dry.
- 28.3 Respray pins by the method described in paragraph 22.2 of this specification.
- 28.4 Place die inserts in 30 percent hot (70°C - 158°F) sodium hydroxide, if necessary, to dissolve any aluminum flash. Rinse and dry.
- 28.5 Recoat die inserts with Oil-dag, graphite in oil (4%) and place in the preheat furnace at 600°C. for at least 15 minutes.
- 29.0 Fuel Element Final Preparation
- 29.1 Etch in 30 percent cold sodium hydroxide for one minute.
- 29.2 Rinse in cold flowing process water.
- 29.3 Etch the fuel elements in hot (65 - 70°C) (149°F - 158°F) 50 percent nitric acid for 10 minutes. Remove all surface imbedded particles.
- 29.4 Machine contour as illustrated in Figure 18. Remove $.065 \pm .005$ from the base of the fuel assembly.
- 29.5 Weld the two closure zones on the cap end using the standard "F" Process.*
- 30.0 Dimensional Check
- 30.1 Weld Test: The weld closures shall be inspected in accordance with the standard "F" Process.*
- 30.2 Dimensional Check
- 30.2.1 Outer diameter to be 1.490 minimum, 1.500 maximum.
- 30.2.2 Inner diameter to 0.375 inch ± 0.005 tapered to 0.3646 inch ± 0.0005 .

DECLASSIFIED

-22-

HW-73111

30.2.3 Overall length shall be $9.000 \pm .010$,
-.040 inches.

30.3 Bond Test - Set up on the external void size of 3/8 inch x 3/8 inch reject accept 1/4 inch x 1/4 inch; internal was set up on void size .300X, 180 inches reject and accept .400X .062. This is tighter than the present AlSi bond test standards.

30.4 Surface Inspection: The surface shall be inspected in accordance with the Standard "F" Process."

31.0 Final Etch

31.1 The fuel element shall be etched according to the standard "F" Process.

32.0 Rail Weld

32.1 The self-support rails shall be ultrasonically welded to the fuel element in accordance with HW-69886, Rev. 2, "Provisional Process Specifications for the Attachment of Projection Rails by Ultrasonic Spot Welding," J. T. Stringer, Dec. 3, 1962.

33.0 Autoclaving

33.1 The fuel elements shall be either steam or water autoclaved at $165 - 180^{\circ}\text{C}$ ($329 - 356^{\circ}\text{F}$) for a minimum of 20 hours.

33.2 Any fuel elements which show signs of blistering, swelling or discoloration shall be rejected.

34.0 Preirradiation Measurements.

Each fuel element shall be measured and arranged according to tube makeup at the time of measurements.

*HW-47029, "Process Specifications Fuel Element Manufacturing Processes," J. T. Stringer, November 15, 1962.

DECLASSIFIEDREFERENCES

1. Blanton, W. A., "A Study of Potential Incentives for the Hot Press Process," HW-56822, July 18, 1958.
 2. Andelin, R. L., "Nickel Plating of Urnaum," HW-30243, December 9, 1953.
 3. Post, R. G. and Kerr, W. B., "Semi-Production Nickel Plating of Fuel Element," HW-35609, July 11, 1955.
 4. Foust, W. E., "Hot Press Canning at Hanford," HW-48329, February 11, 1957.
 5. Trevberg, J. C., "Improvements in the Hot Press Process," HW-59129, April 1, 1949.
 6. Sylvania Electric Products, Inc., "Canning Specifications for Mark VII Fuel Elements," TID-5442, May 14, 1956.
 7. Trevberg, J. C., "Specifications - Laboratory Hot Press Process for "C" Size I&E Fuel Element," HW-61995, September 25, 1959.
 8. Stringer, J. T., "Provisional Process Specifications for the Attachment of Projection Rails by Ultrasonic Spot Welding," HW-69886, Rev. 2, December 3, 1962.
 9. Stringer, J. T., "Process Specifications Fuel Element Manufacturing Processes," HW-47029, November 15, 1962.
-

FIGURE 1

URANIUM CORE FOR HOT PRESS PROCESS

HW-73111

Technical drawing of a tapered shaft with various dimensions and tolerances. The drawing shows a cross-section of the shaft with a central hole. The dimensions are as follows:

- Top diameter: 1.504 DIA
- Top hole diameter: 1.500
- Second diameter from top: 1.445 DIA
- Second hole diameter from top: 1.439
- Third diameter from top: 1.420 DIA
- Third hole diameter from top: 1.414
- Outer diameter tolerance: $\frac{.035}{.025}$
- Inner diameter tolerance: $\frac{.083}{.027}$
- Length: $9\frac{1}{2} \pm \frac{1}{32}$
- Bottom diameter: 1.490 DIA
- Bottom hole diameter: 1.486
- Bottom outer diameter: $\frac{.360}{.354} \text{ DIA}$
- Bottom inner diameter: $\frac{.378}{.372} \text{ DIA}$
- Bottom hole diameter: $\frac{.240}{.230}$
- Bottom outer diameter: $\frac{.310}{.290}$
- Bottom hole diameter: $\frac{.070}{.060}$
- Bottom hole diameter: $\frac{.026}{R}$
- Bottom hole diameter: 45° TYP
- Bottom hole diameter: $12^\circ 30' \pm 30' \text{ TYP}$

FIGURE 2

UNCLASSIFIED

MATERIAL: ALUMINUM ALLOY X-8001-F

FIGURE 3
ALUMINUM CAP

FIGURE 4

ISOMETRIC OF FOUR-UNIT HOT PRESS FURNACE

NOTE: TAPER MUST FIT SLEEVE TO RESULT IN 90% CONTACT AS DETERMINED BY STANDARD BLUEING METHODS.

FIGURE 5

DIE INSERT

FIGURE 6

CAP PUNCH

BASE PUNCH - PART AMATL: FORMITE #2 R_c 44-45 BASE PUNCH - PART BMATL: FORMITE #2 R_c 44-45

FIGURE 7

BASE SUPPORT PUNCHES

MATERIAL: MILD STEEL (SHELBY TUBING)

FIGURE 8

CAP PUNCH RING

MATERIAL: FORMITE 2 OR EQUAL HARDEN TO
R_C 50-55 AND GRIND

FIGURE 9

FUEL ELEMENT PIN

MATERIAL: STENTOR OR KETOS TOOL STEEL
HARDENED TO ROCKWELL 60-64C

FIGURE 10

SIZING DIE

MATERIAL: DRILL ROD - HARDEN BULB END
TO R_c 45-55 - POLISH MARKED
AREA

FIGURE 11

TUBE EXPANDER

(C) Break Die from
Furnace

(B) Pressing

(A) Seating the Die

FIGURE 12

STEPS INVOLVED IN HOT PRESSING THE ASSEMBLED CORE

UNCLASSIFIED

-36-

HW-73111

NICKEL PLATING RACK

FIGURE 13

UNCLASSIFIED

MODIFIED THOMPSON NICKEL PLATING PROCESS
FOR URANIUM FUEL CORES (Rev 1)

FIGURE 14

NICKEL PLATING PROCESS

CLEANING OF ALUMINUM COMPONENTS
FOR HOT PRESSING

FIGURE 15

ASSEMBLY OF FUEL ELEMENT COMPONENTS
FOR HOT PRESSING OPERATION

FIGURE 16

FLWSHEET FOR HOT PRESSING I & E FUEL ELEMENTS

FIGURE 17

(a) FUEL ELEMENT CAP

(b) FUEL ELEMENT BASE

FIGURE 18

TRU-LINING FEATURE FOR HOT PRESSED FUEL
ELEMENTS

DATE

FILMED

9/20/94

END