**Cover Sheet for a Hanford
Historical Document
Released for Public Availability**

Released 1994

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**

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DESIGN GROUPS • BUILT ASSEMBLY AND

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FROM

W.A. Blanton/E.A. Smith/H.P. Shaw

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CG-NMP-1, 6-23-94

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Richland, Washington
November 27, 1951

DESIGN CRITERIA
SLUG ASSEMBLY AND QUENCH MACHINE

This document consists of

15

Mechanization of the 300 Area slug canning facilities is required to obtain uniform high quality product and to eliminate variables introduced by the human element. The work to be covered by this brochure will cover requirements for mechanization of only the operations occurring within the aluminum-silicon canning bath: can and cap preheating and wetting, canning assembly, and quenching operation. Briefly, this machine will be required to insert a prepared uranium slug into an aluminum can and close the can opening with an aluminum cap. All assembly operations are to be carried out underneath a molten bath of aluminum-silicon bonding alloy. The uranium slug is preheated and prewetted before being transferred to the assembly furnace; however, the process must be so timed that proper preheating and wetting is attained before the slug is inserted. After assembly the completed canned slug is transferred to the quenching station, where the components are to be firmly held together until the molten Al-Si has frozen, forming a homogeneously bonded assembly. (See drawing H-3-4885 for, "Triple Dip Process - Flow Sheet.")

The following discussion presents the technical requirements for the above operations, with certain operating conditions that must be met to achieve these requirements.

PROCESS REQUIREMENTS

A satisfactory canned slug must meet the following process requirements.

1. Dimensional stability during irradiation.
2. Suitable dimensions to fit existing pile tubes.
3. Uranium content within specified weight limits.
4. Suitable purity of uranium and other components to provide:

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- a. Satisfactory resistance to corrosion.
 - b. Satisfactory reactivity.
 - c. Satisfactory behavior in the separation process.
5. Sound bond between slug and jacket, possessing:
- a. Suitable adhesive strength.
 - b. Substantial freedom from voids and incompletely bonded areas.
 - c. Good heat transfer characteristics.
6. Sound jacket, having:
- a. Freedom from perforation in the walls.
 - b. Suitable thickness at every point.
 - c. Freedom from perforation in end closures.

ALUMINUM-SILICON BATH

The bonding medium used in the process is an aluminum-silicon alloy containing approximately 11.2 to 11.5% silicon. In order to insure complete bonding between the metal slug and the aluminum can and cap, it is essential that the surface of all the component parts be completely wet by the bonding medium, and that they be assembled in the presence of an excess of the bonding medium in a fluid state.

Control over the composition of the aluminum-silicon bath has been found to be exceptionally important. The silicon content is maintained slightly below that corresponding to the eutectic composition. This prevents lowering of the melting point of the material in contact with the can as aluminum dissolves from the can wall.

The composition of the aluminum-silicon alloy is important since the presence of only very small amounts of certain impurities are sufficient to lower the corrosion resistance of the bond or to lower pile reactivity. Alcoa's A-13 aluminum-silicon alloy is currently being used. The tin content of the bath is kept below 0.2 per cent by analytical control. If the tin content is allowed to build up beyond this maximum, appreciable tin will appear in the braze line between the cap and can. Upon welding, this braze tends to diffuse into the weld bead where the presence of tin is believed to accelerate corrosion during pile exposure. (Present practice is to remove the molten alloy from the canning bath when it approaches the maximum tin content and transfer it to the Al-Si dip furnace.) See attached Data Sheets for typical aluminum-silicon bath composition.

CORROSION OF MACHINE PARTS

Nearly all metals are attacked to some extent by molten aluminum-silicon, particularly, if they are subject to abrasion while in contact with the molten liquid. Therefore, parts extending into the molten Al-Si bath must be of a material that will withstand atmospheric oxidation at the working temperature and must not react with or be wetted with Al-Si. Cast-iron and tungsten are comparatively resistant, but these can not be readily adapted to the fabrication of structural shapes of small cross-section. Graphite and ceramics undergo little attack, but again do not possess the properties necessary for machine construction. Slip coatings and fritted ceramic coatings appear to afford fair protection, but the former is readily abraded off, while the latter is difficult to apply and is subject to spalling. Other materials under study include stellite and oxidized low carbon and stainless steels. The materials of construction must be carefully chosen.

[REDACTED]

By the time design has progressed to a point of selecting the material of construction, sufficient data should be available from the research and experimentation now being carried on by the Hanford Works Technical Section.

TEMPERATURE CONTROL

One of the most important factors in obtaining proper seating and bonding of the slug has been demonstrated to be dependent upon temperature control. If the aluminum can is too cold when the slug is brought to it for insertion, an incompletely seated slug results from aluminum crystals freezing on the can wall and mechanically interfering with slug insertion. If the can is too hot during assembly, excessive side-wall penetration by the Al-Si occurs. (An arbitrary figure has been established limiting the thickness of unpenetrated can wall to .010"; however, it is now believed that this figure is too small.) Simultaneous wetting of the entire inside can surface with Al-Si reduces the tendency toward wall penetration. The cap temperature must be accurately controlled; if too cold caps will not wet properly in the Al-Si; if too hot excessive solution of the cap results, with a reduction of its physical dimensions.

If satisfactory bonding and seating is to be realized, provisions must be made for insuring proper temperatures of all components prior to wetting of their surfaces. To accomplish this, the canning bath must be held as uniformly as possible within the specified temperature range. Adequate temperature control of the molten bath will assist in providing a homogeneous metal which will aid in establishing metal fluidity and uniformly-consistent temperatures, which in turn will increase the ease and effectiveness of slug seating. In the existing resistance type pot furnaces, a wide temperature gradient is encountered as the result of several uncontrollable variables: convection in the molten bath, instrument inaccuracies, and irregular environmental conditions.

Low frequency induction heating has been suggested as a means of heating the Al-Si metal. Oak Ridge is currently using this type of furnace on their canning line. A few of the advantages and disadvantages have been discussed in the attached Data Sheets.

TIME CONTROL

The canning assembly is dependent upon precise timing of all operations in the proper sequence. The length of time that each slug remains in contact with the Al-Si dip and canning bath determines: (a) the thickness of the uranium - aluminum - silicon compound layer and (b) the amount of uranium that will go into solution. If the compound layer is allowed to build up excessively, it becomes brittle and cracks when subjected to thermal or mechanical shock. If the aluminum components are over exposed to the molten Al-Si, excessive dissolving will result, with a reduction of their dimensions. All of these variables must be accurately controlled to produce a consistent high quality product.

WETTING CANS AND CAPS

Several factors must be considered in establishing a technique for wetting aluminum cans and caps with the bonding medium:

1. The aluminum surface must be chemically clean.
2. The surface must be free from areas of fine irregularities or matte condition.
3. The surface must be treated to remove most of the film of aluminum

oxide normally existing on aluminum surfaces exposed to air, and to inhibit further formation of such film. This treatment must not be drastic enough to produce a matte surface, unless accompanied or followed by mechanical abrasion while in contact with the molten Al-Si,

4. Adsorbed moisture tends to react with the aluminum at high temperatures to produce a surface not conducive to wetting.
5. Abrasion of the aluminum surface at a temperature above the melting point of the Al-Si, while in intimate contact with the molten alloy is conducive to the wetting of the surface.
6. It is necessary to control the length of time in the baths and handling times.

ASSEMBLY & QUENCH

Factors that must be considered in mechanization of the assembly and quenching operations include:

1. The assembly of the components must be accomplished at such a rate, and temperature that a homogeneous adherent layer of Al-Si is enclosed in the annulus between the can and the slug, and between the slug and the end closures, without causing excessive penetration of the can.
2. Assembly pressures, holding fixtures and manipulators must be such that they do not erode, tear, or deform the can walls or produce marred surfaces; e. g. excessive hydrostatic pressures within the can during slug insertion and non-axial insertion will tend to erode or otherwise damage the can wall. However, sufficient pressure must be applied to the assembly to insure that a minimum thickness of Al-Si lies between the end closures and the ends of the uranium slug. The pressures required for the assembly operations are dependent upon the ease with which the slug enters the can, surface conditions, temperature of the components, fluidity of the bath, alignment of components, and the amount of slag and other impurities present. Experimental work is currently in progress to measure the pressures required for slug insertion and slug seating. This information will be provided as soon as possible.
3. The specified dimensions of the canned slug must be preserved.
4. Aluminum-silicon has a very pronounced tendency to form oxides as a surface dross. To assure that none of this surface dross is trapped within the assembled slug, the surface of the molten bath must be relatively free from oxide and dirt upon slug immersion. When objectionable quantities of dross appear, they must be mechanically skimmed off. (To relieve this requirement of surface skimming, experimental work is in progress involving the addition of small amounts of beryllium to the aluminum-silicon bath to reduce the amount of surface oxide formed.)
5. The number of fixtures extending into the Al-Si bath must be kept to a minimum. Their dimensional cross-section must be as small as is compatible with the required strength, considering their resistance to corrosion. Any parts in contact with the molten Al-Si bath must be designed for quick disconnecting and replacement. In addition,

[REDACTED]

all fixture designs must have provisions for removing the frozen metal which forms on partially immersed bodies, or fixtures that are in and out of the bath.

6. Each unit must incorporate the required flexibility to process either 4 or 8-inch slugs with only "set up" adjustments. (Physical dimensions for each are given in the attached Data Sheets.) In addition, the units must be flexible enough to accommodate with "set up" adjustments future process changes and/or specification tolerances. There are three potential processes which this machine should be capable of handling with only minor alterations: (1) triple dip, (2) lead dip, (3) single dip.
7. If a steel protective sleeve is used, as at present, care must be exercised to avoid chattering of the canned slug within the sleeve during the quench. (This is caused by quench water being drawn in between sleeve and can and explosively converted into steam) Preventive steps must be taken to prevent Al-Si slopping or running down between the exterior can surface and the sleeve. The protective sleeve will be manually removed from the assembly immediately upon completion of the quench.
8. At the time of quenching the components must be held firmly together until the molten metal is frozen.
9. Successful functioning of a mechanical canning device will depend to a large part upon the precision with which mating components register or align.
10. Each complete unit, section, or assembly, must be so designed that it can be fitted into the production line with a minimum disruption to the operation.
11. All equipment should be designed for ready accessibility and ease of inspection and maintenance.
12. For reliability and ease of synchronization the mechanism should be controlled from a common unit.

CAN PREHEAT & PREWETTING

Provision must be made to prevent, during assembly, the wetting of the exterior surface of the can with Al-Si bonding material. In the present operating process, this requirement is met by encasing the aluminum can in a reusable steel protective sleeve. The mouth of the can is flared out against the sleeve to seal the annulus against the entry of molten Al-Si. This method is not entirely effective and frequently results in the adhesion of Al-Si patches to the exterior can surface, causing its rejection. In addition the desired temperature is not always attained in the specified preheating time to permit satisfactory assembly of the components. There is a comparatively wide variation (ranging through at least 10°C) in the temperature attained by the sleeve encased aluminum can heated under similar conditions of immersion time and bath temperature. This is due principally to irregular contact between the can and sleeve, with consequent irregular heat transfer. Added to these irregularities is the heating cycle variation imposed by manual introduction of the cold can sleeve assembly into the canning bath. Thus there is the probability that the aluminum can will be either too hot or too cold when the slug is inserted.

It is impossible to remedy this situation by mere close control of the bath

[REDACTED]

ADC-1

temperature and preheating time on a fixed cycle. Rather, provisions must be made to insure proper can temperature prior to the wetting and assembly operations. This will involve either preheating the can-sleeve assembly to a predetermined temperature in an external heater using a gas or liquid heat transfer medium, or substituting for the sleeve some other protective device which will permit very rapid heating of the can to temperature equilibrium within the bath. Successful application of this principle should eliminate non-sealing due to cold cans, and should reduce the possibility of excessive can wall penetration, thus improving uniformity of canned slug quality.

Experimental work has indicated the feasibility of using a thin sprayed-on film of graphite to protect the can from the action of molten Al-Si, thus eliminating the need of the sleeve for Al-Si protection. With this arrangement the can may be heated to equilibrium within the bath almost immediately upon immersion and the problems of poor heat transfer, caused by the steel sleeve, will be eliminated. (See list of reference documents for additional information.)

To insure proper heat transfer the homogeneous layer between the slug and the can must be metallurgically bonded to both components. Attainment of this bond requires that both slug and can surfaces be wetted by the bonding medium. After the can has been adequately preheated as outlined above, it is in a condition for immediate alloying with the bonding agent as soon as the insulating film of the aluminum oxide normally covering the interior can surface is broken. In the present canning process this condition is partially realized when the slug is inserted into the can filled with molten Al-Si. The rapid flow of molten Al-Si through the annulus between slug and can, as it is displaced by the entering slug, erodes and abrades the surface oxide film permitting the wetting of the can surface. However, there is no assurance that this oxide film is completely removed allowing perfect wetting over the entire surface. Development work has shown that light mechanical abrasion applied to the interior can wall while in contact with the molten Al-Si, but prior to the insertion of the slug promotes the desired complete wetting. (Both a wire brush and graphite mandrel have been tried with promising results.) The successful development of a means for complete component wetting is essential to eliminate voids and unbonded areas.

CAP PREHEAT & PREWETTING

In order that the aluminum cap used to close the mouth of the jacket may be homogeneously bonded to both slug and can without reduction in dimensions, it is necessary that it be first preheated to such a temperature that it will wet promptly on direct contact with the Al-Si bonding medium. In the present manual operation, the cap, held in gripping tongs, is introduced by the operator into the molten bath at an instant indicated by an electric timer. It is specified that the cap be held motionless during the preheating interval; then when the timer indicates, subsequent manual activities are performed. Both the duration of the preheating interval and the motionless condition during heating are critical. If the preheating time is a few seconds too short, the cap will be too cold to wet properly in the Al-Si; if too long, excessive solution of the cap with reduction of its dimensions results. Agitation during preheat results in irregular erosion of the cap, with reduction of its dimensions, causing an excessively wide braze in the canned slug.

It is almost impossible to coordinate the manual activities required in the component assembly so that every cap is assured the specified treatment. Precise timing and manipulation can be provided only by a mechanical device so synchronized with accessory devices that uniform treatment is applied to every cap.

Successful attainment of this end may be expected to eliminate current troubles with poorly wet caps, thus substantially decreasing the probability of channels extending through the braze to the uranium core.

What has been said regarding the metallurgical bonding of the canned slug applies also to the cap. In the present process the cap is preheated in the Al-Si bath, removed and the bottom surface is wiped on a piece of transite, then returned to the molten bath, given a swirling motion, and then inserted. Like the can, cap wetting is promoted by mechanical abrading in the canning bath. The use of ultrasonic vibration to apply the desired mild abrasion has been under consideration, but has not been evaluated. Mechanically wiping the cap bottom and periphery on a piece of enameled carbon steel is currently being tried.

SLUG INSERTION

In the present manual process the slug is brought to the submerged can in a pair of tongs; its lower end is placed in the mouth of the can; it is then uprighted to a position approximately co-axial with the can and is manually pressed to or near the bottom of the can by a seating tool. During this process there is considerable opportunity for excessive abrasion and attrition of the wall at the can mouth. The degree of wetting is dependent partially upon the zeal with which the operator presses on the slug, and unless the slug is pressed in a direction parallel with the axis it is possible to tear or wrinkle the can wall. To improve the uniformity of quality with respect to slug insertion, it will be necessary to insert each slug co-axial with the can under uniform pressure applied until complete seating of the slug is attained. Realization of this end will reduce the probability of excessive penetration of the can wall and at the same time will reduce the number of slugs rejected because of incomplete seating.

CAP INSERTION

The present process specifies that the cap, after preheating and prewetting, should be carried beneath the surface of the bath to a position co-axial with the can and slug whereupon it is pressed firmly into the can mouth above the slug. Lateral movement beneath the surface of the molten bath is specified to prevent entrapping air or dross beneath the cap and including it in the assembled slug. A suitable canning machine should provide for such a positioning of cans and caps that air or dross inclusions will be prevented.

QUENCH

Under the present procedure the assembled canned slug is transferred manually from the canning bath to the quench tank. During transfer the assembly may be subjected to jolting, bumping, and centrifugal forces which tend to dislodge the components and permit the entry of air into the braze. Furthermore, when the assembly is placed in the quench tank there is some likelihood that drops of water will be thrown on top of the closure while the bonding medium is still in the molten condition and that such drops will be explosively converted to steam, thus literally blasting a channel into the braze. To avoid these difficulties, it is required that the can assembly be (a) transferred smoothly to a quench fixture, (b) that component parts be held firmly together, (c) that the quench water be applied to the exterior of the sleeve without permitting the entrance of water into the mouth of the assembly.

Approved by the Working Committee

W. A. Blanton
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DATA SHEET "A"Production Rate

Each canning machine must be capable of producing 50 tons of acceptable 4" or 8" slugs per month on a 1-shift, 8-hour day, 5 days per week basis. For design purposes assume that each unit is to have 25% additional capacity to offset production lost by Maintenance and "set up" time.

Backlogging of Components

Aluminum caps and cans may be backlogged for a maximum of two hours after preparation. Prepared and preheated uranium slugs will be manually transferred to the canning machine, from the Al-Si dip furnace, at a rate dependent upon the fixed manual cycle.

Flexibility

For design purposes the machine should be capable of operating at any given setting or dimension within the following operating ranges by "set up" adjustments.

1. Aluminum-silicon bath temperature: 580 to 600° C.

Desired temperature control of setting $\pm 1^\circ$ C.

2. Quenching:

Water quench temperature range, 15 to 100° C. $\pm 5^\circ$ C.

3. Bare Slug Dimensions:

Length: 4" to 9" $\pm .010$ "

Diameter: 1.350 to 1.400 $\pm .001$ "
 $\pm .002$ "

4. Aluminum Can Dimensions:

Outside Diameter: 1.442" Max.

Inside Diameter: 1.345 to 1.375"

Bottom Thickness: 0.175 to 0.500"

5. Aluminum Cap Dimensions:

Diameter: 1.340 to 1.370"

Thickness: 0.250 to 0.600

6. Time that the components are to remain in the molten Al-Si:

Can - 10 to 70 sec. Desired tolerance of setting ± 0.5 sec.

Cap - 10 to 40 sec.

Slug - Before being inserted into the can, 2 sec. maximum;
after being inserted into the can - 15 sec. maximum

The furnace should be designed for the possibility of adding a furnace closure, at a later date, for a controlled atmosphere, if deemed advisable.

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DATA SHEET "B"

THE EXCESS PORTION
OF THE CAP AND CAN
ARE MACHINED OFF
PRIOR TO WELDING

ASSEMBLED SLUG
(NOT TO SCALE)

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DATA SHEET "C"

Physical Characteristics of Components
Being Used

Uranium Slugs

	<u>4"</u>	<u>8"</u>
Diameter	1.350" $\pm$.001" $\pm$.002	1.334" $\pm$.001" $\pm$.002
Length	4.045 $\pm$.010	8.400 $\pm$.010
Radii at ends	1/16 $\pm$ 1/64	1/16 $\pm$ 1/64

Surface

General Electric Company finish symbol
"J" (Such that the slug will clean up
in pickle and may be inserted into can
readily.)

Reference Dwg.

H-4-1851

Density

18.97 average

Specific Heat

at 527°C = 9.9 cal/gram atom °C.

at 627°C = 11.0 " " " "

Thermal Conductivity

at 400°C = 0.069 cal/(sec cm °C)

Thermal Expansion

Coefficient (approximate)

4.5 x 10⁻⁶ cm/cm °C.

Cooling Rate

To be supplied later.

Temperature of slug arriving at Al-Si canning bath 595° $\pm$ 5° C.

Aluminum Cans

	<u>4"</u>	<u>8"</u>
Inside Diameter	1.368" $\pm$.003"	1.348 $\pm$.003"
Wall Thickness	0.035 $\pm$.005	0.045 $\pm$.005
Outside Diameter		
Maximum	1.442"	1.442"
Minimum	None	None
Length Outside	4 7/8 $\pm$ 1/16"	9 1/2 $\pm$ 1/16"
Bottom Thickness	0.175 $\pm$.010	0.175 $\pm$.010"
Dimple (Optional with manufacturer)		
Maximum depth	0.087	0.087
Maximum diameter	5/32"	5/32"
Inside Radius at Base	0.050" Max.	0.050" Max.
Outside Radius at Base	0.100" R Max or 0.100" Bevel Max., free from burrs.	

Reference Dwg.

H-3-1575

F-4-1786

Material:

Al content of 99.3% Min.

Surface Finish:

Outside Surface - Scratches shall not exceed .001" in depth and
the surface shall be free of galled and checked areas.

Inside Surface - The surface shall be "As fabricated" and shall be
free of stains and defects except that scratches and die marks not
exceeding .003" in depth shall be permitted.

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Aluminum CansInspection:

All 4" cans shall pass a 1.364" full length mandrel and shall pass a 1.447" full length tube gage.

All 8" cans shall pass a 1.344" full length mandrel and shall pass a 1.447" full length tube gage.

Aluminum Caps

	4"	8"
Diameter	1.365 $\pm$.0005	1.345 $\pm$.0005
Thickness	0.250 $\pm$.000	0.425 $\pm$.000
Bottom Radius	1/16"	1/16"
Shank Diameter	3/4" $\pm$ 1/16"	3/4" $\pm$ 1/16"
Shank Length	1/4" $\pm$ 1/16"	1/2" $\pm$ 1/16"
Reference Dwg.	H-3-1576	H-4-1787
Material	Al content of 99.3% Minimum.	
Surface (Bottom and side)	Fine machine. General Electric Company finish symbol "E". Finish free from tool marks, galls, matte areas, and the bottom must be flat. Break all corners	

Reusable Steel Sleeves

	4"	8"
Inside Diameter (A)	1.448 $\pm$.001	1.448 $\pm$.001
" " (B)	1.451 $\pm$.001	1.451 $\pm$.001
Outside Diameter	1 3/4" O.D. Seamless tubing "as received"	
Length	5" $\pm$ 1/32	9 5/8" $\pm$ 1/32
Reference Dwg.	H-4-1871	H-4-1871
Mouth Chamfer	45° or 3/32" R $\pm$ 1/16" face	

Inside bottom surface shall be in a plane perpendicular to the longitudinal axis, maximum angle of inclination from perpendicular 2° 30'.

Inspection for Straightness: Sleeve must pass full length plug without tightness.

Parts A	-	Plug Dia.	=	1.447 $\pm$.001
B	-	" "	=	1.450 $\pm$.001

Material: S.A.E. 1020 Commercial 1 3/4" O.D. seamless tubing.

Weld must not protrude thru to inside wall.

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Aluminum-Silicon Bath (Alcoa's A-13 Al-Si Alloy)

Composition (typical)

Silicon Content	-	11.5 to 12.5%
Copper	"	0.03%
Iron	"	0.03 to 0.50%
Tin	"	less than 0.01%
Magnesium	"	" " "
Manganese	"	" " "
Zinc	"	" " "
Nickel	"	" " "
Aluminum	"	balance

Note: The aluminum-silicon is butted down by adding 2S aluminum, when charged into the melting furnace, to a silicon content of 11.2 to 11.5%.

Operating temperature of the bath at present, 593 $\pm$ 3°C.

The bath surface is skimmed prior to immersion of the slug.

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DATA SHEET "D"

Types of Slug Rejects

The following lists the types of slug rejects that are detected in the present Hanford manual slug fabrication process. Only a portion of the rejects are detected during the canning operation; however, even though they are picked out later some of them are directly credited to the canning assembly and quench operations.

Symbol	Name	Reason
NS	Non-Seating	Slug not properly seated in the bottom of the can.
MS	Marred-Surface	Marred surfaces; scratches or dents greater than 0.002" deep.
Al-Si	Al-Si on Can	Al-Si on canned slug exterior surface. Can be caused by molten Al-Si wetting the exterior surface or by penetration.
FT	Frost Test	Melted areas on the canned slug surface indicating a void or improperly bonded area in excess of 1 sq. cm.
WC	Wrinkled Can	Excessive hydrostatic pressure, non-axial insertion, or frozen metal on the surfaces during slug insertion.
AP	Air Pocket	Components were not completely submerged during assembly, components were jarred during transfer or steam was formed during quenching.
SS	Stuck Sleeve	Sleeve removed from canned slugs resulting in marred surfaces.
OC	Off Cycle	Failure to meet specified timing.
DC	Defective Can	Defect is detected in the Al can after assembly.
H	Holes	Complete penetration of the can wall.
BW	Bad Weld	Poor weld because of poor braze, dirt inclusion, etc.
PB	Poor Bond	Visual inspection indicates a poor bond between cap and can prior to welding.
P	Penetration	Penetration of the Al-Si in extremely small areas.

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DATA SHEET "E"

Low Frequency Induction Furnaces

One other A.E.C. site is currently using a 30 kv., 60 cycle, single coil, tilt pouring, Ajax-Tana-Wyatt, low frequency induction melting furnace. It is claimed that use of this type of furnace provides better temperature control and metal fluidity of the molten bath than is normally obtained at Hanford with resistance type furnaces. This type of furnace would possibly answer the following requirements:

1. Close temperature control, while cold caps and cans are charged and molten metal is discharged continuously.
2. Thorough mixing of the molten bath.
3. Large melting capacity in small space.
4. Comfortable operating conditions with only small amounts of heat being radiated to the surroundings, improving working conditions.

Disadvantages of this type furnace are:

1. Violent agitation of the metal accelerates the formation of surface oxides.
2. Aluminum-silicon slag particles have about the same specific gravity or are heavier than the Al-Si molten metal. When subjected to vigorous agitation, their settling may be retarded.
3. Aluminum requires high energy per unit of weight for melting. If the heat conductivity of the new metal being charged is too low the rate of heat penetration from the liquid heel to the cold metal may not keep pace with the rate at which heat is dissipated from the melting channels. When this happens, overheating of the heel will result.
4. Slag particles tend to stick to the walls of the melting channels and gradually decrease their cross-section.
5. Slag that settles to the bottom and components that may be dropped into the bath would be extremely hard to remove, particularly from the cross-section.
6. If the bath should freeze for any reason, such as an interruption of power or failure of electrical control, the furnace could not be started again.

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DATA SHEET "F"

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Reference Documents

- HW-10150 - "Operating Process For Machining Uranium Slugs," by E. A. Smith plus attachments HW-9401, HW-9402, HW-9393, and HW-9815.
- HW-10605 - "Aluminum Component Preparation and Use."
- HW-21894 - "Mechanization of the Slug Manufacturing Operation," by E. A. Smith
- HW-22806 - "Detailed Description of Argonne National Laboratory Al-Si Sleeveless Canning Procedures."
- 3-2156 - "Wire-Brushing for Improving Quality of Canning."
- ANL-4618 - ANL Quarterly Report - CP-6 Reactor Program

Reference Drawings

- H-3-1575 - Aluminum
- H-3-1576 - Aluminum Cap
- H-3-4885 - Triple Dip Process - Canning, Welding & Inspection Flow Sheet
- H-3-4886 - Salt Bath Slug Transformation - Canning, Welding & Inspection Flow Sheet
- H-3-4887 - Induction Heating Rod Transformation - Canning, Welding & Inspection - Flow Sheet
- H-4-1786 - Aluminum Can
- H-4-1787 - Aluminum Cap
- H-4-1871 - Steel Sleeve
- H-4-1851 - Dimensional & Surface Specifications for Bare Uranium Slugs

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