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DECONTAMINATION PROCESSES FOR WASTE GLASS CANISTERS

W. NEVYN RANKIN

E. I. du Pont de Nemours & Co.
Savannah River Laboratory
Aiken, SC 29808

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ABSTRACT

The process which will be used to decontaminate waste glass canisters at the Savannah River Plant consists of:

- Decontamination (slurry blasting)
- Rinse (high-pressure water)
- Spot decontamination (high-pressure water plus slurry)

No additional waste will be produced by this process because glass frit used in decontamination will be mixed with the radioactive waste and fed into the glass melter.

Decontamination of waste glass canisters with chemical and abrasive blasting techniques was investigated. The ability of a chemical technique with HNO_3-HF and $H_2C_2O_4$ to remove baked-on contamination was demonstrated. A correlation between oxide removal and decontamination was observed. Oxide removal and, thus, decontamination by abrasive blasting techniques with glass frit as the abrasive was proposed and demonstrated.

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DECONTAMINATION PROCESSES FOR WASTE GLASS CANISTERS

INTRODUCTION

The Savannah River Plant (SRP), operated for the U.S. Department of Energy by the Du Pont Company, has produced special nuclear materials for both defense and peaceful applications since 1953. Production of these materials has generated ~25 million gallons of high-level liquid radioactive waste. Methods to immobilize this waste for long-term storage are currently being developed at Savannah River Laboratory.

The present reference process for immobilization of SRP waste consists of immobilizing the waste in borosilicate glass. The liquid waste is mixed with glass frit, heated to 1150°C in a joule-heated ceramic melter at which temperature the waste is dissolved in the molten glass. The molten product is then poured into Type 304L stainless steel canisters and allowed to cool in air.

This paper describes the process developed to decontaminate the surface of the sealed canisters before removal from the processing facility. Decontamination of the canisters allows them to be removed from the processing facility and emplaced in interim storage without spreading contamination.

DECONTAMINATION TECHNIQUES

Chemical

Chemical decontamination techniques are ideally suited to remote operations because of their simplicity. The canister is immersed in solutions which dissolve the contaminated outer portion of its surface. The canister is then rinsed to remove dissolved contamination.

A technique which includes the use of HNO_3-HF and $H_2C_2O_4$ was previously developed (Table 1) at the Savannah River Laboratory (SRL) to decontaminate stainless steel canisters. HNO_3-HF was selected to remove the oxide film from the stainless steel. These acids are widely used as a standard practice for cleaning and descaling stainless steel parts.[1] $H_2C_2O_4$ is a complexing agent that has been used for decontamination for years.[2]

TABLE 1

Chemical Decontamination Process

Step	Solution	Concentration	Temperature	Time, hr
Etch	HNO_3-HF	3.9M HNO_3-0.4M HF	Room temperature	1
Rinse	H_2O		Room temperature	
Clean	$H_2C_2O_4$	100 g/L	Boiling	1
Rinse	H_2O		Room temperature	
Etch	HNO_3-HF	3.9M HNO_3-0.4M HF	Room temperature	1
Rinse	H_2O		Room temperature	
Clean	$H_2C_2O_4$	100 g/L	Boiling	1
Rinse	H_2O		Room temperature	

Removing Baked-On Contamination

The ability of the HNO_3-HF and $H_2C_2O_4$ technique to remove baked-on contamination from Type 304L stainless steel specimens was evaluated. Specimens used in the test were one-in.^{2} pieces of Type 304L stainless steel with No. 1 surface finishes (hot-rolled, pickled, and annealed).[3] One face of some specimens was wet ground with 240-grit emery paper to evaluate the effect of better surface finishes (simulated No. 2B).[3] Specimens were contaminated up to 300,000 dis(α)/(min dm^2) by placing one drop of a plutonium nitrate solution in the center of one face of each specimen. The specimens were then heated for 16 hr at 600°C in air to produce an oxide film similar to the film expected on the outside of canisters filled with waste glass. Specimens were carried through the chemical decontamination process (Table 1); then they were smeared to determine the remaining amount of contamination.

Correlation With Oxide Removal

Results with oxide removal in the chemical decontamination tests (Table 2) show that consistent decontamination was not achieved with specimens which had No. 1 surface finishes. The amount of contamination remaining on the surfaces of specimens was proportional to the amount of oxide remaining on the surfaces. Specimens with simulated No. 2B surface finishes were consistently decontaminated to 10 dis(α)/(min dm^2). In all of these specimens, all of the oxide was removed from the surfaces.

TABLE 2

Results of Chemical Decontamination Tests

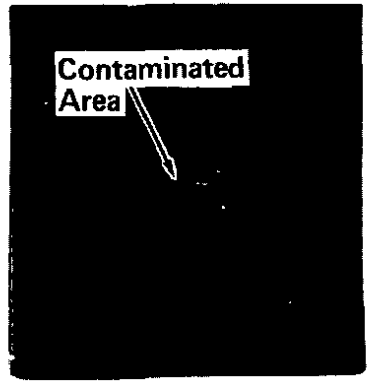
Surface Finish No.	Contamination Start, dis/(min·dm^2)	Contamination Finish, dis/(min dm^2)	Appearance
1	300,000	15,000	Brown oxide
1	300,000	120	Brown oxide
1	200,000	400	Some brown oxide
1	200,000	30	Clean
2B (simulated)	200,000	<10	Clean
2B (simulated)	200,000	<10	Clean
2B (simulated)	200,000	<10	Clean

The difference in appearance of No. 1 and simulated No. 2B surface finishes after each step in the decontamination process is shown with a specimen that was wet ground on 240 grit abrasive paper to simulate a No. 2B surface finish (Figure 1). The ground area in the center of the specimen could be easily seen. The remaining outer portion of the specimen was the original No. 1 surface. This portion of the specimen was not contacted during grinding because the edges of the specimen had been rounded when the specimen was sheared from the plate.

This specimen was photographed and surveyed after each step of decontamination. The oxide was removed from the simulated No. 2B surface finish portion of the specimen by the first HNO_3-HF etch. Oxide still remained on parts of the No. 1 surface finish portion of the sample after the specimen had been through the entire decontamination process.

Disadvantages of Hydrofluoric Acid

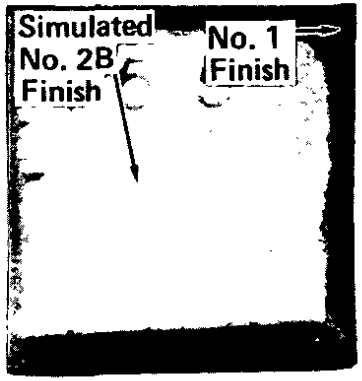
There are disadvantages to using hydrofluoric acid in a remote facility. Process vessels and exhaust ducts would have to be fabricated from more expensive, corrosion-resistant materials. Hydrofluoric acid vapor corrosion throughout the entire cell block is possible. Even the glass windows of the cells could be etched by the hydrofluoric acid. Disposal of hydrofluoric acid-containing wastes would also be difficult.



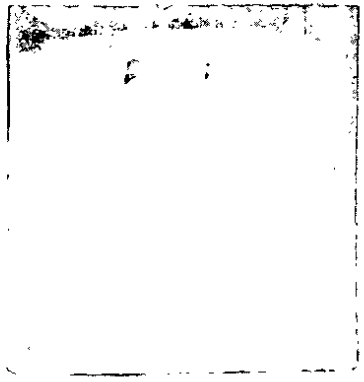
Contaminated, Oxidized Specimen Before Decontamination

200,000 dis(α)/(min dm^2)

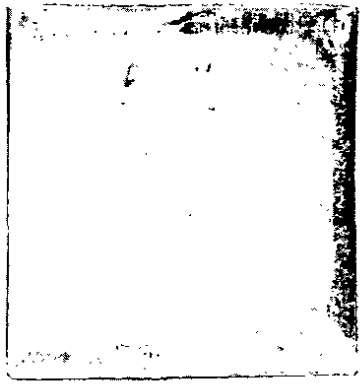
1 inch



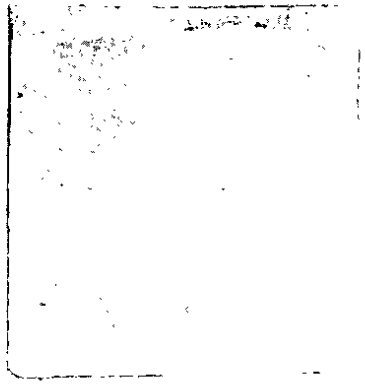
1 hr in HNO_3-HF
30 dis(α)/(min dm^2)



1 hr in HNO_3-HF
1 hr $H_2C_2O_4$
0 dis(α)/(min dm^2)



2 hr in HNO_3-HF
1 hr in $H_2C_2O_4$
0 dis(α)/(min dm^2)



2 hr in HNO_3-HF
2 hr in $H_2C_2O_4$
0 dis(α)/(min dm^2)

FIGURE 1. Appearance of Type 304L Stainless Steel During Chemical Decontamination

Abrasive Blasting Techniques

Abrasive blasting techniques were investigated as an alternative to the HNO_3-HF etch during decontamination because 1) no hydrofluoric acid would be necessary; 2) the cost of the entire waste form fabrication facility could be reduced because the building could be smaller (room for acid-processing equipment would not be needed), and less expensive materials of construction could be used because resistance to hydrofluoric acid would not be required (i.e., ventilation ducts); and 3) decontamination could be effected with the generation of no additional waste if the glass frit that is needed for waste vitrification would be used as the abrasive for blasting.

Oxide Removal

The ability of several abrasive blasting techniques to remove an oxide film from Type 304L stainless steel was demonstrated with several abrasives, including the glass frit which will be used in waste glass production. Specimens were blasted with dry abrasive, wet abrasive, and high-pressure water. Specimens 1 x 3 in. were sawed from a 1/4-in.-thick plate with a No. 1 surface finish or sheared from a 60-mil-thick plate with a No. 2B surface finish.[3] They were oxidized by heating in air for 16 hr at 600°C. These conditions were an estimate of the temperature that the outside of a canister would experience as it was filled with molten waste glass. In all tests, the nozzle was held 6 in. from the specimens at an angle of 45° with the surface of the specimens. Half of the specimens was covered during blasting so that part of the original surface would be retained for comparison. The results of these tests are given in Table 3. These results show that abrasive blasting, with the glass frit as the abrasive, is very effective for removing oxide from Type 304L stainless steel. Blasting with both dry and wet abrasive Frit 411 for only 5 sec removed the oxide. The change in specimen thickness was less than 1 mil. Neither technique was dependent on the surface finishes of the specimens before the specimen was oxidized. High-pressure water blasting (no abrasive) failed to remove any oxide in 30 sec.

Decontamination

The ability of abrasive blasting techniques with glass frit to remove baked-on radioactive contamination from the surface of Type 304L stainless steel was demonstrated. Four blasting techniques were used in these tests — dry abrasive blasting, dry abrasive blasting with water attachment, high-pressure water blasting, and high-pressure water blasting with abrasive. In all techniques with abrasive, Frit 211 (-20+80 mesh) was used (Table 4). For the dry-abrasive blasting technique, a simple,

TABLE 3

Results of Oxide Removal Test

Decontamination Technique	Abrasive	Pressure, psi	Results
Dry-Abrasive Blasting*	Frit 411 (-20+80 mesh)	10-40	Under all conditions, oxide removed in 5 sec.
	Al_2O_3 (180 mesh)	20-40	Changes in dimension <1 mil.
	Glass Beads (100-170 mesh)	20-40	Surface finish inversely proportional to grit size of abrasive and blasting pressure.
			Cleaned Nos. 1 and 2B surfaces equally well.
			Specimens cleaned with glass beads had a brighter finish. Specimens cleaned with Frit 411 or Al_2O_3 had a more matt finish. This difference was attributed to greater "cutting action" of the particles with the more angular shape.
Wet-Abrasive Blasting**	Frit 411 (-20+80 mesh)	250-1000	Under all conditions, oxide removed in 5 sec.
			Change in dimension <1 mil.
			Cleaned Nos. 1 and 2B surfaces equally well.
			Surface finish inversely proportional to blasting pressure.
			Less surface roughness was produced by wet-abrasive blasting with Frit 411 than by dry-abrasive blasting with Frit 411.
High-Pressure Water Blasting**	None	1000	Blasting with water only, for 30 sec, did not appear to remove any oxide from the surface

* The equipment used for dry abrasive blasting was manufactured by the Vacu-Blast Corporation.

** The equipment used for wet abrasive blasting and high-pressure blasting was a Myers MC 10-12M Mobile Hydraulic Cleaner.

TABLE 4

Composition of Glass Frits

Metal Oxide	Frit, wt % 211	21	411
SiO_2	58.3	52.5	58.3
Na_2O	20.6	18.5	12.5
B_2O_3	11.1	10.0	11.1
TiO_2	-	10.0	-
CaO	5.6	5.0	5.6
Li_2O	4.4	4.0	12.5

inexpensive sandblast unit (Pauli and Griffin Model 10W super sand blast machine) was used. In some tests, dust was eliminated by attaching a water attachment to the blasting nozzle to introduce a small amount of water into the blast stream. For high-pressure blasting, a Myers MC 10-12M mobile hydraulic cleaner was used. No abrasive was used in high-pressure water blasting. In some tests with high-pressure water, abrasive was mixed with the water stream from a Myers water sand gun assembly. All blasting was done inside an approximate 9-ft^3 cask decontamination facility in the SRL High Level Caves (HLC) (Figure 2) which is used for decontaminating radioactive casks. It is designed with features that are standard for nuclear equipment to effectively contain airborne and liquid radioactive materials:

- Air is exhausted from the facility at 500 ft^3/min through high efficiency particulate air filters.
- The floor drain from the facility is connected to the high-level drain.

A pair of locking pliers attached to a wooden "saw horse" was used to hold the specimen during testing. The hose from the blasting equipment was run through the door of the cask decontamination facility. Glove ports were used to operate the blast hose.

Two types of specimens were used in these tests (Figure 3):

Specimens with Baked-On Alpha Contamination

These specimens were 1- x 3-in. coupons of Type 304L stainless steel. Their surfaces were prepared the same way as the surfaces of specimens used for evaluating chemical decontamination procedures.[3] The specimens were contaminated with up to 400,000 dis(α)/(min dm^2); then, they were heated for 16 hr at 600°C to incorporate this contamination in an oxide film similar to that expected on a canister containing waste glass.

Specimens with Alpha, Beta, and Gamma Contamination

These specimens were 3/8- x 3-in. coupons of Type 304L stainless steel that were suspended inside the vapor space of the melter for up to 20 hr while the melter was producing waste glass at 1200°C. The melter was being fed 66 g/hr of 65 wt % Frit 21 and 35 wt % sludge from Tank 13.

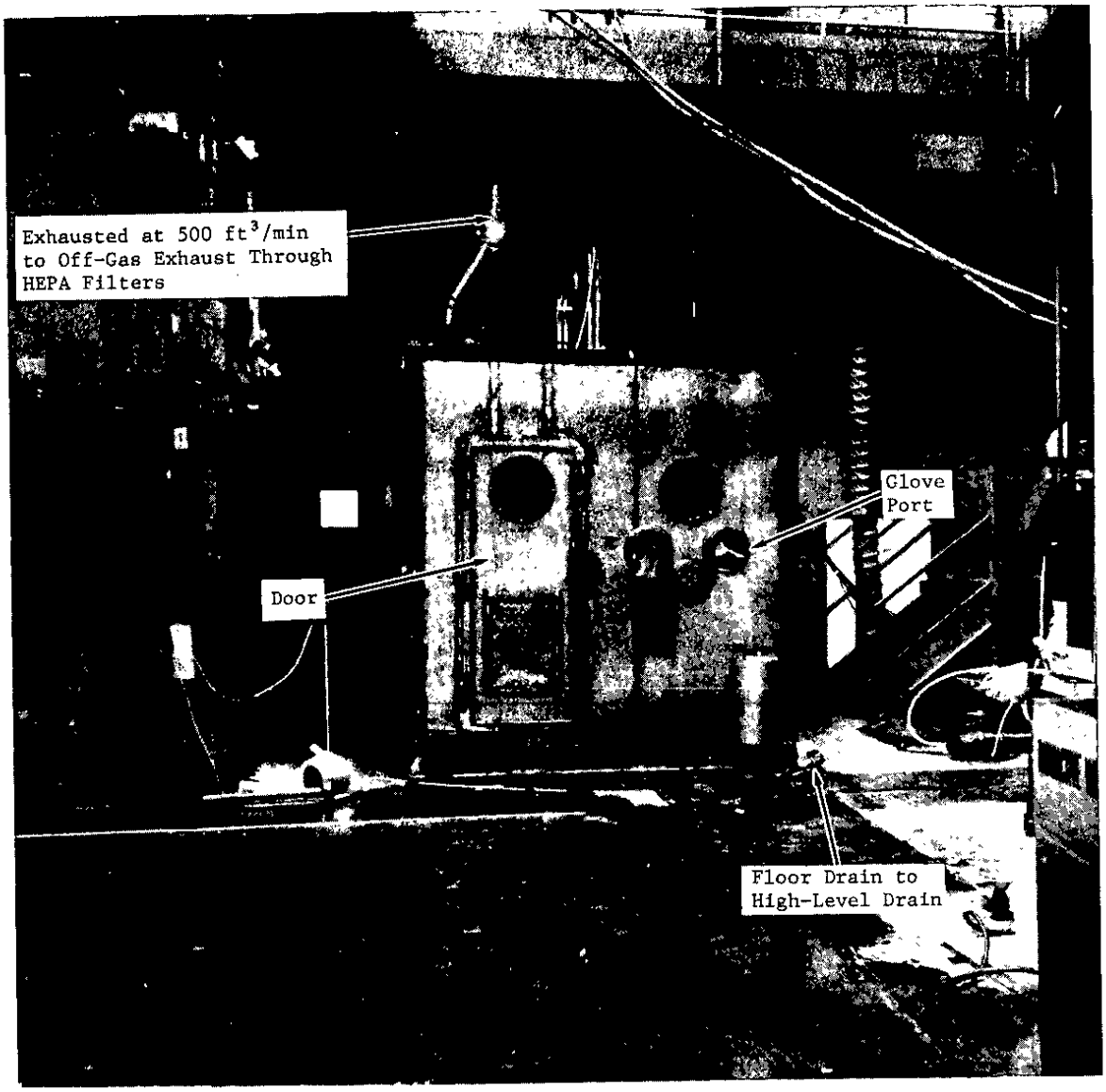


FIGURE 2. HLC Decontamination Facility

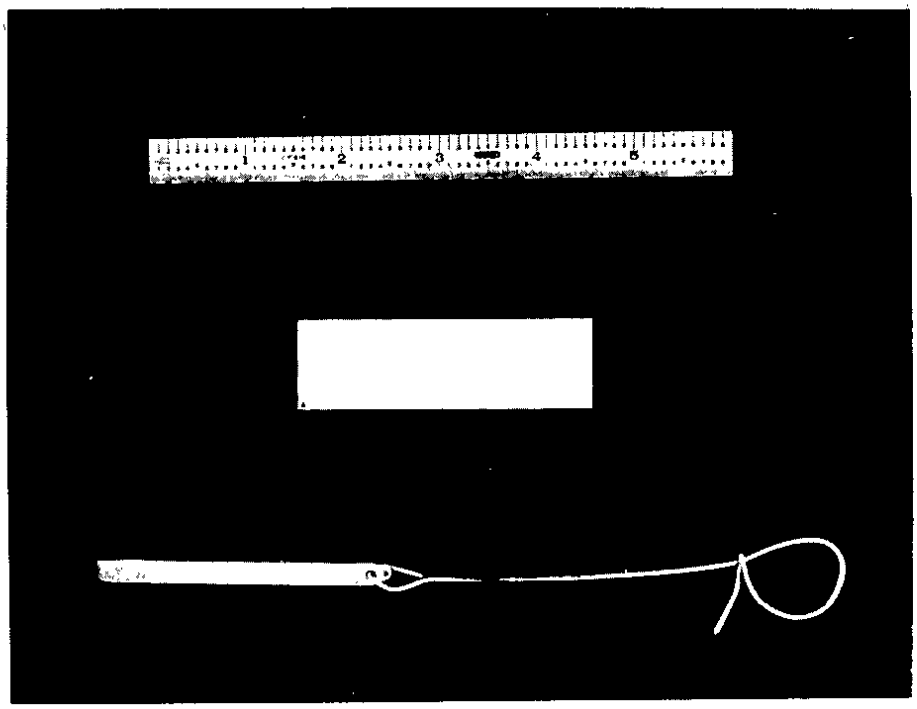


FIGURE 3. Test Specimens

These specimens were both oxidized and covered with a white film. Smearable contamination was 9×10^5 dis/min alpha, beta, and gamma. Gamma scan analyses of acid solutions used to remove this material showed that it was primarily ^{137}Cs.

The results of the tests (Table 5) showed that any of the blasting techniques with Frit 211 (-20+80 mesh) removed all smearable contamination from the Type 304L stainless steel specimens. Blasting with 1000 psi water only reduced but did not eliminate the amount of smearable contamination.

The amount of glass frit and water necessary to decontaminate an entire canister was determined from the amounts used in these laboratory-scale tests. These predictions showed that the amount of frit consumed by each process tested (Table 5) was well below the amount of frit in a canister of waste glass (>2000 lb). The amount of water required was within reason for disposal purposes according to discussions with SRP and Du Pont Engineering Department personnel.

Equipment to contain radioactivity removed from canisters by abrasive blasting techniques was designed from standard concepts for the nuclear industry. Both airborne and liquid radioactivity was successfully contained by the blast chamber in the decontamination facility.

TESTS AT EQUIPMENT MANUFACTURERS

The applicability of several abrasive blasting techniques to canister decontamination was investigated in large-scale tests at equipment manufacturers. Test specimens were 12-in.^{2} plates. In the tests, half of the surfaces of the plates was masked to retain the original surface for comparison.

The procedure followed at the equipment manufacturers was to 1) discuss the usefulness of their process to our applicaton and 2) demonstrate the ability of the processes to remove oxidation from a 12-in.^{2} plate of Type 304L stainless steel. The abrasives used in the demonstrations of the first three processes were -20+80 and -80 mesh Frit 411 (Table 4).

TABLE 5

Results of Tests in Decontamination Facility

Decontamination Technique	Decontamination Level: Before — Baked-On, α dis/min	Before — Melter, α dis/min	Before — Melter, β-γ c/m*	After — Baked-On, α dis/min	After — Melter, α dis/min	After — Melter, β-γ c/m	Projected Consumption Rate/Canister
Dry-Abrasive Blasting	200,000 to 400,000	4,000	9×10^5	Background**	Background**	Background**	500 lb frit
Dry-Abrasive Blasting With H_2O Attachment	200,000 to 400,000	4,000	9×10^5	Background	Background	Background	500 lb frit 200 gal H_2O
High-Pressure H_2O Blasting (1000 psi)	200,000 to 400,000	4,000	9×10^5	Up to 3690	Up to 354	Up to 68,000	50,000 gal H_2O
High-Pressure H_2O Blasting (1000 psi) with Frit	200,000 to 400,000	4,000	9×10^5	Background	Background	Background	3500 gal H_2O 500 lb frit

* One mR/hr = 4000 c/m.

** The smears from these specimens were counted in specially shielded counters where the background is <4 counts/24 hours alpha and <0.2 counts/min β-γ from ^{137}Cs.

Blasting Techniques Tested

The techniques investigated are discussed briefly in the following paragraphs:

- Dry

  Abrasive particles were propelled by compressed air at pressures of 20 and 40 psi against the surfaces of the plates being decontaminated. for all tests, 400 ft^3/min of air was circulated through the blast chamber, and the abrasive was fed through a 1/4-in. nozzle at a distance from 6 to 18 in. and at blast angles of 30, 45, and 90°. After the plates were blasted, they were blown with compressed air for cleaning.

- Slurry

  A slurry of abrasive particles in water was propelled by compressed air against the surface being decontaminated. These tests were carried out with a Vacu-Blast® slurry honing machine (Vacu-Blast Corp., Belmont, CA) which had a 3/8-in.-dia nozzle and a 3/16-in-dia air jet. The blast angle, frit size, and blast pressure were varied.

  After the plates were blasted, they were rinsed with high-pressure water at 2000 psi by an Aqua-Dyne GE 150 high-pressure pump. Approximately 7.2 gal/min was directed at the surfaces for 20 sec with a 15° fan nozzle 12 in. from the plates.

- High-Pressure Water Plus Frit

  A frit and water slurry was incorporated with the high-pressure water stream from an Aqua-Dyne GE 150 high-pressure pump (Aqua-Dyne Engineering, Inc., Houston, TX) and directed at the surfaces being cleaned. About 15 gal/min of water at 5000 psi was directed at the plates for about 30 sec through a 1/4-in. orifice of an Aqua-Dyne sand gun held about 12 in. from the plates. During this time, 2-1/2 gal of a 20 vol % slurry of water and -80 mesh Frit 411 was drawn into the blast stream by the venturi effect.

- High-Pressure Water

  High-pressure water blasting consists of blasting the surfaces of plates being cleaned with jets of high-pressure water, eliminating the need for abrasive. About 21 gal/min of water at up to 10,000 psi was supplied by an Aqua-Dyne GE 150 high-pressure pump. The water was passed through a 15° fan nozzle located 1/2 in. from the surfaces of the plates. The nozzle was moved at about 1.8 ft/min across the plates.

- Solid CO_2 Pellet[4]

  Approximately 500 lb/hr of about 1/8-in.-dia x about 1/4-in.-long solid CO_2 pellets was propelled by 300 psi CO_2 or compressed air through a 3/4-in.-dia nozzle at the surfaces being decontaminated. The nozzle was held 4 in. from the plates at 90°.

Evaluation Criteria

After the tests, the plates were returned to SRP for evaluation. The criteria used in this evaluation are discussed in the following paragraphs:

- Oxide Removal

  Plates were blasted until the oxide appeared to be completely removed. The cleaning rate (min/ft^2) was determined.

- Consumption Rate

  The amount of glass frit and/or water or CO_2 needed to clean a canister was projected from the amount needed to clean the test specimen.

- Surface Finish Measurements

  The surface finishes of the plates were measured with a "Surtronic 3" (Rank Taylor Hobson, Leichester, England). This instrument has a motor driven arm which pulls a small, sharp contact point across the surfaces of the plates. The contact point is displaced as it passes over the minute hills and valleys of the surfaces. This movement is electrically measured and averaged. A direct reading meter shows the average deviation of the surface in microinches.

- Surface Topography

  Oblique lighting was used to examine and characterize the surface topography of the specimens on the metallograph.

- Surface Cleanness

  Two techniques were used to determine surface cleanness: 1) The surfaces of the specimens were observed on the metallograph with polarized light. Frit particles trapped in topographical features showed as white areas. The volume of frit particles trapped in the surface topography of a canister was estimated.

  2) Surface cleanness was evaluated by a modification of a simple wiping test. Immediately after the specimens were blasted, a piece of Minnesota Mining and Manufacturing Company's double-coated neoprene foam tape No. 4262 was pressed against the surfaces. The volume of loose frit particles per unit of surface area was determined by scanning electron microscopy and x-ray emission spectroscopy techniques with the low x-ray background tape as the specimen. This volume was projected to estimate the volume of loose frit that would remain on the surface of a canister.

- Nozzle Lifetime

  Nozzle lifetime was predicted from the manufacturer's estimates.

Results

The results of the tests at equipment manufacturers are given in Table 6 and discussed in the following paragraphs. A considerable amount of dust occurred in dry blasting when the -80 mesh frit was used. No dust was observed for any blasting process when water was used. The concentration of airborne droplets of water was independent of the frit size.

- Oxide Removal

  Dry frit, slurry, and high-pressure water plus frit blasting removed the oxide from the Type 304L stainless steel plates at a rate fast enough to make these processes attractive for canister decontamination. Oxide removal by all of these techniques was rather insensitive to process variables. High-pressure water plus frit is the fastest process (1 min/ft^2)

TABLE 6

Results of Evaluation of Plate Surfaces

Decontamination Technique	Oxide Removal Rate, min/ft^2	Projected Consumption Rate/Canister: Frit No.	Water, gal	Rinse Water, gal	Surface Finish, RMS*: -20+80 Mesh**	-80 Mesh**	Surface Topography: -20+80 Mesh**	-80 Mesh**	Surface Cleanness: Frit Observed in Topography, in.^{3}/Canister: -20+80 Mesh**	-80 Mesh**	Volume of Loose Frit on Surface	Nozzle Lifetime, hr: -80 Mesh**
Dry-Abrasive Blasting	~2	400	None	None	140	100	Deep Cuts	Unchanged	~10	~2	~0.2 in.^{3} after blowing with compressed air	300 (130 canisters)
Wet (Slurry)-Abrasive Blasting	~3	620	100	100	120	100	Deep Cuts	Unchanged	~10	<1	~0.02 in.^{3} after rinsing with high-pressure water	500 (145 canisters)
High-Pressure Water Plus Frit-Abrasive Blasting	~1	540	1100	240	Not tested	90	Not tested	Unchanged	Not tested	<1	~0.02 in.^{3} after rinsing with high-pressure water	60 (65 canisters)
High-Pressure Water Blasting	Does not remove oxide								Not Applicable	Not Applicable		100 (65 canisters)
Solid CO_2 Pellet Blasting	~1440											

* Surface of plates before blasting 100 RMS. (RMS is the root-mean-square average deviation from the mean surface. A laver value indicates a rougher surface.)

** Frit 411.

because part of the energy of the 5000 psi water was used in scouring the surfaces of the plates with the frit particles. Oxide was not removed by blasting with high-pressure water. These results confirmed the results of oxide removal tests at SRL, which indicated that high-pressure water alone would not remove baked-on contamination from Type 304L stainless steel. Solid CO_2 pellet blasting removed the oxide from Type 304L stainless steel, but the removal rate (1440 min/ft^2) was so that this process cannot be used for canister demontamination. However, the decontamination process can be used for applications where the contamination is not incorporated into an oxide film.

- Consumption Rate

The estimated amount of frit and water necessary to clean a canister with dry frit, slurry, and high-pressure water plus frit blasting is within reason for canister cleaning. In all cases, the amount of frit required is well below the approximate 2000 lb of frit required for fabrication of a canister of waste glass.

Blasting with dry frit is the simplest process requiring only frit. Blasting with slurry requires more frit plus water for blasting and rinsing. Blasting with high-pressure water and with dry frit requires about the same amount of frit as blasting with slurry but with much more water.

- Surface Finishes

The surface finishes of the plates were dependent on the size of the frit used during the blasting with dry frit, slurry, or high-pressure water plus frit. The surface finishes were changed very little by either process with -80 mesh frit. The larger frit, -20+80 mesh, roughened the surfaces.

- Surface Topography

The correlation between the appearance of surface topography (Figure 4) and surface finish measurements was good. Irregularities on the surfaces of plates blasted with the smaller frit (-80 mesh) were smaller than those that existed on the original hot-rolled, pickled surfaces of the plates. More surface irregularities occurred on plates blasted with -20+80 mesh frit than on plates blasted with -80 mesh frit. Surfaces blasted with the larger frit (-20+80 mesh) were covered with a series of small gulleys caused by the cutting and scouring action of the impacting frit particles.

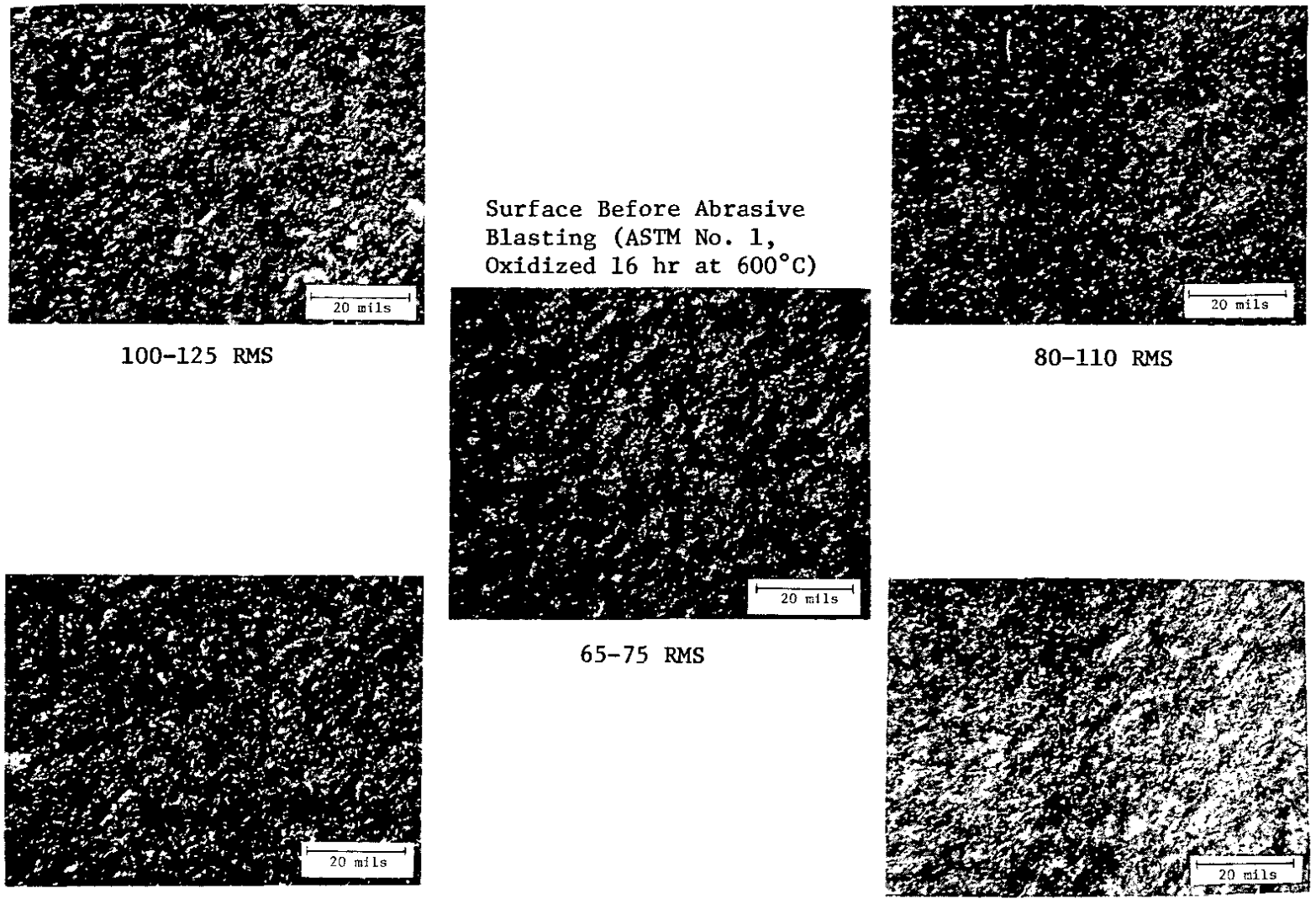


FIGURE 4. Surface of Abrasive Blasted Type 304L Stainless Steel

- Frit Observed in Topography

  A small amount of frit particles was observed in the surface topography of the plates (Figure 5). This frit was mechanically wedged in relief features on the surfaces. The frit was not displaced by blowing the surfaces with compressed air after the surfaces were blasted with dry frit or rinsed with high-pressure water after blasting with slurry. The volume of frit in the surface topography is directly proportional to the surface roughness. The volume of frit in the valleys on the rougher surfaces produced by blasting with the larger frit (-20+80 mesh) is projected to about 10 $in.^3$ per canister. The projected volume of frit is <1 $in.^3$ on a canister with a smoother surface finish produced by blasting with the smaller frit (-80 mesh).

- Volume of Loose Frit on Surfaces

  A small amount of loose frit remained on the surfaces that had been blasted with either dry frit, slurry, or high-pressure water plus frit. A high-pressure water rinse was more effective in removing this material than in blowing the surfaces with compressed air.

- Nozzle Lifetime

  The nozzle lifetime, after being used for blasting with dry frit, slurry, and high-pressure water plus slurry, is within reason for use in canister decontamination applications. The lifetime of nozzles used for blasting with high-pressure water plus frit is shorter than that of nozzles used for blasting with slurry or dry frit. Blasting with high-pressure water plus dry frit is a more powerful process and, therefore, wears out nozzles faster.

PROCESS DESCRIPTION

Blasting Process

The abrasive blasting process to be used to decontaminate SRP waste glass canisters consists of the following techniques with -80 mesh frit as the abrasive:

- Slurry for decontamination
- High-pressure water for rinsing
- High-pressure water plus slurry for spot decontamination

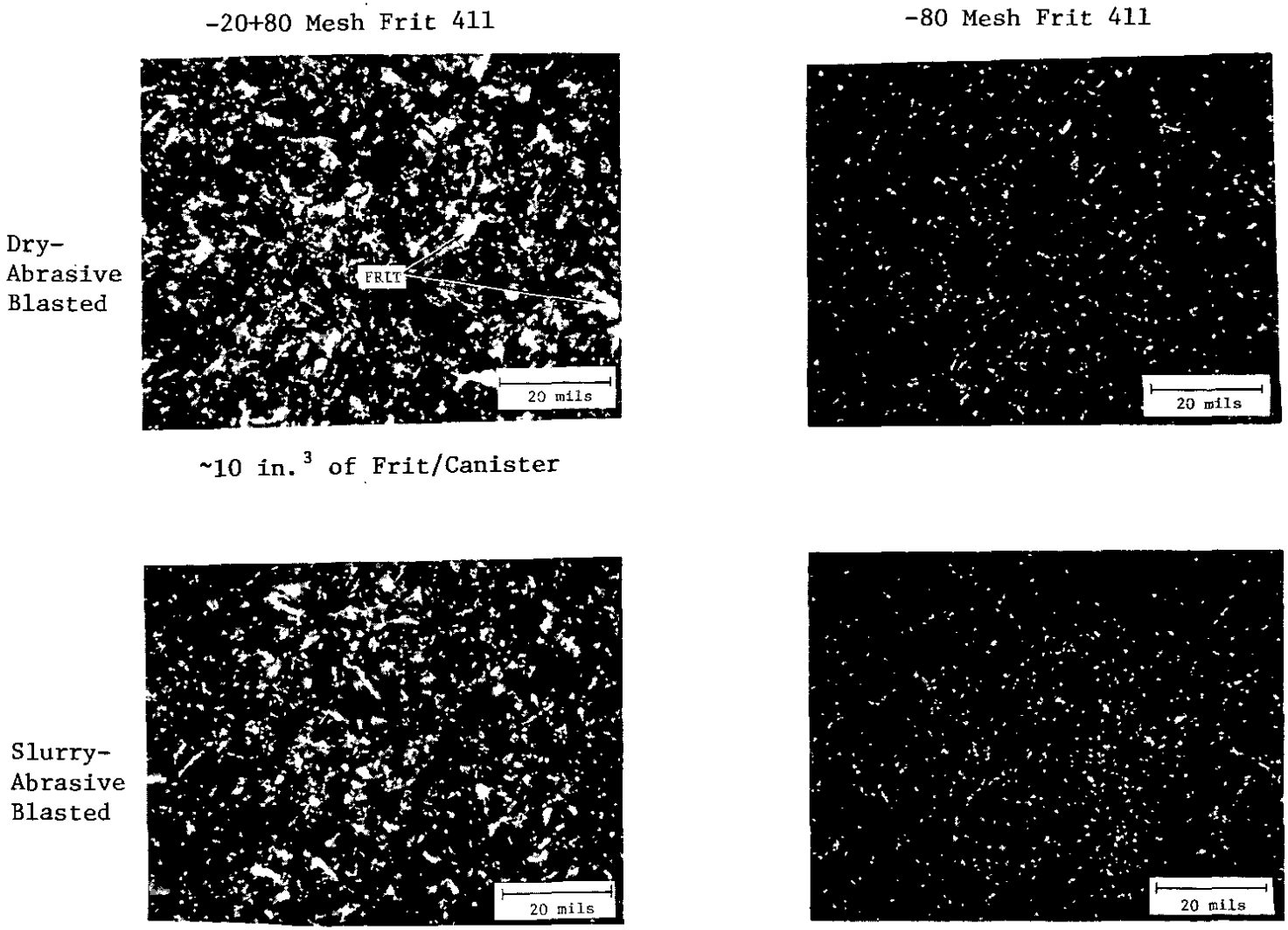


FIGURE 5. Frit Observed in Surface Topography

This process was chosen by comparing the advantages and disadvantages of all abrasive blasting processes investigated (Table 7). All processes were compared from test data with -80 mesh frit. All investigated processes with -80 mesh frit produced a better surface finish with less frit observed in the topography of the surface.

- Dry Abrasive

  Blasting with dry abrasive is the easiest technique to apply because no water is used, and less equipment is required. This technique has the disadvantage, however, especially with the -80 mesh frit, of covering the surface being decontaminated plus the inside of the process vessel and associated ductwork with dust. This dust is not sufficiently removed by blasting the surface with compressed air to 1) produce the cleanest surface possible or 2) allow a good chance for contact maintenance of equipment. There is also the possible problem of filtering the small particles of the -80 mesh from the exhaust air.

- Slurry

  Water is used for the slurry-abrasive blasting techniques If waste glass is produced in a dry-fed melter, this water would have to be removed. If a slurry-fed melter is used (the present reference process), the water will not have to be removed. There is no dust in a wet system, and mist is not expected to be a problem.[5] Wet techniques produce cleaner surfaces than dry techniques and allow a good chance for contact maintenance of equipment by flushing out the system with water.

- High-Pressure Water Plus Frit

  This technique is more powerful and better than slurry-abrasive blasting for removing adherent glass. Less water and frit are used for high-pressure plus frit blasting than with slurry. This technique is ideally suited for spot decontamination.

Conceptual Design

Equipment necessary for decontaminating canisters with abrasive blasting techniques will be located in both the service and cell areas of the processing facility (Figure 6).

The main piece of decontamination equipment will be the decontamination chamber. A canister to be decontaminated will be put inside the chamber, and the top of the chamber will be closed.

TABLE 7

Advantages and Disadvantages of Abrasive Blasting Processes*

Process	Advantages	Disadvantages
Dry-Abrasive Blasting	No water disposal Less equipment required	Dusting Surfaces not as clean - more loose frit on surface - more frit observed in surface topography Conveying dry frit more difficult Little chance of decontaminating equipment by blowing for contact maintenance Possible problems filtering frit from exhaust air
Slurry-Abrasive Blasting	No dusting Cleaner surfaces - Less loose frit on surface - Less frit observed in surface topography Better chance of decontaminating equipment by flushing for contact maintenance	Water disposal Wear on feed system More equipment required
High-Pressure Water Plus Frit-Abrasive Blasting	No dusting Cleaner surfaces - Less loose frit on surface - Less frit observed in surface topography Most powerful technique for removing adherent glass High-pressure water needed for rinse Better chance of decontaminating equipment by flushing for contact maintenance	Water disposal Uses more water than slurry Wear on feed system More equipment required

* All processes are compared with only -80 mesh frit.

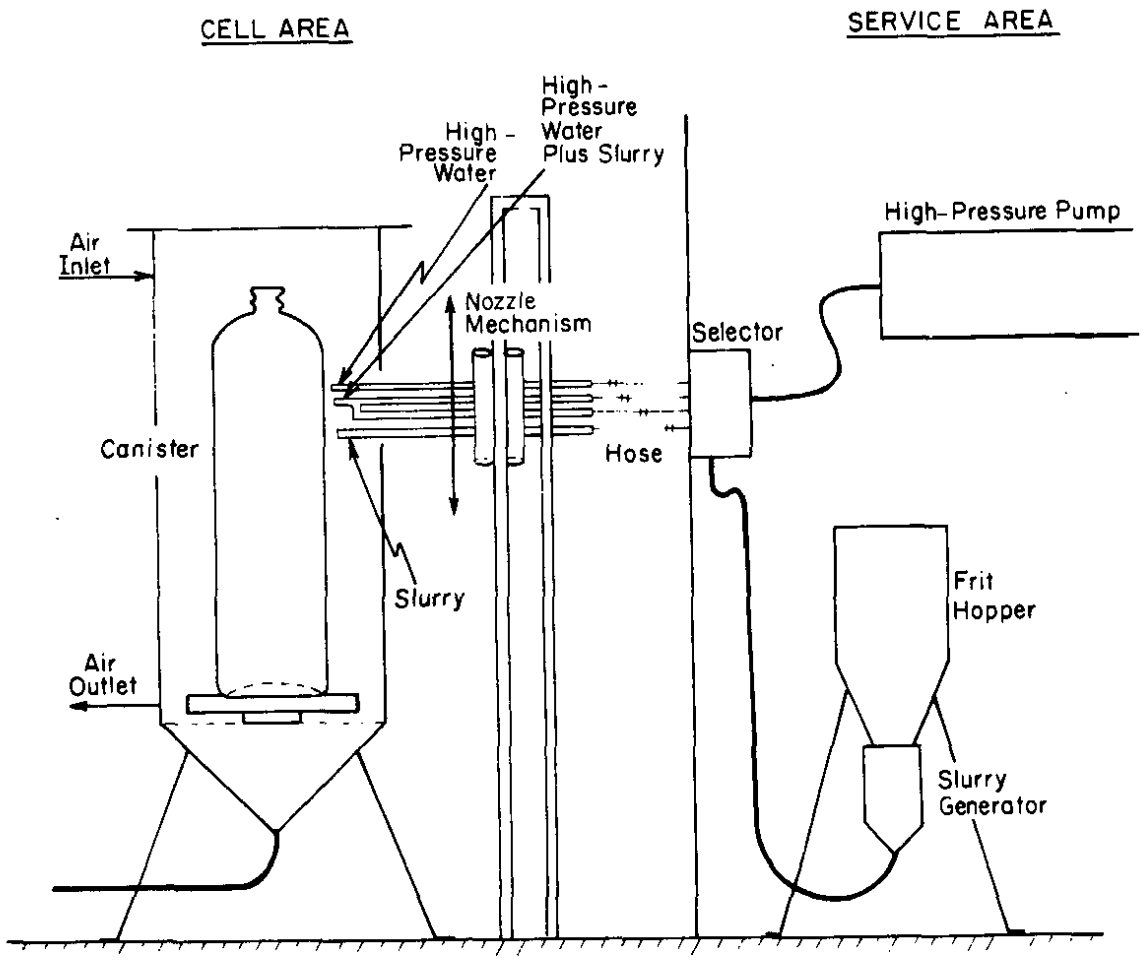


FIGURE 6. Concept of Equipment for Decontamination With Abrasive Blasting

Inside the chamber, the canister can be picked up by the top flange and rotated. An array of nozzles on a single carrier can be moved vertically the length of the rotating canister. Slurry, high-pressure water, or high-pressure water plus slurry from the nozzles will be able to contact every part of the canister as it is rotated. To clean the part of the flange under the grasping device on the canister, the canister will be lowered to the floor of the chamber, and the grasping device will be reoriented. The waste from the decontamination process will have to be removed from the chamber; the excess water will have to be separated; and finally, the frit plus the stainless steel oxides will have to be combined with the feed which goes to the glass melter. Before the top of the chamber can be opened and a decontaminated canister can be removed, air should circulate through the chamber to remove all airborne mist and to dry the canister. Air should also be exhausted through filters that can be backwashed periodically for cleaning. After a decontaminated canister has been removed from the chamber, it is moved to a monitoring station where its surface is surveyed for transferrable radioactive contamination. The orientation of the canister in the monitoring station must be referenced to an orientation mark so that it can be returned to the decontamination chamber for spot decontamination of a specific area.

The decontamination chamber will be supplied high-pressure water and slurry from equipment in the service area. The equipment in the service area does not become contaminated; therefore, maintenance of this equipment is easy.

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