70-3091

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 13, 1997

MEMORANDUM TO: Robert C. Pierson, Chief, SPB, FCSS, NMSS, NRC
N. Sridhar, EBS Element, CNWRA

THROUGH: Michael Tokar, Chief, TWRS, SPB, FCSS, NMSS, NRC

FROM: John G. Spraul, TWRS, SPB, FCSS, NMSS, NRC
JGS for Bruce Mabrito, QA, CNWRA

SUBJECT: FAMILIARIZATION WITH SAVANNAH RIVER DEFENSE WASTE PROCESSING ITEMS/ACTIVITIES

During April 21-24, 1997, the writers of this memorandum observed an annual U.S. Department of Energy (DOE), Environmental Management, Office of Waste Management, Office of Technical Services (EM-37) compliance audit of the quality assurance (QA) program of the Savannah River Defense Waste Processing Division (SR/DWPD). This audit was conducted at the SR/DWPD facilities near Aiken, South Carolina. The audit evaluated the adequacy and effectiveness of the SR/DWPD QA program as applied to the SR/DWPD activities related to high-level radioactive waste form production. The audit took place while SR/DWPD personnel were completing the fill of the 120th of several hundred canisters with the high-level radioactive waste slurry at the Savannah River site. The audit was also observed by a representative of DOE's Office of Civilian Radioactive Waste Management Office of Quality Assurance (WR-3). Attachment 1 is a diagram of the SR/DWPD facilities.

The objective of our observing this audit was to become familiar with the SR/DWPD processes and procedures for vitrification of high-level radioactive waste and its associated QA program. The familiarization was very helpful to us as we continue to perform our respective assignments with respect to the privatization of the Hanford Tank Waste Remediation System - particularly the quality assurance aspects of the privatization effort.

At the pre-audit meeting on April 21, the audit team leader described the purpose of the audit and introduced the 14 audit team members and five observers. SR/DWPD personnel then briefly described the SR/DWPD organization and ongoing activities Auditing followed the pre-audit meeting and continued until the post-audit meeting on April 24.

While observing the design control portion of the audit on April 21, we visited the Analytical Cell Mockup Facility, a mockup of a proposed revision to the analytical laboratory. The facility will be used to demonstrate (in a non-radioactive environment) a revised sampling and analytical process that is expected to reduce typical analysis time for process samples from its current value of 72 hours to about 18-24 hours. SR/DWPD has

NFOS

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415-6715

developed a testing program that will be used at the facility to demonstrate the new sampling and analytical process that will improve production.

The audit team and observers toured the vitrification facility on April 23 and the analytical laboratory (part of the facility not toured on April 23) was toured on April 24. During the tour of the analytical laboratory, we observed where the samples from the Slurry Mix Evaporator and the Melter Feed Tank were being analyzed. These analyses have been determined by SR/DWPD personnel to be critical to the quality of the melt. Although we had no opportunity to observe the tungsten-inert gas closure weld of a canister, we were able to see the rooms where the canisters are prepared to enter the "hot-lab" areas and receive the vitrified waste. Each of the canisters filled to date contains approximately 3,700 pounds of glass waste and 94 pounds of radionuclides.

The Audit Team Leader arranged for us to meet with pertinent SR/DWPD personnel to discuss questions we had prepared before the audit. The questions and a summary of the responses are provided in Attachment 2.

Our observation of this DOE audit and the associated tours greatly increased our familiarization with the vitrification work that is ongoing at Savannah River and planned for Hanford.

Docket Number 70-3091

Attachments: 1. Diagram of SR/DWPD Facilities
2. Questions and Summary Responses

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ATTACHMENT 1

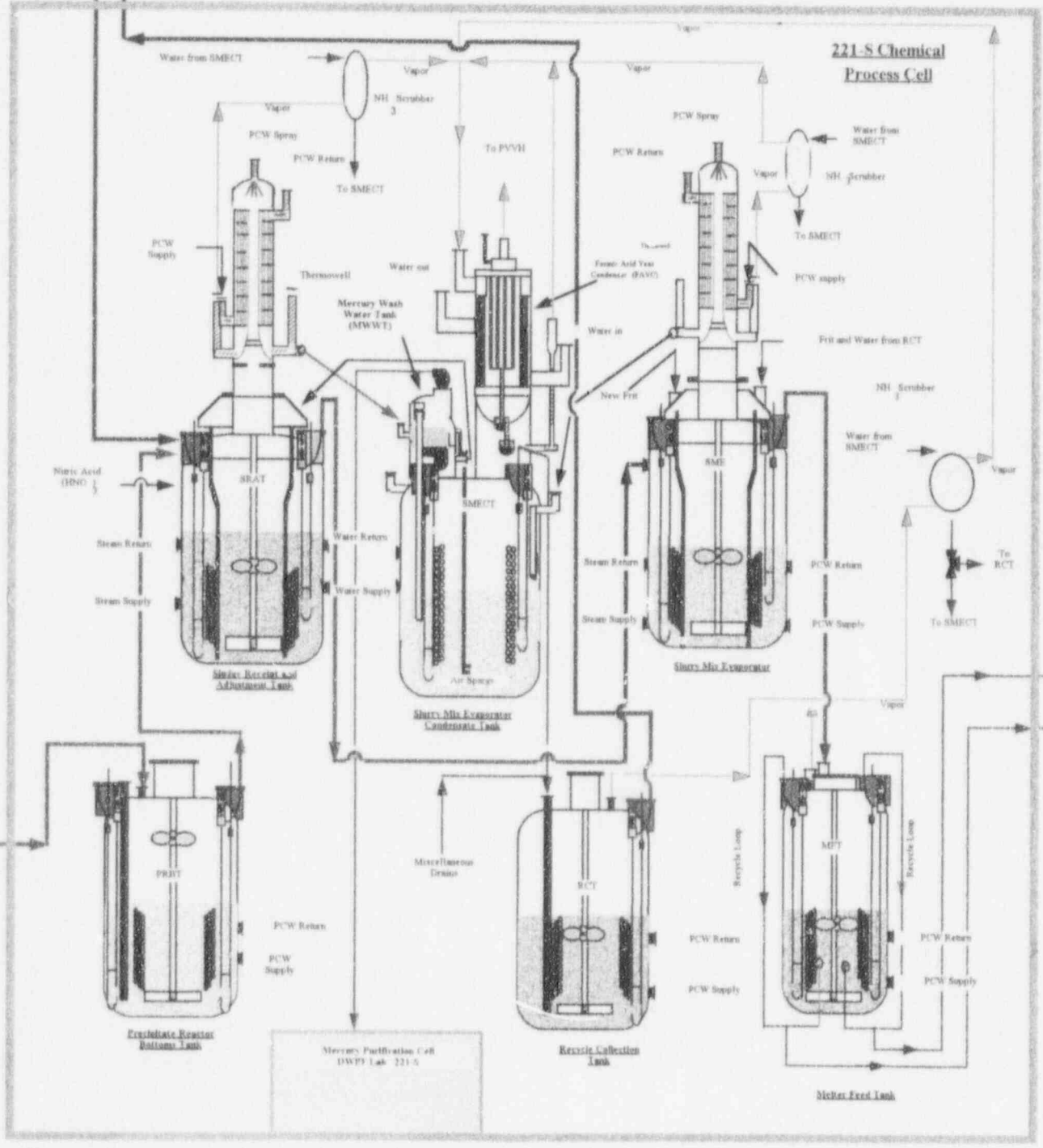
DIAGRAM OF SR/DWPD FACILITIES

The four pages of this attachment have a common point - the box titled "Low Point Pump Pit." If desired, a single figure can be produced by a cut and paste "overlaying" process.

LOW POINT
PUMP PIT

DEFENSE WASTE PROCESSING FACILITY

S-Area (DWPF)



Each Cell
100-ft (L) x 100-ft (W) x 25-ft (H)

Flush Water
Receipt Tank

(4.5 million cu. ft. total volume)

Onsite Interim Canister Storage in
250-S
Glass Waste Storage Building
(GWSB)

Canister Contents:

1700 pounds glass
94 pounds of radionuclides
234,000 curies (max)
690-watt decay heat (max)
6000 rad/hr at canister surface
64 Ci/lb glass

Offsite Federal
Repository for
HLW

221-S Melt Cell

Feed
Loop #2

Thermowell

Feed
Loop #1

Melter

To Offgas
System

CCTV

Feed Tubes

MONOFRAX

DOME Heaters

Pour
Canisters

Water
Frit

Canister
Decon Cell
221-S

Weld
Test Cell
221-S

Cold Cap

Melt

Elevated
Turntable

K3

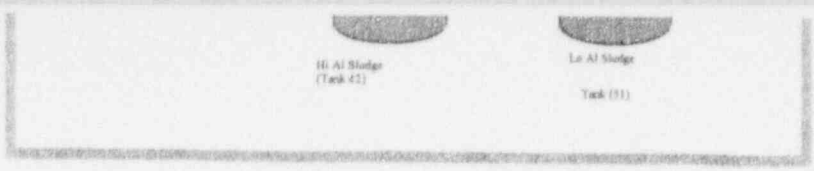
ZIRMUL

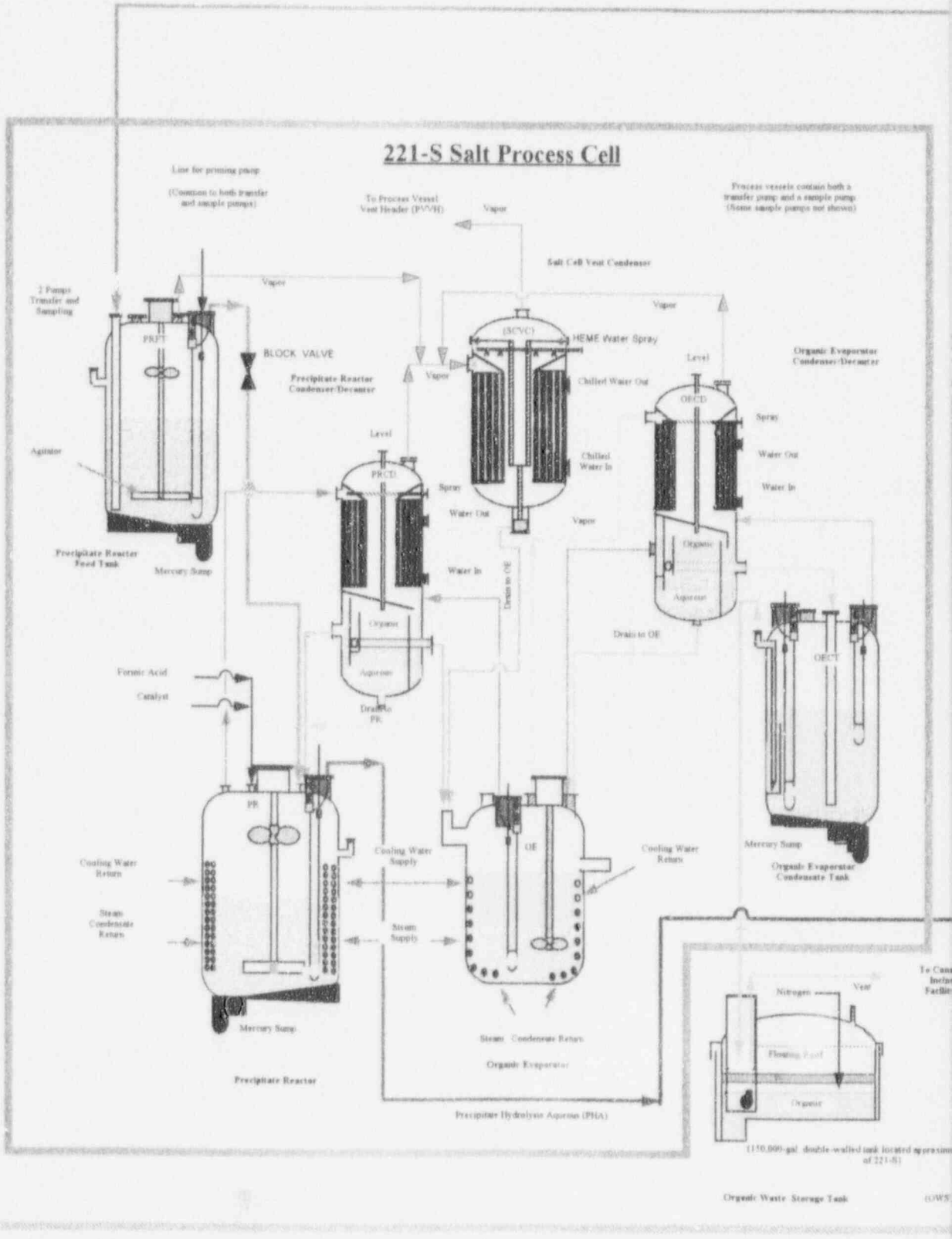
Drain
Valve

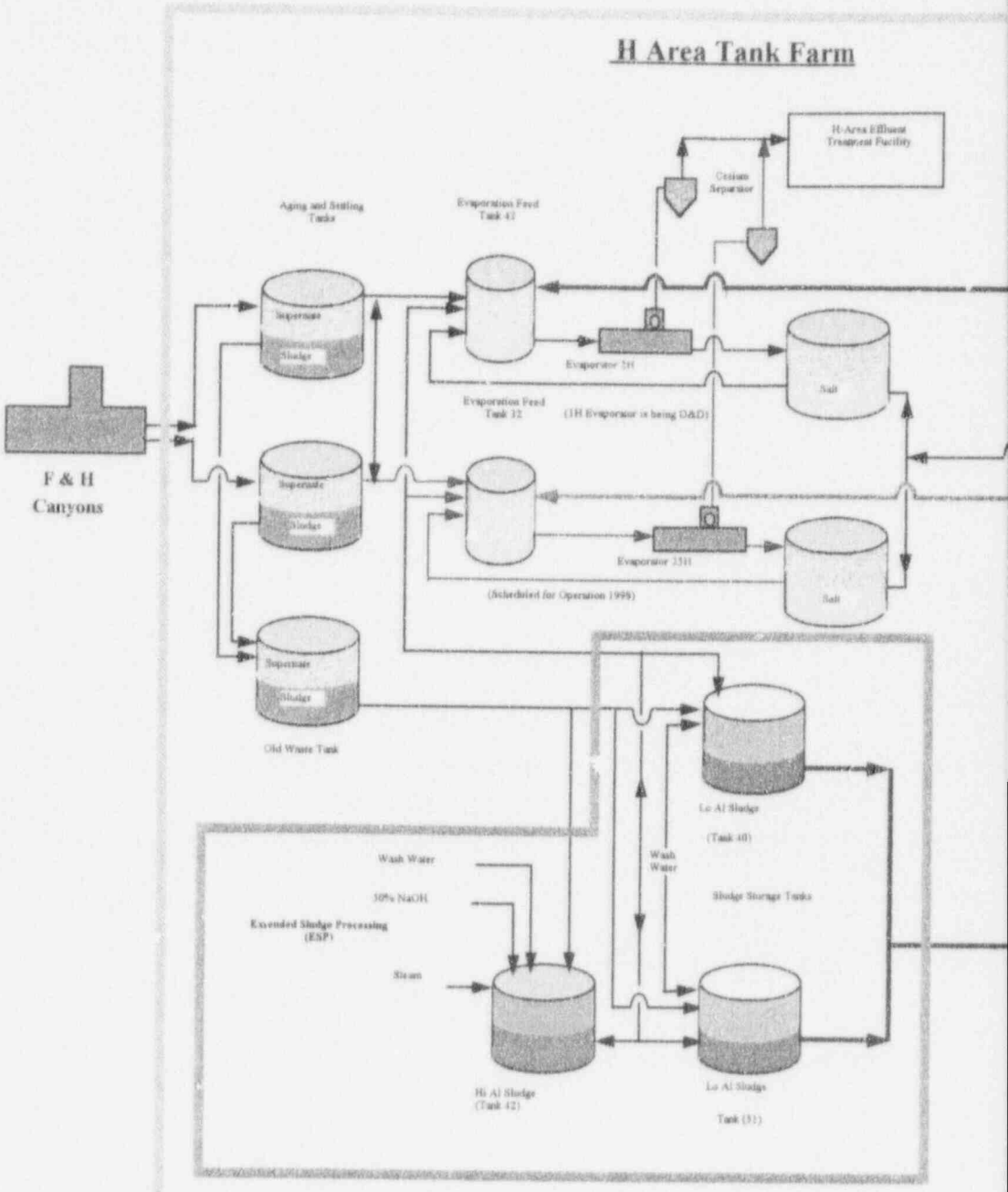
Drum
Canisters

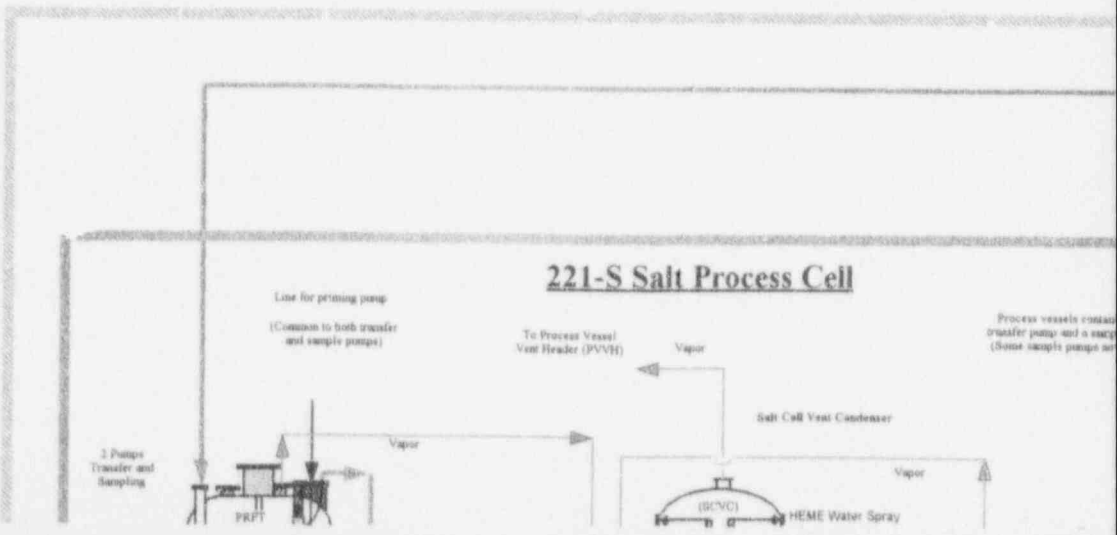
High pressure water and frit used in decanning, recycled to SME to reuse in making the glass

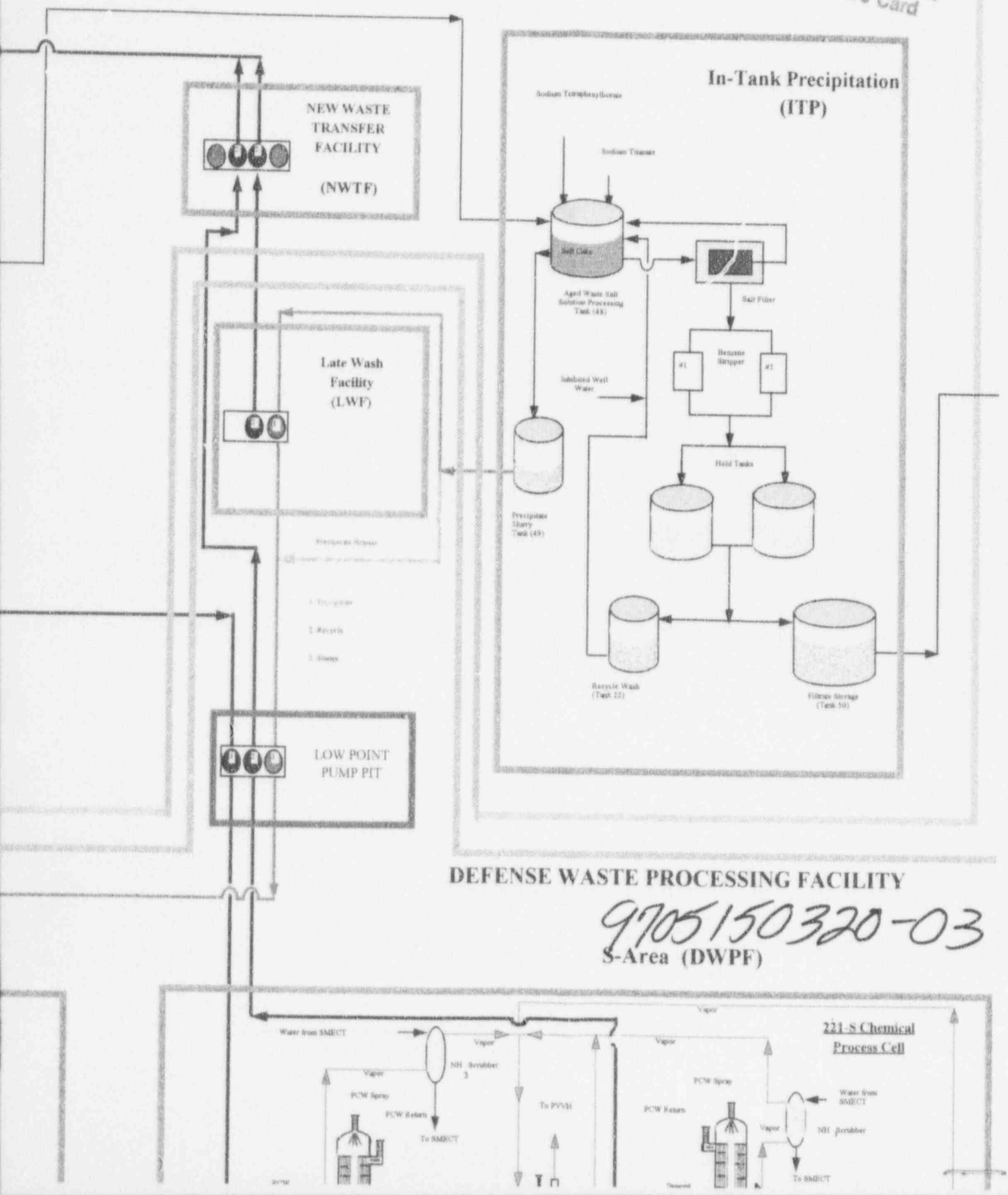
Frit and Water


Hi Al Sludge
(Tank 42)
Lo Al Sludge
Tank (51)


221-S Salt Process Cell
Line for priming pump
(Common to both transfer and sample pumps)
To Process Vessel Vent Header (PVVH)
Vapor
Process vessels contain both a transfer pump and a sample pump (Some sample pumps not shown)
Salt Cell Vent Condenser
2 Pumps Transfer and Sampling
PRPT
BLOCK VALVE
Precipitate Reactor Condenser/Decanter
(SCVC)
HEME Water Spray
Chilled Water Out
Chilled Water In
Organic Evaporator Condenser/Decanter
OECD
Spray
Water Out
Water In
Level
Agitator
PRCD
Spray
Water Out
Water In
Vapor
Organic
Aqueous
Drain to OE
Drain to PR
Precipitate Reactor Feed Tank
Mercury Sump
Formic Acid
Catalyst
OECT
Mercury Sump
Organic Evaporator Condensate Tank
PR
OE
Cooling Water Return
Steam Condensate Return
Cooling Water Supply
Steam Supply
Cooling Water Return
Mercury Sump
Steam Condensate Return
Organic Evaporator
Precipitate Reactor
Precipitate Hydrolysis Aqueous (PHA)
Nitrogen
Vent
Floating Roof
Organic
(150,000-gal double-walled tank located approxim of 221-S)
Organic Waste Storage Tank


H Area Tank Farm
H-Area Effluent Treatment Facility
Cesium Separator
Aging and Settling Tanks
Evaporation Feed Tank 43
Supernate
Sludge
Evaporator 241
Salt
Evaporation Feed Tank 32
(3H Evaporator is being D&D)
F & H Canyons
Evaporator 2H1
(Scheduled for Operation 1998)
Old Waste Tank
Lo Al Sludge
(Tank 40)
Wash Water
50% NaOH
Extended Sludge Processing (ESP)
Steam
Sludge Storage Tanks
Hi Al Sludge (Tank 42)
Lo Al Sludge Tank (51)


221-S Salt Process Cell
Line for priming pump
(Common to both transfer and sample pumps)
To Process Vessel Vent Header (PVVH)
Vapor
Salt Cell Vent Condenser
2 Pumps Transfer and Sampling
PRPT
(SCVC)
HEME Water Spray



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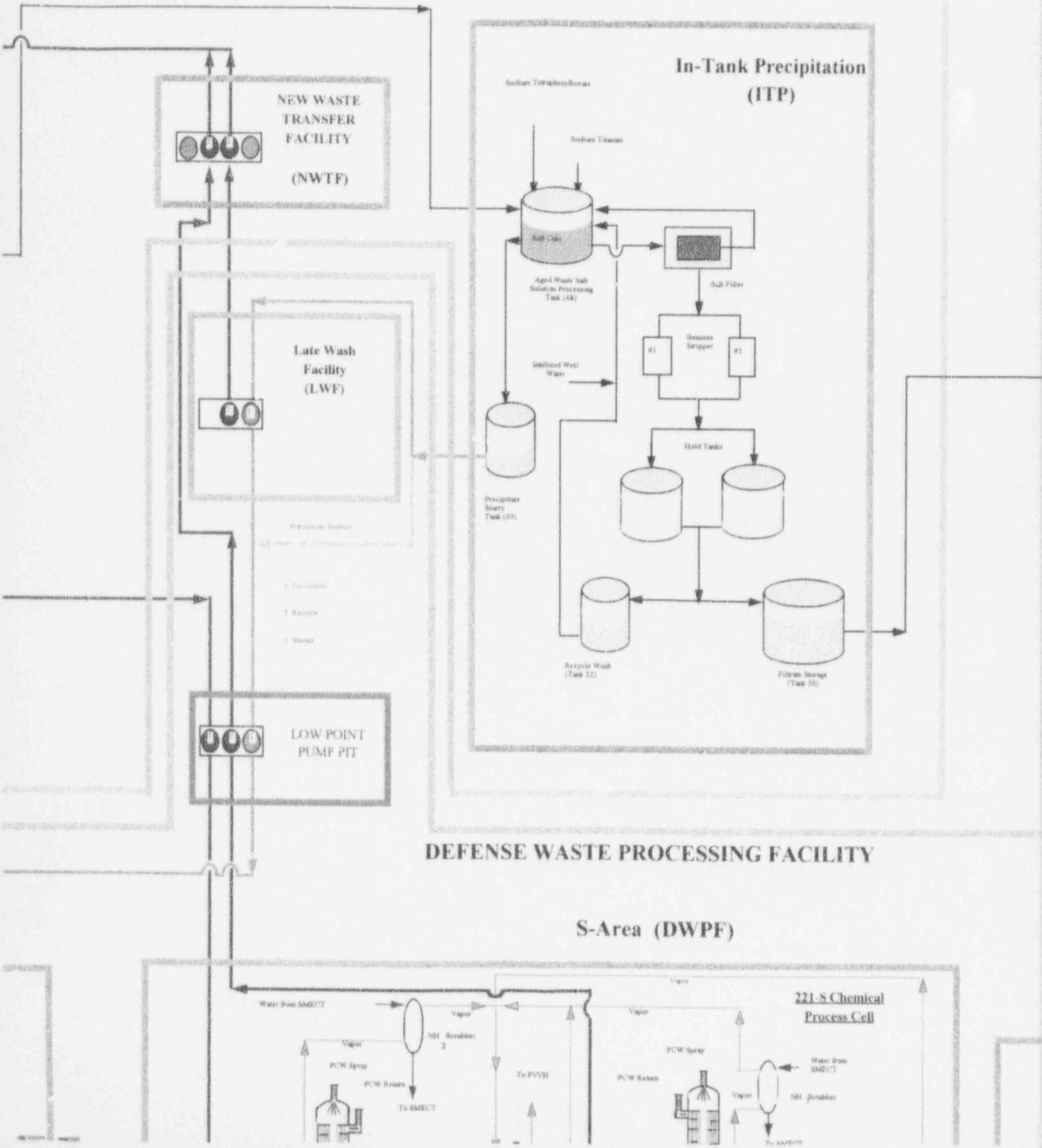
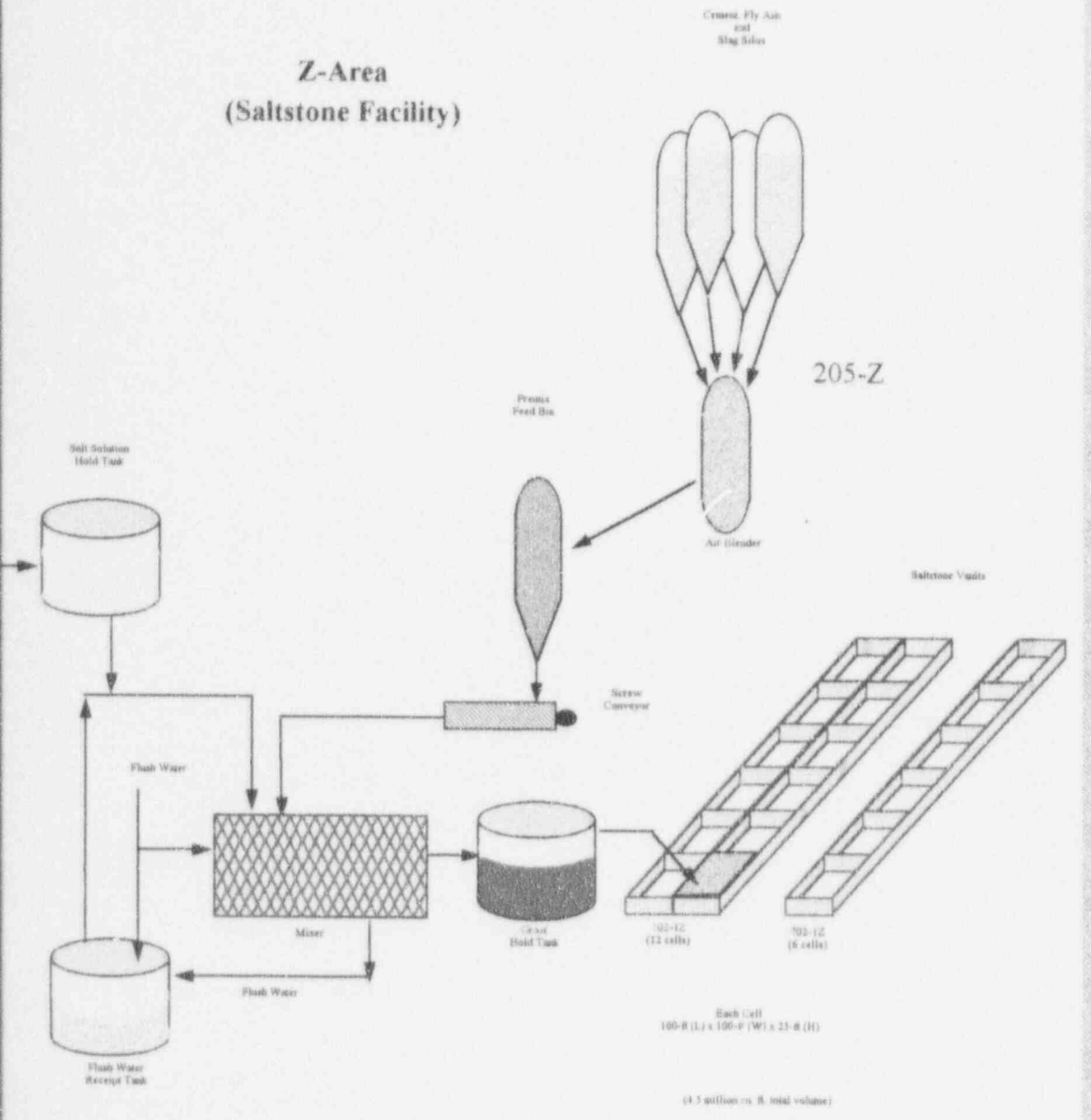
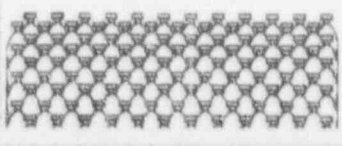
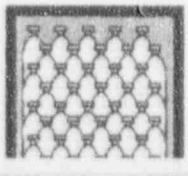

NEW WASTE
TRANSFER
FACILITY
(NWTF)
Late Wash
Facility
(LWF)
LOW POINT
PUMP PIT
In-Tank Precipitation
(ITP)
Sodium Tetraphenylborate
Sodium Titanate
Salt Cake
Aged Waste Salt
Solution Processing
Tank (48)
Salt Filter
Benzene
Stripper
#1
#2
Inhibited Wet
Water
Hold Tanks
Precipitate
Slurry
Tank (49)
Recycle Wash
(Tank 22)
Filtrate Storage
(Tank 50)
DEFENSE WASTE PROCESSING FACILITY
S-Area (DWPF)
221-S Chemical
Process Cell
Water from SMECT
Vapor
NH3 Scrubber
3
PCW Spray
PCW Return
To SMECT
To PVVH
Water from
SMECT
NH3 Scrubber

Z-Area
(Saltstone Facility)

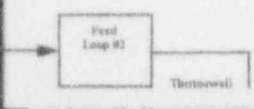


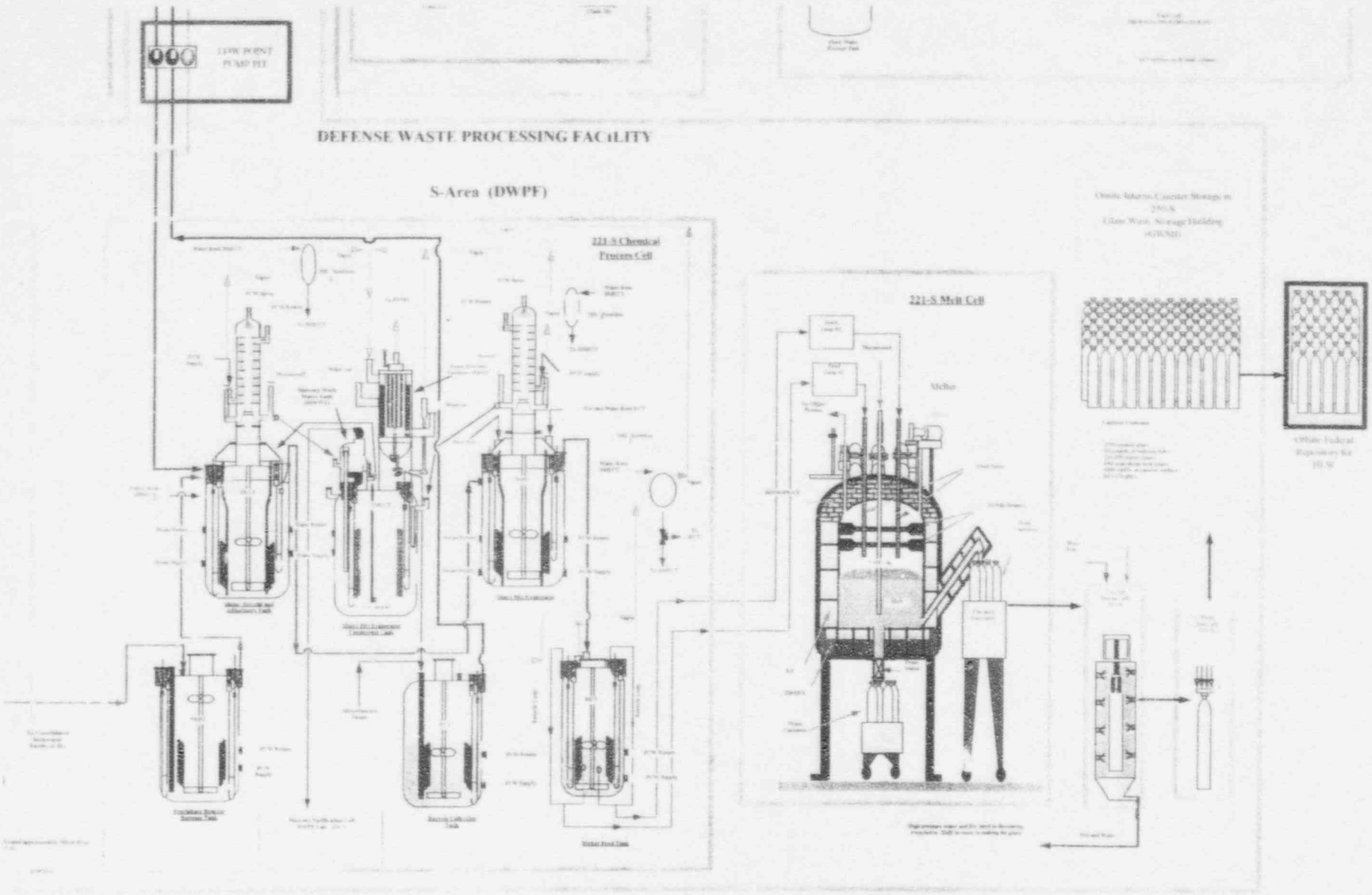
Onsite Interim Canister Storage in
250-S
Glass Waste Storage Building
(GWSB)

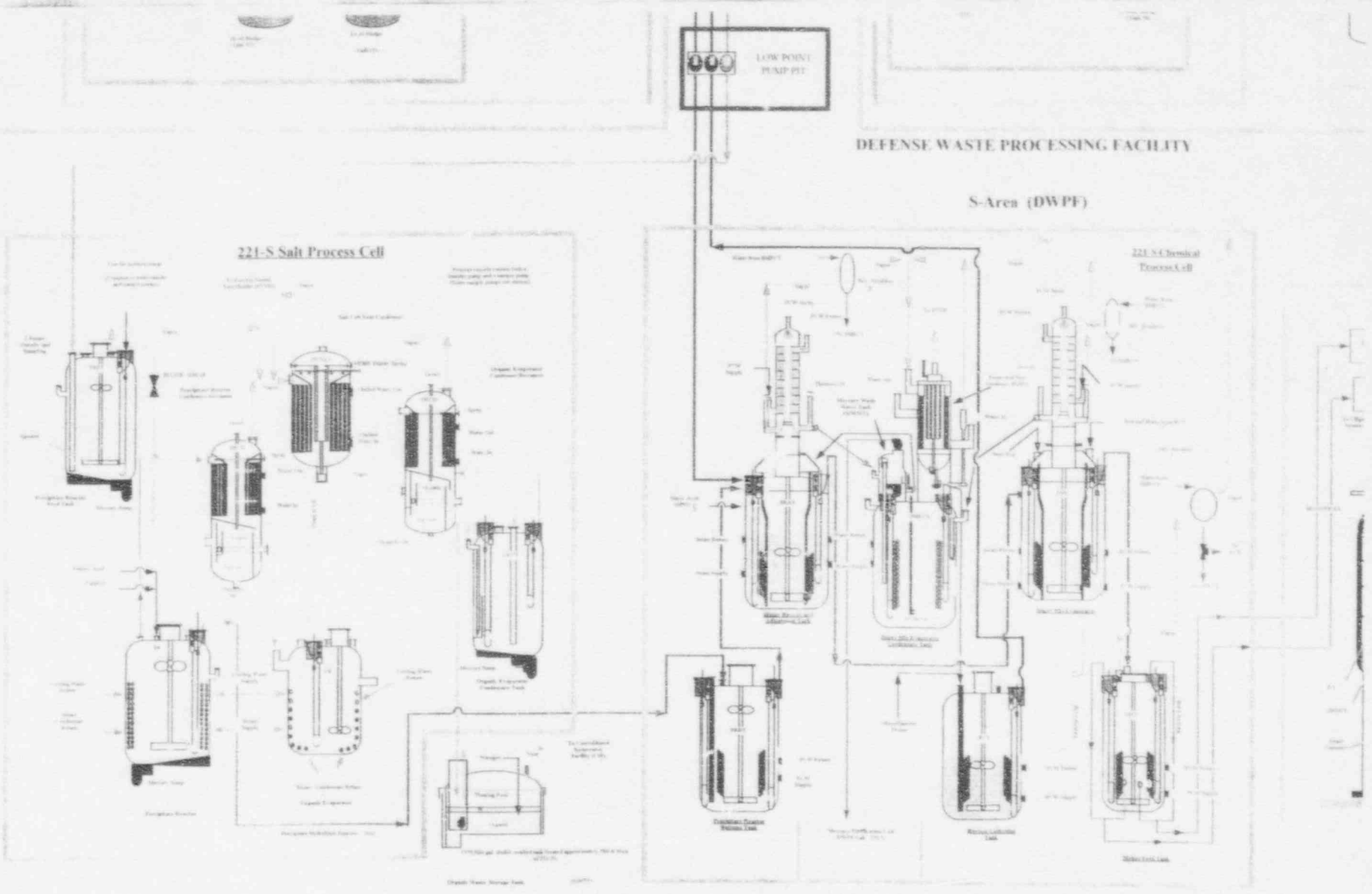


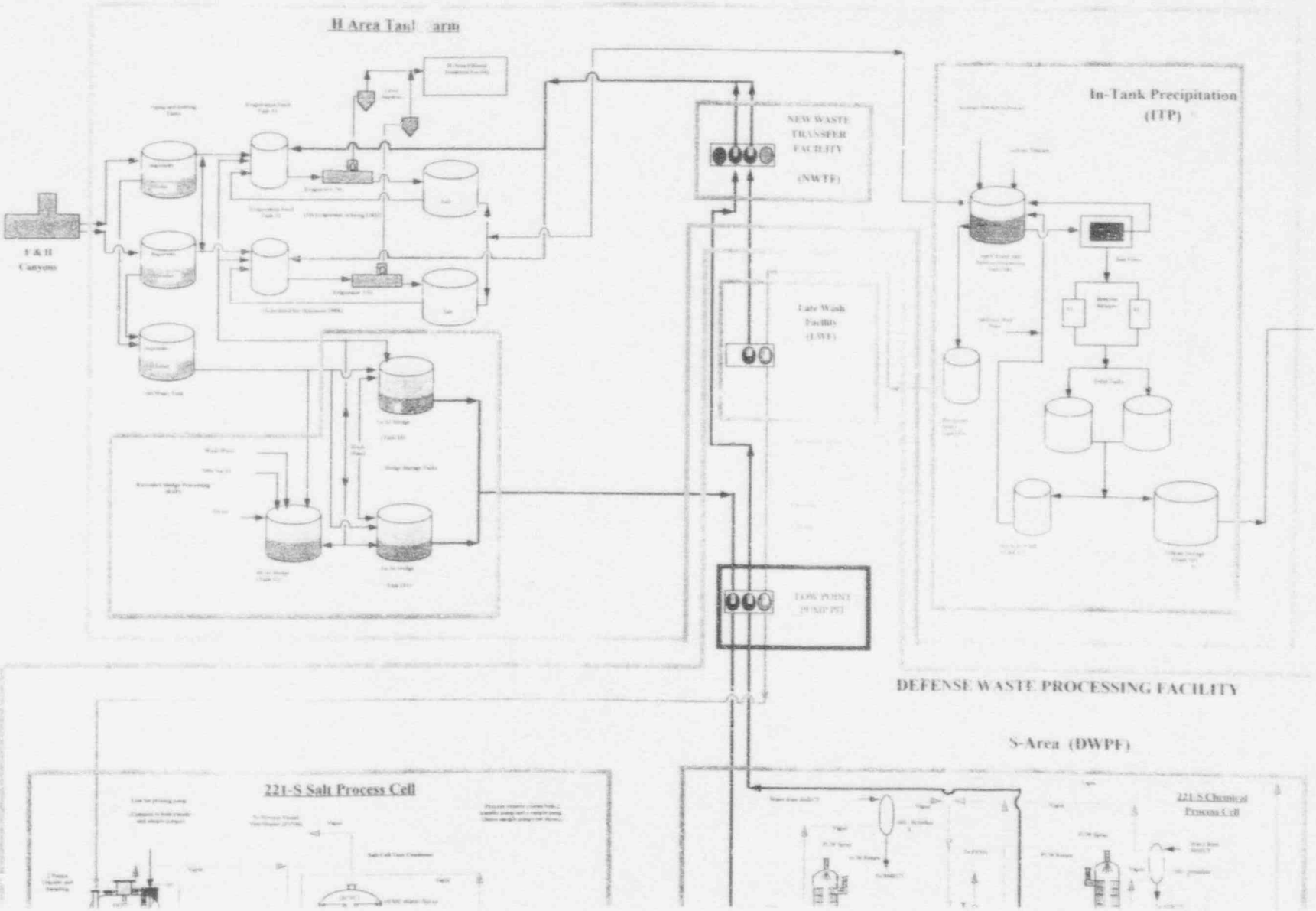


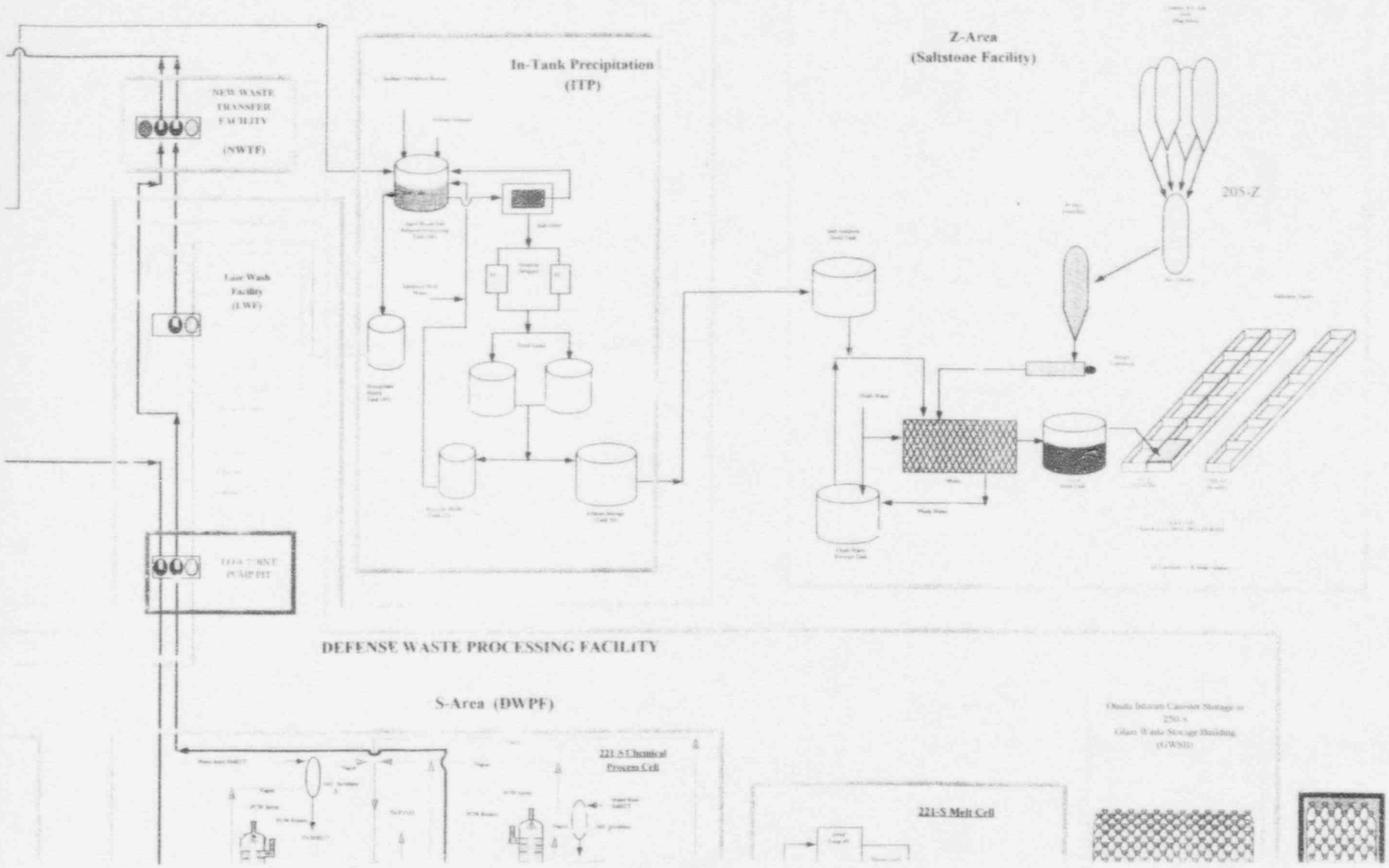
221-S Melt Cell




DEFENSE WASTE PROCESSING FACILITY
S-Area (DWPF)
221-S Chemical Process Cell
221-S Melt Cell
Melter


LOW POINT
PUMP PIT
DEFENSE WASTE PROCESSING FACILITY
S-Area (DWPF)
221-S Salt Process Cell
221-S Chemical
Process Cell


H Area Tank Farm
F & H
Canyons
NEW WASTE
TRANSFER
FACILITY
(NWTF)
Late Wash
Facility
(LWF)
In-Tank Precipitation
(ITP)
DEFENSE WASTE PROCESSING FACILITY
S-Area (DWPF)
221-S Salt Process Cell
221-S Chemical
Process Cell


In-Tank Precipitation
(ITP)
Z-Area
(Saltstone Facility)
NEW WASTE
TRANSFER
FACILITY
(NWTF)
Low Wash
Facility
(LWF)
DEFENSE WASTE PROCESSING FACILITY
S-Area (DWPF)
221-S Chemical
Process Cell
221-S Melt Cell

ATTACHMENT 2

QUESTIONS AND SUMMARY RESPONSES

1.a How did SR/DWPD qualify its process/procedures for glass forming?
Response: It was indicated that the entire development process took about 10 years. The vitrification and handling procedures in other countries were studied at length prior to deciding on one process.

1.b How long did the qualification process take after the process/procedures were finalized?
Response: The Savannah River Technical Center qualified the process over about an 18-month period using water runs, chemical runs, and waste qualification runs. About 150,000 pounds of glass were produced during the qualification process.

1.c How long did it take to develop and finalize the procedures?
Response: Years.

1.d What were the major problems?
Response: Since there was no design basis, the design of the facility was a major challenge and maintaining the proper range of complex glass chemistry has been identified as a key contributor to product quality. Additionally, there were many lessons learned about remote controls and the limitations of such devices; the SR/DWPD staff referred to some parts of the plant as a "remotable" facility. It was noted that the facility controls a lot of the operations by controlling pump speed with variable frequency drives, as opposed to other methods such as controlling pressure drop. Determining the actual pump speeds was a problem. There were also problems with the complexity of the chemistry and monitoring the reaction kinetics. The system has some 64 interlocks (alarms).

2.a How did SR/DWPD qualify its process/procedures for closure welding the canisters?
Response: The canister closure is a resistance weld. A parametric study of the weld process was used to determine a range of parameters that gave acceptable welds. In practice, the ranges used during production welding are narrowed to ensure acceptable welds. Destructive tests are used during qualification and requalification, although less bend testing was done as time progressed. The welds are made using a short-time (about one second) "burst" of 260,000 to 400,000 amperes current while pressing the cap into the canister with a hydraulic ram.

2.b How long did the qualification process take after the process/procedures were finalized?
Response: About one year.

2.c How long did it take to develop and finalize the procedures?
Response: About three months.

2.d What were the major problems?
Response: One SR/DWPD staff member said that they had problems with the "flow path of the resistance weld." Another indicated that a high degree of cleanliness was required on the surface of the canister closure lid and that the required cleanness is now achieved by a frit and water decontamination process.

3. How do SR/DWPD personnel prevent a melt-through as occurred at Fernald?
Response: The SR/DWPD melter concept and construction are quite different from the Fernald approach. For example, the SR\DWPD melter uses a jacket cooling system. There have been no indications of any melt-through problem.

4. If SR\DWPD technical personnel had the opportunity to "start over," what would they do differently? Why?
Response: An earlier assessment would be made of the potential chemistry and safety problems in order to minimize the amount of rework required to come to resolution.

5. DOE QA requirements - Why QARD? Why not 10 CFR 830.120?
Response: DOE/RW imposed the QARD in order to meet the requirements of 10 CFR Part 60. 10 CFR 830.120 is viewed more as a plant safety regulation than a product quality assurance regulation. It was noted that the NRC had already accepted the QARD for site characterization as meeting the requirements of Part 60.

6. Grading of QA program? If so, what are the details? If not, why not?
Response: There is a "deterministic approach" to grading the QA for procurement: Level 1 is the full QA program, Level 2 has specific attributes and specific QA attributes are required, and Level 3 is used for "off-the-shelf" items where good commercial practices apply. Grading of the QA program has been a joint effort by SR/DWPD Engineering and QA personnel. Overall, however, it appeared that the application of QA was basically either "yes" or "no."

7. Q-list or equivalent? If so, how was it developed?
Response: DOE/RW "owns" the Q-List and it is utilized in conjunction with the Waste Acceptance Product Specification. All such lists are developed as a joint product of the Engineering and QA staffs.

8. Describe SR/DWPD process/procedure changes as the composition of the radioactive waste changes.
Response: It was learned that the waste itself is pumped from the "H" Area tank farm, through the "low point pump pit." From there it enters the "S" Area of the facility which includes the following tanks through which the waste is processed (see Attachment 1): the sludge receipt and adjustment tank, the slurry mix evaporator, and the melter feed tank. The "S" Area also includes the precipitate reactor bottoms tank, the slurry mix evaporator condensate tank, and the recycle collection tank, all of which are critical to controlling the process. From the melter feed tank, the sludge material (which has the consistency of heavy molasses) is pumped to the melter where heaters melt the mixture to form the glass for insertion into the canister. Following the fill, the canister is mechanically fitted with an inner lid (to keep the interior dry), leak tested, and then decontaminated with glass frit and water (which is recycled back to the slurry mix evaporator). The outer cap is then fitted into and welded to the canister.

9. If SR/DWPD QA personnel had the opportunity to "start over," what would they do differently? Why?
Response: The SR/DWPD staff stated that they would start over again in exactly the same way, but that they would make a change to their accepted QA program only when the change could be shown to provide significant program improvement.