89001455

SEP 30 1991

Mr. Dwight E. Shelor, Associate Director
for Systems and Compliance
Office of Civilian Radioactive Waste Management
U. S. Department of Energy, RW 30
Washington, D.C. 20585

Dear Mr. Shelor:

SUBJECT: TRIP REPORT FROM THE AUGUST 7-8, 1991 U.S. NUCLEAR REGULATORY COMMISSION VISIT TO THE SAVANNAH RIVER DEFENSE WASTE PROCESSING FACILITY

Enclosed for your information is a trip report from the August 7-8, 1991 U.S. Nuclear Regulatory Commission (NRC) staff visit to the Defense Waste Processing Facility (DWPF) at the Savannah River Site operated by the U.S. Department of Energy (DOE).

During this visit, briefings were given by DOE and Westinghouse Savannah River Corporation personnel. Much of the discussion at the meeting focused on the Waste Acceptance Process (WAP) which DOE developed in 1985 to describe the documentation and activities necessary to ensure that the produced high-level waste (HLW) forms (i.e., borosilicate glasses) would be acceptable at any potential geologic repository.

DOE representatives indicated that the latest revision to the DWPF WAPS will change the "radionuclide release specification" to a "product consistency test"; thereby removing the relationship of the vitrified waste form component of the waste package from any considerations that relate to either long-term glass performance in the repository environment or performance allocation. Further, DOE representatives indicated that they are treating glass as a "given," analogous to their approach with regard to spent fuel. This approach to glass waste package development appears to run counter to the overall purpose of the WAP to ensure glass waste acceptance in the repository licensing process.

The NRC staff expressed concerns in three areas: (1) the need for an integrated schedule which identifies all current WAP-related milestones and activities relative to the repository program; (2) the apparent lack of a linkage or relationship between DOE's glass waste acceptance specifications and the performance allocated to the waste form in the Yucca Mountain Site Characterization Plan; and (3) as part of the WAP, the need to conduct a preliminary assessment of the performance of the glass waste form in the context of both the Yucca Mountain near-field environment and the other waste package components.

WM-1
109.7
NMSS

9110070377 910930
PDR WASTE
WM-1 PDR

In summary, the NRC staff found the visit to be helpful in understanding the glass production program at the DWPF. The NRC staff does have concerns, as a result of the interaction with DOE staff, that DOE is changing its postion on the allocation of performance to the waste form.

If you have any questions regarding this letter or the enclosed trip report, please contact Kenneth R. Hooks on (301)/FTS 492-0447.

Sincerely,

(Original Signed by Joseph J. Holonich)

for John J. Linehan, Acting Director
Repository Licensing and Quality
Assurance Project Directorate
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: As Stated

cc: R. Loux, State of Nevada
C. Gertz, DOE/NV
S. Bradhurst, Nye County, NV
M. Baughman, Lincoln County, NV
D. Bechtel, Clark County, NV
D. Weigel, GAO
P. Niedzielski-Eichner, Nye County, NV
C. Thistlethwaite, Inyo County, CA
V. Poe, Mineral County, NV
F. Sperry, White Pine County, NV

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JConway, HLPD	JBuckley, HLPD	WBelke, HLPD	TAhn, HLGE
MNataraja, HLGE	MFinkelstein, OGC		

*See previous concurrence

OFC	:HLPD	:HLGE	:HLGE	:HLPD	:	:
NAME	:KHooks*	:RWeller*	:RBallard*	:JLinehan	:	:
Date	:09/ /91	:09/25/91	:09/25/91	:09/30/91	:	:

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OFC	:HLPD	:HLGE	:HLGE	:HLPD	:	:
NAME	:KHooks	:RWeller	:RBallard	:JLinehan	:	:
Date	:09/25/91	:09/25/91	:09/25/91	:09/ /91	:	:

Trip Report

SAVANNAH RIVER DEFENSE WASTE PROCESSING FACILITY
August 7-8, 1991

Members of the U.S. Nuclear Regulatory Commission (NRC) staff met with representatives of the U.S. Department of Energy (DOE) at the Savannah River Site near Aiken, South Carolina, August 7-8, 1991. The purpose of this interaction was for the NRC staff to be briefed on the status of radioactive waste glass production at the Defense Waste Processing Facility (DWPF) and to tour the DWPF.

The briefings were given by DOE and Westinghouse Savannah River Corporation (WSRC) personnel. Attendees included NRC and Center for Nuclear Waste Regulatory Analyses (CNWRA) staff and representatives of the State of Nevada (Nevada), West Valley Nuclear (WNV), Westinghouse Hanford Company (WHC) and others as listed on Attachment 1. The schedule for the briefings and the tour of the DWPF is shown on Attachment 2, and the material provided during the briefing is provided as Attachment 3.

Much of the discussion at the meeting focused on the Waste Acceptance Process (WAP) which DOE developed in 1985 to describe the documentation and activities necessary to ensure that the produced high-level waste (HLW) forms (i.e., borosilicate glasses) would be acceptable at any potential geologic repository.

DOE representatives indicated that the latest revision to the DWPF WAPS will change the "radionuclide release specification" to a "product consistency test" thereby removing the relationship of the vitrified waste form component of the waste package from any considerations that relate to either long-term glass performance in the repository environment or performance allocation. Further, DOE representatives indicated that they are treating glass as a "given," analogous to their approach with regard to spent fuel. This approach to glass waste package development appears to run counter to the overall purpose of the WAP to ensure glass waste acceptance in the repository licensing process.

Regarding DOE plans for initiation of "hot" operations at DWPF, which is reportedly December 1993, the staff does not disagree with this schedule or DOE's policy decision to proceed with vitrification of the HLW currently in storage at the DWPF prior to the licensing of the geologic repository. The staff recognizes the overall benefit to public health and safety that can be achieved by the immobilization of the considerable volume of HLW currently stored in underground storage tanks. The staff also recognizes DOE's obligations to initiate "hot" operations at the DWPF by December 1993, under the requirements of the Federal Facilities Compliance Agreement for DWPF.

The DOE staff indicated that, prior to the initiation of high-level waste vitrification, it would likely seek some statement from the NRC regarding conclusions from the WAP and the technical documents that form the basis for glass production at the DWPF. In this regard, the NRC staff questions whether substantive and meaningful conclusions can be drawn if the WAPs lack a clear relationship to long-term performance in the repository environment.

Specifically, the NRC staff expressed concerns in three areas: (1) the need for an integrated schedule which identifies all current WAP-related milestones and activities relative to the repository program; (2) the apparent lack of a linkage or relationship between DOE's glass waste acceptance specifications and the performance allocation assigned to the glass waste form in the Yucca Mountain Site Characterization Plan; and (3) as part of the WAP, the need to conduct a preliminary assessment of the performance of the glass waste form in the context of both the Yucca Mountain near-field environment and the other waste package components.

ATTACHMENT 1

Attendees at the August 8, 1991 orientation for the Defense Waste Processing Facility.

NRC

R. Ballard
K. Hooks
R. Weller
P. Nair (CNWRA)
H. Manaktala (CNWRA)
T.M. Ahn

DOE

K. Hall
W.S. Ketala
A. Berysch
D. Harrison-Giesler
C. Russomanno
D. Stahl (M&O)*
R. Fish (M&O)
L. Berkowitz (M&O)
C. Charles (Weston)
M. Dev (Richland)
S. Burnum (Richland)
S. Cowan
L. Desell
J. Roberts
C. Macaluso
W. Pearson

WSRC

J. Ortaldo
C. Randall
C. Jantzen
R. Edwards
H. Elder
S. Kilpatrick
S. Marra
D. Bickford
W.G. Ramset
W. Holtzscheiter
K.S. Kim
W.T. Golston

Others

D. Shettel (Nevada)
L. Cadoff (WVN)
K.A. Wetmore (Glasstech)
R.S. Richards (Glasstech)
S. Schaus (WHC)
P.M. Krishna (Battelle)

* Management and Operations Contractor

ATTACHMENT 2

DWPF Orientation and Tour
August 7-8, 1991
AGENDA

August 7, 77343A, Room 228

8:00 to 9:00	Badging	
9:00 to 9:15	DOE Welcome	(Cowan/Sjostrom)
9:15 to 9:25	DWPF Startup Program	(Kevin Hall)
9:25 to 9:45	DWPF Introduction	(Joe Ortaldo)
9:45 to 10:15	Process/Product Overview	(Hank Elder)
10:15 to 10:30	Break	
10:30 to 11:15	Waste Acceptance Overview	(Sonny Goldsten)
11:15 to 12:00	Glass Product Control Program/ Product Composition Control System Overview	(Sharon Marra/ Richard Edwards)
12:00 to 1:00	Lunch and Startup Test Program Glass Characterization	(Carol Jantzen)
1:00 to 3:30	Tour Shielded Cells Facility	
3:30 to 4:30	Document Review and Approval Cycle	(John Plodinec)
4:30 to 4:40	Quality Assurance	(Dave Fenstermacher)

August 8

8:00 to 8:30	Meet at 703-A
8:30 to 10:00	Tour Defense Waste Processing Facility
10:00 to 10:30	Travel by bus to TNX
10:30 to 11:30	Tour Integrated DWPF Melter System
11:30 to 12:30	Lunch
12:30 to 1:00	Travel by bus to 703-41A to the Orange Room
1:00 to 2:00	Follow up discussions with DOE and Westinghouse Management

DWPF Orientation and Tour

for the

Nuclear Regulatory Commission

Department of Energy
Office of Civilian Radioactive Waste Management
Office of Environmental Restoration and Waste Management

State of Nevada

August 7-8, 1991

DWPF Process and Product Overview

A Review for:

The Nuclear Regulatory Commission

August 7, 1991

by H. H. Elder

Defense Waste Processing Facility (DWPF)
Mission

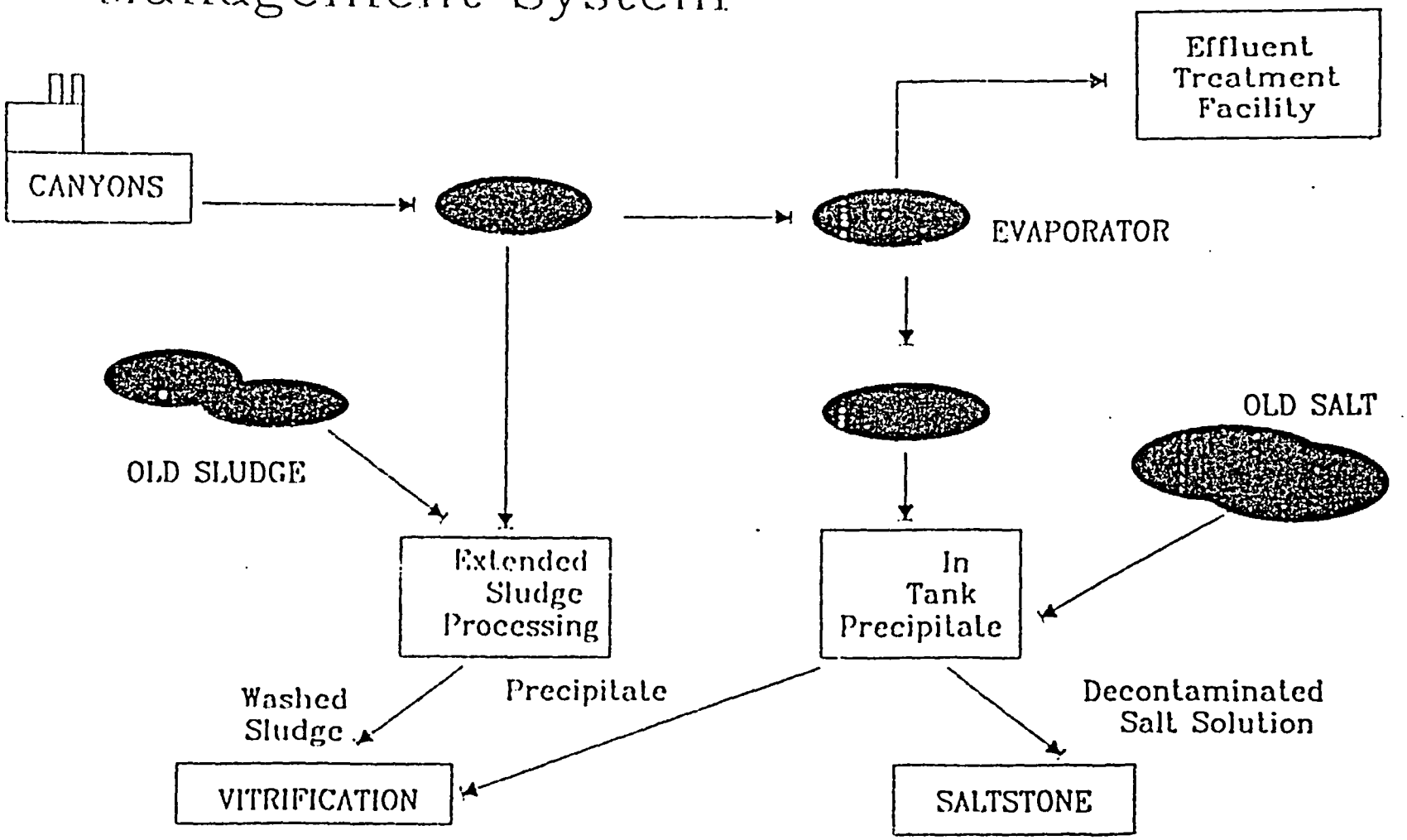
TO: startup, operate and maintain the DWPF to immobilize Radioactive Liquid Wastes

In a Way That:

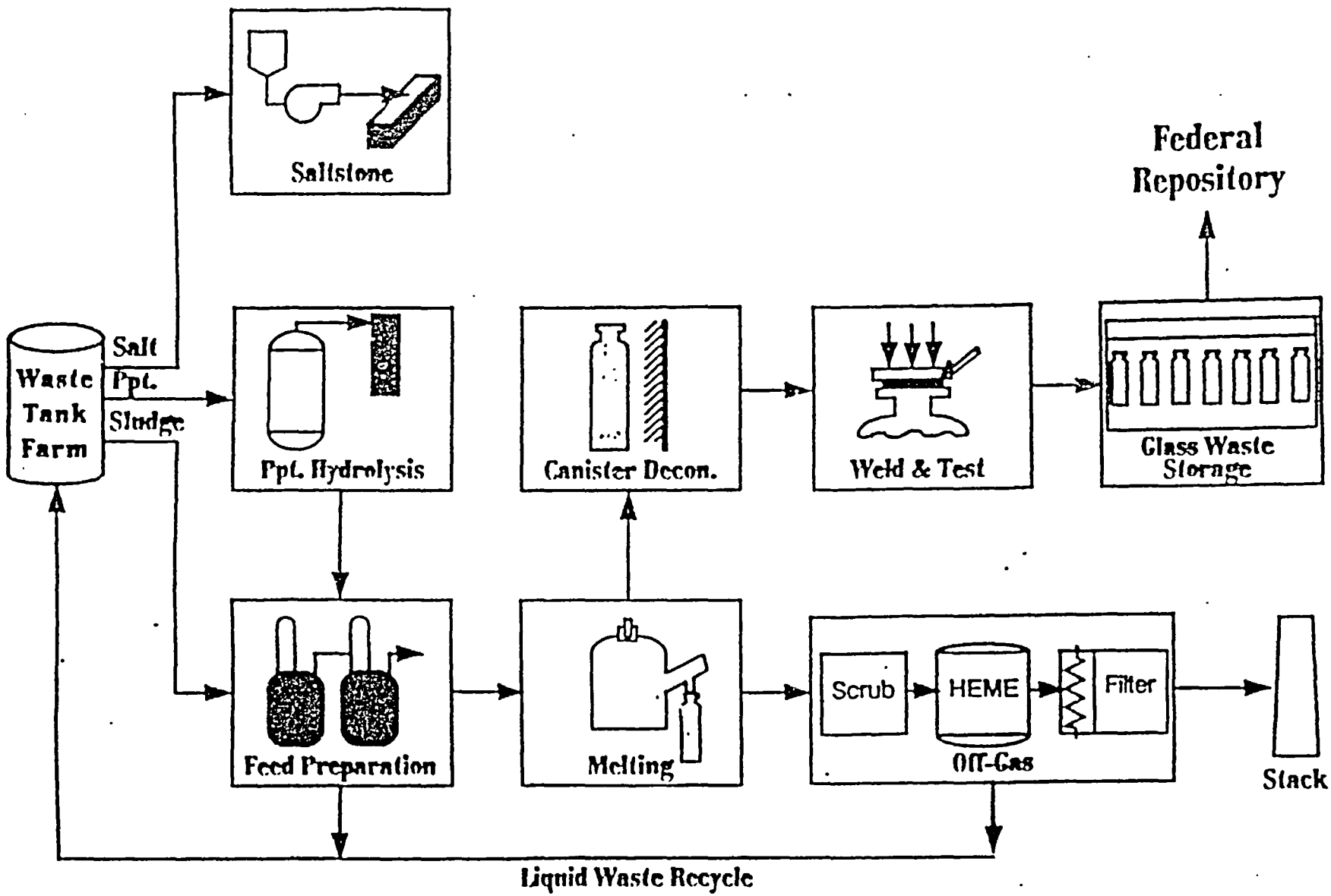
Protects Environment Health and Safety, Produces Quality, Meets Legal and Regulatory Requirements ...

So That: We meet the Site Mission, Protect the Environment and Enhance Confidence in the Nuclear Industry.

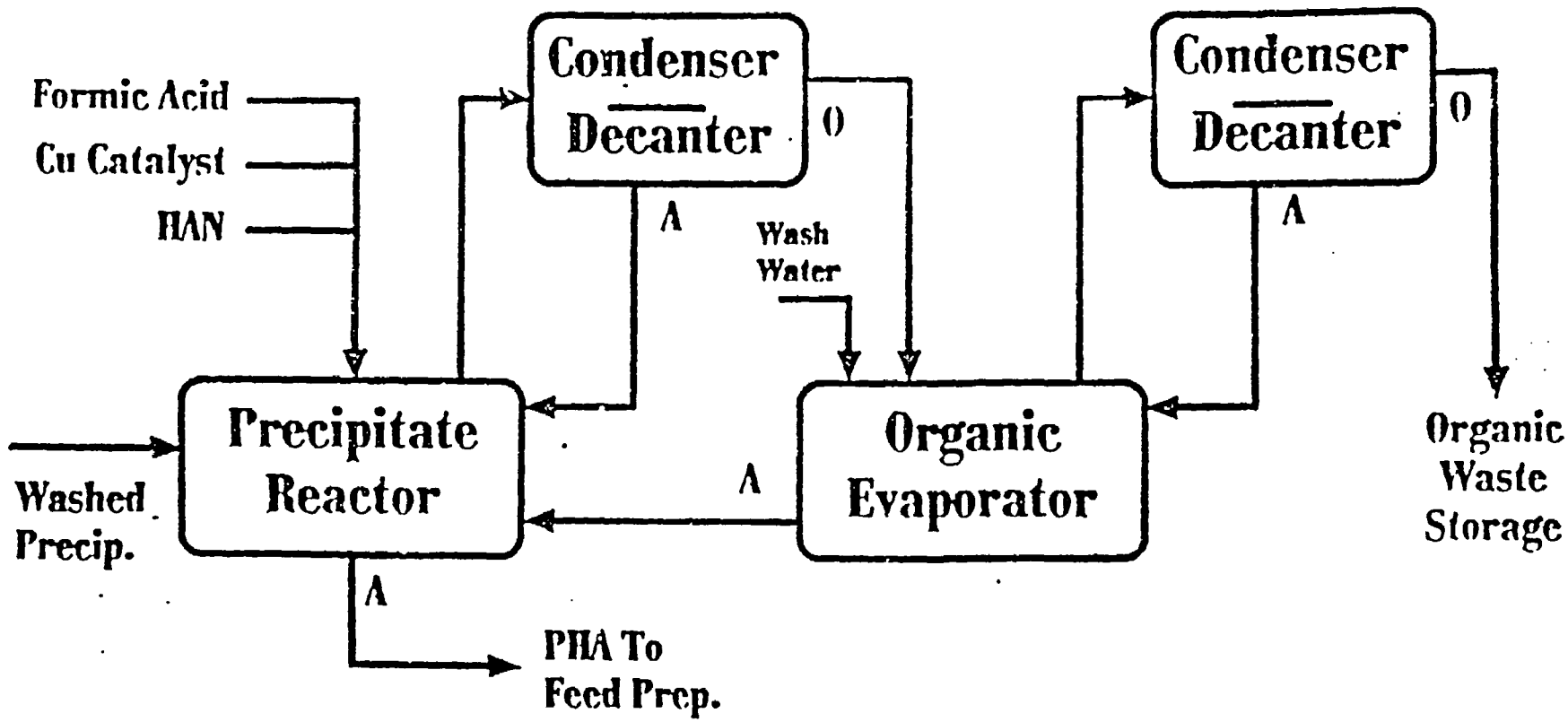
SRS High-Level Waste Management System



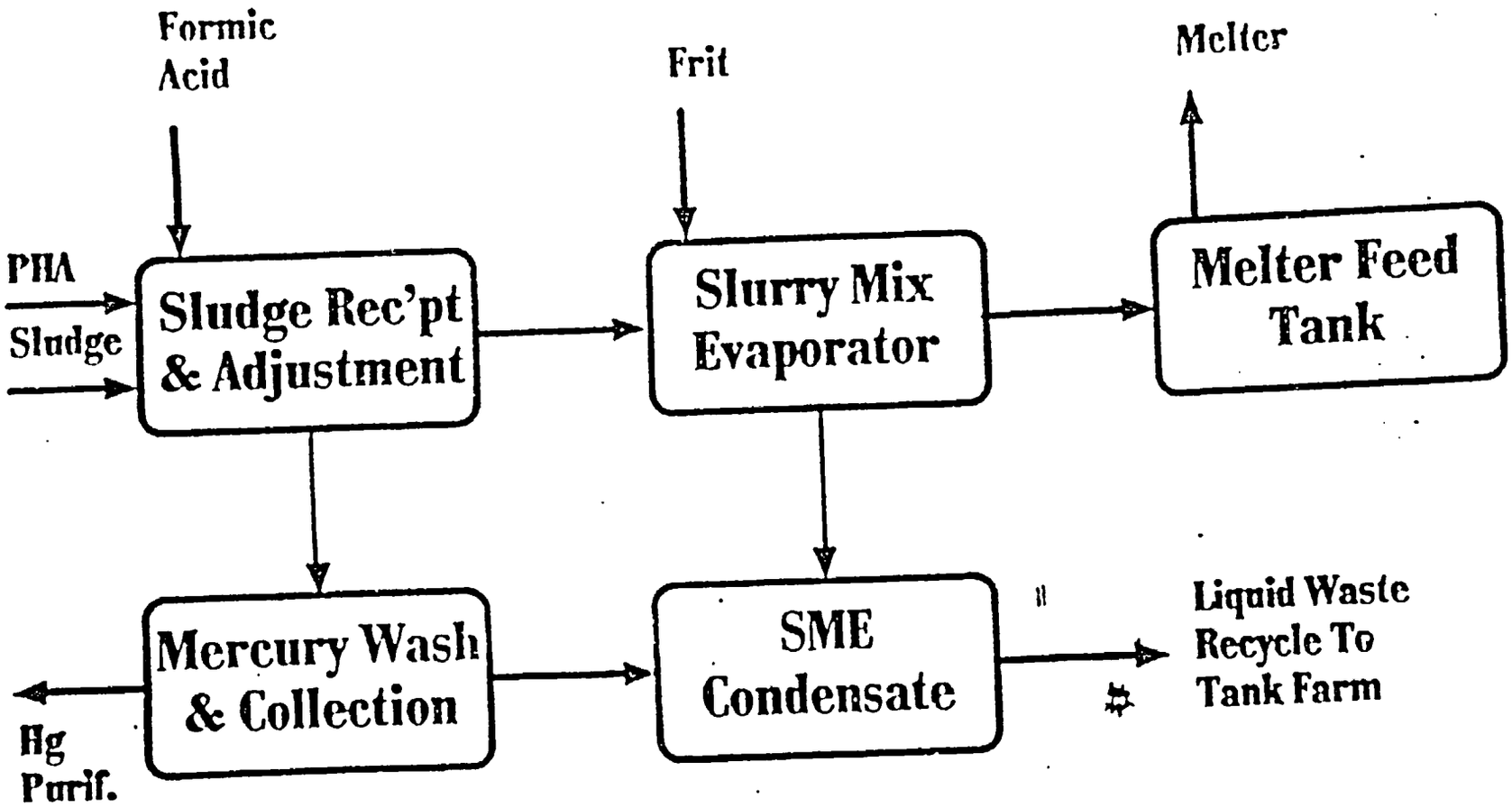
DWPF PROCESS



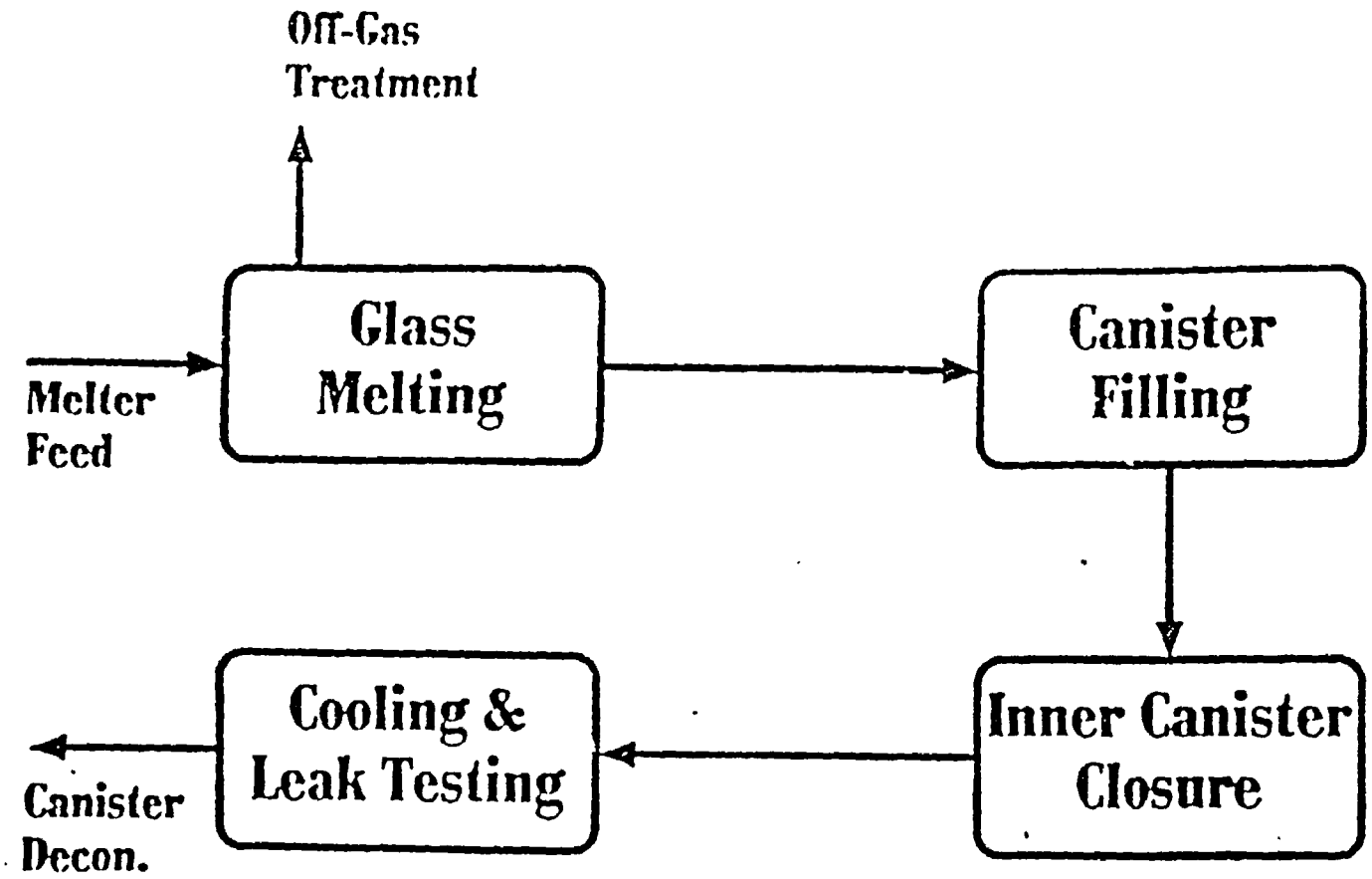
PRECIPITATE HYDROLYSIS



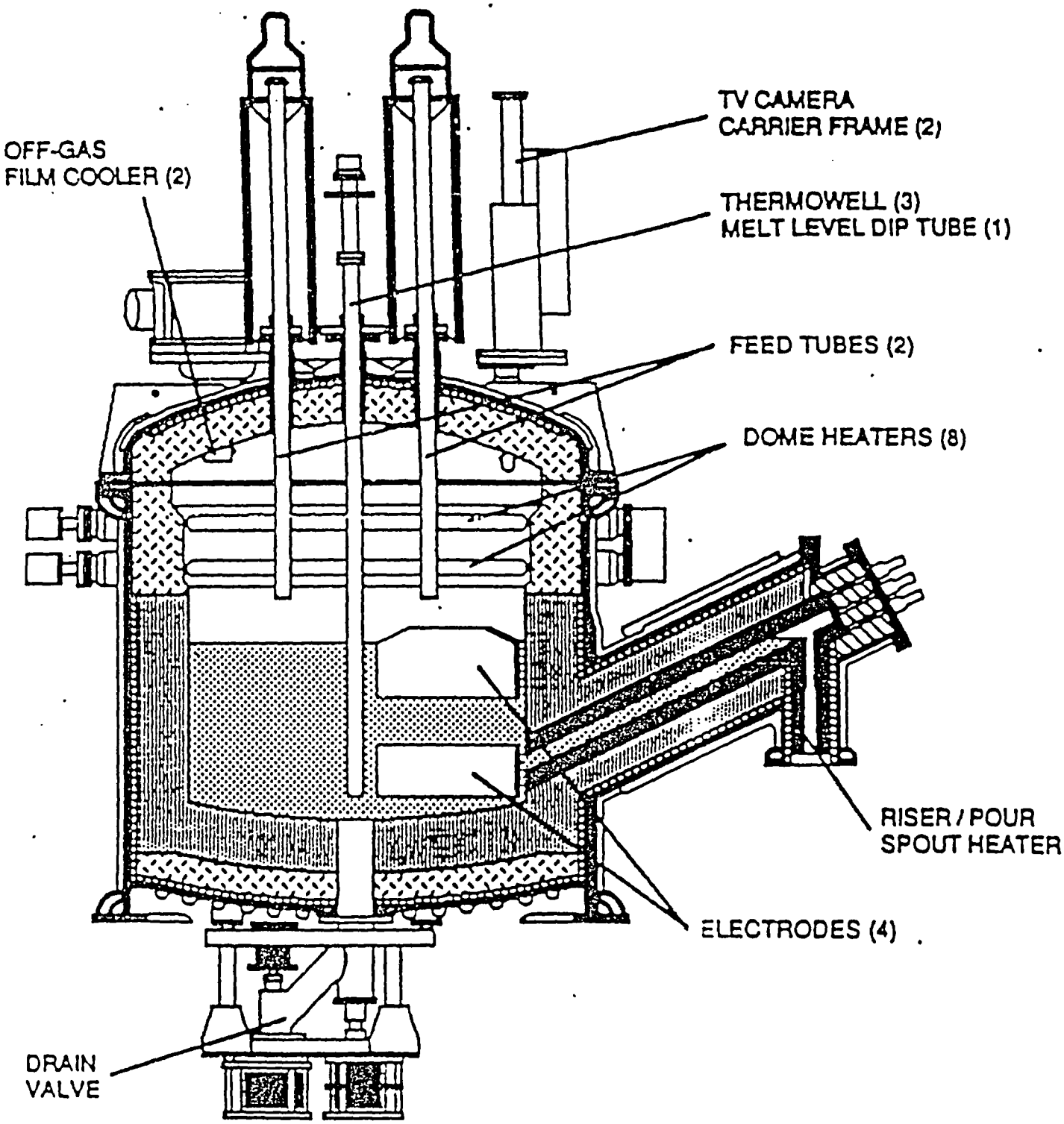
MELTER FEED PREPARATION



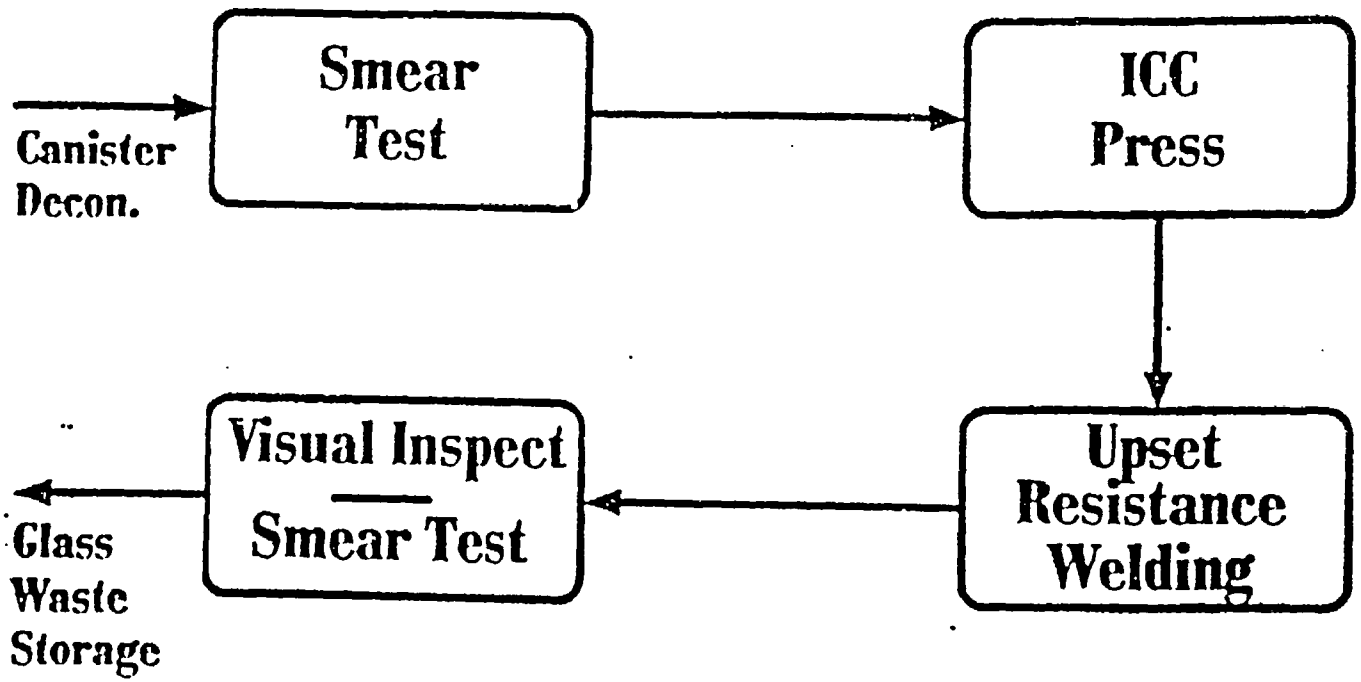
MELTING


Off-Gas
Treatment
Glass
Melting
Melter
Feed
Canister
Filling
Inner Canister
Closure
Cooling &
Leak Testing
Canister
Decon.

DWPF GLASS MELTER

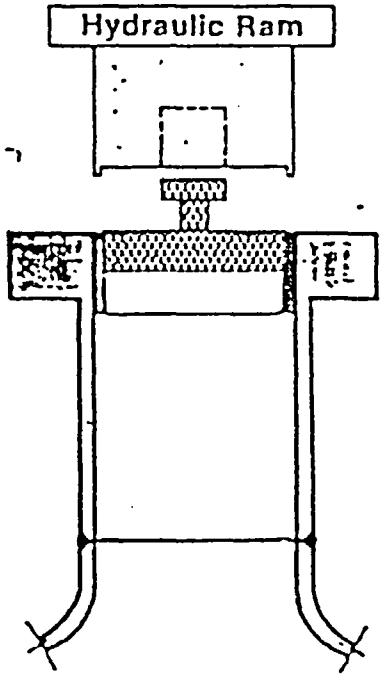


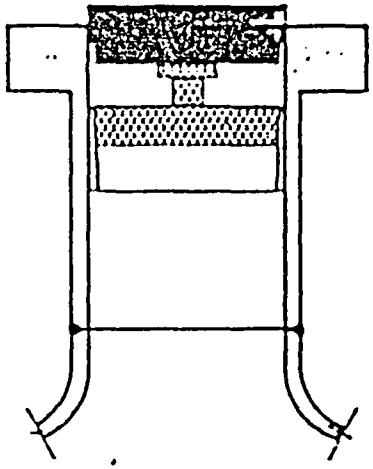
CANISTER WELDING & TESTING

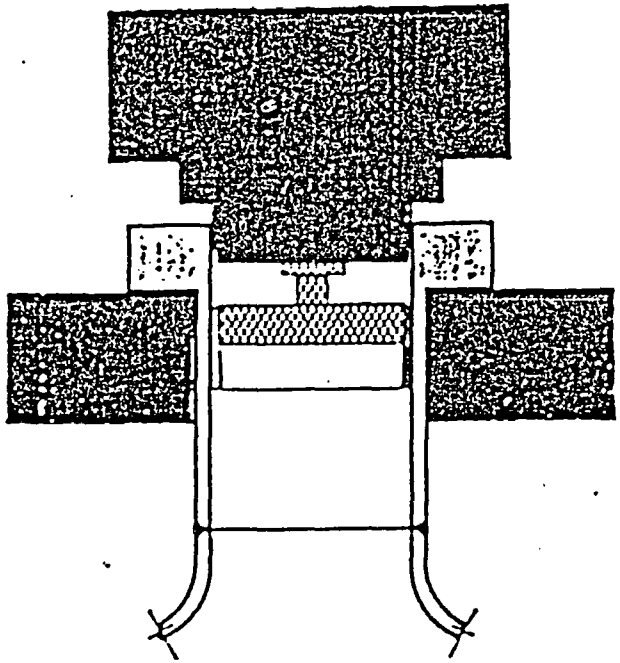


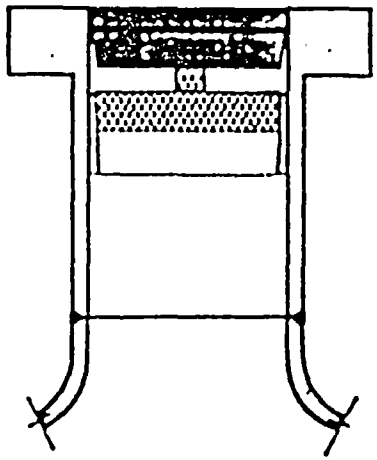
Canister Sealing Process

Weld Test Cell



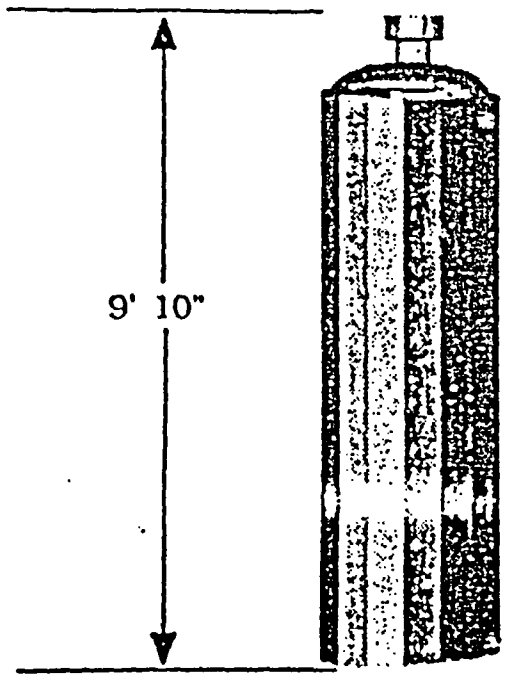






HHE 7/83

DWPF CANISTER



REFERENCE PRODUCT CHARACTERISTICS:

Canister Material: 304L stainless steel, 24" diameter
3/8" wall
Canister Weight: 1100 lb
Net Weight: 3700 lb
Weight of Radionuclides: 56 lb
Total Curies: 176,000
Decay Heat: 470W
Radiation: 5500 rem/hour at surface
Contamination: $<10^{-4}$ uCi/cm^2
DWPF Production: 410 canisters/year at 75% attainment

Overview of DWPF Product Acceptance Programs

M. J. Plodinec
August 7, 1991

Background

- DOE set up Waste Acceptance Process to ensure vitrified waste suitable for repository disposal
- Repository program (OCRWM) establishes specifications
- DWPF blending information from laboratory, hot cells, pilot plant and facility to demonstrate compliance with specifications
  - — Demonstrate effectiveness of process controls
  - — Develop component specifications

Waste Acceptance Process

DOE - OCRWM

SPECIFICATIONS

ASSURE COMPATIBILITY WITH REPOSITORY

DWPF

WASTE FORM COMPLIANCE PLAN

- HOW WILL WE COMPLY?

WASTE FORM QUALIFICATION REPORT

- CAN WE COMPLY, IN DWPF?

PRODUCTION RECORDS

- HAVE WE COMPLIED, IN DWPF?

Waste Acceptance Preliminary Specifications

- Cover three technical areas, and Quality Assurance
- Latest revision - 6/91

Glass

Chemical Composition
Radionuclide Inventory
Product Consistency
Phase Stability

Canister

Material
Fabrication and Closure
Identification and Labeling

Finished Product

Free Liquid
Gas
Explosives, Pyrophorics, Combutibles
Organic Materials
Fill Height
Surface Contamination
Heat Generation
Dose Rate
Chemical Compatibility
Subcriticality
Weight, Length, Diameter, Overall Dimensions
Drop Test
Handling Features

Chemical Composition Projections

- Specification:
  - — Provide expected chemical composition and microstructure for all DWPF glasses

- Progress:
  - — Defined reference waste types, and glass composition for each waste type
  - — Procured several pounds of each from Corning Glass
  - — Determined expected canister cooling curves
  - — Characterization of glasses almost complete; only PCT remaining

Projected DWPF Waste Glass Compositions

MAJOR GLASS COMPONENTS weight %	CONSTITUENT SLUDGE TYPE						
	Blend[d]	Batch 1	Batch 2	Batch 3	Batch 4	HM	Purex[w]
Al_2O_3	3.98	4.87	4.46	3.25	3.32	7.08	2.89
B_2O_3	8.01	7.69	7.70	7.69	8.11	6.94	10.21
$BaSO_4$	0.27	0.22	0.24	0.26	0.38	0.18	0.29
CaO	0.97	1.17	1.00	0.93	0.83	1.00	1.02
$CaSO_4$	0.077	0.12	0.11	0.10	0.0034	trace	0.12
Cr_2O_3	0.12	0.10	0.12	0.13	0.14	0.086	0.14
CuO	0.44	0.40	0.41	0.40	0.46	0.25	0.42
Fe_2O_3	10.41	12.52	10.61	11.16	11.32	7.38	12.74
Group A[a]	0.14	0.099	0.14	0.10	0.20	0.20	0.078
Group B[b]	0.36	0.22	0.44	0.25	0.60	0.89	0.084
K_2O	3.86	3.49	3.50	3.47	3.99	2.14	3.58
Li_2O	4.40	4.42	4.42	4.42	4.32	4.62	3.12
MgO	1.35	1.36	1.35	1.35	1.38	1.45	1.33
MnO	2.03	2.06	1.62	1.81	3.08	2.07	1.99
Na_2O	8.73	8.62	8.61	8.51	8.88	8.17	12.14
Na_2SO_4	0.10	0.10	0.12	0.096	0.13	0.14	0.12
NaCl	0.19	0.31	0.23	0.22	0.090	0.093	0.26
NiO	0.89	0.75	0.90	1.07	1.09	0.40	1.21
SiO_2	50.20	49.81	50.17	49.98	49.29	54.39	44.56
ThO_2	0.19	0.36	0.63	0.77	0.24	0.55	0.011
TiO_2	0.90	0.66	0.67	0.66	1.02	0.55	0.65
U_3O_8	2.14	0.53	2.30	3.16	0.79	1.01	2.89
Total	99.76	99.88	99.75	99.79	99.66	99.59	99.85

[a] Group A: semi-volatile radionuclides (e.g., Se, Te, Rb, Mo).
[b] Group B: nonvolatile radionuclides (e.g., Sm, Sn, Co, Np, Am, Cm).
[d] The "Blend" is the current DWPF design-basis glass.
[w] The "Purex" glass is a possible "worst-case" composition.

Comparison of Projected to Actual Waste

Elements	Actual Waste	Projected
Fe	30.5	30.9
Al	8.8	6.0
Na	4.0	5.6
Mn	3.3	4.8
Ca	2.9	1.7
Mg	1.5	0.15
Si	0.92	1.0
P	0.63	0.03
Ni	0.37	1.5
Cr	0.21	0.17
Zn	0.17	0.18
K	0.11	0.22
Hg	0.23	1.2
U	3.5	1.1
Th	0.05	0.65

Chemical Composition During Production

- Specification:
  - Report all elements > 0.5 wt % (excluding O)
  - Report precision and accuracy of values

- Progress:
  - Developed strategy based on use of slurry samples – incorporated in Product Control Program
  - Slurry sampler developed, characterized
  - Analytical procedures developed, tested in round robins (typically 1 -3 % RSD), being incorporated in DWPF Laboratory Manual
  - Use of standard glass important to achieving good results
  - Glass sampler developed
  - Will quantify "as-built" uncertainties as part of Startup Test Program

Radionuclide Inventory Projections

- Specification:
  - Estimate total inventory to be shipped to repository
  - Estimate inventory for each waste type, and estimate errors

- Progress:
  - Developed projected glass types
  - Estimated canister production through 2025
  - Provided canister by canister estimates, and bounding cases for total inventory
  - Projections completed; draft approved by TRG

Radionuclide Inventory During Production

- Specification:
  - Report all radionuclides > 0.05 % of inventory (Ci) at any time up to 1100 years; and with $\tau_{1/2}$ > 10 years

- Progress:
  - Developed strategy: will report most elements based on ratios determined from tank farm samples
  - Direct analyses for Cs-137, Sr-90, gross α, α- and γ-PHA
  - ICP-MS turning out to be key instrument
  - Characterization of initial DWPF feed underway

Product Consistency

- Specification:
  - Control process so glass better than benchmark glass – "EA glass" – (lower release of Li, Na, B on Product Consistency Test)
  - Verify mean reported value ≥ 2 standard deviations below mean of benchmark glass

- Progress:
  - Glass Product Control Program describes strategy and bases — key is control of feed composition; occasional glass sampling will confirm control
  - Preparation of benchmark glass standard nearly complete
  - Product Composition Control System software developed
  - Have tested PCCS on actual waste in hot cells; will test in pilot plant tests, and as part of Startup Test Program
  - Initial WQR draft due 12/91; Startup Test Program data ~ 3 months after last campaign

Importance of Glass Composition

- Performance of glass on PCT (or any leach test) depends on:
  - Glass composition
  - Water composition, Eh, pH
  - Temperature of interaction
  - Flow rate
  - Ratio of glass surface area to solution volume (SA/V)
  - Time of contact between glass and water

- The PCT fixes: water composition (DIW), temperature (90°C), flow rate (static), SA/V, time (7 days)

- Therefore, the DWPF must control the composition of the glass to meet specification

Product Consistency Compliance

DOE - OCRWM

SPECIFICATIONS

CONTROL PRODUCT TO MEET LIMIT

VERIFY CONTROL DURING PRODUCTION

DWPF

LABORATORY TESTS

- QUALIFY RANGE OF GLASS COMPOSITIONS

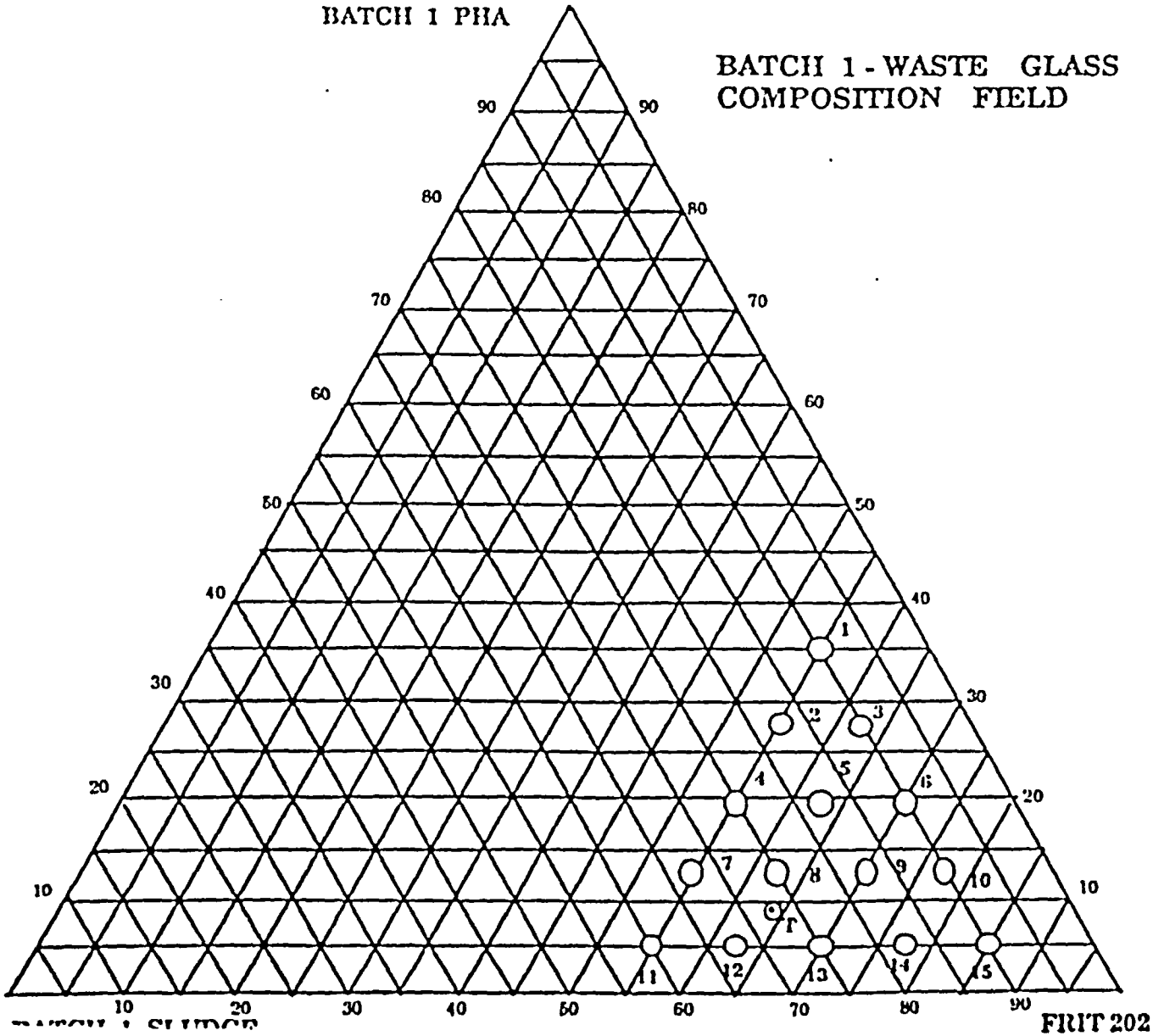
STARTUP TEST PROGRAM

- DEMONSTRATE ABILITY TO CONTROL PRODUCTION

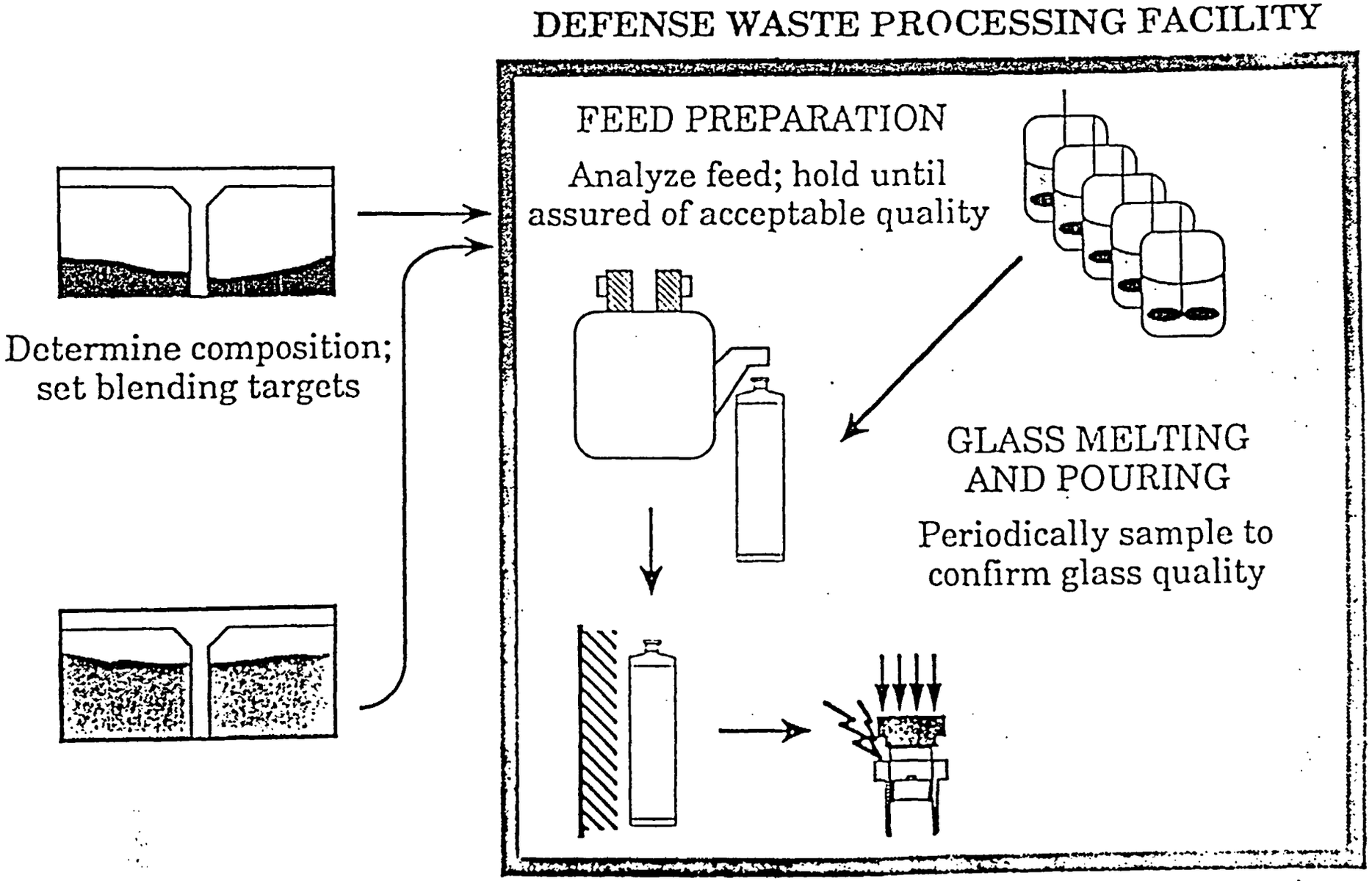
PRODUCTION

- USE PRODUCT CONTROL PROGRAM TO CONTROL, AND VERIFY CONTROL

Qualification of Glasses



Glass Product Control Program



Phase Stability

- Specification:
  - — Glass transition temperatures for each waste type
  - — Time-temperature-transformation data for each waste type
  - — Effects of heat treatments on radionuclide release
  - — Storage temperature < transition temperature - 100°C

- Progress:
  - — Transition temperatures of projected glasses measured
  - — Developed model of Glass Waste Storage Building; T(GWSB) << transition temperature
  - — T-T-T work in progress

Canister Material

- Specification:
  - Canister must be austenitic stainless steel
- Progress:
  - Specifications developed for all canister components, based on pilot plant and DWPF experience
  - Plan for vendor and receipt inspections developed
  - WQR section issued

Canister Fabrication and Closure

- Specification:
  - Canister closure must be leaktight – $1 \cdot 10^{-4}$ cc(He)·atm/sec

- Progress:
  - Specifications developed for canister fabrication and testing
  - Upset resistance welding process developed
  - Extremely wide operating window
  - WQR section issued
  - Section will be revised based on Startup Test Program; test plans developed

Canister Identification and Labeling

- Specification:
  - Canister must have legible label and unique identification
- Progress:
  - Specifications developed for canister labels
  - Viewing study completed
  - Process Information Management System set up
  - WQR section issued

Foreign Materials

- Specifications:
  - Canistered waste form must not contain free liquids, free gas, explosives, pyrophorics, combustibles or organics

- Progress:
  - Independent review of containerization process
  - Developed Inner Canister Closure Station
  - Developed welder
  - Tested prototypical canisters
    - Upper bound of 41 mg/canister of volatile material
    - Canisters under slight vacuum
    - Dew point < 6°C; RH < 20 % at 30°C
    - CO_2 depletion
  - Initial WQR section issued; will be revised based on Startup Test Program

Fill Level

- Specification:
  - — Canistered waste form should be filled to height corresponding to 80% full
- Progress:
  - — Level detection by gamma, neutron techniques (monitor weight for off-normal fills)
  - — Fill to at least 85 %
  - — Issued initial WQR section; will be revised based on non-radioactive and initial radioactive operations

Surface Cleanliness

- Specification:
  - — Canistered waste form external surface must meet DOT shipping regulations

- Progress:
  - — Air-injected frit blasting used for decontamination
  - — Study of smearing operation completed; compared remote smear technique to hand smears - remote better
  - — Initial WQR section issued; will be revised after initial radioactive operations
  - — Smears will be performed in Shipping Facility (not yet designed)

Heat Generation, Dose Rate Projections

- Specifications:
  - — Project heat generation for each waste type
  - — Project maximum dose rate (both gamma and neutron), and range

- Progress:
  - — Calculated from radionuclide inventory projections
  - — Bounding values also determined
  - — Draft WQR section approved by TRG

Heat Generation, Dose Rate During Production

- Specifications:
  - — Heat generation < 1500 w/canister
  - — Dose rate < 100,000 R/hr gamma; < 10 rem/hr neutron

- Progress:
  - — Strategy to measure dose rate, and calculate heat generation from radionuclide inventory
  - — Heat generation in Production Records
  - — Dose rates in Shipping and Storage Records

Chemical Compatibility

- Specification:
  - — Contents must not lead to internal corrosion of canister
- Progress:
  - — Glass does not corrode canister
  - — However, halides and sulfates inside canister ⇒ can only ensure integrity by excluding water
  - — Review of containerization process
  - — Tests planned as part of Startup Test Program

Subcriticality

- Specification:
  - Canistered waste form must be subcritical
- Progress:
  - Performed conservative bounding calculations
  - $k_{eff} < 0.27$ for very conservative assumption
  - $k_{eff} \sim 0$ for first batches
  - WQR draft section approved by TRG

Weight and Dimensions

- Specification:
  - Canistered waste form must weigh < 3500 kg
  - Length 3.000 m (+0.005, -0.020 m)
  - Diameter 0.610 m (+0.015, -0.010 m)

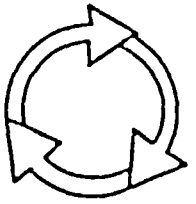
- Progress:
  - Not possible to fill canister full enough to exceed weight
  - Measurements on prototypic canisters before and after filling
  - Control through canister procurement specifications
  - Weight and dimensions reported based on measurements in Shipping Facility

Canister Impact

- Specification:
  - Canistered waste form must withstand 7 m drop
- Progress:
  - Prototypic canisters remain leaktight after dropping
  - Deformation only 25 % of failure strength of material
  - WQR section issued

Startup Test Program

Facility



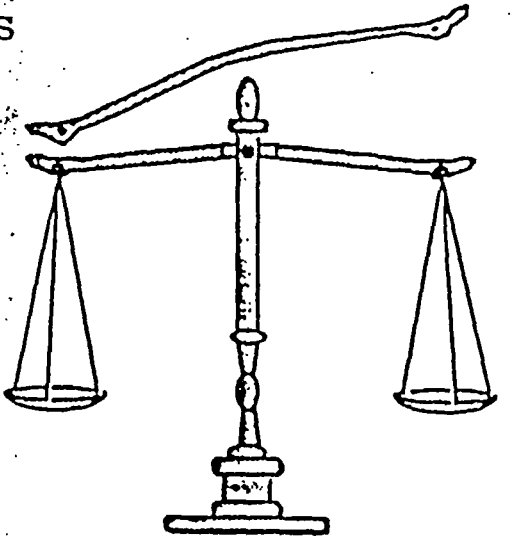
Shielding
Emergency Power
Crane Operations
HVAC

10 tests

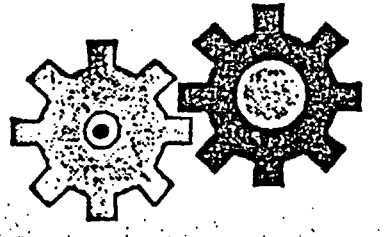
Product

Product Control Demonstrations
Glass Sampling
Welding
Foreign Materials
Temperature Profiles
Reporting

18 tests



Process



Integrated Operation with Water
Vessel Materials
Startup of each Vessel
Continuing Operation of each Vessel
Feed, OG, Waste Handling Systems

17 tests

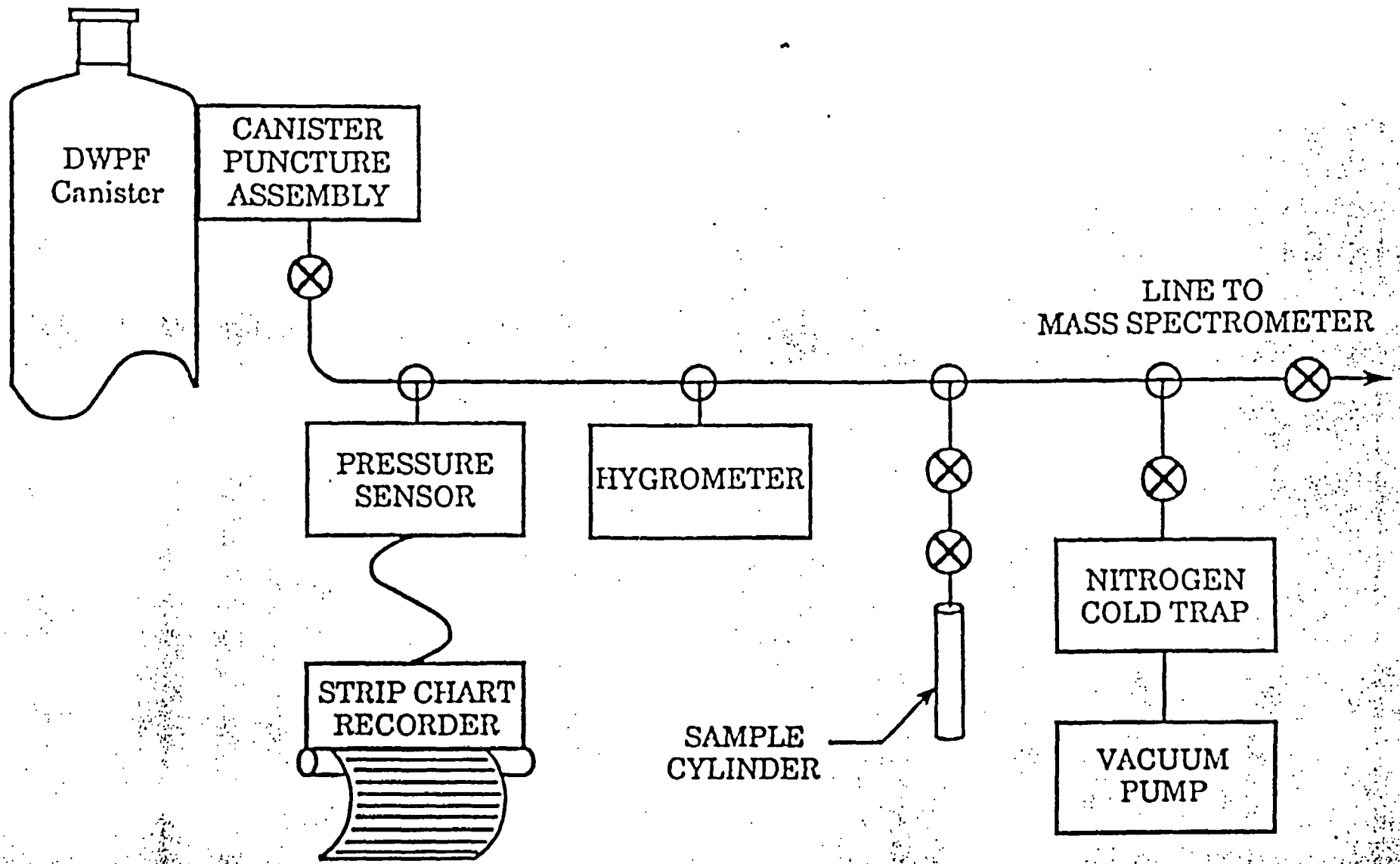
Product Control Demonstrations

- Will use results to verify ability to control over most adverse credible conditions
  - First, verify for small changes in melter feed
  - Then, step change in viscosity (low), density (high)
  - Then, step change in viscosity (high), density (low)
  - Finally, back to baseline for first batch of radioactive feed
- Each canister produced will be sampled, most destructively examined as well
  - Compare glass sample to canister contents
  - Compare observed performance to prediction from feed and glass composition
- Will also use results to determine mode of flow through melter (plug vs. continuous stirred tank) for reporting
  - Compare feed analyses to measured output

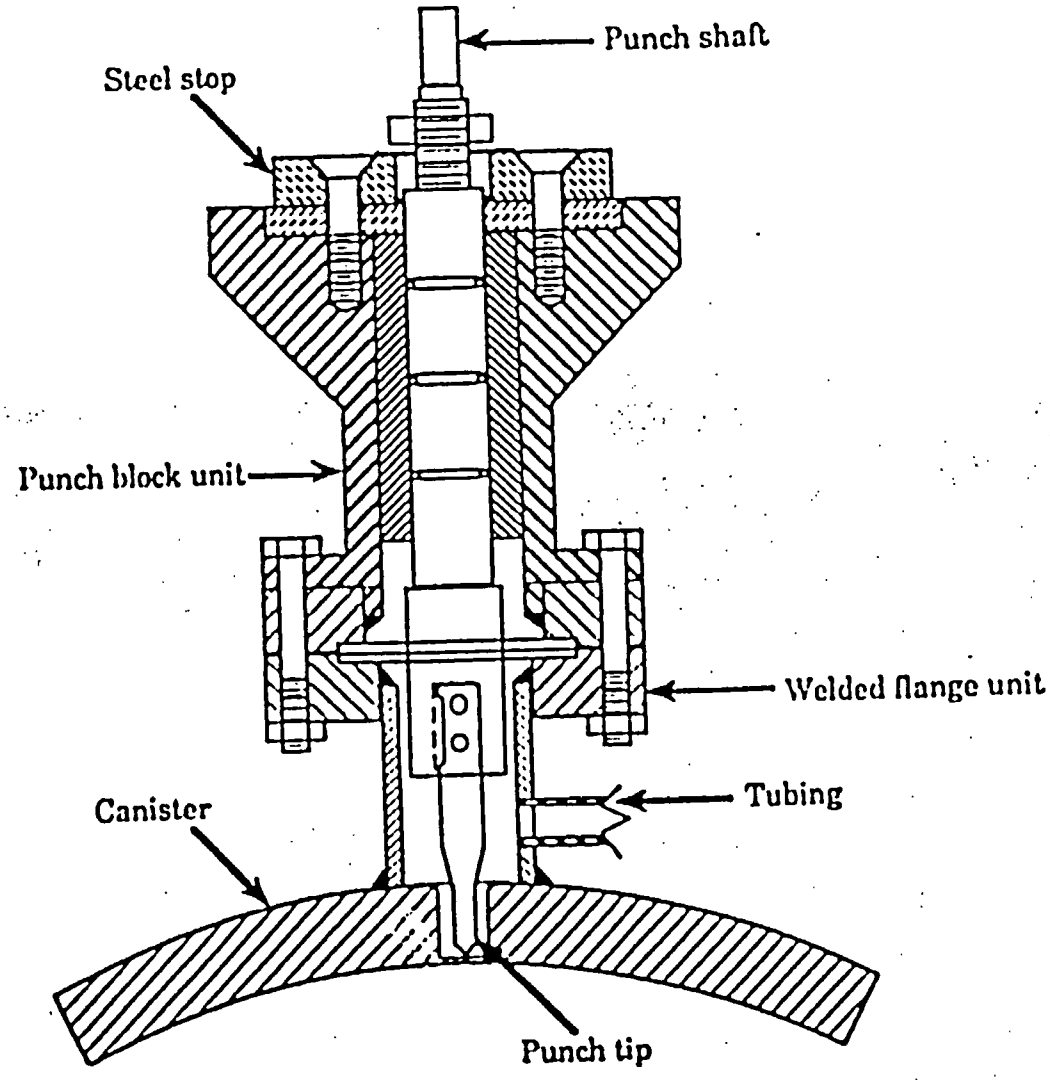
Characterization of Products

- Each of 124 canisters will be sampled (with sampler), during filling
- Canisters from each campaign will be examined for foreign materials
- Most will be destructively examined as well
  - Canisters filled during greatest changes in composition will be sectioned
  - Canisters filled near steady-state in composition will be sectioned
  - Rest will have wall removed from side of canister
- Glass characterization
  - Chemical composition
  - Product Consistency Test
  - Non-vitreous phase identification

Testing for Foreign Materials



Canister Puncture System



Conclusions

- Have developed strategies to consistently make acceptable product
- Multi-faceted demonstrations are showing the strategies will work; but Startup Test Program will be crucial evidence of ability to comply
- Want to work closely with NRC / RW to ensure concerns identified and addressed, and to avoid delays in waste vitrification

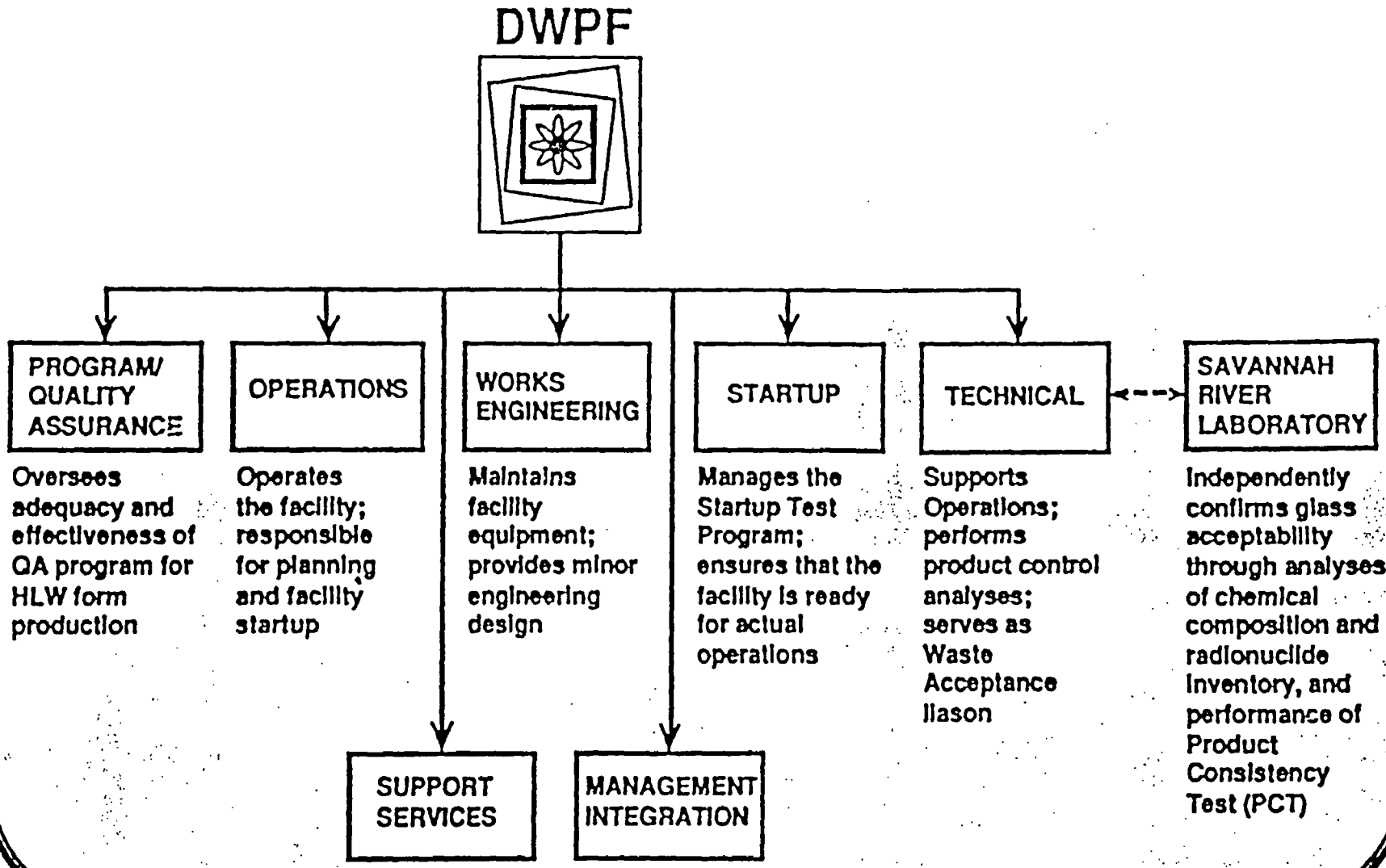
DWPF GLASS PRODUCT CONTROL PROGRAM

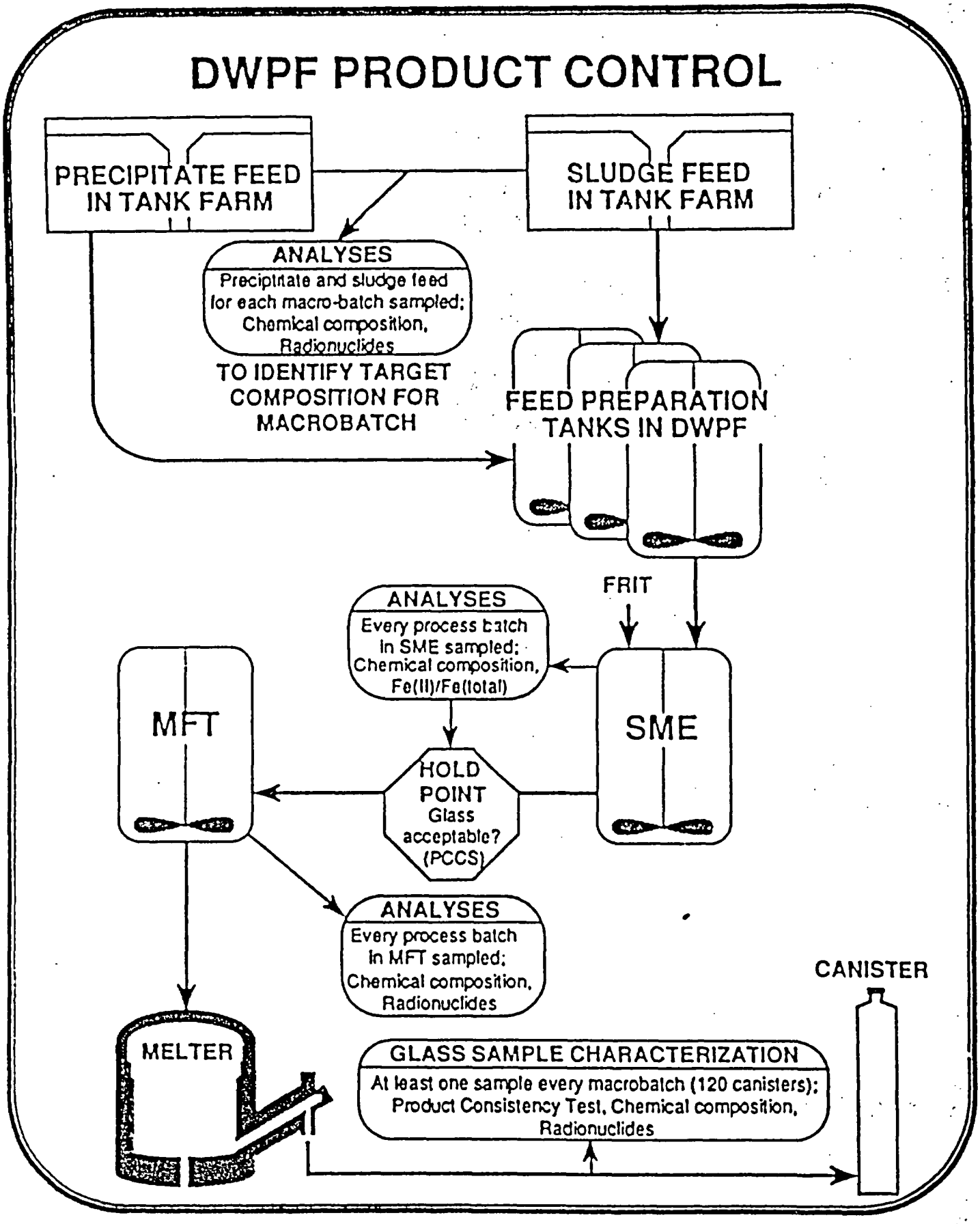
Sharon L. Marra
August 7, 1991

OBJECTIVES OF PROGRAM

- Ensure that the waste glass produced satisfies the WAPS
  - Chemical composition
  - Radionuclide inventory
  - Product consistency
- Document that the WAPS have been satisfied

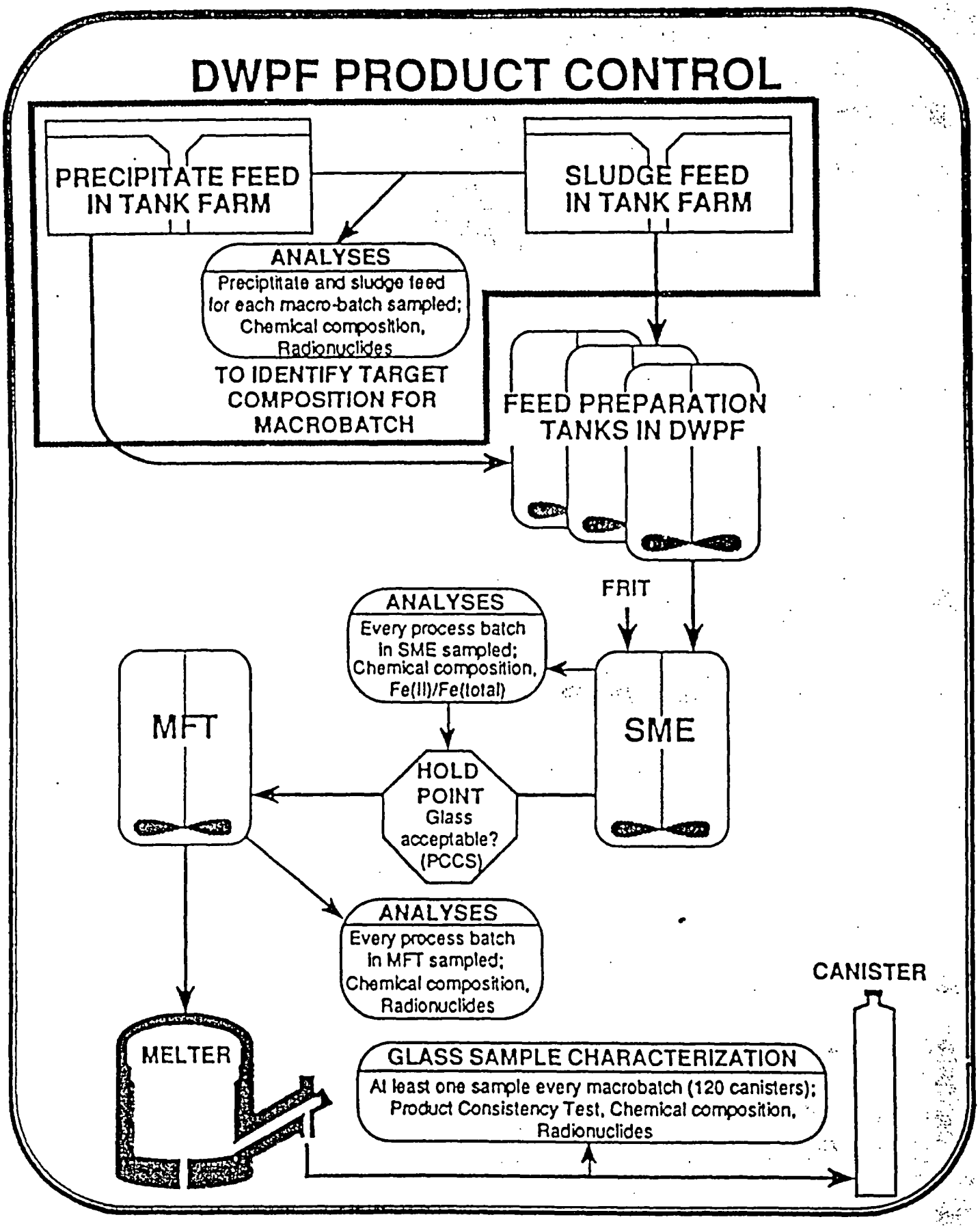
DWPF ORGANIZATION




DWPF PRODUCT CONTROL
PRECIPITATE FEED IN TANK FARM
SLUDGE FEED IN TANK FARM
ANALYSES
Precipitate and sludge feed for each macro-batch sampled; Chemical composition, Radionuclides
TO IDENTIFY TARGET COMPOSITION FOR MACROBATCH
FEED PREPARATION TANKS IN DWPF
FRIT
ANALYSES
Every process batch in SME sampled; Chemical composition, Fe(II)/Fe(total)
MFT
SME
HOLD POINT
Glass acceptable? (PCCS)
ANALYSES
Every process batch in MFT sampled; Chemical composition, Radionuclides
CANISTER
MELTER
GLASS SAMPLE CHARACTERIZATION
At least one sample every macrobatch (120 canisters); Product Consistency Test, Chemical composition, Radionuclides

POINT OF CONTROL

- Glass composition is key control variable
- Control product through control of each process batch
- Control composition of feed in last feed preparation vessel, Slurry Mix Evaporator (SME)
  - unacceptable feed can be corrected
  - no chemical additions routinely made downstream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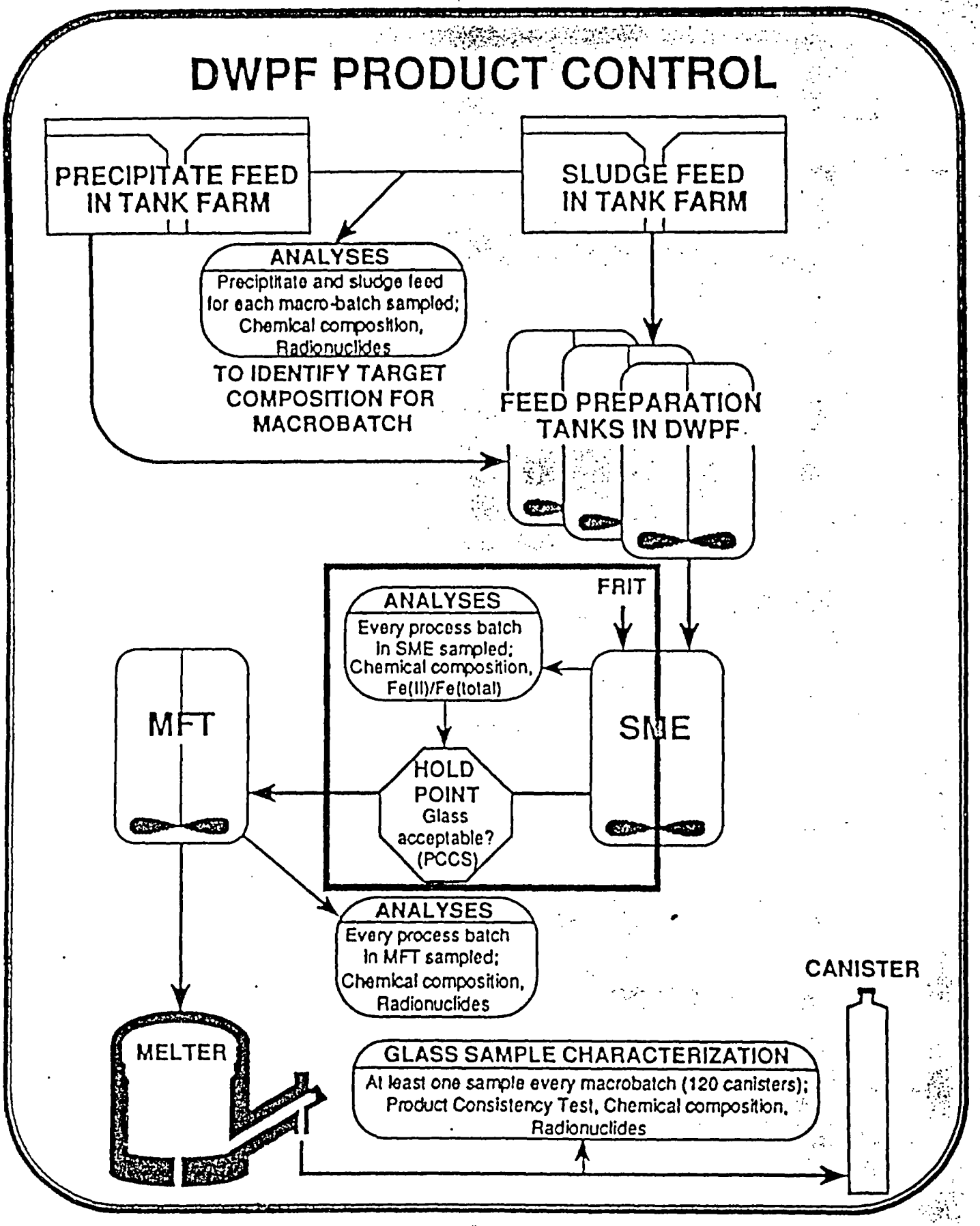
TANK FARM

- Sludge and precipitate feed for each macro-batch
  - characterized by Savannah River Laboratory (SRL)
  - major elements identified (>0.5 wt%)
  - correlations developed for some radionuclides
- Composition of waste used to verify frit composition specification
- Blending target and SME sampling regimen established using sludge, precipitate and frit compositions
  - demonstrate product quality/process reliability for the macro-batch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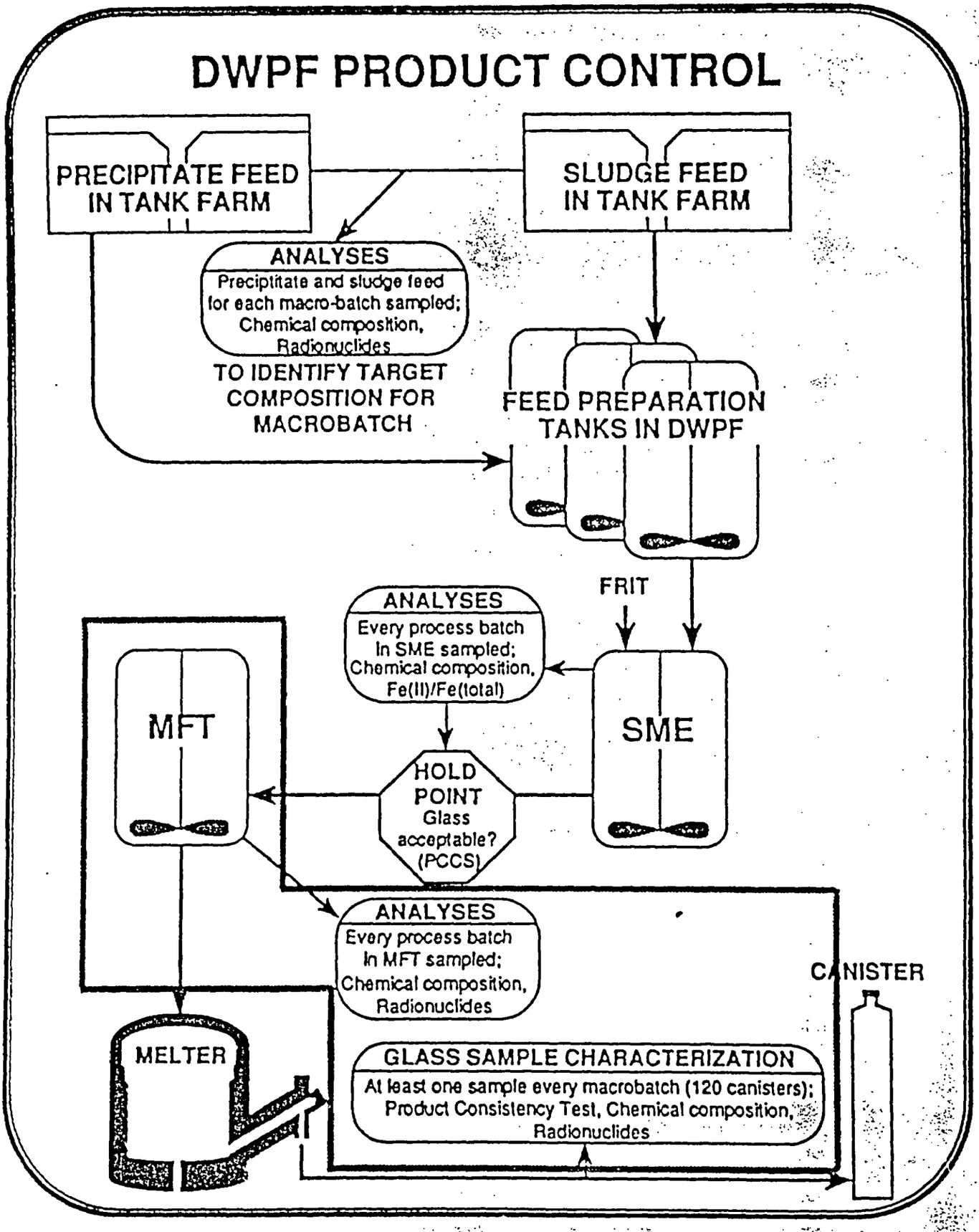
SLURRY MIX EVAPORATOR (SME) - HOLD POINT

- Every Process batch sampled
  - slurry samples vitrified and chemical composition and Fe^{2+}/Fetotal determined
- No material transferred from SME until it is determined to be acceptable (better than EA glass)
  - if acceptable transfer from SME to MFT
  - if unacceptable , adjust feed (addition of frit and/or trim chemicals) and resample
- Use of PCCS to judge acceptability and ensure high confidence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REPORTING

- Elemental composition of the glass
  - average of process batch analyses corresponding to the macro-batch
- Radionuclide content
  - average of measured process batch analyses corresponding to the macro-batch
  - calculated radionuclides
- Average of leach rates calculated from the composition corresponding to the macro-batch
- Results from occasional analyses of glass pour stream samples

CONCLUSION

- DWPF has developed a Glass Product Control Program which will:
  - ensure glass product satisfies the WAPS
  - document that specifications have been met
- Program will be used and refined as part of Startup Test Program
- PCCS key for ensuring acceptability of the glass

Overview of The Product Composition Control System (PCCS)

Richard Edwards
SRL - DWPT

Product Composition Control System

WHAT IS THE PCCS ?

The PCCS Is a Statistical Process Control System.

R. E. Edwards - 8/07/91

Product Composition Control System

PURPOSE

Provide Assurance That the Melter Feed *Composition* Leaving the Slurry Mix Evaporator (SME) Vessel Will Produce an *Acceptable Glass*

R. E. Edwards - 8/07/91

Product Composition Control System

ACCEPTABLE GLASS

Product Constraints: Durability

Heat Generation

Process Constraints: Liquidus

Viscosity

Waste Solubility

R. E. Edwards - 8/07/91

Product Composition Control System

GLASS PROPERTY MODELS

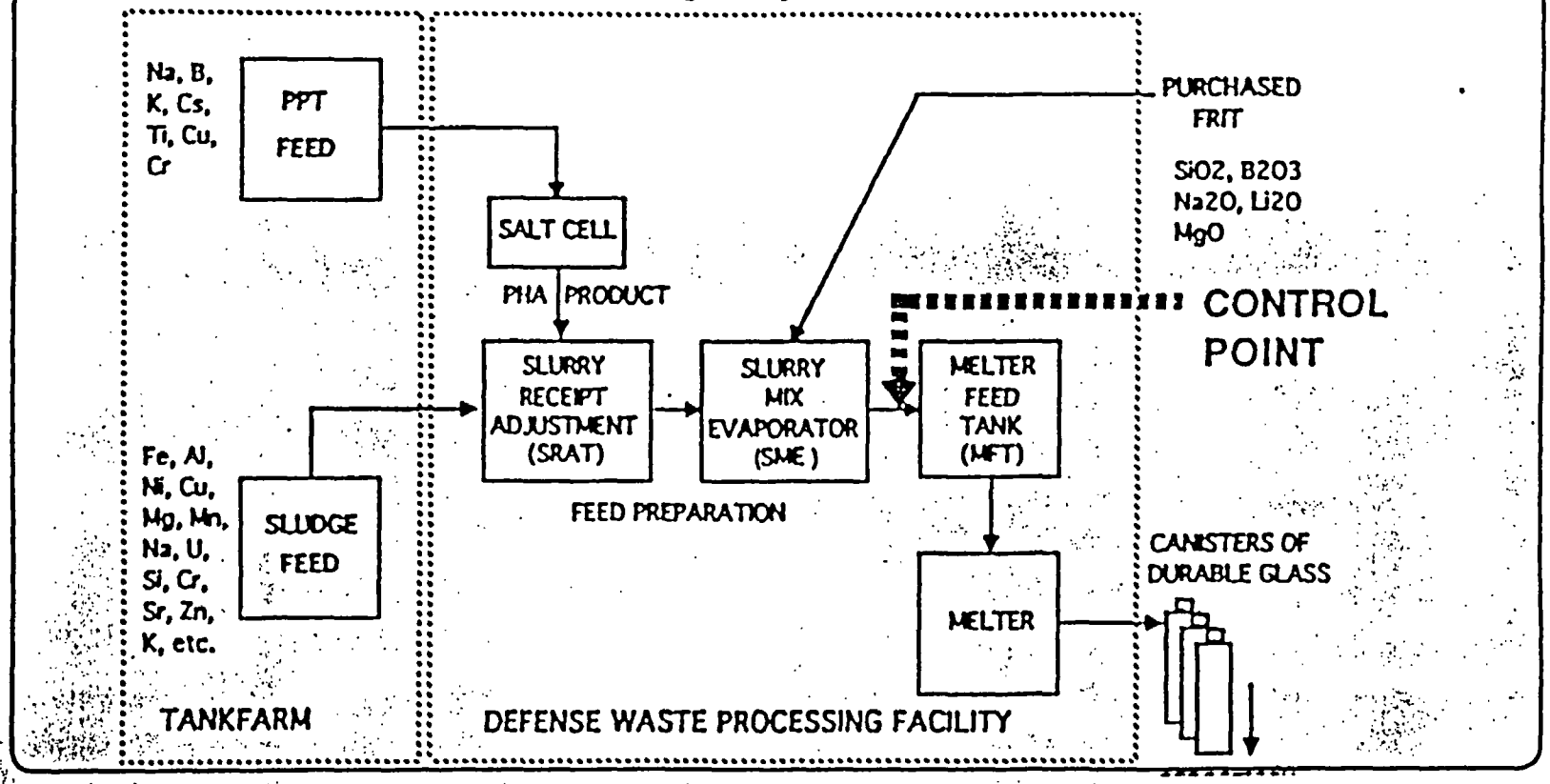
Glass Property	Criteria	Property Model
Durability	Leach Rate Better Than EA Glass	$\sum_{i=1}^{all} \Delta G_{HYD,i} \geq -7$ kcal/mole (Free Energies of Hydration)
Liquidus	≤ 1050 °C	$T = 700 + 3174\left(\frac{134\ Fe_2O_3}{156\ SiO_2 - 360\ Al_2O_3}\right) \leq 1050°C^{\dagger}$
Viscosity	$20 \leq \mu \leq 100$ poise @ 1150 °C	$20 \leq \mu(\text{poise}) = 2138 * 10^{-2.875x} \leq 100$ where $x = \left(\frac{Na_2O + LiO + Cs_2O + K_2O + B_2O_3}{SiO_2}\right)^{\dagger}$

† SiO_2, Fe_2O_3, B_2O_3, Li_2O, etc. represent the mole fractions of the components in the DWPF waste glass form.

R. E. Edwards - 8/07/91

Product Composition Control System

Control Philosophy



R. E. Edwards - 8/07/91

Product Composition Control System

NEED for PCCS:

- Need for Accurate Chemical Compositional Control to Ensure That Acceptable Melter Feed (SME Product) is Produced.

- Need For A Means to Judge the Acceptability of the Melter Feed (SME Product) with Respect to Glass Product and Processing Constraints

Product Composition Control System

OBJECTIVES

1. Provide Target Blend of Waste Streams (Sludge and Precipitate) with Glass Former (Frit).

2. Provide Statistical Methods to Judge SME Product Acceptability

3. Provide Statistical Methods to Remediate Any SME Product Which is Judged Unacceptable

Product Composition Control System

PCCS ACCOUNTS FOR:

- Uncertainties inherent in slurry *sampling*, sample *preparation*, and *measurement*
- Uncertainties in the *prediction of glass properties* from slurry composition
- The *simultaneous* variation of the individual slurry constituent concentrations

R. E. Edwards - 8/07/91

Product Composition Control System

QA Requirements

- Task in the SRL-DWPT Section - Appropriate DWPT Controls and Procedures Apply
- "Essential Software" - RW0214 Applies
- Code and Documentation must meet NUREG-0856.
- Software Life Cycle Incorporated as Part of the Customer's (DWPF) Software QA Plan for Process Software.

Product Composition Control System

PCCS Testing

- Verification - Independently by DWPF and SRL-DWPT
  - Used by IDMS
  - Used for High Level Caves Batch 1 Study
  - Defined Test Cases (IDMS Data)
- Validation - Conducted during Cold Runs of DWPF

Product Composition Control System

Summary:

The PCCS Is a Statistical Process Control System.

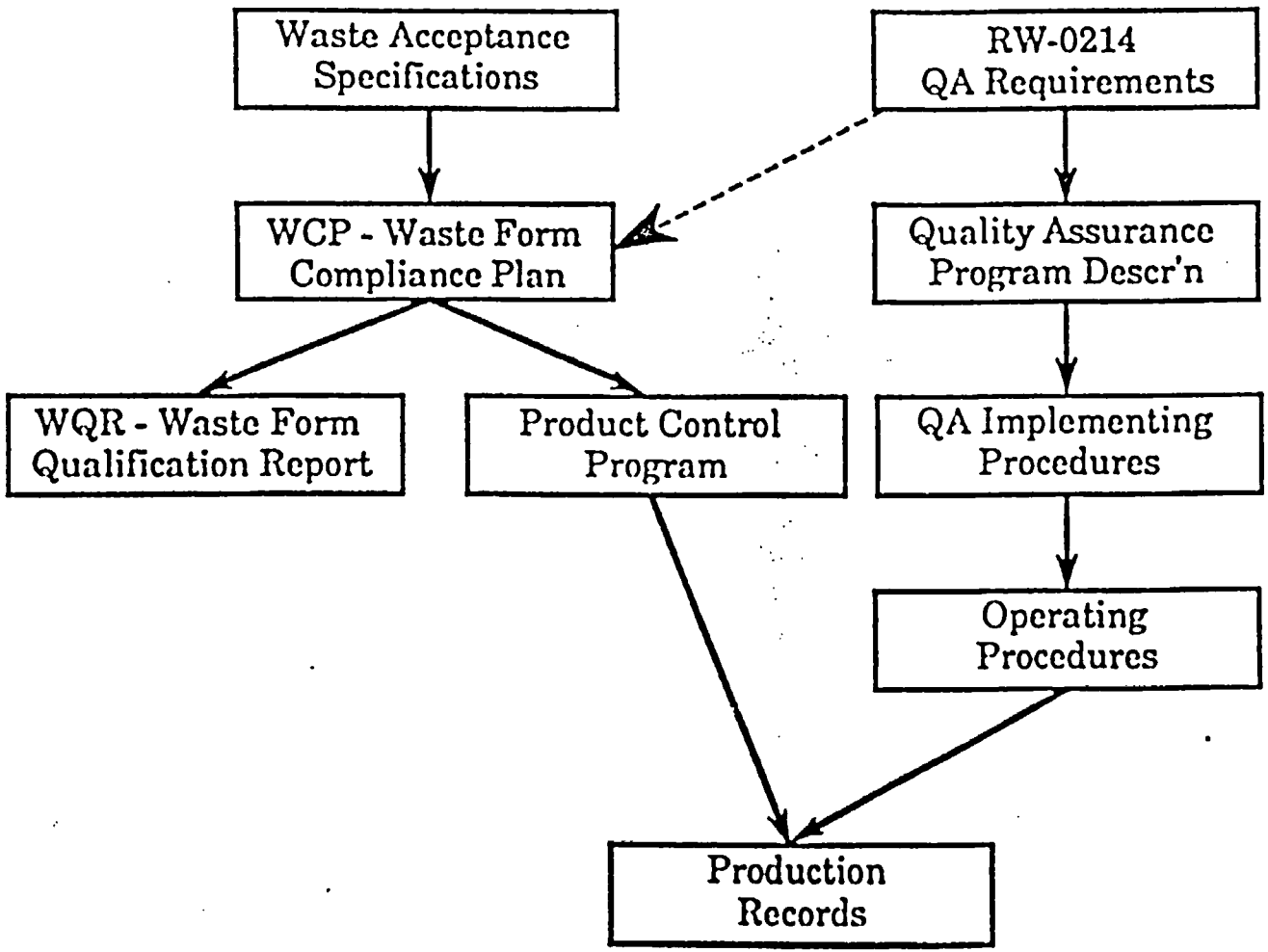
It uses the Appropriate Statistics to Provide Assurance That DWPF Will Make Acceptable Glass.

R. E. Edwards - 8/07/91

Waste Acceptance Document Review

M. J. Plodinec
August 7, 1991

Waste Acceptance Documents



Waste Form Compliance Plan

- Management plan for product acceptance programs
- Defines methodology for determining what is important to meet each specification
- Describes programs and activities for both product qualification and production control, for each specification
- Describes role of Startup Test Program
- Key technical document for understanding application of RW-0214 to DWPF

Waste Form Qualification Report

- Broken WQR into packages for resource leveling, and to facilitate review
- Projected length: ≥ 3000 pages
- Contents of each "chapter":
  - — Specification
  - — Compliance strategy summary
  - — Description of item or process
  - — Description of item or process controls
  - — Demonstration(s) of effectiveness of controls
  - — Production Records (or Shipping and Storage Records) content

Role of DOE Technical Review Group

- Participants independent of waste form production
  - — Consultants
  - — HQ Project Technology Support Office
  - — Repository program – both HQ and Yucca Mountain Project
- Review of WCP: activities described sufficient to satisfy WAPS?
  - — Accepts WAPS as a given
- Review of WQR: were WAPS requirements met?
  - — Accepts WCP as a given

Status of Waste Acceptance Documents

- Initial WAPS reviewed and accepted by NRC
- WAPS revised 6/91
- Waste Form Compliance Plan reviewed by Technical Review Group, recently revised in response to revised WAPS
  - *Not yet reviewed by NRC*
- Waste Form Qualification Report
  - 17 initial sections drafted (out of 24) - projections of composition, radionuclides, heat, dose; canister-related specifications; foreign materials
  - 16 reviewed by TRG, and comments resolved on 15
  - 8 issued, available for review
  - *Not yet reviewed by NRC*
- Formalized Startup Test Program in place
  - Qualify technology developed before Waste Acceptance Process
  - Demonstrate ability to control product
  - Program driven by specification on product consistency
  - *Qualification Runs not yet reviewed by NRC*

Role of DWPF Joint Test Group

- Participants represent all organizations involved in startup
  - DOE-SR
  - Startup
  - Operations
  - Technical
  - Works Engineering
  - Design
  - QA
  - SRL
- Reviews Waste Acceptance Test Plans: consistent with WCP?
- Reviews Test Procedures: were Test Plan requirements accurately translated into objectives, acceptance criteria, test methods, ...?
- Reviews Test Results: were Test Procedure acceptance criteria met?

NRC Involvement

- Entire test program (and thus startup) at extreme risk until specifications, and testing and compliance plans, are reviewed and accepted
  - Must be done before start of qualification runs in DWPF

- Risks:
  - By NUREG-3003 (Draft), NRC will review Waste Acceptance documents
  - This review could identify need for additional testing, which would mean delay (and extra costs) unless accomplished soon
  - Delay entails possible violation of Federal Facilities Compliance Agreement at SRS (startup by 12/93)

- Possible NRC review methods
  - Observer on TRG
  - Observer on JTG
  - Separate reviews
  - DWPF wants to facilitate review, but decisions are needed on method soon to avoid program delays

Proposed Document Review Sequence

- WAPS: likely to be all that is needed at time of LA? *Immediately*
- WCP: activities described sufficient to satisfy WAPS? *10/91*
  - — Glass Sampling Program
  - — Canister Disposition Plan
- Glass Product Control Program: controls adequate to achieve consistently acceptable product? *1/92*
- Test plans with Waste Acceptance implications: if successful, will the tests meet the goals of the WCP? *2/92*
- Currently completed WQR sections: were WAPS requirements met?
  - — Projections of chemical composition
  - — Projections of radionuclide inventory
  - — Projections of radiogenic properties
- Results of Startup Test Program (in WQR): were tests successful? *When available*

Conclusions

- NRC will review Waste Acceptance documents
- None of the DWPF's Waste Acceptance documents have been reviewed by NRC
- DWPF needs to resolve question of NRC review very rapidly
  — DWPF will do all it can to facilitate NRC reviews

SAVANNAH RIVER SITE

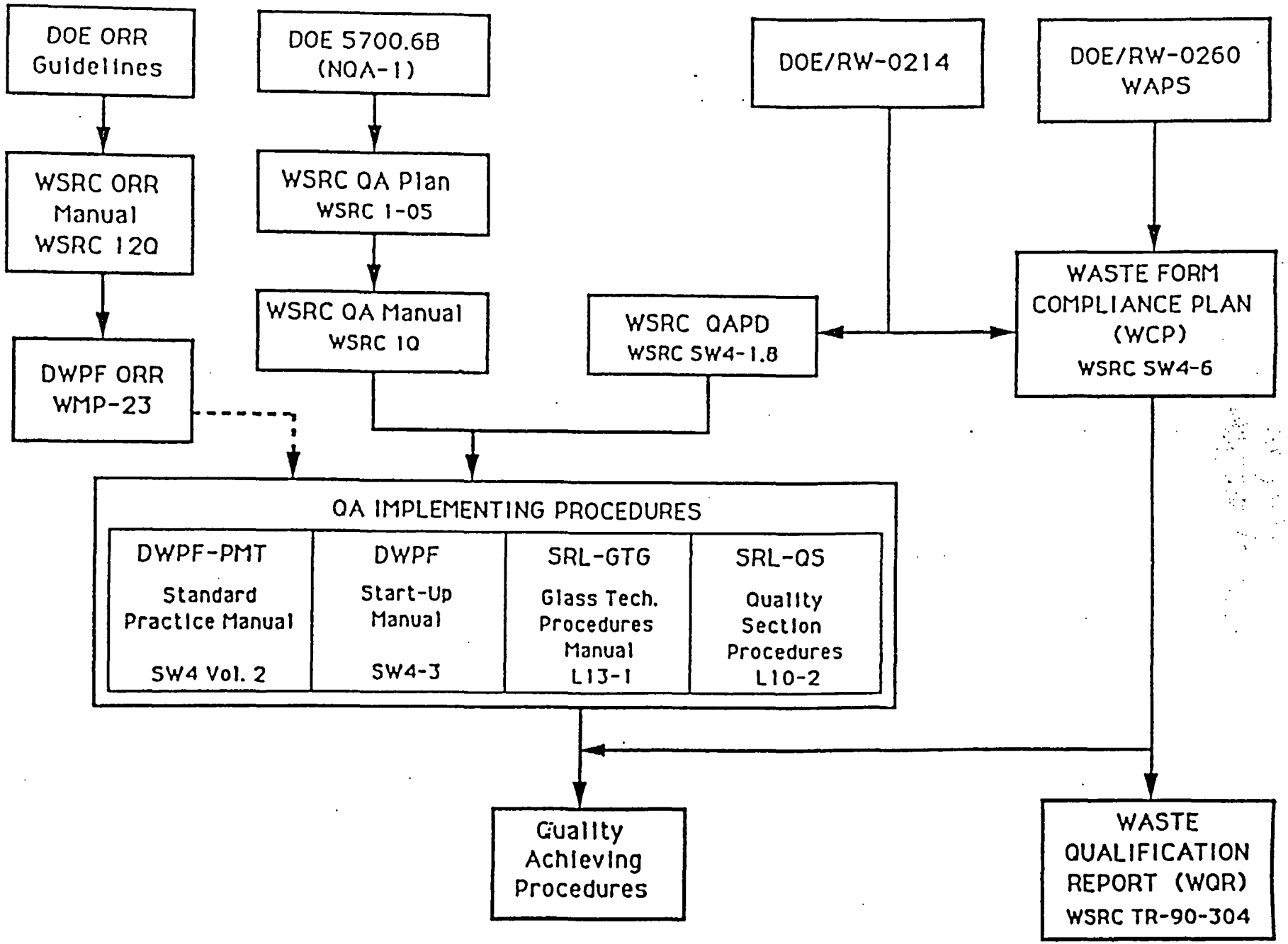
QUALITY ASSURANCE PROGRAM

FOR

HIGH LEVEL WASTE PROCESSING

David Fenstermacher
August 7, 1991

WASTE FORM PRODUCER QA PROGRAM DOCUMENTS



DWPF QUALITY ASSURANCE PROGRAMS

WSRC QUALITY ASSURANCE MANUAL

The WSRC Quality Assurance Manual (1Q) provides a description of the requirements, responsibilities and controls necessary for systematic implementation of the Quality Assurance program requirements specified in DOE Order 5700.6B, and the WSRC Quality Assurance Plan, WSRC 1-05.

The WSRC 1Q Manual is responsive to both the Basic and Supplementary requirements of NQA-1.

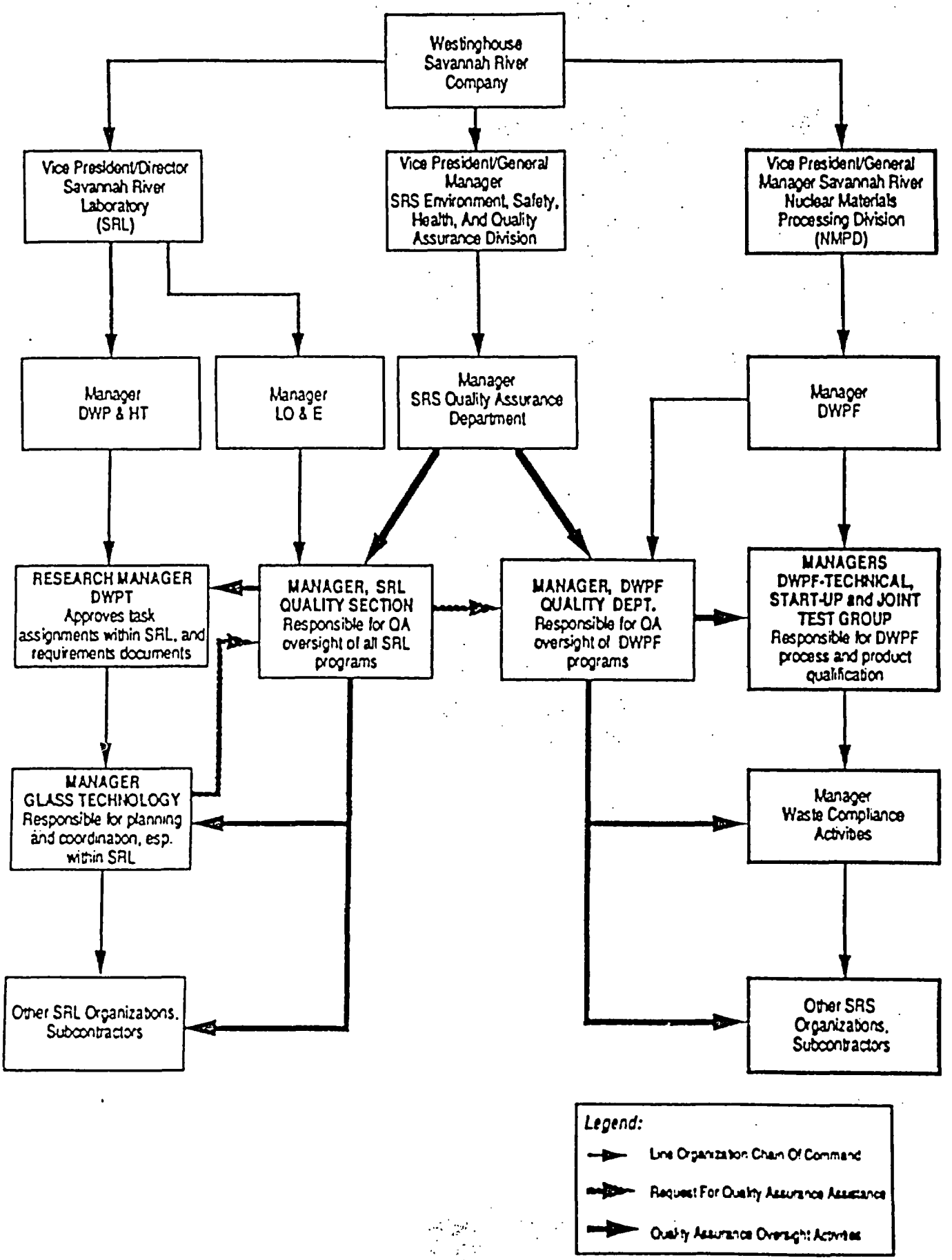
This program establishes the minimum quality assurance requirements for all Site activities.

QAPD FOR DWPF PRODUCT QUALIFICATION

The DWPF Quality Assurance Program Description (SW4-1.8) updates the WSRC Site Quality Assurance Program to meet the amplified requirements of RW-0214.

The High Level Waste Quality Assurance Program is selectively applied in accordance with the provisions of RW-0214.

SRS QUALITY ASSURANCE PROGRAM ORGANIZATION



QUALITY ASSURANCE OVERSIGHT RESPONSIBILITIES

- SRL Quality Section and DWPF Quality Department Identified as the Cognizant Area Function (CQF)
  - Oversee and Monitor the Quality Assurance Program
  - Assess the adequacy and effectiveness of the Quality Assurance Program.
  - Review and approve the task plans and procedures which implement the Program.
  - Review and approve the WCP, WQR, and the Glass Product Control Description.
  - Review and concur with technical specifications for procurements.
- WSRC Site Quality Departments (ESH&QA)
  - Perform the internal and external audits for DWPF.
  - Prepare, implement, and maintain the WSRC supplier evaluation and oversight program.
  - Implements the centralized auditor, surveillance, and inspector training and certification programs.
  - Performs material receipt inspections.

QUALITY ASSURANCE REQUIREMENTS FOR DWPF PRODUCT QUALIFICATION

PER THE WAPS, THE DOE/RW-0214 QUALITY ASSURANCE PROGRAM:-

"SHALL BE APPLIED TO ALL TESTING AND ANALYSIS ACTIVITIES THAT PROVIDE INFORMATION TO BE INCLUDED IN THE WQR."

THESE ACTIVITIES ARE CONDUCTED BY THE FOLLOWING ORGANIZATIONS:-

- SRL-GTG ---- Activities are conducted by appropriately trained and qualified personnel in accordance with approved task plans.

- DWPF Start-up ---- The DWPF start up program is based on the programs used in the nuclear power industry. Start-up tests are performed in accordance with detailed procedures developed by certified test engineers. The performance of the qualification tests are overseen by the test engineers.

- DWPF Analytical ---- Laboratory personnel are trained and qualified in accordance with a performance based training programs which meet the DOE Order for Training Accreditation Programs (TAP). This training includes class-room instruction, on-the-job exercises, and examinations.

  Note:- Analyses performed by Other SRS Laboratories, which may perform analyses in support of the DWPF program, will adopt and implement the DWPF program as required.

- Testing by suppliers ---- The appropriate DOE/RW-0214 requirements for the selection, training, and qualification of test personnel has been imposed on suppliers of essential materials.

- QA Oversight ---- The cognizant quality functions are staffed with sufficient numbers of Quality Assurance Engineers and Level II inspectors to perform in-process surveillances and to provide review and acceptance of HLW items and documents.

QA PROGRAM STATUS

- SRL (GTG&QS)

  PROGRAMS ARE IN PLACE AND IMPLEMENTED TO RW-0214.

  REVIEW BY DOE-HLWD NOW IN PROGRESS.

- DWPF

  IT IS ESTIMATED THAT PROGRAM IS NOW 90% IN PLACE. COMMITTED TO BE IN PLACE BY END OF OCTOBER 1991.

  ASSESSMENTS NOW IN PROGRESS BY DWPF QUALITY DEPARTMENT. DUE TO BE COMPLETED BY 9/30/91.

  PRELIMINARY REVIEW BY DOE-HLWD NOW IN PROGRESS.

STARTUP TEST PROGRAM: GLASS CHARACTERIZATION

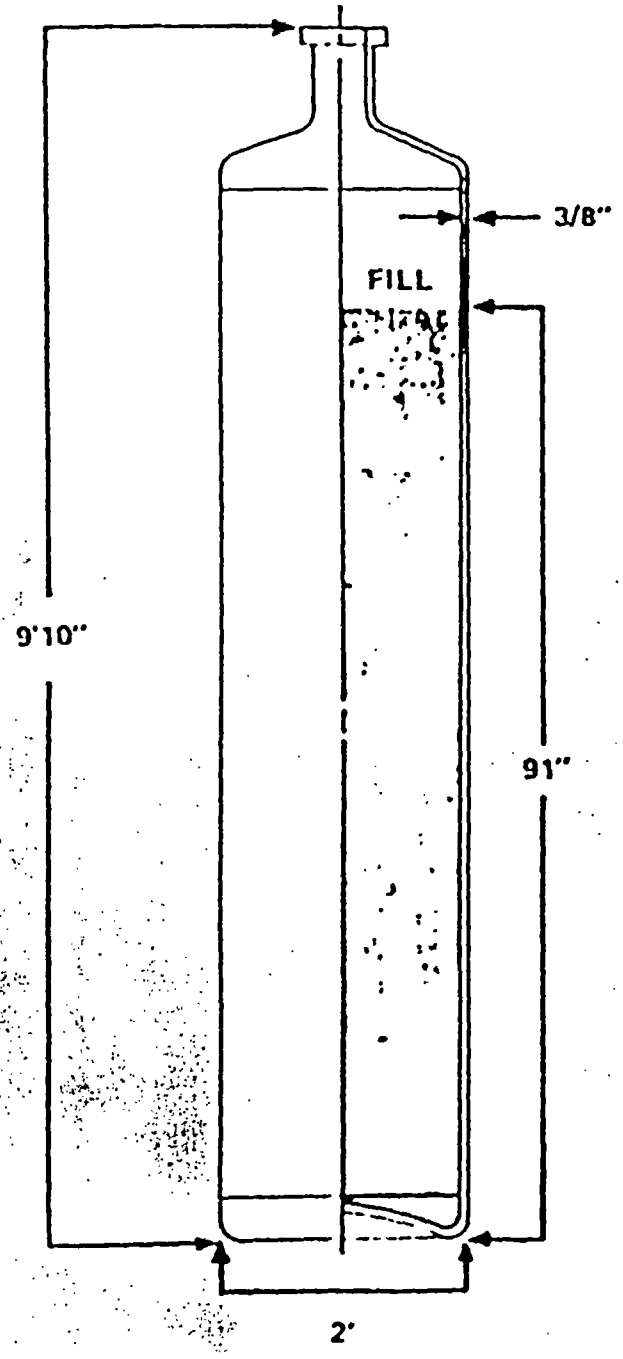
Carol M. Jantzen

Westinghouse Savannah River Company
Savannah River Laboratory
Aiken, SC 29803

SAFETY • RESPONSIBILITY • SECURITY
SRS
SAVANNAH RIVER SITE

OBJECTIVES

- o Provide statistical basis for sampling frequency for radioactive operation
  - Verification of DWPF process/product models
  - Verification of melter behavior as a Continuously Stirred Tank Reactor (CSTR)
  - Verification of glass sampler "sample" as representative of canister contents
  - Examination of homogeneity of canister contents
  - Determination of crystal content in canister



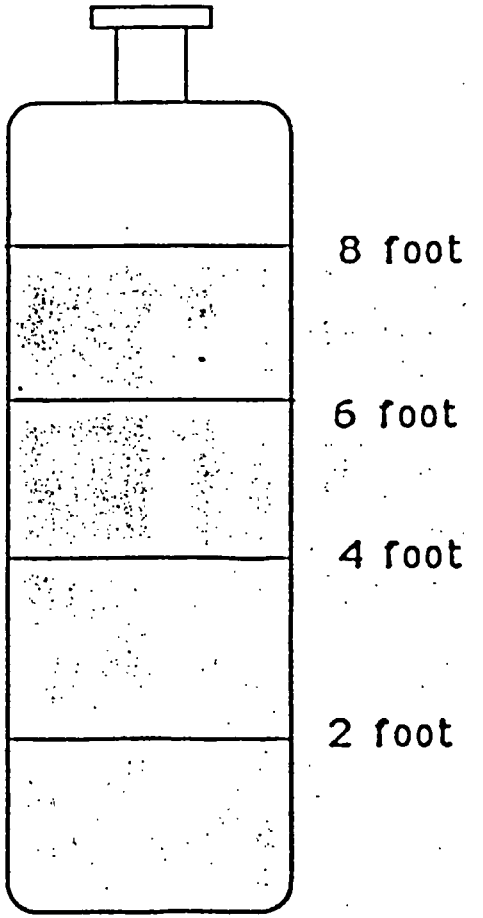
FILLED CANISTER

MATERIAL:	304L STAINLESS STEEL
EMPTY WEIGHT:	1100 LB
NET WEIGHT:	3710 LB
WEIGHT OF RADIONUCLIDES:	94 LB
ACTIVITY:	234,000 Ci
DECAY HEAT:	692 W
RADIATION FIELD (AT SURFACE):	6,500 rad/hr
SURFACE CONTAMINATION:	LESS THAN 10^{-4} $\mu Ci/cm^2$

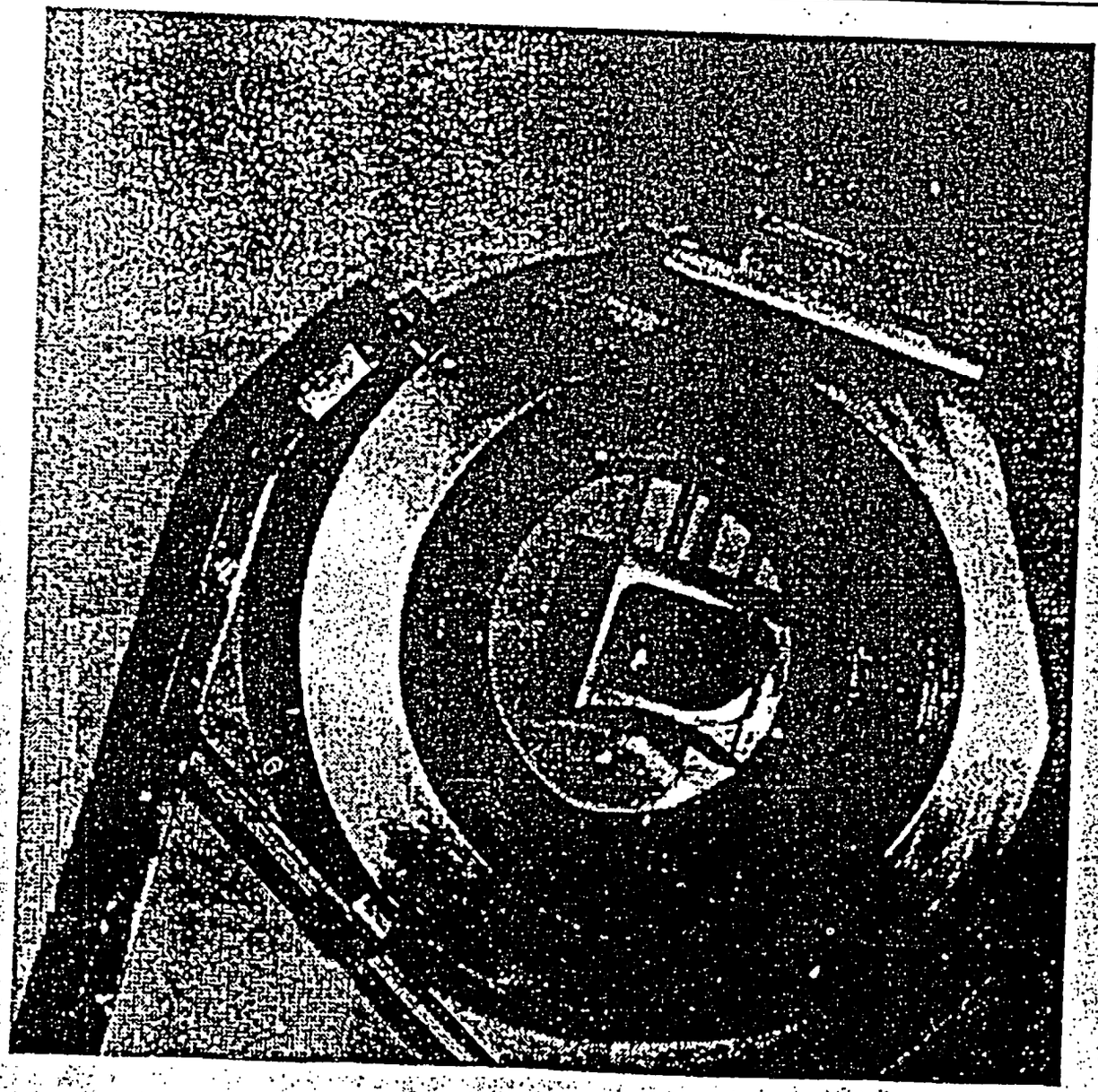
CANISTER SAMPLING TECHNIQUES

CANISTERS WITH
WALLS REMOVED

CANISTERS
SECTIONED



DWPF Glass Sampler



CANISTER SAMPLING PLAN

DWPF "COLD CHEMICAL RUNS"	CANISTERS SECTIONED	CANISTERS WITH WALLS REMOVED	GLASS SAMPLER
INITIAL CONDITIONS	3	3	24
DOPED RUN	6	14	20
LOW VISCOSITY	7	13	21
HIGH VISCOSITY	7	13	21
BLEND 1 FEED WITH Hg (return to baseline)	7	13	20
	30	56	106

Total canisters opened = 86

Total canisters sampled = 106

ANALYTIC TECHNIQUES

- o Product Consistency Test (PCT)
- o Whole element chemistry
- o Redox
- o X-ray Diffraction
- o Magnetic Susceptibility
- o Scanning Electron Microscopy

SCHEMATIC OF THE PRODUCT CONSISTENCY TEST

7 day

90 C

Filter

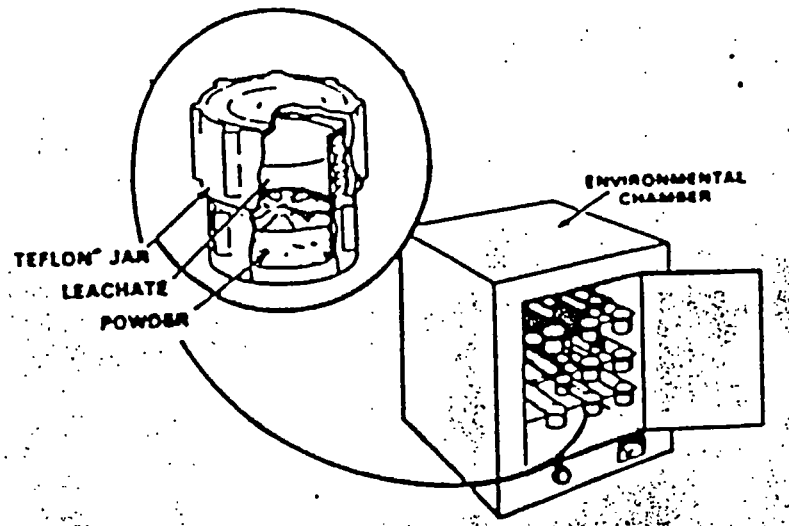
0.11 mm

mL soln/g solid = 10

static

analyze pH and concentration

standard glass as control



OBJECTIVES

- o Provide statistical basis for sampling frequency for radioactive operation
  - Verification of DWPF process/product models
  - Verification of melter behavior as a Continuously Stirred Tank Reactor (CSTR)
  - Verification of glass sampler "sample" as representative of canister contents
  - Examination of homogeneity of canister contents
  - Determination of crystal content in canister

ANALYTIC TECHNIQUES

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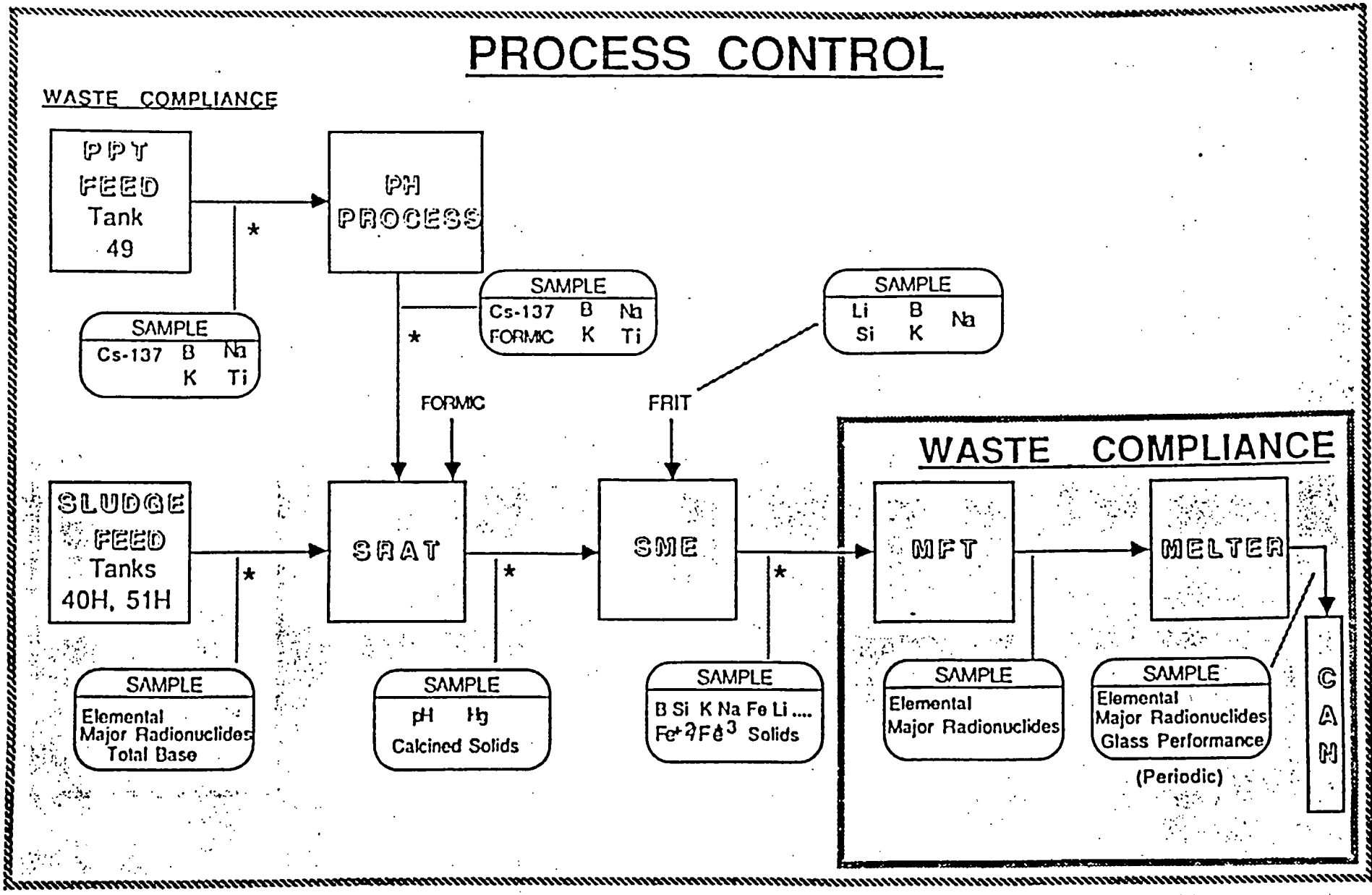
PROCESS CONTROL



* Process Control Point Prior to Making Batch Transfer

RESULTS

- Predictability of glass chemistry in the canister
- Predictability of glass redox in the canister
- Predictability of glass durability in the canister (calculated from glass composition and measured using the PCT)
- Comparison of the chemistry, redox, and durability of the canister glass to that of the sampler glass

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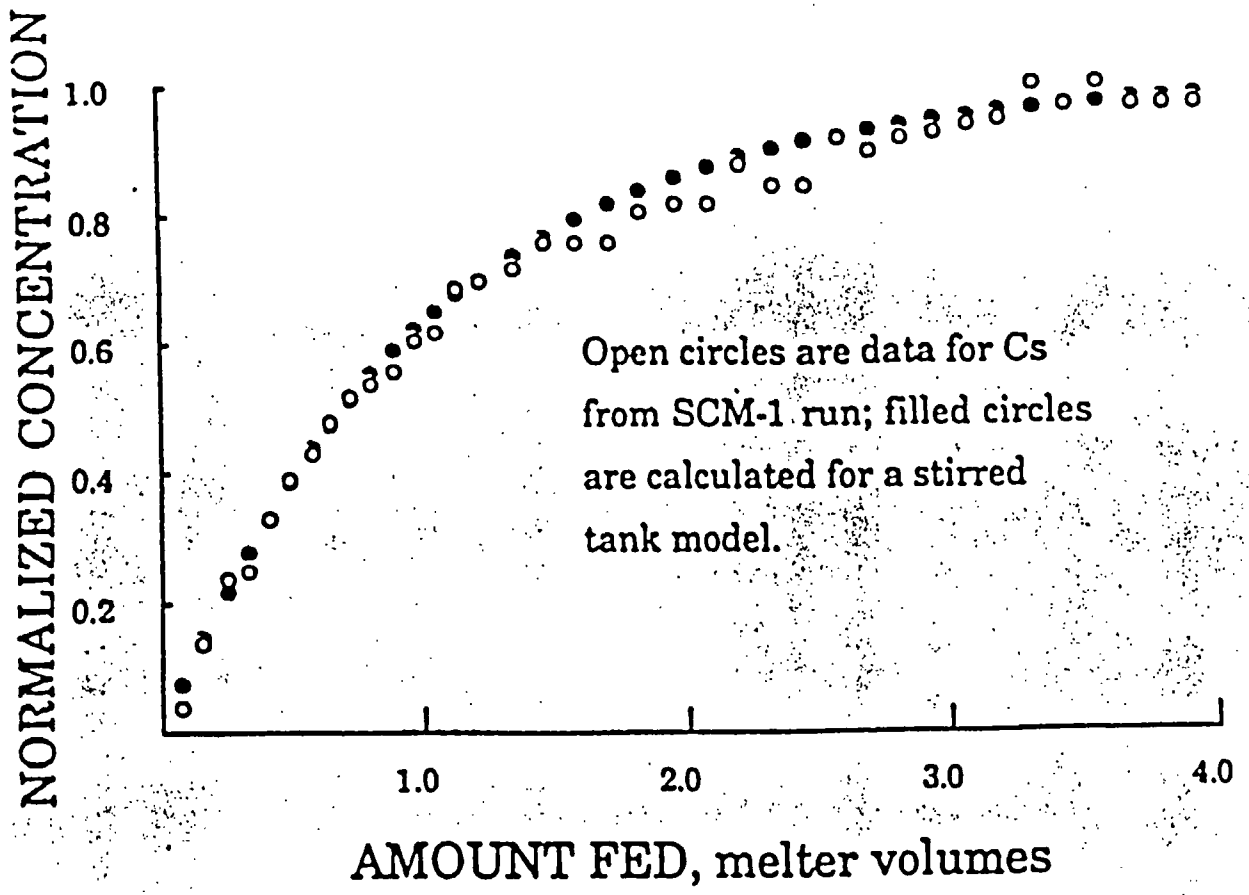
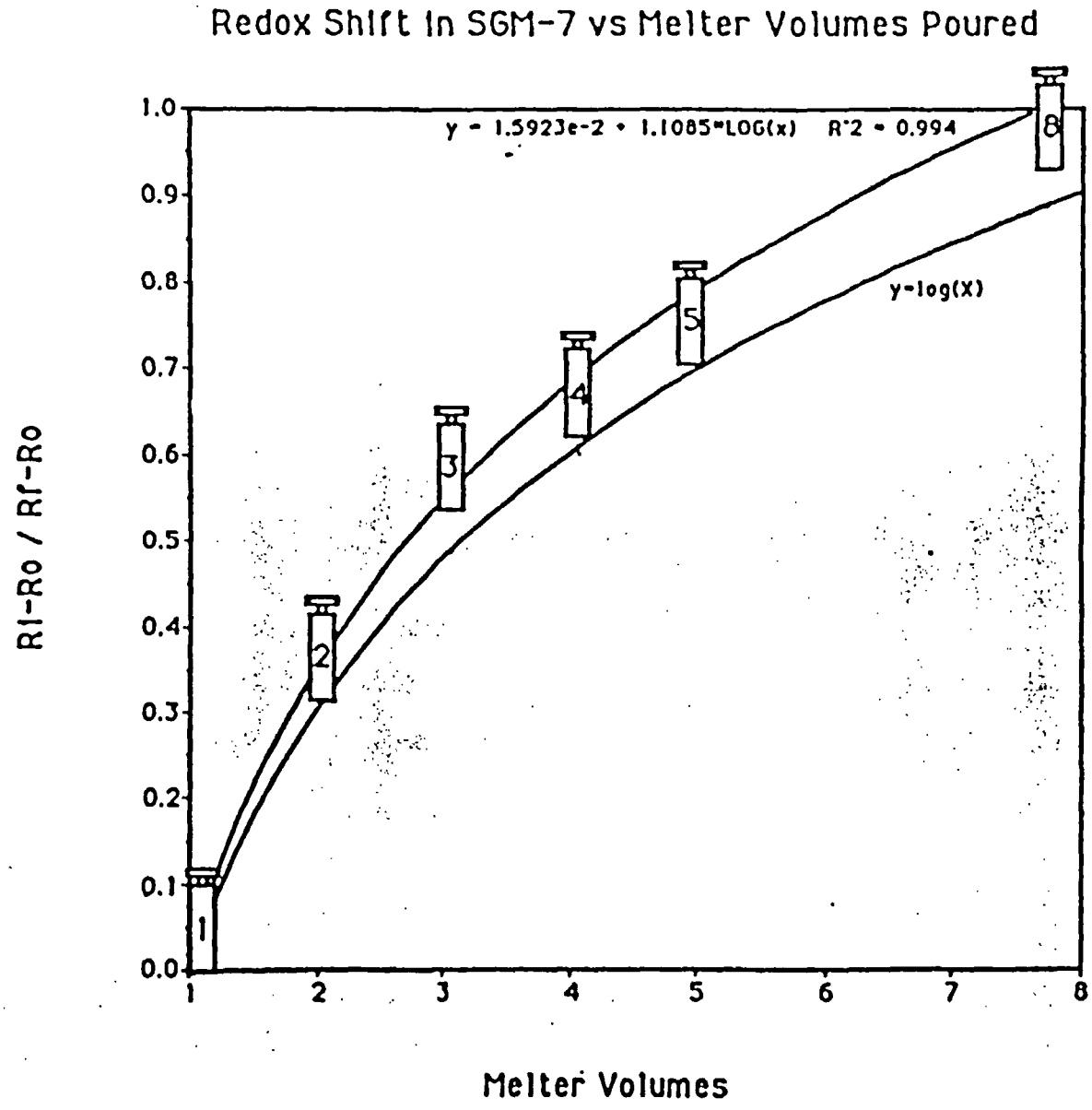
CHANGE IN GLASS COMPOSITION WITH CHANGE IN FEED




Redox Shift in SGM-7 vs Melter Volumes Poured
y = 1.5923e-2 + 1.1085*LOG(x) R^2 = 0.994
y=log(X)
Ri-Ro / Rf-Ro
Melter Volumes
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1
2
3
4
5
6
7
8

OBJECTIVES

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ANALYTIC TECHNIQUES

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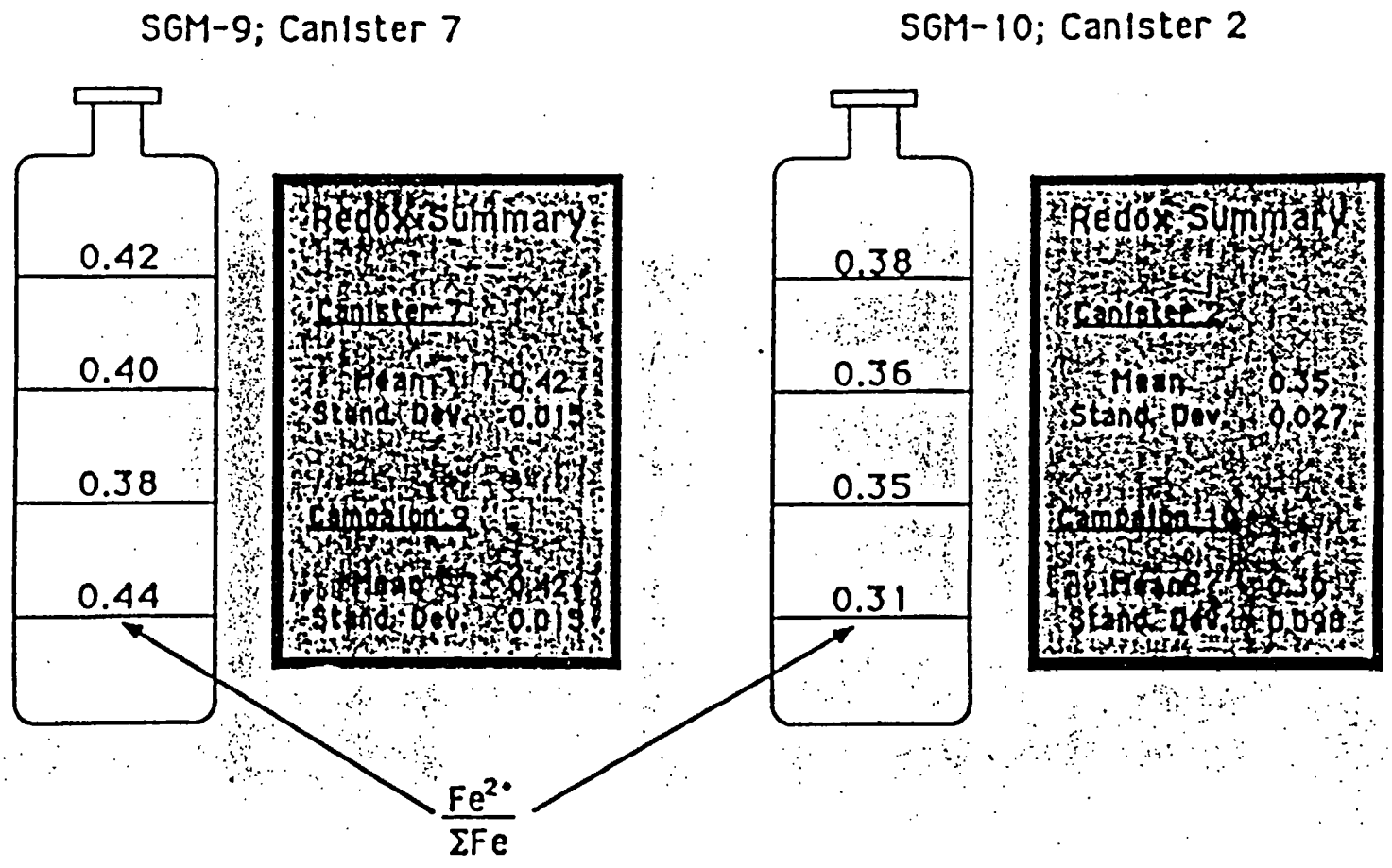
- o Scanning Electron Microscopy

RESULTS

- Compare measured composition of vitrified melter feed to measured composition of canister and sampler glass
- Compare durability predicted from glass composition to Product Consistency Test results for canister and sampler glass

In-Can Iron Redox Variation During Scale Glass Melter Campaigns 9 and 10



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ANALYTIC TECHNIQUES

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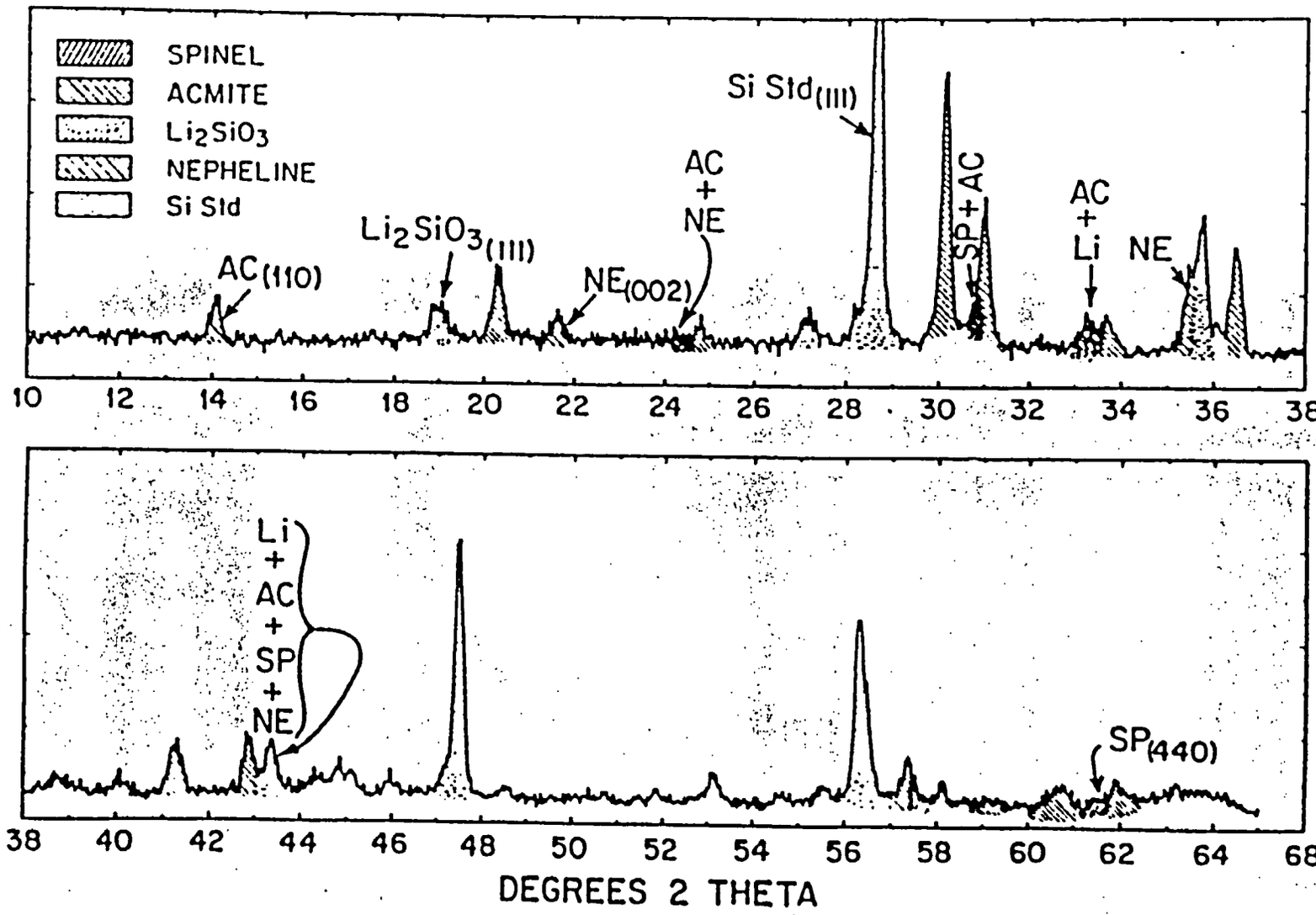
X-RAY DIFFRACTION SPECTRA OF A DEVITRIFIED GLASS



CONCLUSIONS

- Preparations have been made for glass characterization during qualification runs
- Extensive glass characterization will provide the statistical basis for determining the sampling frequency during radioactive operation