89000990

FEB 13 1990

Mr. Ralph Stein
Associate Director for Systems Integration
and Regulations
Office of Civilian Radioactive Waste Management
U.S. Department of Energy RW-24
Washington, D.C. 20545

Dear Mr. Stein:

SUBJECT: TRIP REPORT FROM THE OCTOBER 31 AND NOVEMBER 1, 1989 U.S. NUCLEAR REGULATORY COMMISSION VISIT TO THE WEST VALLEY DEMONSTRATION PROJECT

Enclosed for your information is a trip report from the October 31 and November 1, 1989 U.S. Nuclear Regulatory Commission (NRC) staff visit to the West Valley Demonstration Project (WVDP) operated by the U.S. Department of Energy (DOE).

In summary, the NRC staff found the visit to be helpful in understanding the glass production program at WVDP. The staff also believes that WVDP's work on obtaining an outside review of its planned glass-making activities will be beneficial to DOE's overall program. Moreover, WVDP may want to consider soliciting additional input from those in industry with experience in commercial glass making. Such input might be advantageous in providing WVDP with the advice it seeks concerning the adequacy of certain technical aspects of its glass-making program.

However, as a result of this visit, the staff has three major comments it believes DOE should consider. The first major comment concerns the WVDP Product/Process Control Program. While the staff believes that a well-developed process control program can provide a good measure of confidence in the quality of products resulting from WVDP radioactive glass-making operations, DOE should consider conducting some tests (e.g., leach tests) on archived glass samples of production glass retrieved from the pour canisters. It is believed that such tests would verify the quality of the glass actually produced and provide confidence in related performance measurements of the glass waste form in the context of the overall waste package container and anticipated repository conditions.

The second major staff comment addresses the lack of plans for dealing with any production glass that is "out-of-specification" with the Waste Acceptance Preliminary Specification (WAPS). At present, WVDP has no plans to develop the capability to rework or reprocess production glass that is found to be "out-of-specification" with WAPS. The staff suggests that before taking a final position on the need not to have such a capability, that DOE should have a strategy with respect to how it will deal with such glass.

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The third major staff comment focuses on the linkage of the WVDP glass and the MCC-1 leach test in WAPS to the post-containment performance allocation in the SCP. Based on the presentations of the waste form research currently sponsored by DOE, WVDP did not indicate how their MCC-1 test for "durable glass" complies with the SCP's post-containment performance allocation. Furthermore, the staff understands that both WVDP and DOE/Office of Civilian Radioactive Waste Management (OCRWM) recognize that this linkage has yet to be established. With this linkage undefined, it is not clear what basis would exist for asserting that WVDP's proposed glass composition is adequate. DOE needs to establish a specification that will link the performance of the glass to the allocation defined in the SCP.

A fourth area addressed by WVDP during the briefings and identified by the staff as an area of concern at the bi-monthly quality assurance (QA) meetings, is the lack of a fully developed and implemented QA program for both DOE glass producers: the WVDP and the Defense Waste Production Facility (DWPF). The staff is concerned that DOE has not sufficiently developed and implemented the QA programs for the glass producers and submitted that information for NRC review. For example, the NRC staff transmitted comments to DOE on OGR/B-14, entitled "Quality Assurance Requirements for High-Level Waste Form Production," on February 7, 1989. DOE has not responded to these comments, to date. However, at the September 9, 1989 bi-monthly QA meeting, DOE indicated that the QA requirements for waste form production would be incorporated into the OCRWM Quality Assurance Requirements (QAR) document. NRC comments would be addressed in a QAR revision, and OGR/B-14 would be superseded.

During the September 9, 1989 bi-monthly QA meeting, DOE noted that the schedule for submitting the QAR revision to NRC for review was November 1, 1989. DOE also stated that milestones and schedules for the qualification of one of the glass producer programs would be provided. At the December 13, 1989 bi-monthly QA meeting, the NRC staff proposed a set of milestones that could be used to accept the glass producers QA program. At the meeting, DOE committed to reviewing the staff's proposal and providing comments no later than the next bi-monthly QA meeting scheduled for February 1990.

As of February 9, 1990, the NRC staff has received neither the QAR revision nor the Quality Assurance Program Descriptions for both the WVDP and the DWPF. Although the glass producers have been performing work under a QA program, the programs have neither been accepted by DOE OCRWM nor reviewed by the staff. Without having an accepted QA program in place, DOE OCRWM may be unable to ensure that those activities that need to be conducted under a 10 CFR Part 60, Subpart G QA program are properly controlled.

The final staff comment covers one topic which was not addressed during the visit. It concerns DOE's demonstration of compliance with the requirements of the Resource Conservation and Recovery Act (RCRA).

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In this regard, DOE did not indicate how its glass-making programs would address the applicability of or its compliance with the requirements of RCRA. However, as a result of the December 14, 1989 letter from DOE, we understand that DOE is working with the the U.S. Environmental Protection Agency, the agency responsible for enforcing RCRA, to determine what course of action might be necessary to ensure that the pertinent requirements of RCRA receive consideration during the development of all aspects of the repository program. We would appreciate being kept informed of the status of this effort.

In closing, the NRC staff found this particular forum to be a very effective means for gaining insight into DOE's glass producer program under the WAP. Moreover, we would appreciate an opportunity to continue the dialogue with DOE as a means of understanding its WAP for the vitrification of high-level radioactive wastes. As an example, the staff was interested to learn that DOE had been tracking developments in foreign glass-making programs; consequently, the staff intends to accept a DOE invitation to be briefed on these activities.

If you have any questions or desire additional clarification regarding this correspondence, please contact Michael P. Lee of my staff. Mr. Lee can be reached at FTS 492-0421.

Sincerely,

ORIGINAL SIGNED BY

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

Enclosure: As stated in the binder

cc: R. Loux, State of Nevada
M. Baughman, Lincoln County, NV
S. Bradhurst, Nye County, NV
D. Bechtel, Clark County, NV
C. Gertz, DOE/Nevada
K. Turner, GAO

DISTRIBUTION AND CONCURRENCE: See Next Page

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Mr. Ralph Stein

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Enclosure

SUMMARY OF STAFF COMMENTS OF THE SF-12 VITRIFICATION RUN AT THE WEST VALLEY DEMONSTRATION PROJECT

On October 31 and November 1, 1989, members of the staff from the U.S. Nuclear Regulatory Commission (NRC) met with representatives of the the U.S. Department of Energy (DOE). The meeting was arranged by the staff of the West Valley Demonstration Project (WVDP) so that it could provide a briefing on its plans and schedules for conducting high-level waste (HLW) glass production to those DOE organizations also involved in HLW glass production. The staff attended at the invitation of DOE's Office of Civilian Radioactive Waste Management (OCRWM). The principal focus of the briefing was a demonstration of the final full-scale qualification run (designated "SF-12") of the vitrification testing program prior to preparation of the WVDP facility for radioactive glass production. Such operations are currently scheduled to commence in October 1993.

A list of attendees at this demonstration is given in attachment 1. No representatives from the State of Nevada or the affected units of local governments attended.

The briefings were conducted by both DOE and DOE's on-site contractor, West Valley Nuclear Services (WVNS). Following a general briefing on the HLW vitrification technology being used at WVDP, the attendees were briefed on WVDP's strategy for producing glass that complies with DOE's Waste Acceptance Preliminary Specification (WAPS). Based on the briefings and demonstrations, the staff understood the essential elements of this strategy to include the following:

- The definition of an acceptable envelope of glass compositions to meet the pertinent requirements in WAPS.
- The development of a Product/Process Control Program sufficient to meet the desired range of target glass compositions.
- Reliance on a qualification testing program and integrated test-runs in order to certify the WVDP program prior to the commencement of full-scale operations.
- The proper development and implementation of an NRC-approved quality assurance program.

Attachment 2 contains copies of the presentations that were made on these aspects of the WVDP program.

In addition to the briefings, the staff participated in two tours of the WVDP facility; one which was general in nature and the other a more detailed tour involving a demonstration of the slurry-fed ceramic melter facility.

During the meeting, DOE and the WVNS contractor asked the attendees for feedback on the briefings and demonstration test run. They requested that specific concerns be documented by the audience in order to focus the forthcoming technical discussions. It was understood, though, that NRC staff were in attendance at these sessions only as "observers" and, as such, would not participate in the drafting of any meeting notes nor would the staff concur in them. However, it was understood that the staff would be preparing a trip report which would document the staff's comments regarding the SF-12 briefings and demonstrations.

Based upon the SF-12 briefings and demonstrations, the staff understood the WVDP presentations to be focused to make the case that, based on the research sponsored by DOE (principally at the Catholic University of America -- CUA), there was a solid technical basis for the glass design (composition) selected by WVDP based on durability; and that through its full-scale demonstrations with simulated waste, WVDP could demonstrate that by controlling the composition of the glass melt, they could assure the quality of the production glass without the need to test the product.

Given this premise, the WVDP staff indicated that the current plan is to rely on "process control" of the feed composition and melter temperature as indicators of glass quality. The WVDP staff noted that this approach, which relies upon previous operational experience, is one which has been used with great success by the commercial glass industry. The WVDP staff went on to state that because of this approach, there were no plans to have the capability to test production glass (in a hot cell), either with respect to its properties or composition.

Based on the information presented at the briefings, the staff had two general comments about DOE's proposed approach to the production control of glass composition. The first is that the WVDP briefings did not demonstrate that a credible linkage between the verified performance of glass with simulated waste and production glass with actual waste has been established. Consequently, it was not clear if WVDP's process control strategy alone is a sufficient indicator of glass quality and performance. The staff believes that, until the need is demonstrated to the contrary, WVDP develop plans for a testing program to confirm the expected performance of its production glass.

With regard to the staff's second general comment on WVDP production control, the staff queried the WVDP staff about how production glass that was found to be "out-of-specification" with WAPS would be handled. The WVDP staff stated that it had no plans to develop the capability to rework or reprocess any "out-of-specification" glass. This question was raised by the staff owing to its interest in understanding what plans DOE might have relative to the repository to treat such wastes.

In a related matter, the staff noted that WVDP intends to archive samples of production glass from each pour canister; however, the WVDP staff indicated that there were no plans to perform quantitative tests on the samples. The staff suggested that it would be desirable for WVDP to perform such tests, as previously noted, as an independent means of verifying the results of its Product/Process Control Program and expected performance. This would also add confidence to any waste package related performance assessments.

The third staff concern focused on the correlation of the performance allocation for glass in the Site Characterization Plan (SCP) with the WAPS. One of the stated objectives of the SF-12 briefings and demonstrations was to seek a consensus that high quality, durable glass would be produced at WVDP. In order to reach that consensus, the staff would expect DOE to demonstrate what linkage exists between the post-containment performance allocation for glass in the SCP and the radionuclide release rate specification for glass defined in the WAPS.

Based upon the SF-12 briefings and demonstrations, the staff understands that both WVDP and DOE/OCRWM recognize that a correlation of both the WVDP glass design and the MCC-1 leach test in WAPS to the post-containment performance allocation for glass in the SCP has not yet been made. This observation was reinforced in so far that while it was stated that the MCC-1 test was a measure of durability, there was no attempt to demonstrate that this test would meet the performance allocation stated in the SCP. Moreover, in presenting the case regarding CUA's design for "durable" glass, the presentations did not attempt to show that the CUA design would meet the SCP's post-containment performance allocation for glass. Before WVDP can take credit for producing an acceptable glass, the staff believes that necessary correlation between the performance allocation for glass in the SCP and the WAPS must be demonstrated.

Through the course of the briefings, the staff also queried DOE on its understanding of the foreign experience in radioactive glass making and how that understanding was presently being applied to DOE's glass-making operations. A DOE contractor indicated that DOE had been tracking foreign developments in this area for a number of years and that a knowledge of this experience was presently being applied to WAP, to the extent practical. Moreover, the contractor offered to brief the staff on DOE's assessment of foreign experience in the area of vitrified waste production and how it was being applied by DOE to the WAP.

Additional detailed staff comments are listed in attachment 3.

Attachment 1

ATTENDEES AT THE OCTOBER 31 AND NOVEMBER 1, 1989 SF-12 VITRIFICATION RUN AT THE WEST VALLEY DEMONSTRATION PROJECT

DOE
E. Rengier
D. Shellor*
C. Macaluso*
J. Hale
W. Stringfield
W. Wrzensinski
C. Conner*
T. Gutmann*
P. LaMout
T. McIntosh
C. Enos#
S. Volger (Argonne Nat. Lab.)
D. Eggett (Pacific Northwest Lab.)
B. Pulsipher (Pacific Northwest Lab.)
D. McIntosh (DWPF)
W. Bixby (WVDP)
T. Rowland (WVDP)
P. Allen (DWPF)
A. Spooner (Weston)
M. Plodinec (DWPF)*
D. Lege' (BDM Corp.)
K. Hall (DWPF)
P. Macedo (CUA)
E. Maestas (WVDP)
N. Chapman (DWPF)
W. Ross (Pacific Nat. Lab.)

NRC
J. Bunting
R. Weller
J. Swift*
D. Hurt*
J. Schiffgens
M. Lee
H. Manaktala (CNWRA)
B. Adams (Precision Analytical)

WVNS
C. McVay
D. Shugars
D. Dempster*
J. Buggy
J. Dempston
J. Pope
R. Palmer*
S. Barnes
K. Routt#
M. Henderson
P. Klanian#
O. Kruger#

NYSERDA@
F. Lorey
S. Harbison
A. Schneider (Georgia Tech.)

* Only attended on October 31, 1989.
\# Only attended on November 1, 1989.
@ New York State Energy Research and Development Administration

Attachment 2

DOE/WVNS PRESENTATIONS AT THE SF-12 VITRIFICATION RUN AT THE WEST VALLEY DEMONSTRATION PROJECT ON OCTOBER 31 AND NOVEMBER 1, 1989

TOPIC/PRESENTER

Final Agenda for October 31, 1989

Proposed Tour for SF-12 Review Meeting

Revised Agenda for November 1, 1989

WVDP Overview -- W. Bixby

SF-12 Meeting Objectives -- E. Maestas

WVDP Physical Plant -- J. Buggy

WVDP Process Technology and Testing -- J. Pope

WVDP Process Technology and Testing: Backup materials -- J. Pope

CUA/VSL Activities -- P. Macedo

Chemical Durability of Nuclear Waste Glasses -- P. Macedo

Melter Feed Composition Control -- W. Ross

WVDP Full-scale Testing Results -- S. Barnes

Waste Glass Product Control -- M. Plodinec

Slurry Feed Makeup -- K. Routt

WVDP Quality Assurance -- D. Shugars

Attachment 3

DETAILED STAFF COMMENTS OF THE SF-12 VITRIFICATION RUN AT THE WEST VALLEY DEMONSTRATION PROJECT

1. The staff would also like to comment on what appeared to be a lack of coordination between DOE/OCRWM and WVDP on certain aspects of the engineered barrier system (EBS) design. For example, the staff detected inconsistencies in several of the assumptions used to model waste form performance by the WVDP glass producers from those understood to be used by the DOE/OCRWM waste package material designers. Consequently, the staff are concerned that the decisions on glass waste form and materials selection could be made independently of each other and independently of the assumptions regarding the site-specific conditions at the repository considering anticipated processes and events. The following examples are cited to illustrate the point:

   a. In the discussions about the conditions expected at Yucca Mountain, the emphasis was on the expected "baseline" conditions at the repository. The staff did not detect a strong recognition that post-containment release rate performance under anticipated processes and events, which is required to be demonstrated by 10 CFR 60.113, is part of this baseline.

   b. To further emphasize this point, during the exchange between DOE and the audience regarding whether water could be present at in the near-field environment temperatures above boiling, it was apparent that the DOE's answer was valid for the assumption of matrix flow. However, as fracture flow is also likely to occur at Yucca Mountain, DOE needs to demonstrate that fracture flow scenarios have been recognized as part of their baseline.

   c. The NRC staff also understood DOE to say that, as a modeling assumption, all of the waste packages would isolate the glass for 1,000 years, and there was no need to address glass performance until after 1,000 years. The NRC staff believes this assumption is inconsistent with an earlier position taken by DOE's waste package designers in which they were understood to have said that some waste packages will be expected to fail earlier than 1,000 years.

Moreover, the staff also notes that the DOE waste package materials selection program is faced with somewhat of the same dilemma. However, based on the very limited technical interactions to date, the staff perceives an attempt by the DOE waste package designers to deal with the uncertainties in site parameters.

Accordingly, if the necessary site-specific data are not available to assess the performance of the various components of the EBS with respect to meeting the post-containment release rate requirement for the EBS, OCRWM may wish to consider conducting more generic tests that cover a wider range of repository environmental conditions before proceeding into glass production, and materials package design and selection. Absent site-specific data, we believe that such tests would aid the glass manufacturers in understanding what interactions might occur between the proposed waste form, the waste package, and the repository environment.

2. The staff would also like to express its concern for the possibility of an adverse interaction (e.g., galvanic coupling) between the glass waste form/pour canister product generated at WVDP and the waste package overpack material, which has yet to be selected. The staff believes that as part of its waste package design, that DOE consider how it will demonstrate that the pour canister/overpack product interaction does not pose an internal threat to containment.

3. The staff understood the WVDP staff to indicate that they only plan to test for 25 specific elements in the waste because these 25 elements account for the vast bulk of the total mass in the waste feed. On the other hand, the NRC staff understood that a 10% variation in each of the 25 elements tested is permissible. The NRC staff recommends that WVDP be prepared to demonstrate that given the resultant maximum permissible variation in total mass balance, that no untested elements could be present in sufficient quantities such that they could significantly alter the performance of the production glass.

4. The staff understood that the water content of commercial glass can vary as much as tenths of a percent and that this variation can influence glass performance (e.g., durability). As part of its analyses, the staff believes that DOE should understand how variations in the water content of the glass would ultimately influence glass performance and implement the necessary measures in its product/process control program to control such variations to desired levels.

WEST VALLEY DEMONSTRATION PROJECT

FINAL AGENDA FOR SF-12 VITRIFICATION RUN INFORMATION EXCHANGE

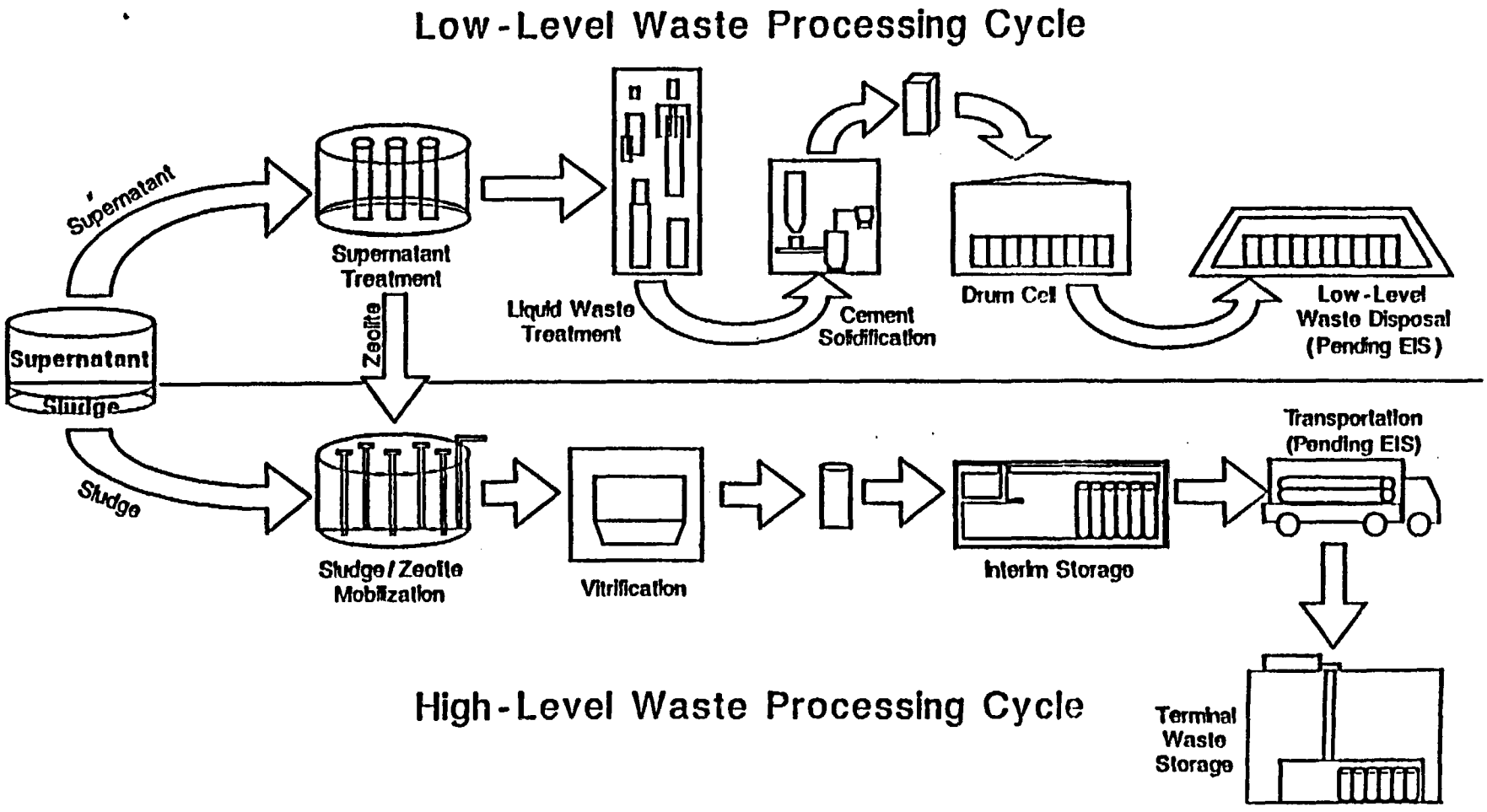
OCTOBER 31, 1989

Conference Room B & C

8:30 - 9:00	Welcome/Introduction Statement Of Meeting Objectives Agenda Of Activities	W. Bixby E. Maestas E. Maestas
9:00 - 9:30	HLW Processing	J. Buggy
9:30 - 10:15	Run Strategy To Meet WAPS: Good Feed, Correct Temperature, Good Glass - Future Verification Testing	J. Pope
10:15 - 10:30	Break	
10:30 - 11:00	Establishing Acceptable Target Glass	Catholic University of America
11:00 - 11:30	Simulated Waste And Glass Former Slurry Verification	Pacific Northwest Laboratories
11:30 - 12:00	Results From Testing To Support Compliance Strategy	S. Barnes
12:00 - 12:30	Product Control	Savannah River
12:30 - 1:15	Lunch On Site	
1:15 - 1:45	Work Control To NQA-1 & RW-0214	D. Shugars
1:45 - 3:30	Site Tour STS, Drum Cell, Vit, and Analytical Laboratory	E. Maestas J. Pope
3:30 - 4:00	Matrix Of Activities And Products For Working Group	J. Pope
4:00 - 4:30	Discussion	All

PROPOSED TOUR FOR SF-12 REVIEW MEETING

	Drum Cell (Garland)	STS (Valenti)	VIT (Barnes)	Lab (McVay)
Group 1: (Buggy)	1:45 - 2:05	2:10 - 2:30	2:35 - 2:55	3:00 - 3:25
Group 2: (Maestas)	3:00 - 3:25	1:45 - 2:05	2:10 - 2:30	2:35 - 2:55
Group 3: (Pope)	2:35 - 2:55	3:00 - 3:25	1:45 - 2:05	2:10 - 2:30



REVISED AGENDA FOR SF-12 VITRIFICATION WORKING GROUP

November 1, 1989

Conference Room B & C

8:30 - 9:00	Agenda Review/Plan for the day Summary of previous day	J. Pope
9:00 - 10:00	Product Meeting WAPS	P. Macedo
10:00 - 11:00	Process Control to yield acceptable product	K. Routt
11:00 - 11:30	Test Control	P. Klanian
11:30 - 12:00	Revisit Vit Facility (?)	S. Barnes
12:00 - 12:45	Lunch on site	
12:45 - 1:15	Working Group Assignment	All
1:15 - 3:30	Verification by Working Groups	
3:30 - Depart	Caucus/Summary of Observations	E. Maestas/ J. Pope/ All

Dr. W. W. Bixby
DOE Project Director

C2347WV001

WEST VALLEY HISTORY

1962	NFS Reached Agreement with AEC and New York State to Construct Reprocessing Plant
1966	Construction Completed
1966 - 1972	NFS in Operation ($\sim$ 640 Metric Tons of Spent Fuel Reprocessed)
1972	Plant Shut Down for Modifications
1973 - 1975	Received Spent Fuel in Preparation for Resuming Production

C6225WV001

WEST VALLEY HISTORY (CONTINUED)

1976	NFS Decided to Withdraw From Reprocessing Business and Turn Over Responsibility to New York State
1978	DOE Study Resulted in Allocation of Responsibilities Between New York State and DOE
1980	Congress Authorized DOE to Carry Out High-Level Nuclear Waste Management Demonstration
1981	Westinghouse Selected as Operating Contractor of West Valley Demonstration Project
Feb. 25, 1982	DOE and WVNS Assumed Operational Control of the Site

C6225WV002

THE WEST VALLEY DEMONSTRATION PROJECT

OBJECTIVE

Demonstrate Solidification and Preparation of High-Level Waste for Permanent Disposal

AUTHORITY

Public Law 96-368, West Valley Demonstration Project Act

SCOPE

Solidify Liquid High-Level Waste

Develop Containers

Transport to Federal Repository

Dispose of Low-Level and Transuranic Waste

Decontaminate and Decommission Facilities Used

C6225WV003

PHASE I

OBJECTIVE

Demonstrate Solidification and Preparation of High-Level Waste for Permanent Disposal

AUTHORITY

Public Law 96-368, West Valley Demonstration Project Act

SCOPE

Solidify Liquid High-Level Waste

Develop Containers

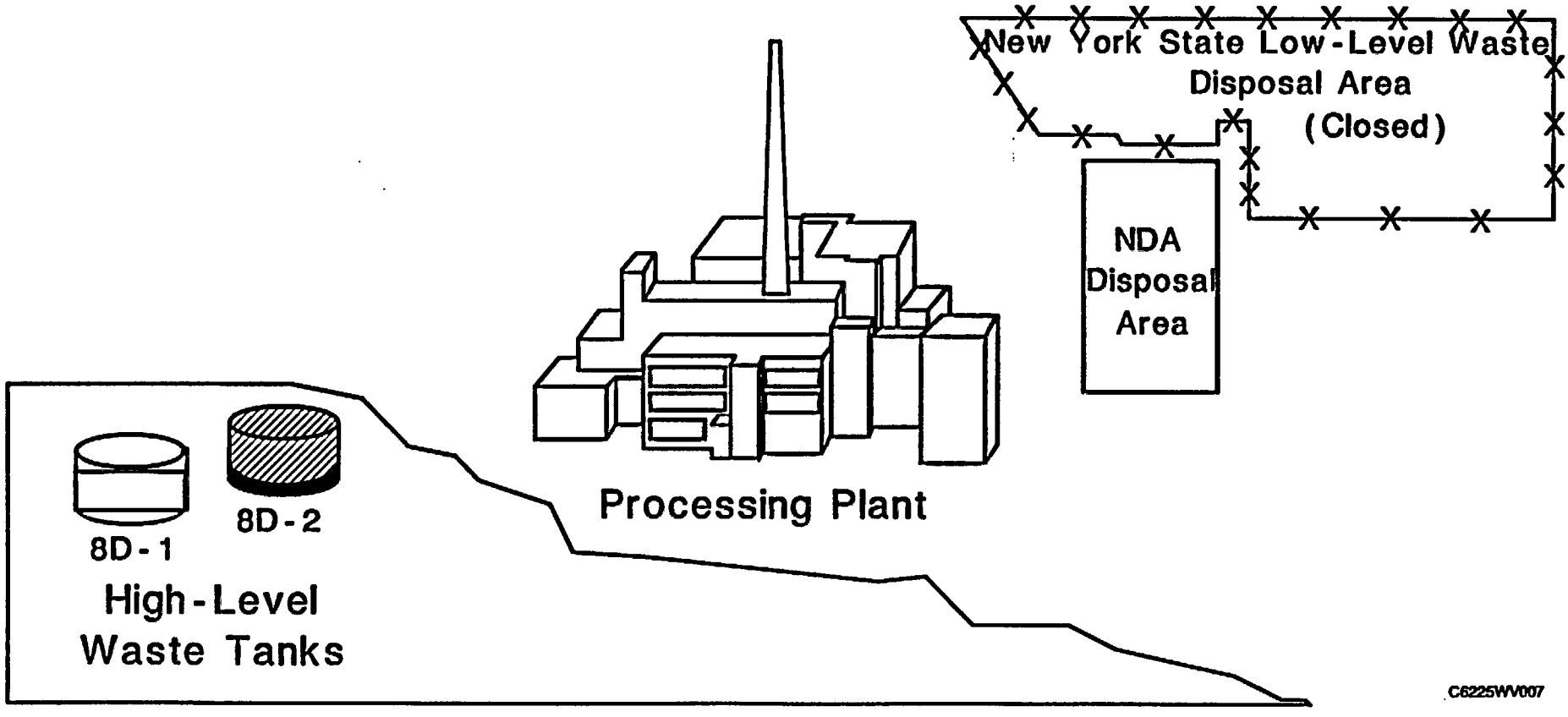
Transport to Federal Repository

Dispose of Low-Level and Transuranic Waste

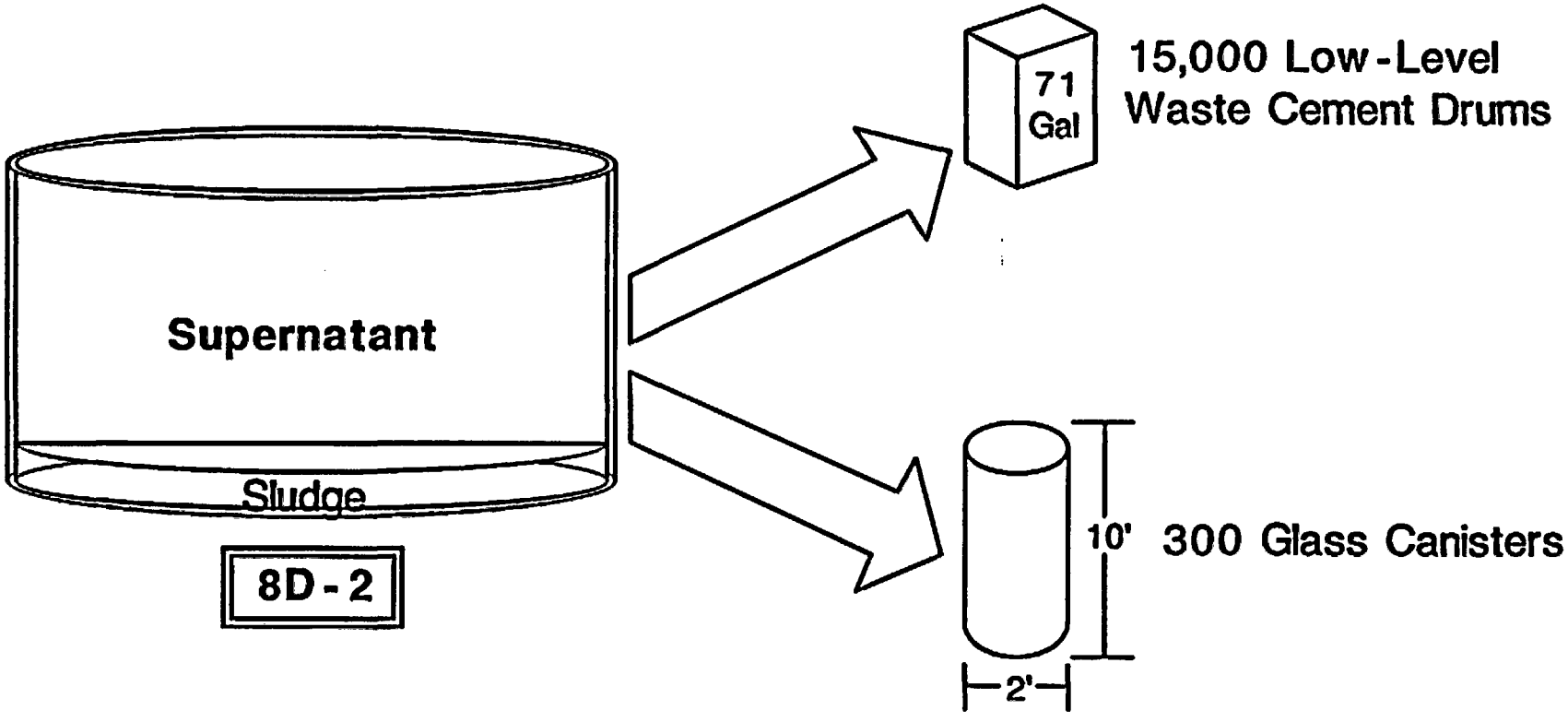
Decontaminate and Decommission Facilities Used (To Support Solidification)

C6225WV004

WESTERN NEW YORK NUCLEAR SERVICE CENTER - 1981

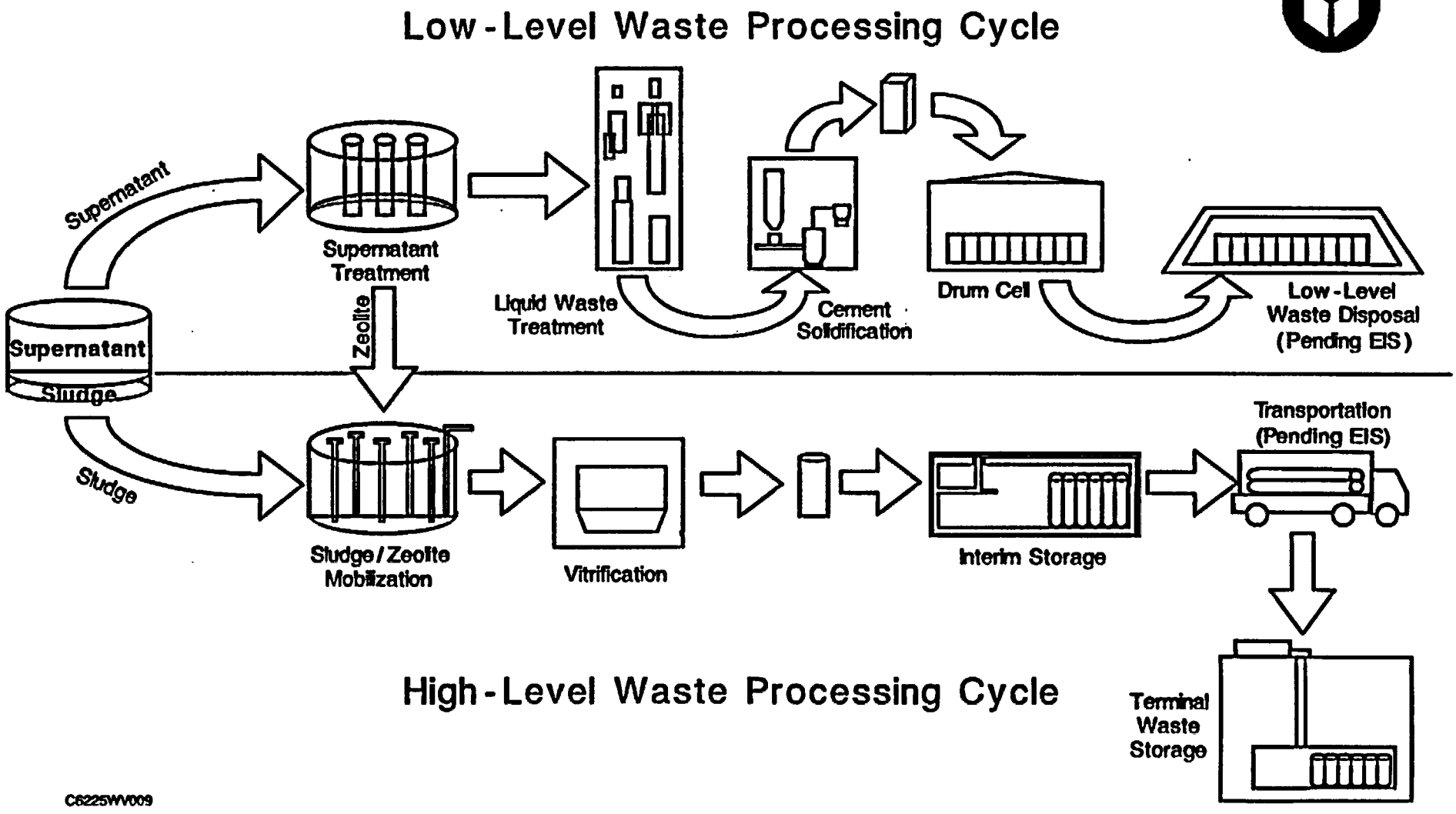


PHASE I END PRODUCTS



C6225WV006

PROCESS OVERVIEW



C6225WV009

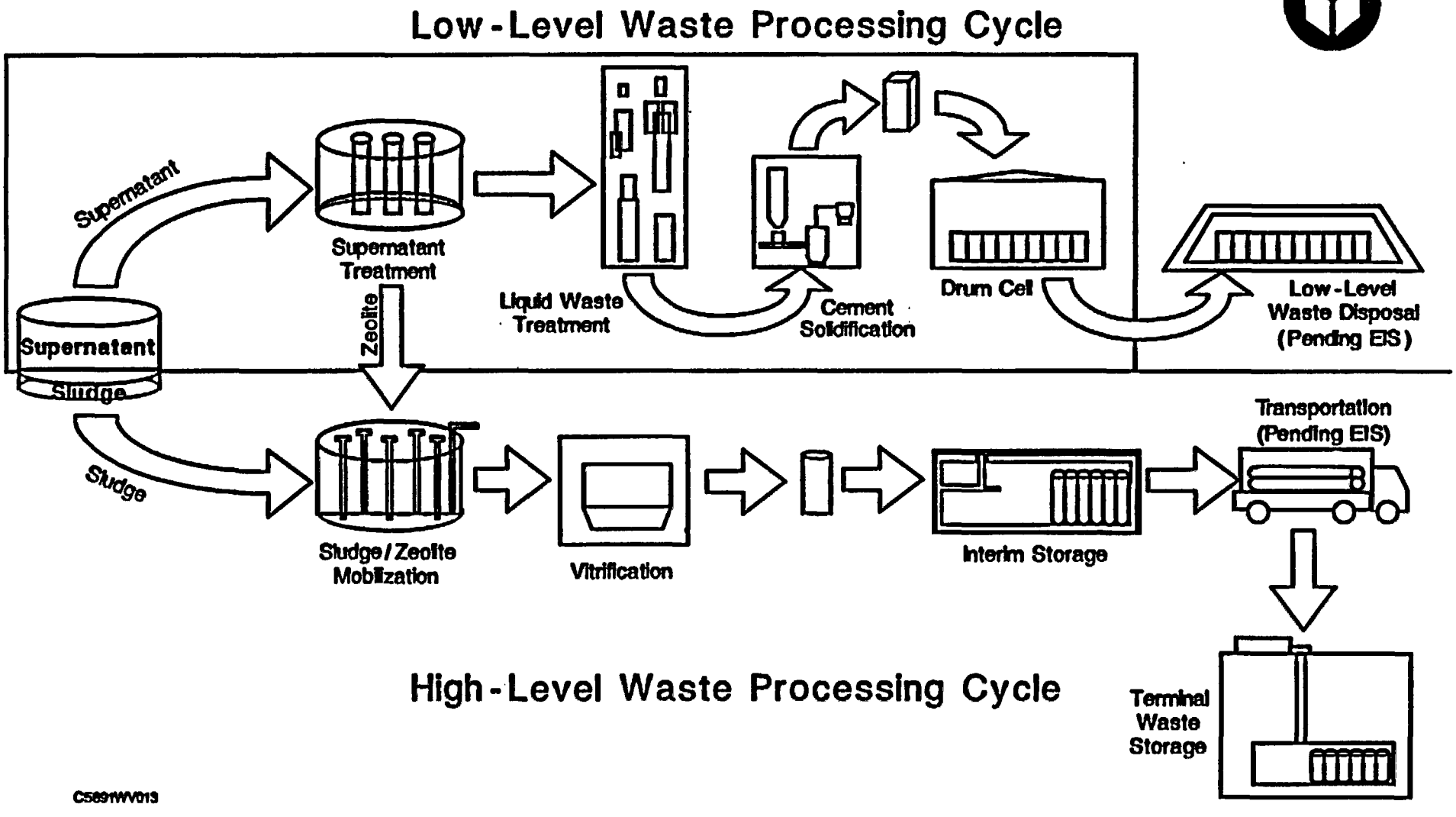
LOW-LEVEL WASTE PROCESSING: TECHNICAL PERFORMANCE EXCEEDS DESIGN

Status: (As of September 14, 1989)

- Processing Initiated May 1988
- 280,000 Gallons Processed (38% of Total to Process)
- 4,985 Cement Drums Produced (38% Complete)
- Product Acceptance Rate 99.92%
- Drum Dose Rates 80 mRem/HR vs. 700 mRem/HR Design
- NRC Agreement on Waste Form; Topical Report to be Used as NRC Reference

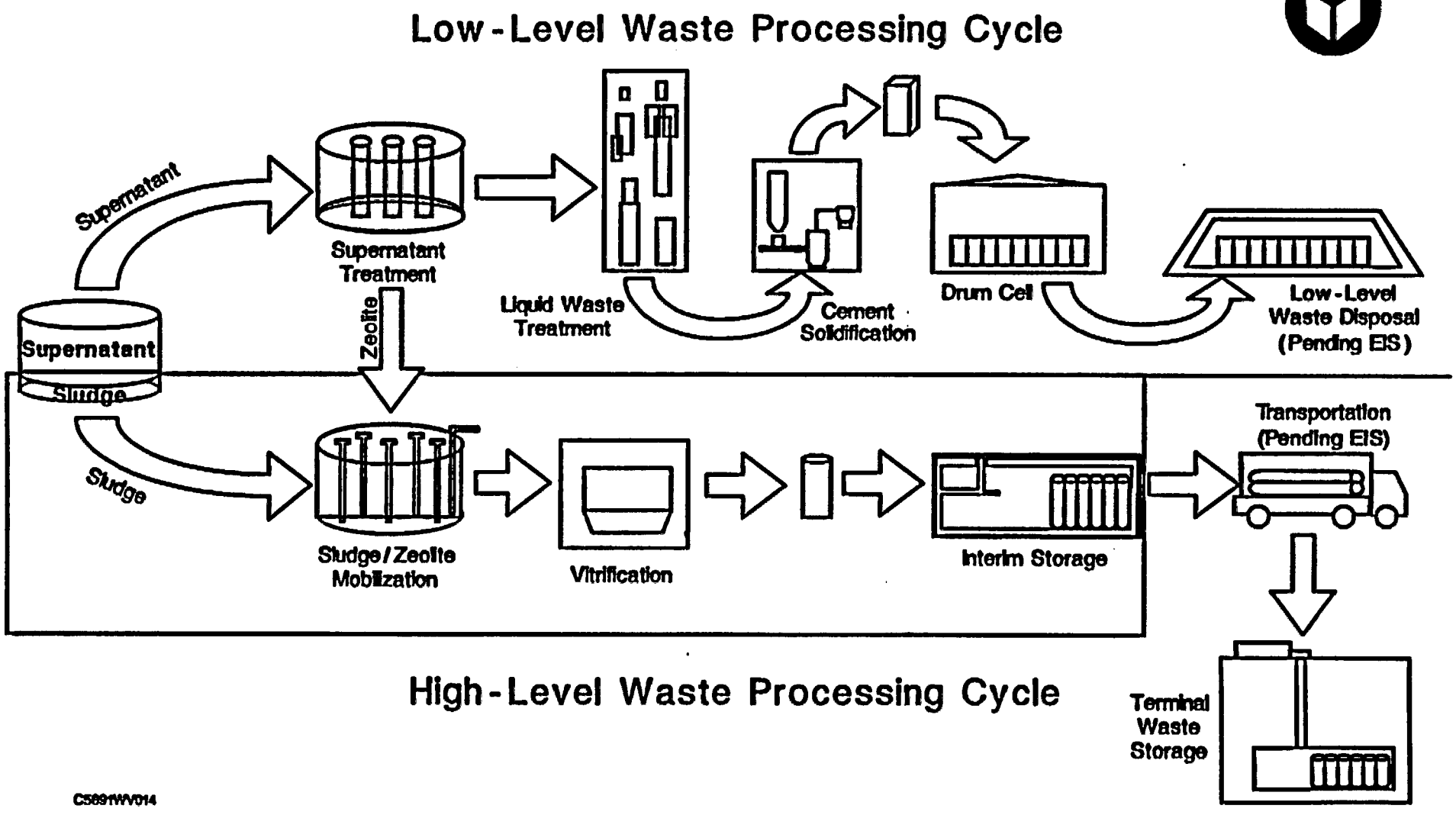
C5891WV012

PROCESS OVERVIEW



C5691WV013

PROCESS OVERVIEW



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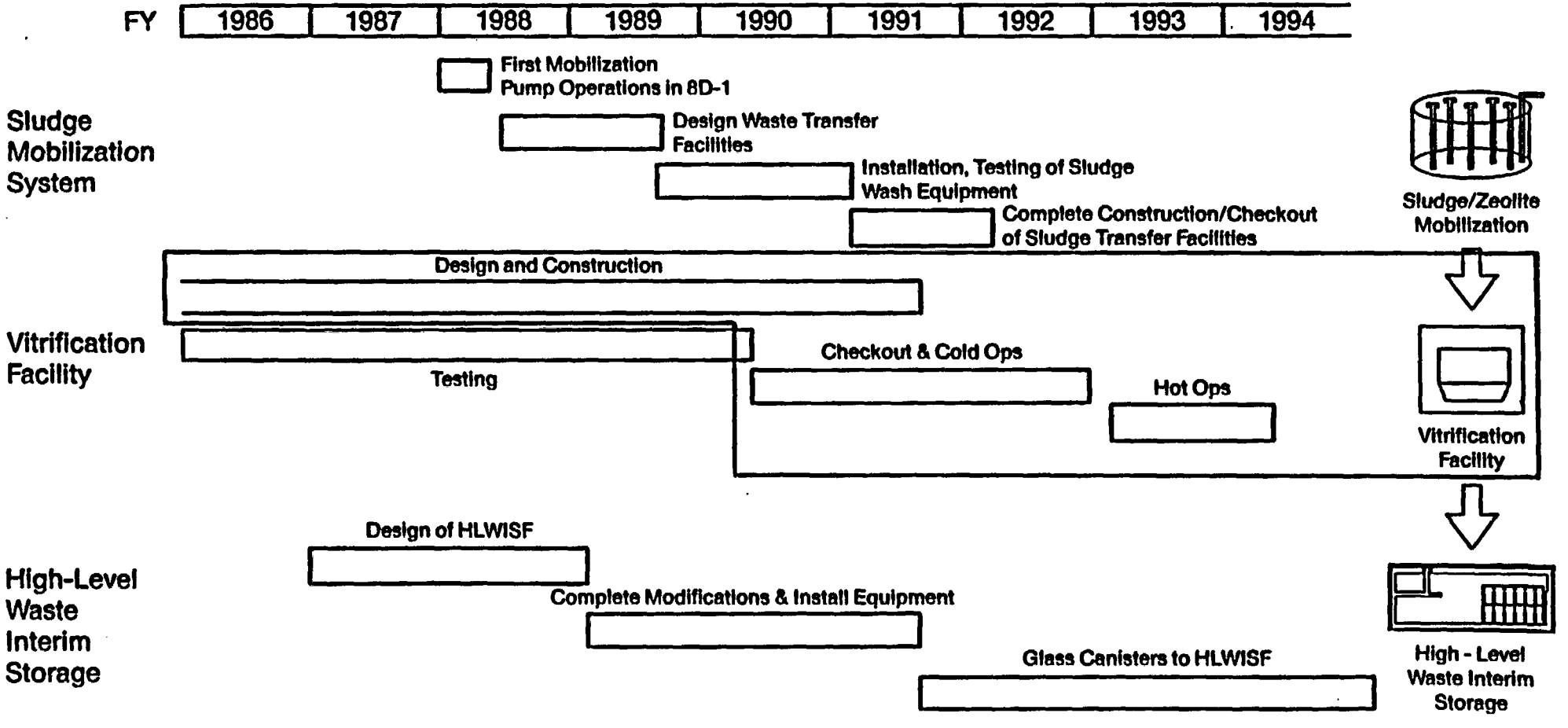
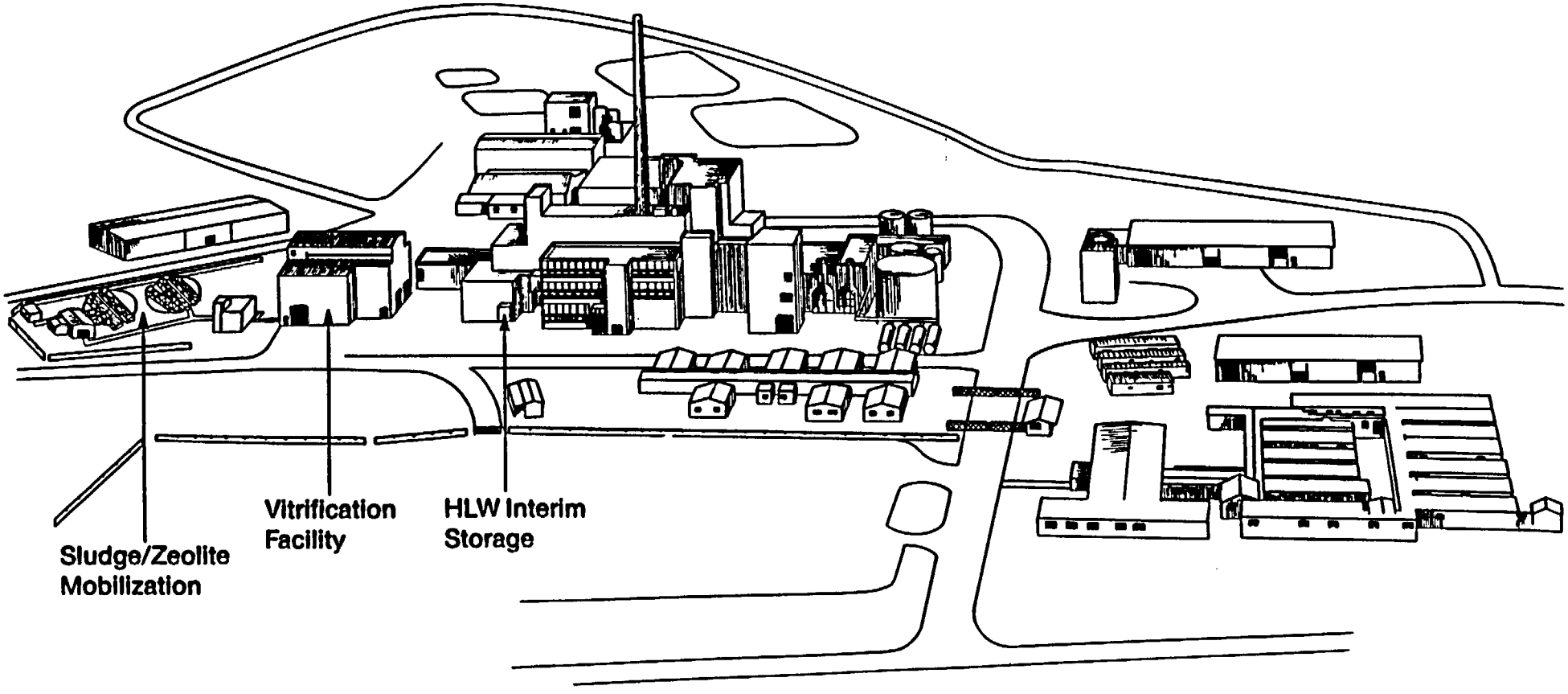
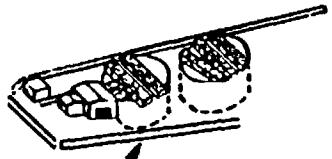
VITRIFICATION SYSTEM SCHEDULE



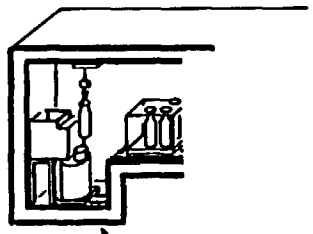
WEST VALLEY DEMONSTRATION PROJECT



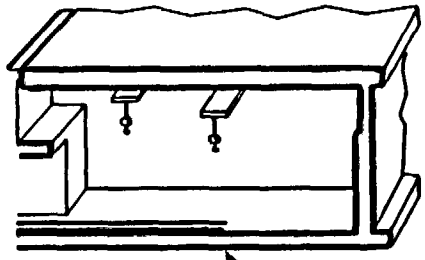
HIGH-LEVEL WASTE PROCESSING



Sludge/Zeolite Mobilization

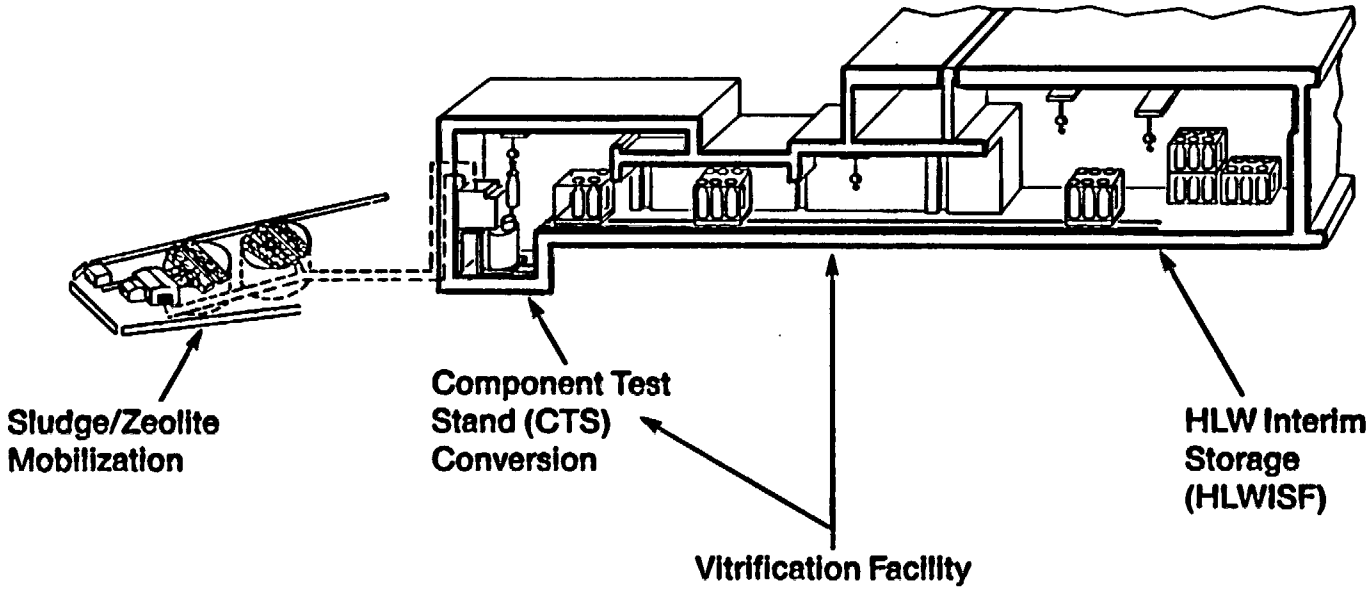


Component Test Stand (CTS) Conversion

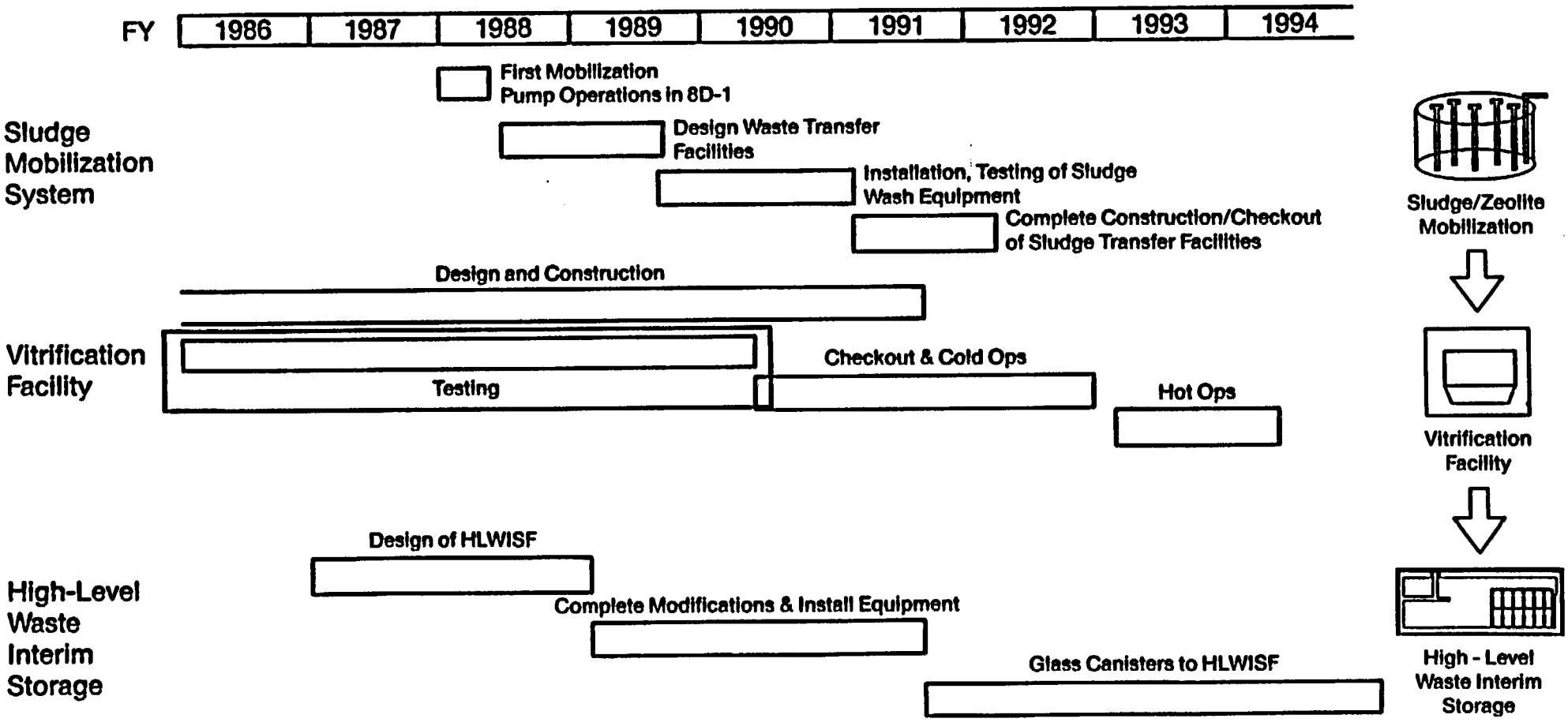


HLW Interim Storage (HLWISF)

HIGH-LEVEL WASTE PROCESSING



VITRIFICATION SYSTEM SCHEDULE

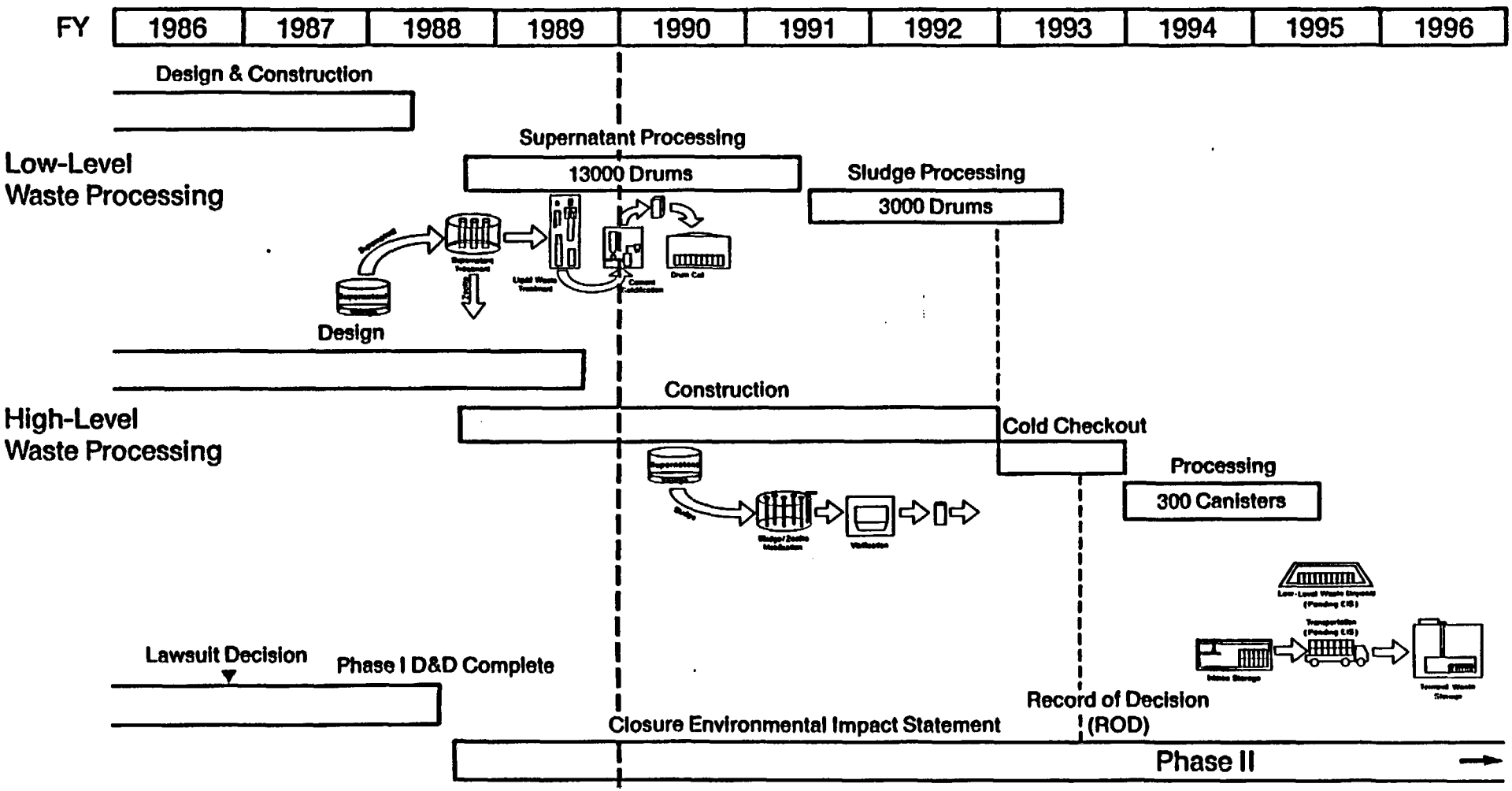


VITRIFICATION TESTING

- Five Full-Scale Melter Runs Completed per Integrated Test Schedule
- Steady State Operations Achieved; On-Line Efficiency of Greater Than 96% Overall
- Verified Performance Equality of Lab and Full-Scale Melter
- Preparations Underway for Final Full-Scale Qualification Run (SF-12); External Reviewers Invited to Participate

C5891WV009

SUMMARY MASTER SCHEDULE



Low-level/High-level Waste Acceptability Programs

- Vitrification Testing Program is Being Conducted in the Same Manner as the STS/CSS Program
- STS/CSS Program Produced Industry Standard Product
- Expect the Same Product Acceptability from the Virtification Program

SF-12 Meeting Objectives

- Feedback Sought:
  - Product Qualification Strategy
  - Process Control Strategy
  - Work Control Approach

Eli Maestas

SF-12 Meeting Leader

WV-DOE Project Office

SF-12 Meeting Objectives

Information Exchange

- Acceptable Strategy to Meet WAPS
  - Feed Analysis (Only on Spec Feed to Melter)
  - Melter Temperature Control
  - Glass Product Sampling
  - FACTS Data are WQR Data
  - Cold Operations Provides Confirmatory Results
- QA Approach
  - Proper Implementation of NQR-1 & RW-0214/Appendix B
- Materials to be Provided
  - Surveillance Type Documentation

Meeting Agenda

October 31, 1989

● Test Strategy to Meet WAPS-Process Control	J.M. Pope
● Establishing Acceptable Target Glass-Product	CUA
● Feed Verification-Product	PNL
● Test Results to Support Compliance Strategy-Process	S. M. Barnes
● Product Control-Same Approach as WVDP	SRL
● Work Control to NQA-1 & OGR/B-14	D. L. Shugars
● Establish Working Groups	E. Maestas

November 1, 1989

- Morning: Detailed Flowchart Explanation
  - Documentation (1)
  - Test Control (2)
  - Process Characterization
  - Product Acceptance (3)
  - Analytical Chemistry (4)
  - Vitrification Tour
- Afternoon: Verification
  - Finalize Four Working Groups
  - Walk Through Flowcharts/Documents

Meeting Agenda (Cont.)

<u>November 2, 1989</u>

- Morning: Verification Continuation
  - Local Visits; See Documentation/Results First Hand

- Afternoon: Develop Observations
  - Caucus
  - Discussion with WVDP
  - Summary of Observations

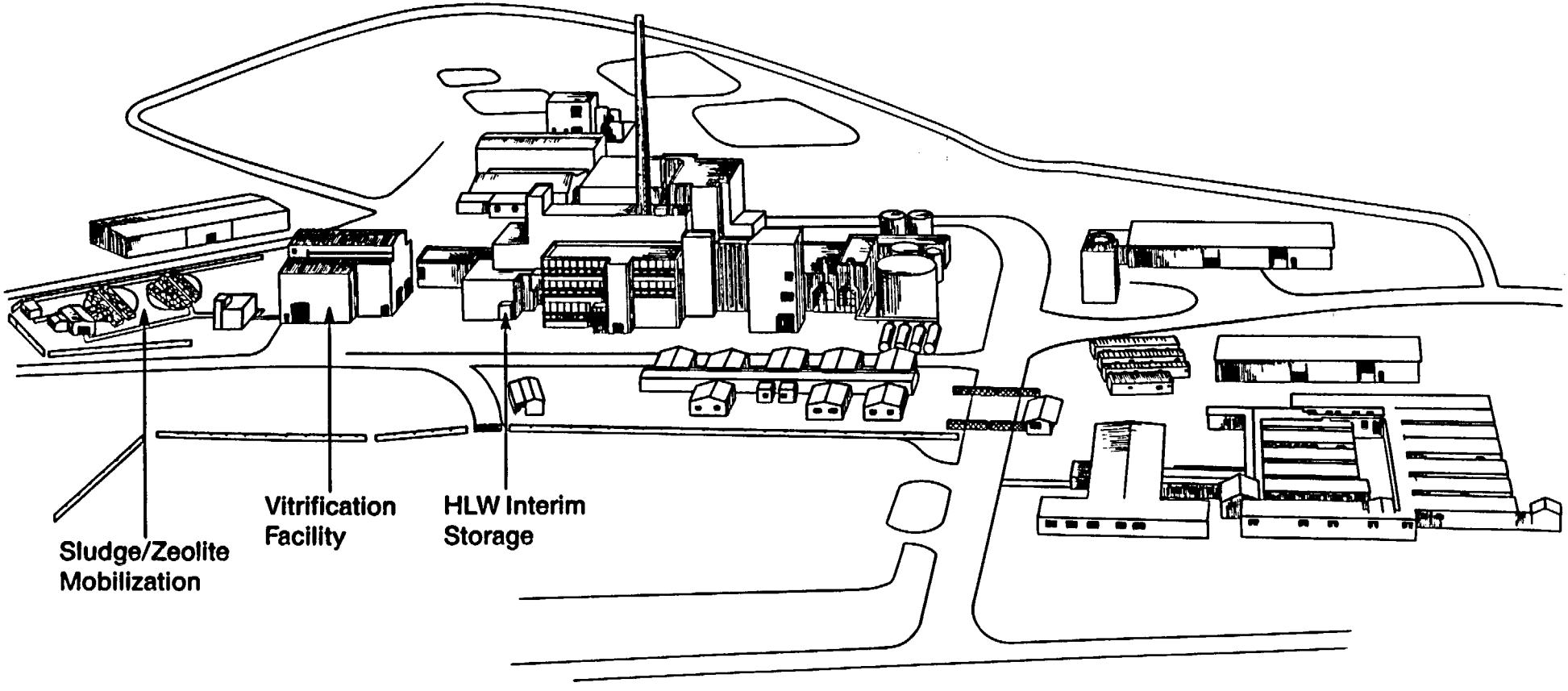
3

J. J. Buggy

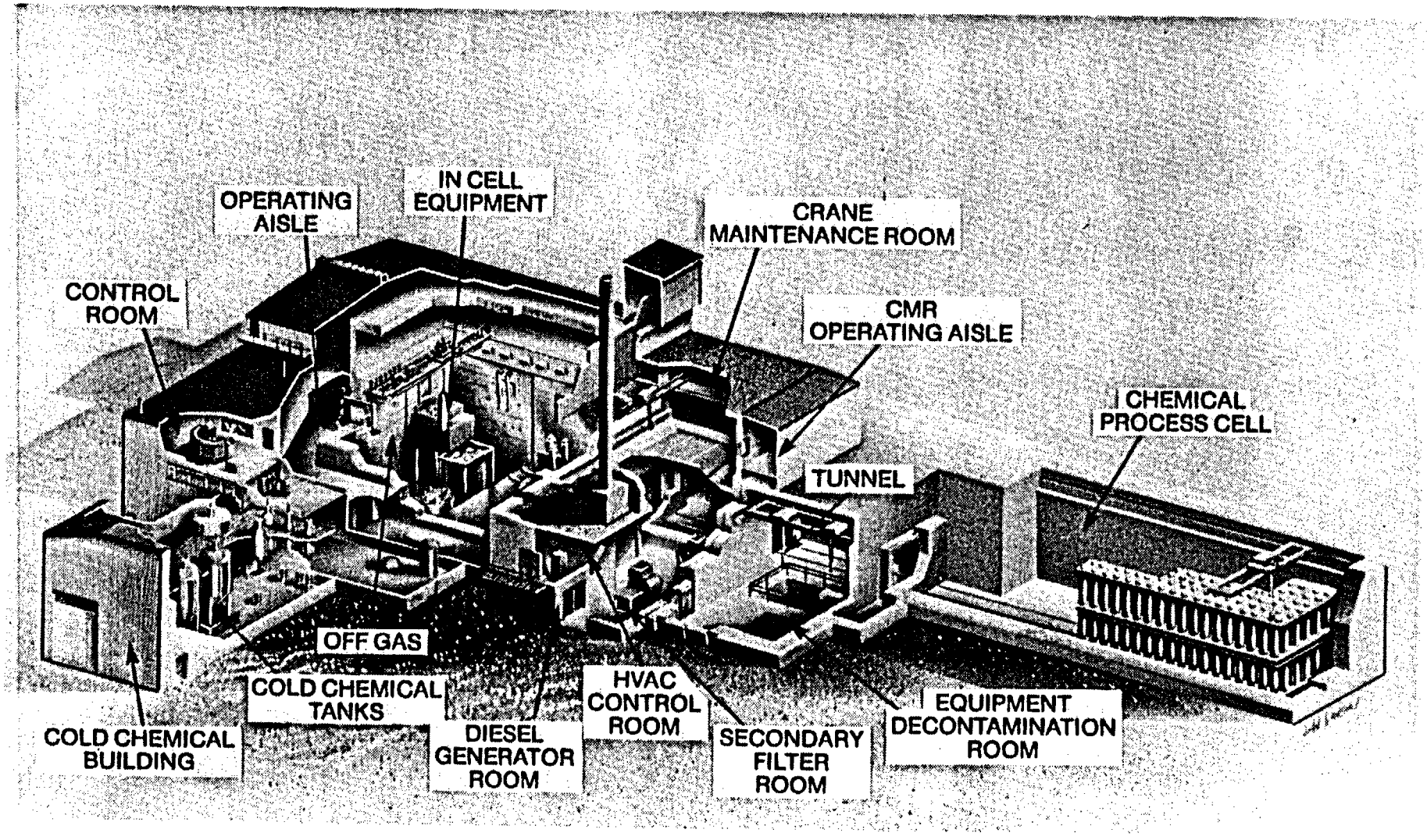
Vice President & Deputy Manager

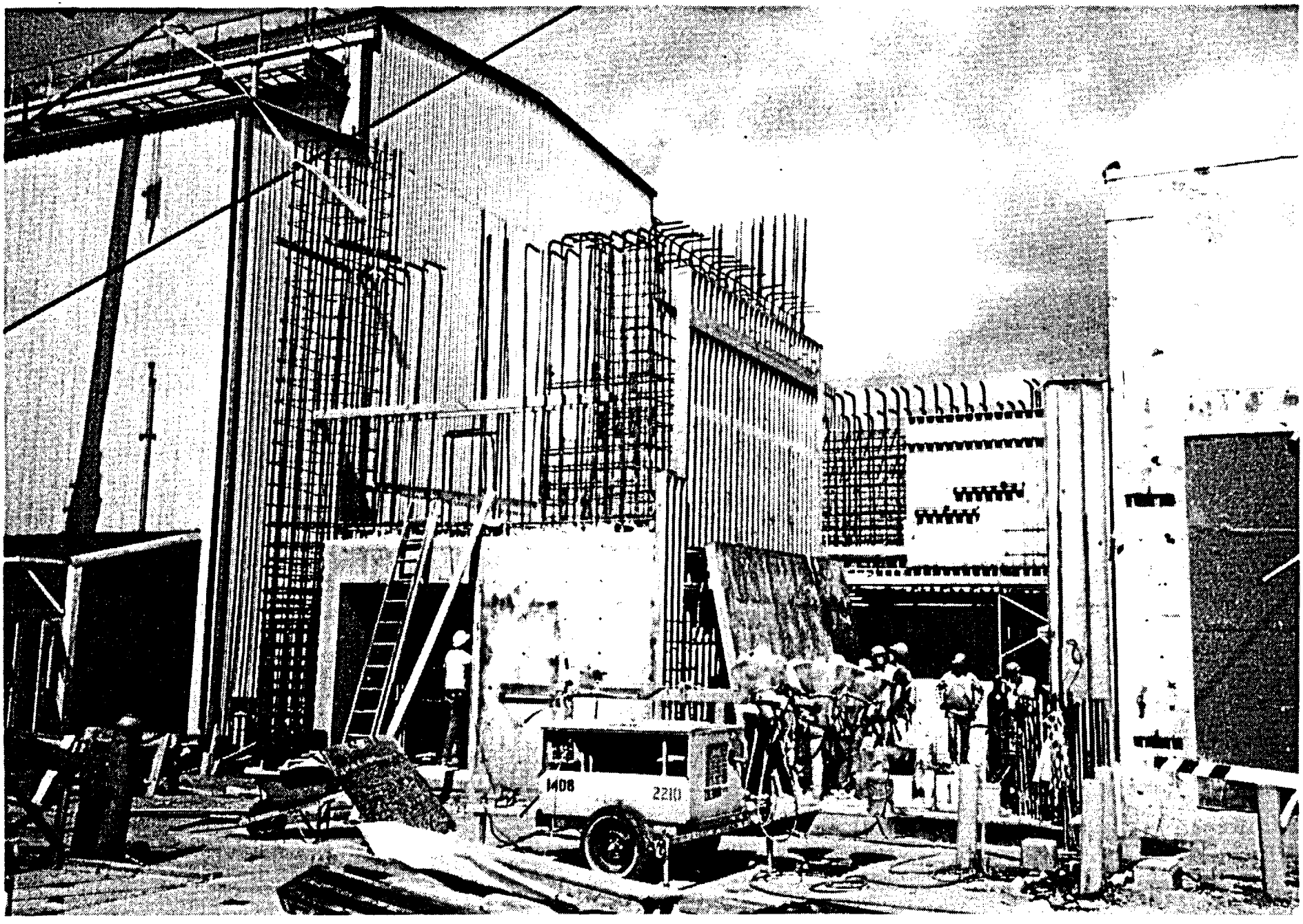
C6171WV001

WEST VALLEY DEMONSTRATION PROJECT



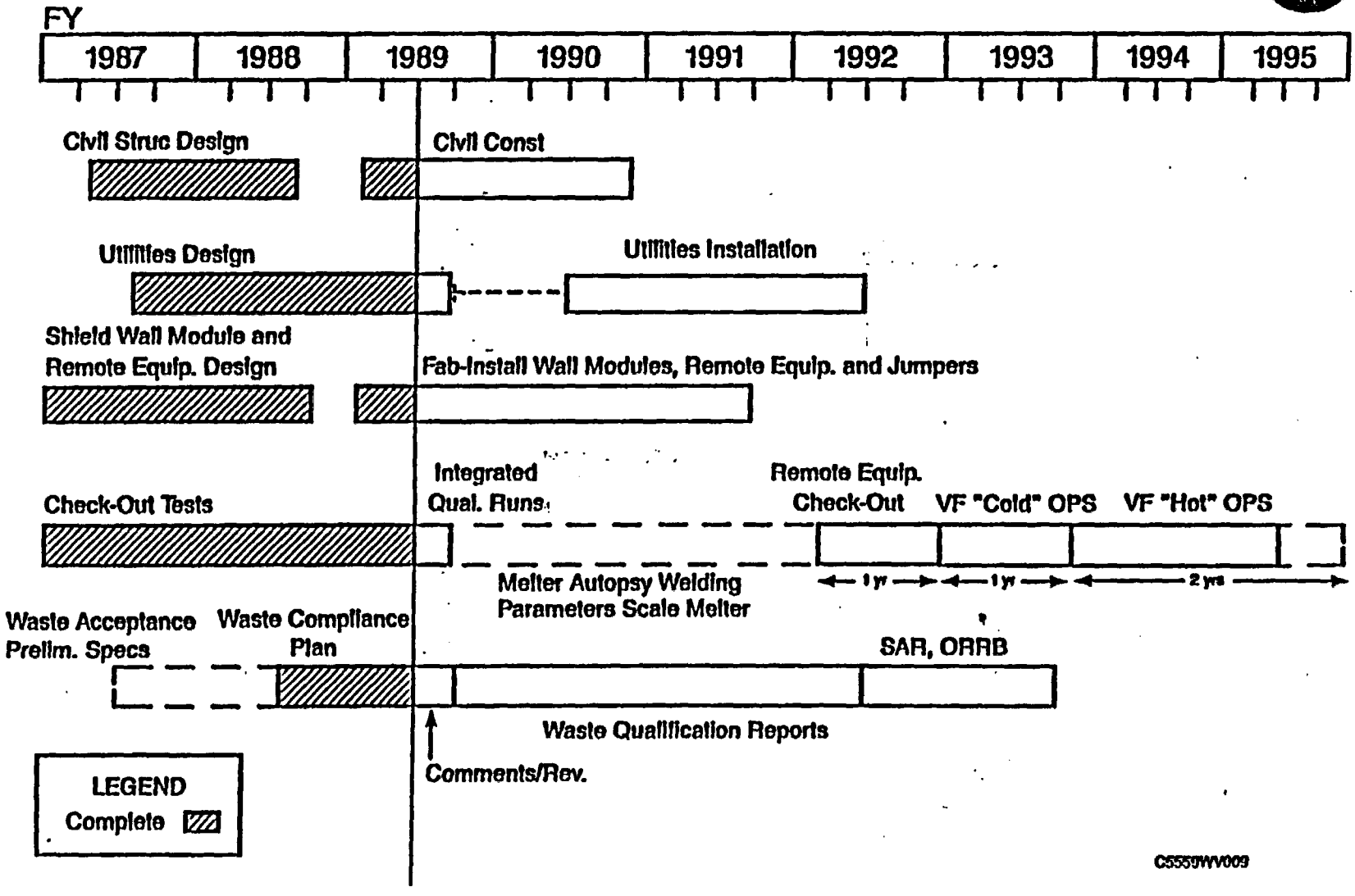
VITRIFICATION FACILITY

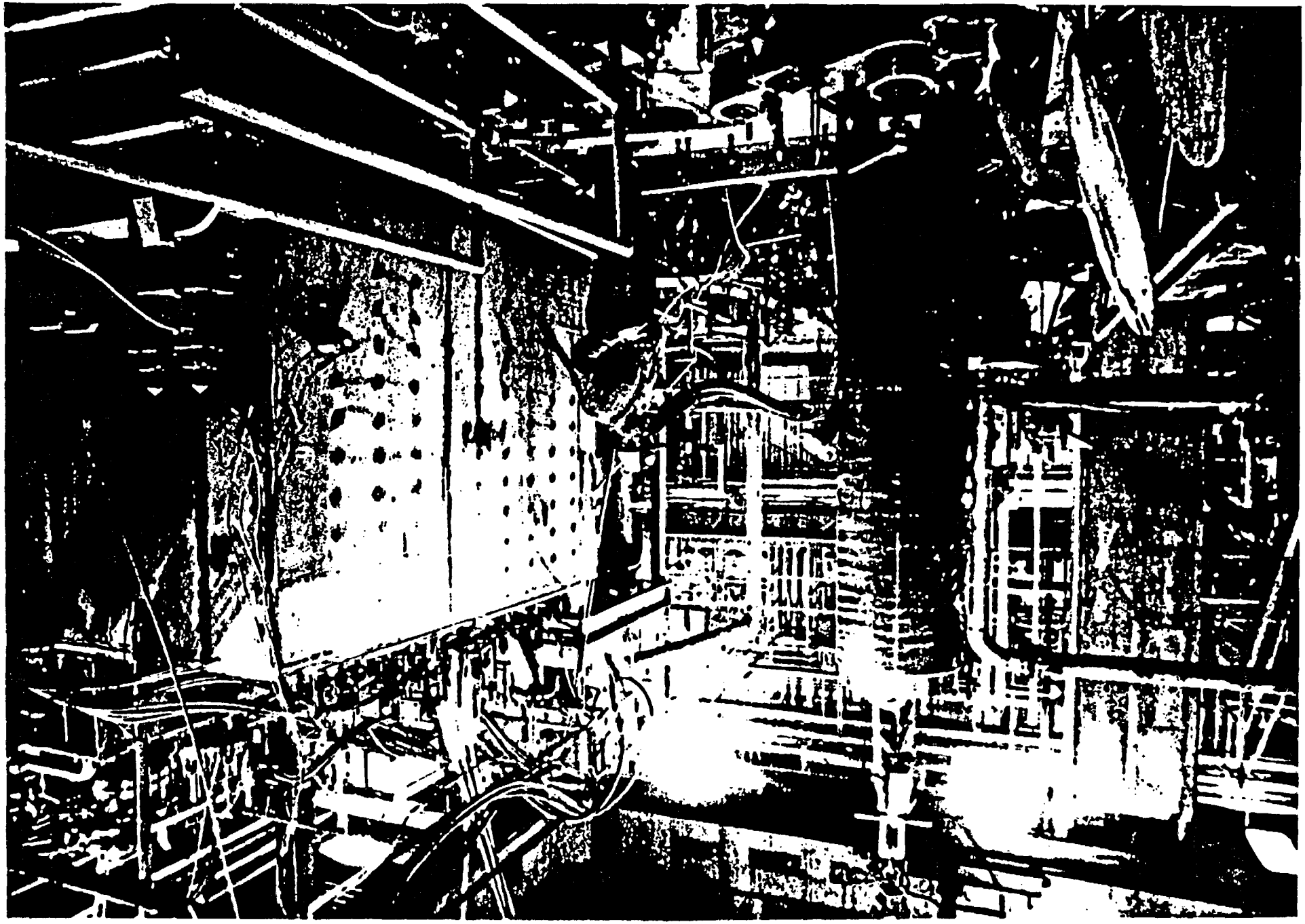




September 1989

SUMMARY PLAN VITRIFICATION FACILITY, TESTING & QUALIFICATION





Vitrification Functional and Checkout Testing of System (Facts) Accomplishments

- Full-Size Melter at 1150^0 C Continuously Since 12/84
- Systematic Advancement
  - Equipment Integration
  - Automatic Control
  - Process Chemistry
  - Off-Gas Performance
  - Steady State
  - Remote Operation

Vitrification Accomplishments (Cont.)

- Completed All Melter Runs on Schedule and Met All Objectives, e.g.,
  - Demonstrated Control to Give Product Meeting Acceptance Requirements
  - Characterized Process Performance
- Reference Composition
- Feed Makeup
- Sampling Melter As Well Mixed Vessel
- Analytical Chemistry Accuracy & Precision
- Culminating in 45-Day Qualification Run "Slurry Fed" (SF-12 to Meet WAPS and Show Acceptable Product
- Providing Experience to DWPF, HWVP, WINCO
- Reviewed with TRG, Tigers, NRC, ACNW, etc.

Vitrification Test Program Near Term Objectives

- Conduct Important External Review of SF-12 45-Day Qualification Run
- Produce Waste Form Qualification Reports with Subcontractor's Assistance and in Concert with DWPF
  - Accomplish Technical Review (TRG), i.e., RW Acceptance for Submittal to NRC

WVDP "Bottom Line"

- 40 % of the High-Level Liquid Waste Has Been Safely Decontaminated and Stabilized in Cement Exceeding 10CFR61 and Branch Technical Position

- The Full-Scale Melter Test Program Has Reached a Successful Conclusion

  - Need Feedback/Support From Regulatory Agencies as: Your Showing Now for Startup to Proceed

- The Civil Structural Construction for the Vitrification Facility is Nearing Finalization

4

J. M. Pope
Process Technology
& Testing Manager

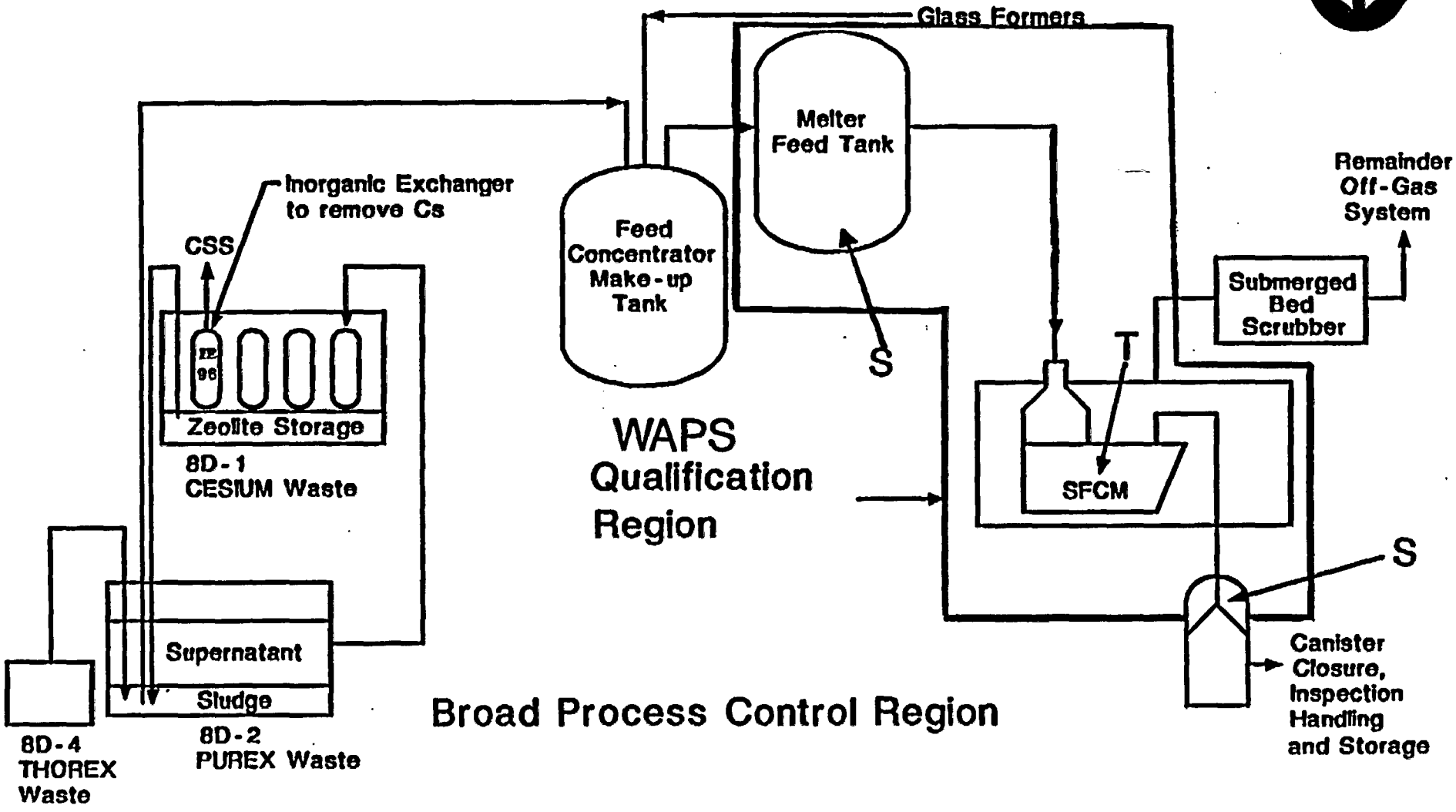
Presented at SF-12 Meeting
at West Valley

October 31, 1989

Presentation Objectives

- Outline WVDP Approach to Product Acceptance
  - Only Acceptable Feed (Composition) to Melter
  - Melter Temp.
  - Glass Composition as Required
- Introduce Other Presentors to Provide Bases for Product Acceptance:
  - Program Leading to Acceptable Feed (PNL)
  - Acceptable Glass Region (CUA)
  - Process Performance (WVNS)
  - Close Similarity in Product Control Approach for Acceptance (SRL)

WEST VALLEY HLW PROCESS/PRODUCT ACCEPTANCE STRATEGY



FLOWSHEET/PROCESS CONTROL CHARACTERISTICS

Tank Farm:

- All Wastes Combined = 1 Batch
- Well Sampled
- Zeolite Quantity Being Confirmed
- Grinding to < 50 um
- Sampled Before Transfer To Vitrification
- Close Proximity to Vitrification Facility

FLOWSHEET/PROCESS CONTROL CHARACTERISTICS (CONT)

Feed Makeup:

- Batch Prep (~ 5000 Gal); Continuous Feed To Melter
- Batch Prep Time ~ 100 Hours
- Sample Waste Transferred
- Add Glass Formers After Sampling
- Evaporate; Resample; Shim
- Transfer To Melter Feed Tank; Sample
- Melter Feed Tank is Control Point
- Out-Of-Spec Feed That Cannot Be Adjusted Is Recycled To Tank Farm (not expected)

FLOWSHEET/PROCESS CONTROL CHARACTERISTICS (CONT)

Melter Temperature Control:

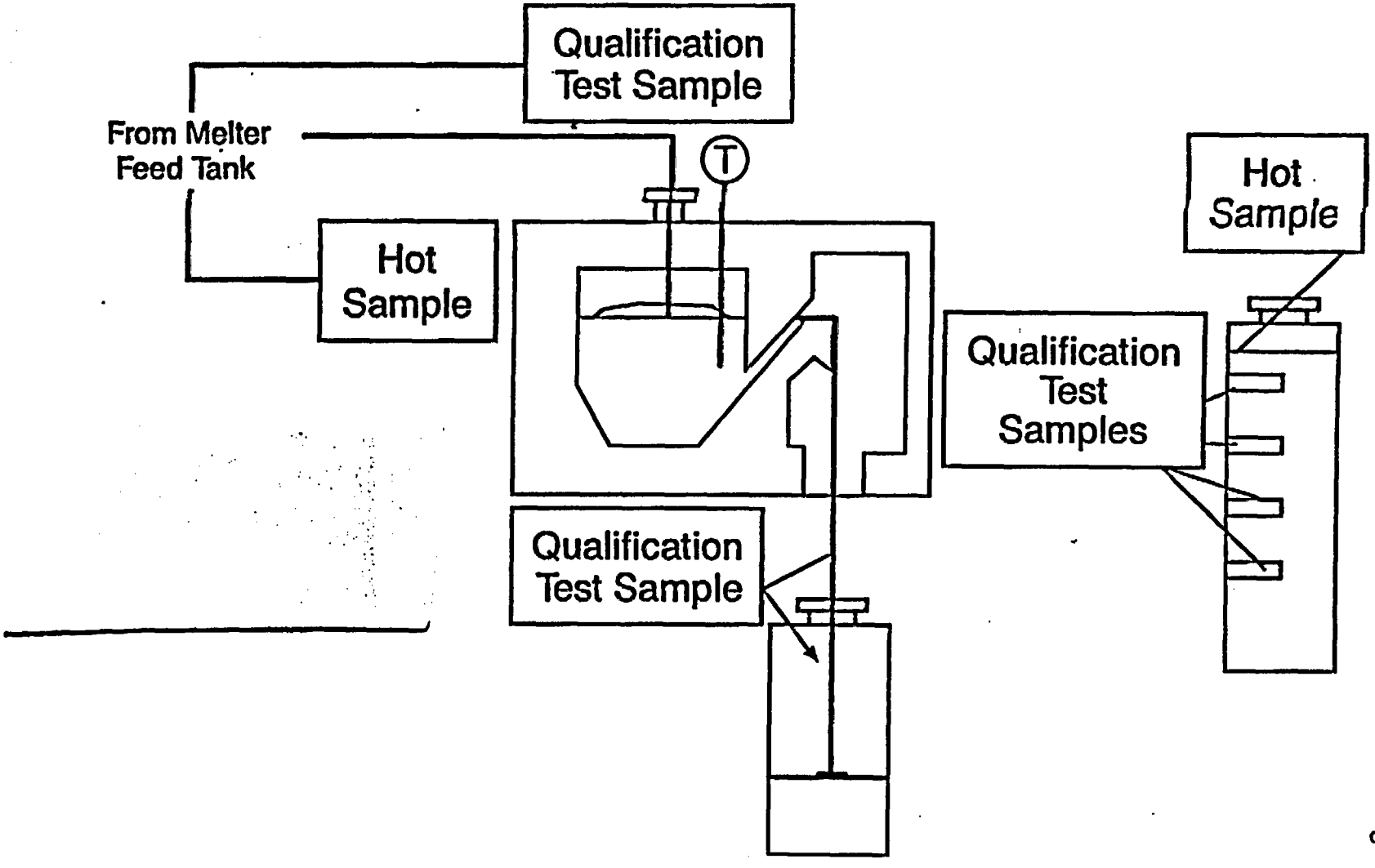
- ≥ 100 Degrees Celsius Above Liquidus

Glass Product:

- Composition
- Sample As Required For Verification

REFERENCE - FLOWCHARTS

PROPOSED QUALIFICATION AND HOT SAMPLING LOCATIONS



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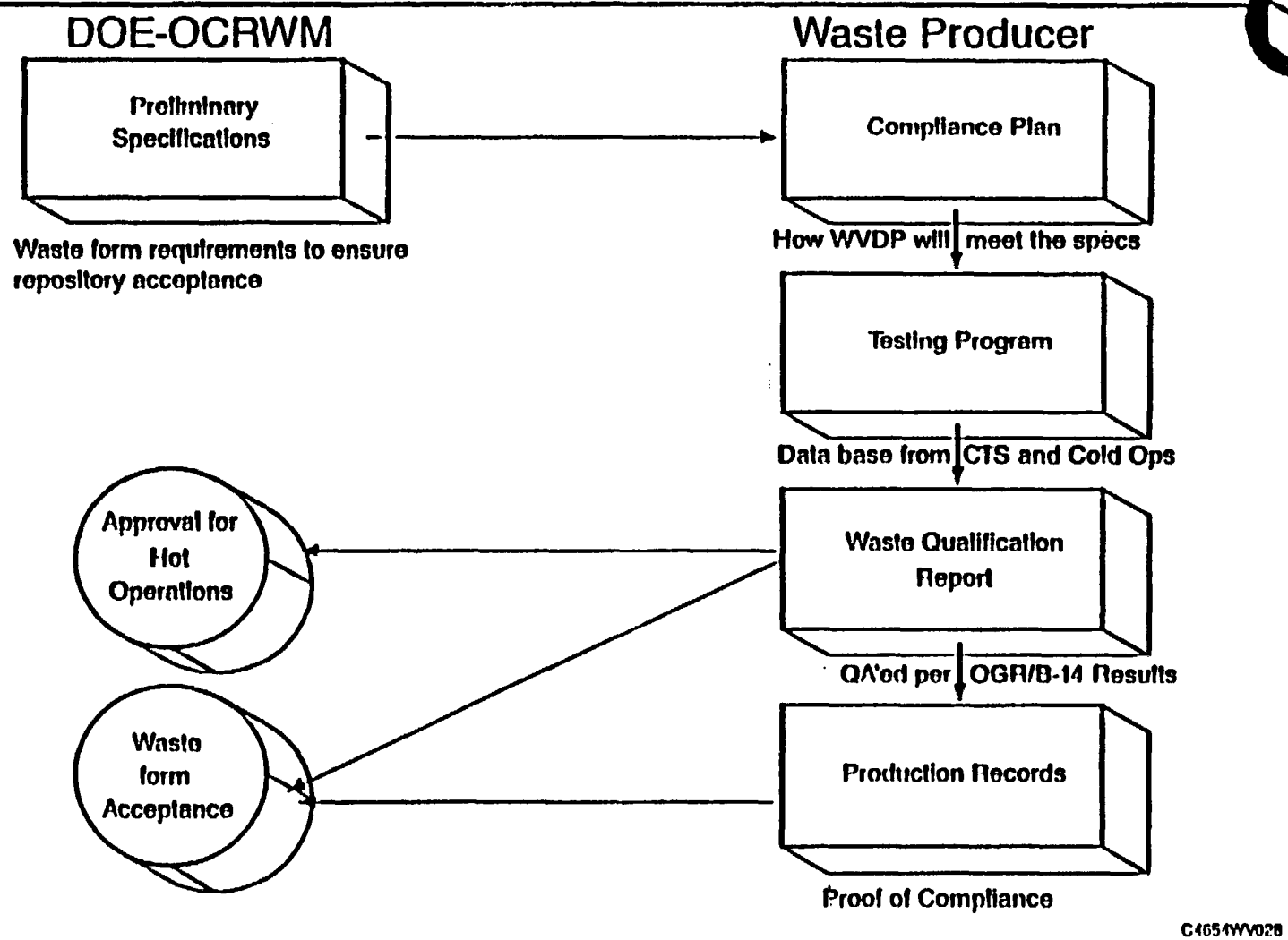
WASTE ACCEPTANCE PROCESS



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WASTE ACCEPTANCE ACRONYMS

WAC	- Waste Acceptance Committee
WAP	- Waste Acceptance Process
WFCD	- Waste Form and Canister Description
WAPS	- Waste Acceptance Preliminary Specifications
WCP	- Waste Compliance Plan
QAPD	- Quality Assurance Program Description
WQR	- Waste Qualification Report
WAS	- Waste Acceptance Specification (Final)
OCRWM = "RW"	- Office of Civilian Radioactive Waste Management
SCP	- (Repository) Site Characterization Plan

C4654WV012

WASTE ACCEPTANCE PROCESS ELEMENTS

- Waste Form Description
  - Gives Specifics of Producer Waste Form
- Waste Acceptance Preliminary Specifications
  - Defines the Waste Form/Canister Requirements
- Waste Compliance Plan
  - Describes Testing/Process Control to Meet Specifications
- Waste Qualification Report
  - Provides Data to Show Compliance with WAPS
- Production Records
  - Describe Actual High-Level Waste Form

C4654WV014

WASTE ACCEPTANCE SPECIFICATIONS

Waste Form

Composition
Radionuclides Conc.
Radionuclide Release
Chemical Stability

Canister

Material
Closure
Labels

Canistered Waste Form

No Liquids
No Gases
No Combustibles
No Organics
Free Volume
Surface Contamination
Heat Generation
Dose Rate
Chemical Compatibility
Subcritical
Dimensions
Drop Test
Grapple Design

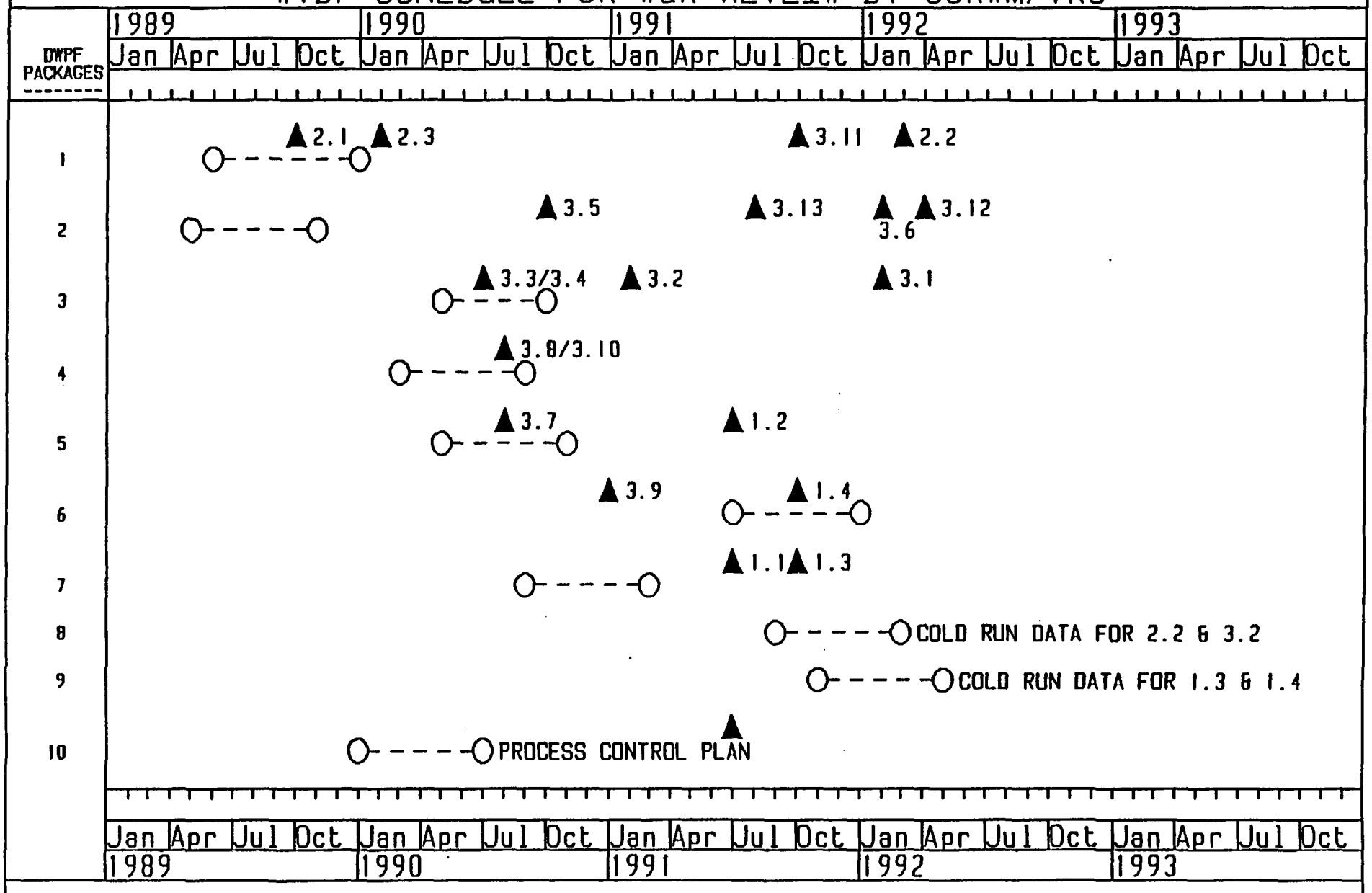
Quality Assurance

C5558WV013

VITRIFICATION WASTE ACCEPTANCE PROCESS STATUS

- Achieved Significant Progress
  - WVDP/NE Have Accepted Same Specifications as Savannah River; Expecting Updated WAPS From RW Imminently
  - Submitted Waste Compliance Plan after WV-TRG Endorsement; Included on RW Formal Schedule and Being Reviewed Now
  - Integrated Waste Form Qualification Reports with SR; Progressing to Use Same Reviewers

WEST VALLEY DEMONSTRATION PROJECT
WVDP SCHEDULE FOR WQR REVEIW BY OCRWM/TRG



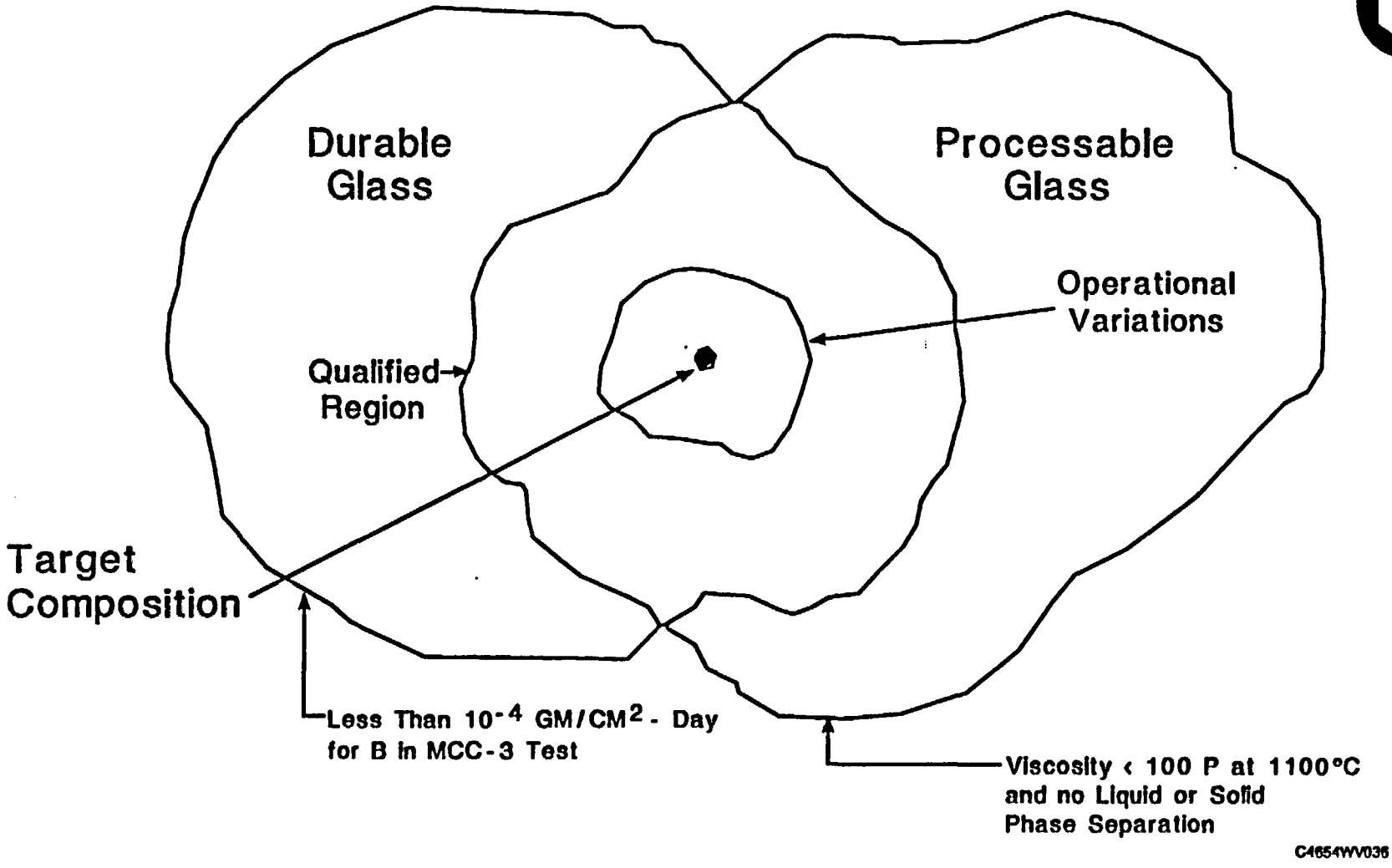
Q _ O DWPF REVIEW CYCLE
▲ WVDP SUBMITTAL SCHEDULE

Westec Artemis MAINFRAME BARCHART DRAWING SYSTEM 30-OCT-89 4.41 PM PAGE 1 OF 1

WAPS GLASS SPECIFICATIONS

- 1.1 CHEMICAL SPECIFICATION
  Report all elements present at >0.5% by weight (except O).
- 1.2 RADIONUCLIDE INVENTORY SPECIFICATION
  Report all radionuclides with $t_{1/2}$>10 years present at >0.05% of the total radioactive inventory in curies.
- 1.3 SPECIFICATION FOR RADIONUCLIDE RELEASE
  The glass shall leach <1g/sq. m/d (by MCC-1, 28d).
  Producer be 95% certain that 95% of the product qualifies.
  Alternative means are allowed if correlated to MCC-1.
- 1.4 SPECIFICATION FOR CHEMICAL AND PHASE STABILITY
  Producer shall provide T-T-T diagram and Tg.
  Producer shall certify that the glass is 100C below Tg at shipment and has never seen T>Tg during storage.

SCHEMATIC OF PROCESS AND PRODUCT QUALIFICATION



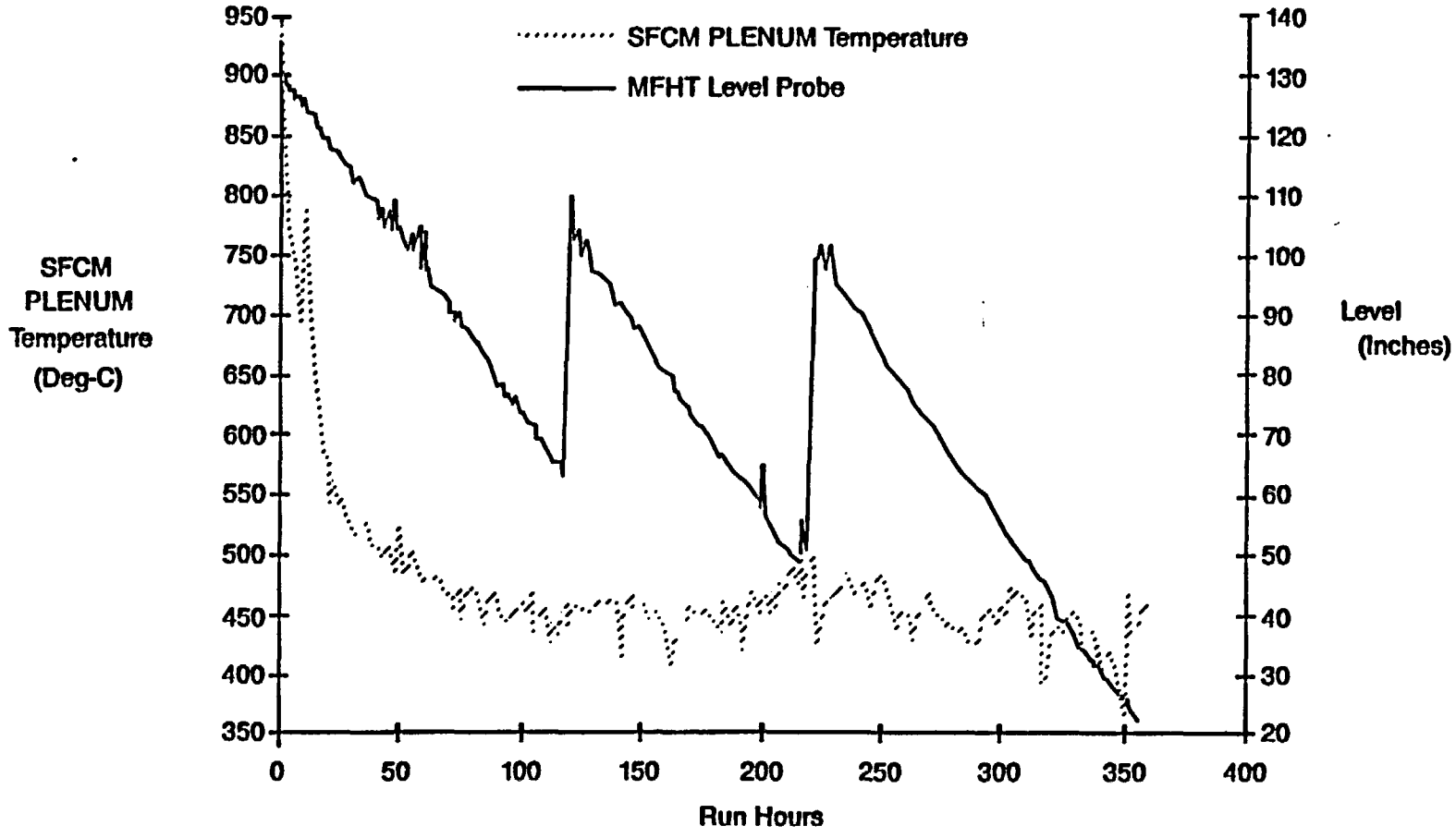
STRATEGY TO MEET GLASS RADIONUCLIDE RELEASE REQUIREMENTS

- Establish Range of Acceptable Compositions to Meet WAPS Limit of < 1 g/m2-d in MCC-1 28 Day Leach Test
  - Alternate Test Acceptable if Satisfactorily Related to Specification
- Demonstrate Full-Scale, Remote Process Operational Control to Achieve 95% Confidence Level That 95% of Product Will Meet Limits
  - Verify Control During Production
- Utilize Axiom That Glasses of the Same Compostion Have Same Leach Characteristics

PROCESS CHARACTERISTICS FOR CONTROL

- Operate in established range of selected parameters, e.g.
  - Composition
  - Plenum Temperature
  - Fe^{2+}/Fe^{3+}
- Operate at steady state = stably
- Operate as you would remotely

STEADY STATE OPERATION



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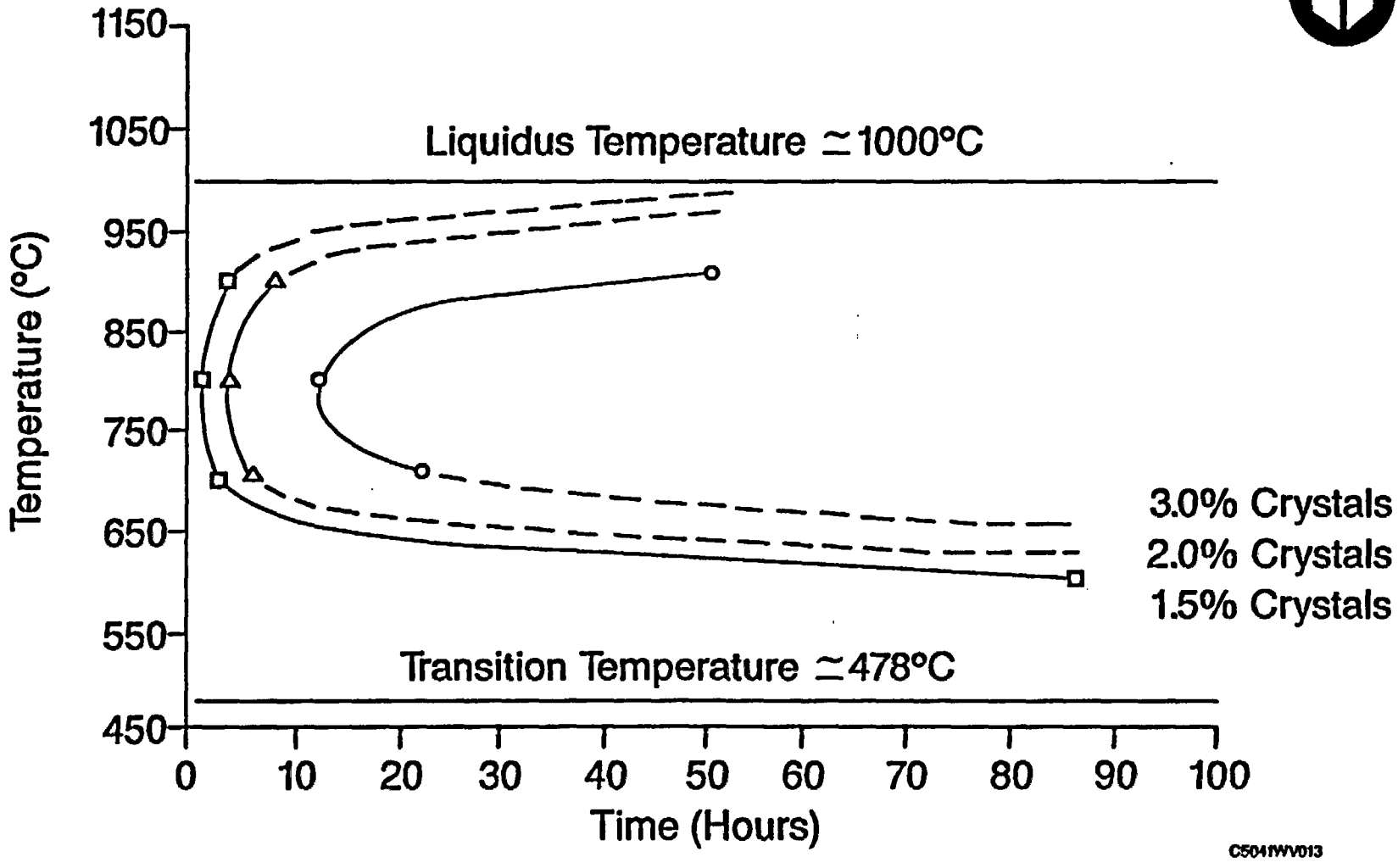
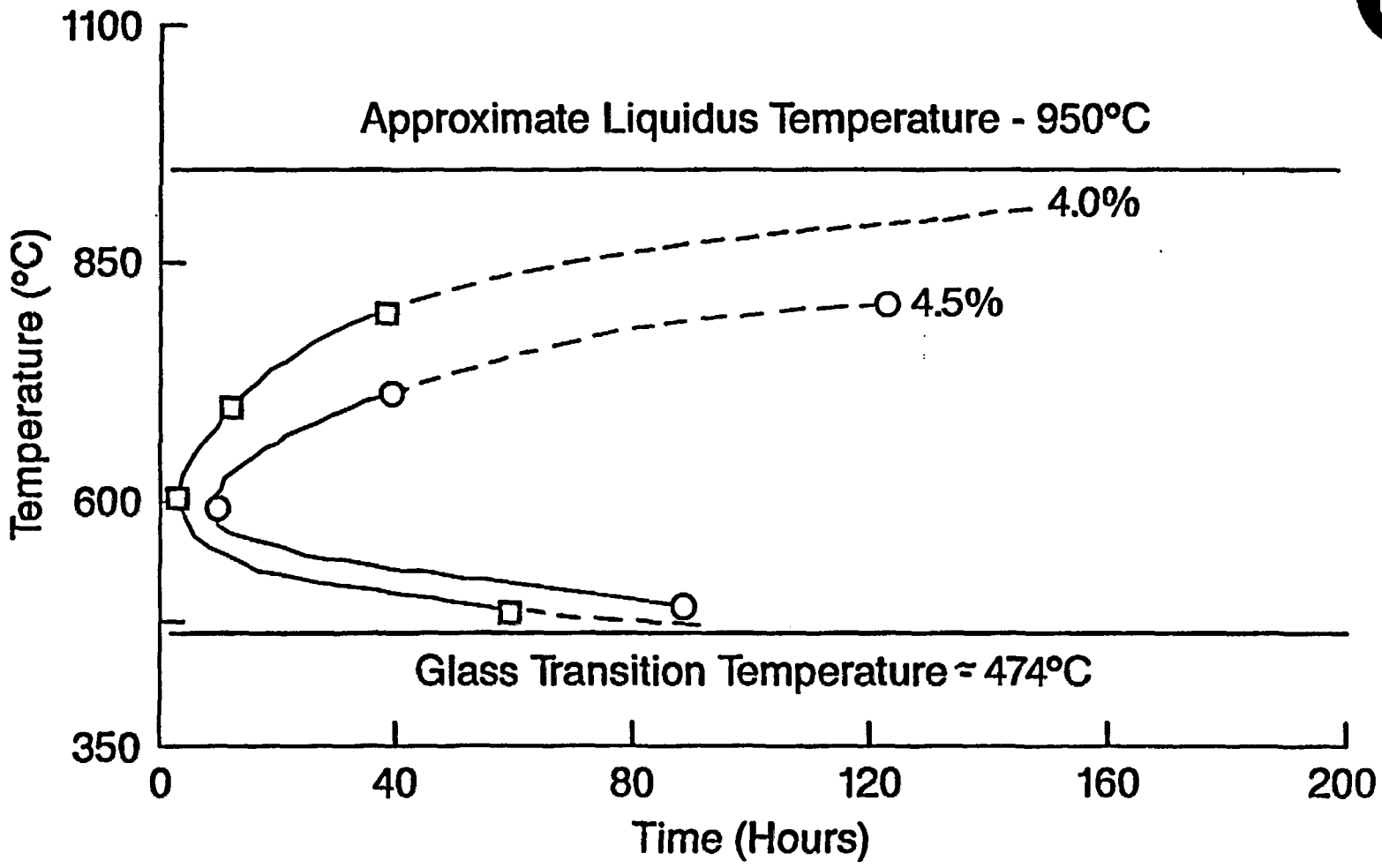
TTT DIAGRAM FOR OXIDIZED REFERENCE GLASS



TTT DIAGRAM FOR THE REDUCED GLASS REFERENCE



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PROCESS CONTROL SUMMARY

- Establish acceptable composition range
  - Leach rate to meet Specifications
  - Processable
- Achieve it during feed makeup
- Sample/analyze to verify
- Control it
  - Do it repeatedly,
  - Deliver it to melter

PROCESS CONTROL SUMMARY (CONT)

- Melt it
  - In = Out
- Know its thermal history
- Model it

WASTE FORM ACCEPTANCE SUMMARY

- Assure Product Quality By:
  - Process Characterization
  - Process Control
- Utilize:
  - Certified Contractor Data
  - FACTS Integrated Nonradioactive Tests
  - Cold Operations Verification Runs
- Provide NRC The Same Type Of Documentation As DWPF For Review and Comment:
  - Process Control Program Description
  - QA Implementation
  - Radionuclide Release And Chemical/Phase Stability Results To Address WAPS 1.3 and 1.4

SUMMARY VITRIFICATION QUALIFICATION PROGRAM

WVDP has High Confidence that an Acceptable Glass will be Produced Because:

- Achieved Steady State Process Testing
- Defined Operating Parameters for Excellent Melter Behavior/Control
- Characterizing Process
  - Testing Based on Statistics
  - Quantifying Uncertainties in Equipment, Sampling, Analyses

SUMMARY VITRIFICATION QUALIFICATION PROGRAM (CONT)

- Processing Composition Envelope Appears Adequately Broad
- Achieving Acceptable Leach Rates for Processing Envelope to Meet WAPS
  - Full-Size Canisters with Actual Thermal History
  - Radioactive Samples with Actual Waste
- Continuing Extended Leach Tests
- Continuing Interaction with Savannah River Laboratory, Repositories, Nuclear Regulatory Commission, etc.

SUMMARY VITRIFICATION QUALIFICATION PROGRAM (CONT)

- Obtaining Agreement Between PNL, CUA, AU, MCC, SRL, etc.
- Process Model Calculated and Measured Data Show Good Agreement
- Conducted Fully Radioactive Vitrification Demonstration of Flowsheet without Difficulties at PNL B-Cell

J. M. POPE

BACKUP MATERIAL FOR SF-12 MEETING AT WEST VALLEY

OCTOBER 31, 1989

FULL SIZE, INTEGRATED TEST PROGRAM PARAMETERS

- Operated under wide yet credible range of conditions
  - Composition/Viscosity
  - Concentration (Rheology)
  - Redox
  - Additives
  - Bubblers
  - Power Skewing
  - Temperature
- Sample "everything" in nonradioactive testing
- Model and verify
  - Tracers

Integrated Cold Operations
Melter Runs

Run #1	Baseline: nominal glass with halogens; melter and process characterization	2/93-3/93 (6 weeks)
Run #2	Batch cycle time verification; process model verification with tracers; sampling precision/accuracy; welding, decontamination; produce reference canisters for drop testing	4/93-5/93 (6 weeks)
Run #3	mercury addition; power skewing; temperature variations; direct frit additions; low viscosity (high Fe) and high viscosity glasses (high zeolite) as possible; assess corrosion	6/93-7/93 (up to 8 weeks)

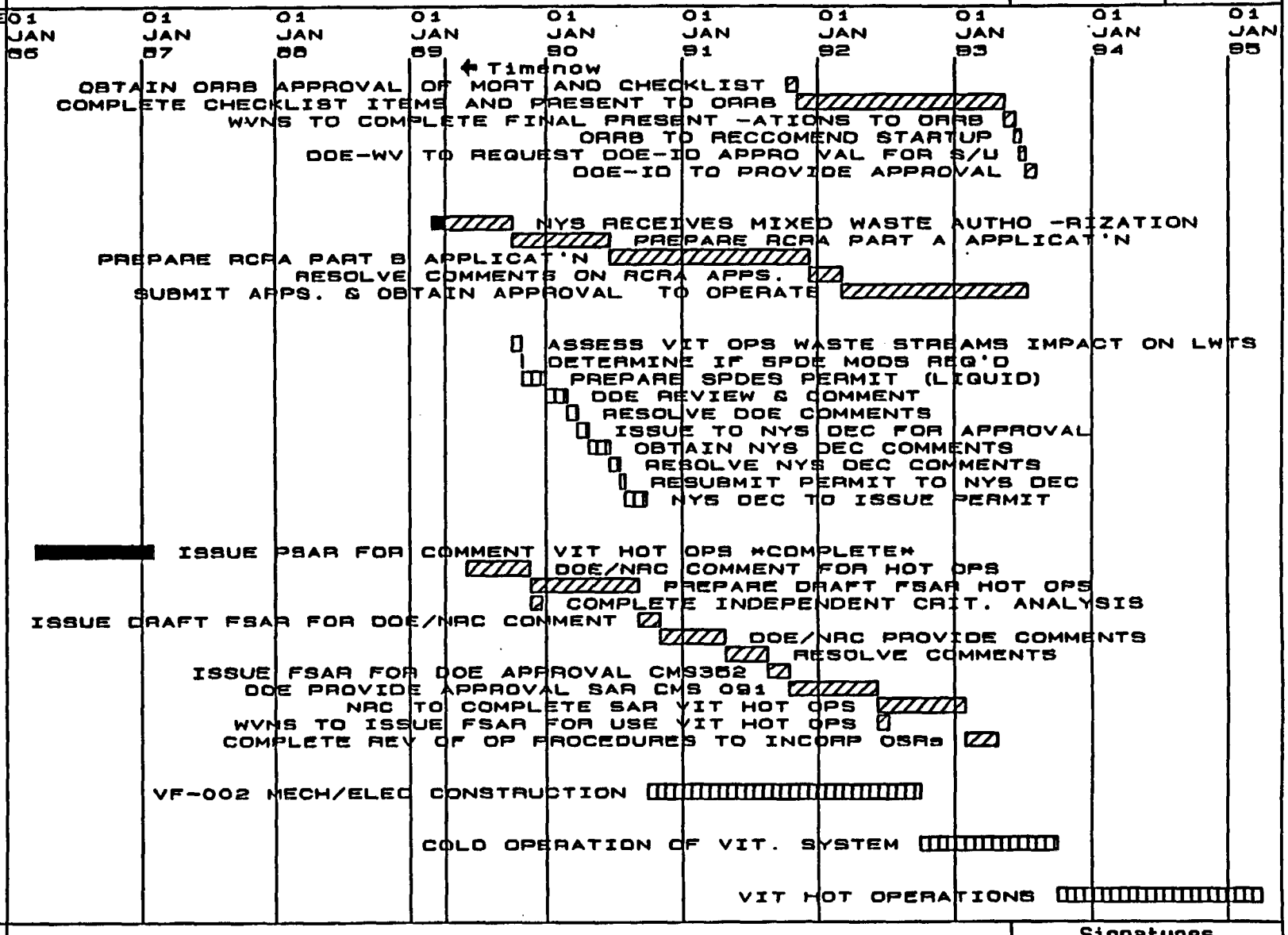
OPEN PLAN (tm)

Report: WVGRFBAR
Project: INSTREQ
Time Now: 06APR89
Date: 12SEP89
Time: 09:26:52
Page: 2

INSTITUTIONAL REQUIREMENTS NETWORK

West Valley Nuclear Services

ACT NUM	EF DATE	
ORRB0400	06NOV91	OBTAIN ORRB APPROVAL OF MORT AND CHECKLIST
ORRB0500	12MAY93	COMPLETE CHECKLIST ITEMS AND PRESENT TO ORRB
ORRB0600	09JUN93	WVNS TO COMPLETE FINAL PRESENT -ATIONS TO ORRB
ORRB0700	22JUN93	ORRB TO RECCOMEND STARTUP
ORRB0800	06JUL93	DOE-WV TO REQUEST DOE-ID APPRO VAL FOR S/U
ORRB0900	03AUG93	DOE-ID TO PROVIDE APPROVAL
RCRA		
RCRA0050	02OCT89	NYS RECEIVES MIXED WASTE AUTHO -RIZATION
RCRA0100	20JUN90	PREPARE RCRA PART A APPLICAT'N
RCRA0200	09DEC91	PREPARE RCRA PART B APPLICAT'N
RCRA0250	05MAR92	RESOLVE COMMENTS ON RCRA APPS.
RCRA0300	12JUL93	SUBMIT APPS. & OBTAIN APPROVAL TO OPERATE
SPDE		
SPDE0100	27OCT89	ASSESS VIT OPS WASTE STREAMS IMPACT ON LWTS
SPDE0150	30OCT89	DETERMINE IF SPDE MODS REQ'D
SPDE0200	29DEC89	PREPARE SPDES PERMIT (LIQUID)
SPDE0220	26FEB90	DOE REVIEW & COMMENT
SPDE0240	26MAR90	RESOLVE DOE COMMENTS
SPDE0300	24APR90	ISSUE TO NYS DEC FOR APPROVAL
SPDE0400	20JUN90	OBTAIN NYS DEC COMMENTS
SPDE0500	19JUL90	RESOLVE NYS DEC COMMENTS
SPDE0600	02AUG90	RESUBMIT PERMIT TO NYS DEC
SPDE0700	26SEP90	NYS DEC TO ISSUE PERMIT
VSAR		
VSAR0100	29JAN87	ISSUE PSAR FOR COMMENT VIT HOT OPS *COMPLETE*
VSAR0200	17NOV89	DOE/NRC COMMENT FOR HOT OPS
VSAR0300	05SEP90	PREPARE DRAFT FSAR HOT OPS
VSAR0400	19DEC89	COMPLETE INDEPENDENT CRIT. ANALYSIS
VSAR0500	01NOV90	ISSUE DRAFT FSAR FOR DOE/NRC COMMENT
VSAR0510	26APR91	DOE/NRC PROVIDE COMMENTS
VSAR0520	20AUG91	RESOLVE COMMENTS
VSAR0530	16OCT91	ISSUE FSAR FOR DOE APPROVAL CMS362
VSAR0600	05JUN92	DOE PROVIDE APPROVAL SAR CMS 091
VSAR0700	26JAN93	NRC TO COMPLETE SAR VIT HOT OPS
VSAR0800	06JUL92	WVNS TO ISSUE FSAR FOR USE VIT HOT OPS
VSAR1000	21APR93	COMPLETE REV OF OP PROCEDURES TO INCORP OSAs
VF-002 CONSTRUCTION		
VF002	30SEP92	VF-002 MECH/ELEC CONSTRUCTION
COLD OPERATIONS		
COLDOPS	30SEP93	COLD OPERATION OF VIT. SYSTEM
HOT OPERATIONS		
EOP01	30MAR95	VIT HOT OPERATIONS



Legend
- In progress
- Planned
- Critical

All characters represent 44 time unit(s)

Signatures

Prep: J.H. Fiske

Aprv: P.S. Klanian

OPEN PLAN (tm)

Report: WVGRFBAR
Project: INSTREQ
Time Now: 06APR89
Date: 12SEP89
Time: 09:26:52
Page: 1

INSTITUTIONAL REQUIREMENTS NETWORK

West Valley Nuclear Services

ACT NUM	EF DATE	01 JAN 86	01 JAN 87	01 JAN 88	01 JAN 89	01 JAN 90	01 JAN 91	01 JAN 92	01 JAN 93	01 JAN 94	01 JAN 95
						← Time now					
HSAR											
HSAR0100	24AUG89					DEFINE HAZARD CLASS HLW STORAGE					
HSAR1000	24AUG89					PREPARE DRAFT NEPA DOCUMENTATN					
HSAR0400	20MAR90					PREPARE SAR HLW STORAGE					
HSAR0200	20OCT89					ISSUE TO DOE FOR APPROVAL HLW STORAGE					
HSAR1100	22SEP89					ISSUE TO DOE FOR APPROVAL					
HSAR1200	12DEC89					DOE REVIEW & PROVIDE COMMENTS					
HSAR0300	01MAR90					OBTAIN DOE APPROVAL HLW STORAGE					
HSAR1300	09FEB90					RESOLVE DOE COMMENTS/ RESUBMIT					
HSAR1400	09MAR90					RECIEVE DOE APPROVAL					
HSAR0500	18APR90					ISSUE SAR FOR DOE/NRC COMMENTS HLW STORAG					
HSAR0600	13JUL90					DOE/NRC PROVIDE COMMENTS HLW STORAGE					
HSAR0610	10SEP90					RESOLVE COMMENTS HLW STORAGE					
HSAR0620	08OCT90	ISSUE FOR DOE APPROVAL HLW STOR CMS3									
HSAR0630	07JAN91	DOE PROVIDE APPROVAL HLW STOR CMS080									
HSAR0700	25JAN91	WVNS TO ISSUE SAR FOR USE HLW STORAGE									
HSAR0800	30APR91						NRC TO COMPLETE SER HLW STORAGE				
NESHAP											
NSPR0090	15JAN88			FINALIZE CONFIG OF PROCESS OFF GAS SYSTEM *COMPLETE*							
NSIC0090	01FEB89				FINALIZE CONFIG OF CELL VENT SYSTEM *COMPLETE*						
NSIC0100	31JUL89					PREPARE DRAFT EPA APPS. CONST CELL VENT SYS.					
NSPR0100	31JUL89					PREPARE DRAFT EPA APPS. CONST. PROCESS OG SYS					
NSIC0200	31AUG89					DOE REVIEW DRAFT EPA APPS. CELL VENT SYS.					
NSPR0200	31AUG88					DOE REVIEW DRAFT EPA APPS. PROCESS OG SYS.					
NSIC0300	29SEP89					REVISE WVPO COMMENTS ON EPA APPS.					
NSPR0300	29SEP89					REVISE WVPO COMMENTS ON EPA APPS.					
NSIC0400	29DEC89					SUBMIT EPA APPS. FOR CONST. OF CELL VENT S					
NSPR0400	29DEC89					SUBMIT EPA APPS. FOR CONST OF PROCESS OG SY					
NSIC0500	31JAN90					EPA ISSUE CONSTR. PERMIT FOR CELL VENT SYS					
NSPR0500	31JAN90					EPA ISSUE CONSTR. PERMIT FOR PROCESS OG SY					
NESP0600	14OCT92				NOTIFY EPA OF COLD OPS START						
NESP0700	11NOV92				EPA TO ISSUE OPER. CERTIFICATE						
NOX											
NXIC0090	30JUN89					FINALIZE CONFIG OF NOx SYSTEM					
NXIC0100	02AUG89					ASSESS NOx DISCHARGE FROM SYS.					
NXIC0200	28SEP89					PREPARE NYS PERMIT FOR NOx EMMISSIONS					
NXIC0300	26OCT89					ISSUE TO NYS FOR APPRVAL					
NXIC0400	20APR90					OBTAIN NYS COMMENTS					
NXIC0500	18MAY90					RESOLVE NYS COMMENTS					
NXIC0600	15JUN90					RESUBMIT NOx EMMISSIONS PERMIT TO NYS					
NXIC0700	12SEP90					NYS TO ISSUE PERMIT FOR NOx EMMISSION					
ORRB											
ORRB0100	25DEC90	FORM & TRAIN ORR TEAM TO COM- PLETE CH									
ORRB0200	19APR91						DEVELOP MORT				
ORRB0300	09OCT91							DEVELOP CHECKLIST FROM MORT			

Legend
- ■ = In progress
- ▨ = Planned
- ▥ = Critical

All characters represent 44 time unit(s)

Signatures

Prep: J.H. Fiske

Aprv: P.S. Klanian

4

ACTIVITIES AT VSL IN SUPPORT OF THE WEST VALLEY DEMONSTRATION PROJECT

OCTOBER, 1989

VITREOUS STATE LABORATORY
THE CATHOLIC UNIVERSITY OF AMERICA
WASHINGTON, DC 20064

I. Process Model

↓

Composition

↓

II. Product Model

A. Processability
   (i) Viscosity
   (ii) Crystallization

B. Durability
   (i) Short term
      (a) MCC-1
      (b) PCT

   (ii) Long term
      (a) Extended PCT
      (b) Flow tests

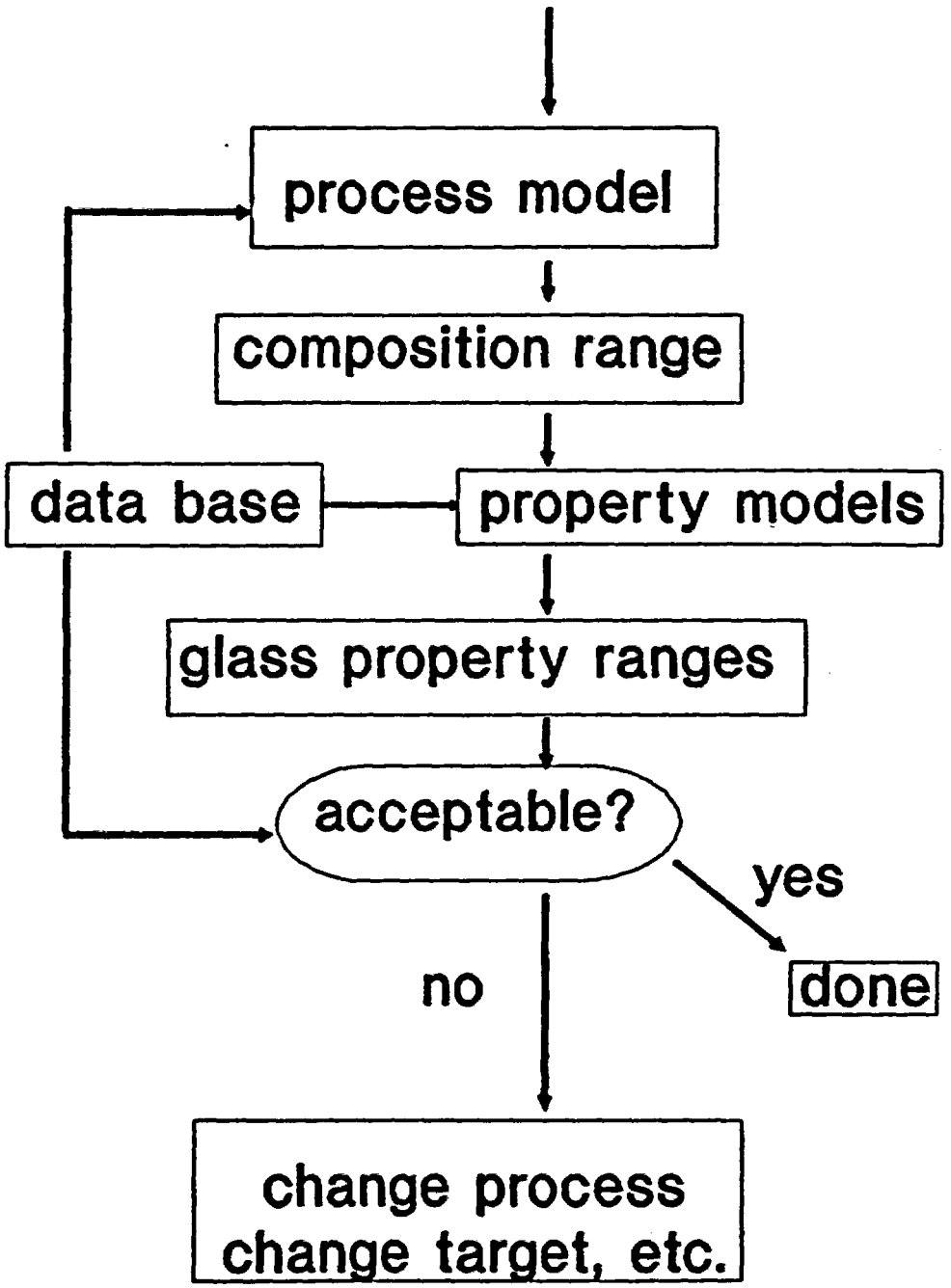
↓

III. Statistical Analysis

↓

GOOD PRODUCT

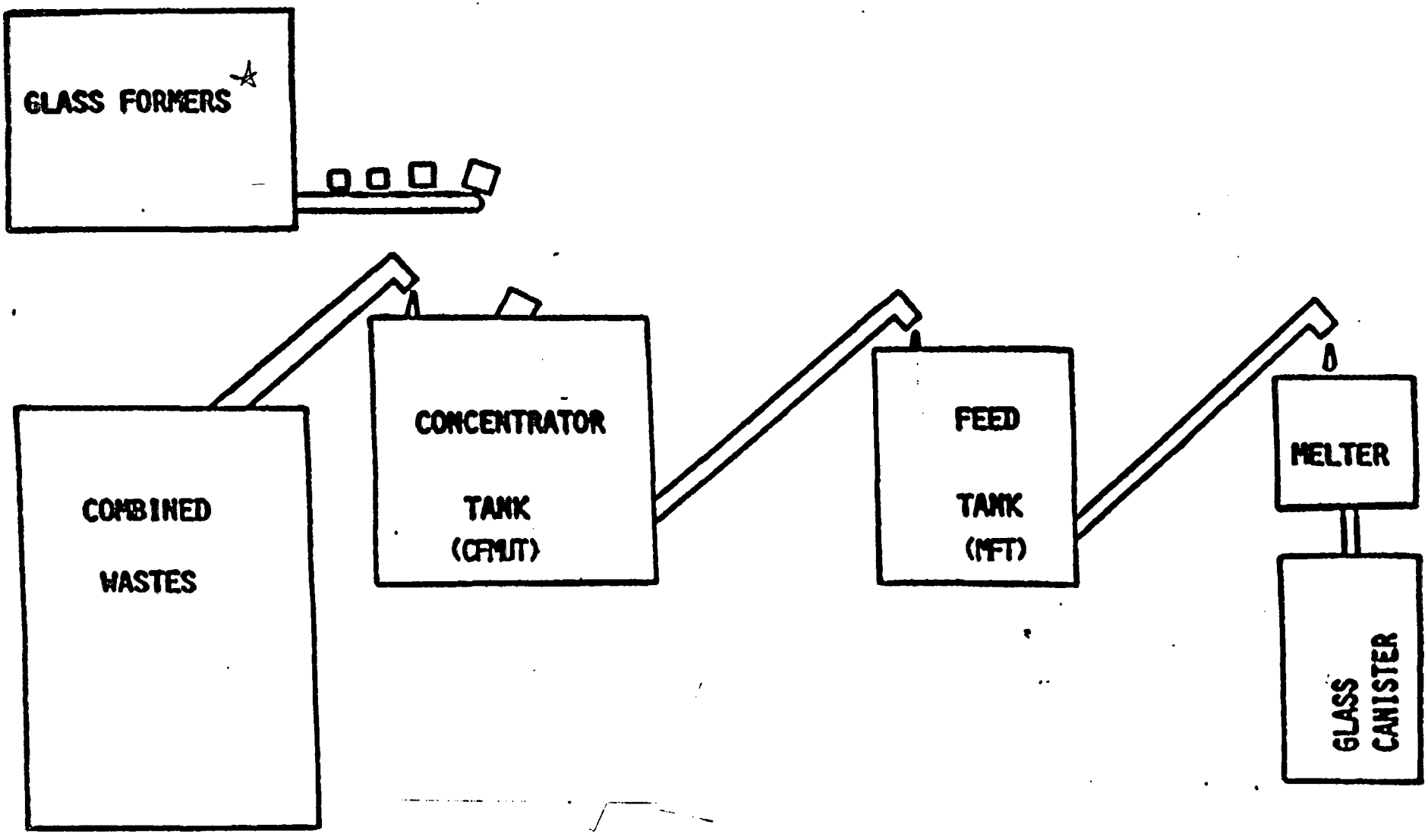
WVDP PROCESS



PROCESS MODEL
CUA/VSL Approach

- Identify key process parameters and expected variabilities
  - e.g. volume and concentration measurements with rsd's
- Do mass balance for process
- Analytic error propagation
- Yields expected variability in production glass composition
- Permits precise statistical definition of process region:
  e.g. "composition region expected to contain 99% of production glasses"
- Clearly identifies which process control variables play most important roles
  - i.e. <u>gives insight</u>

PROCESS MODEL - SCHEMATIC

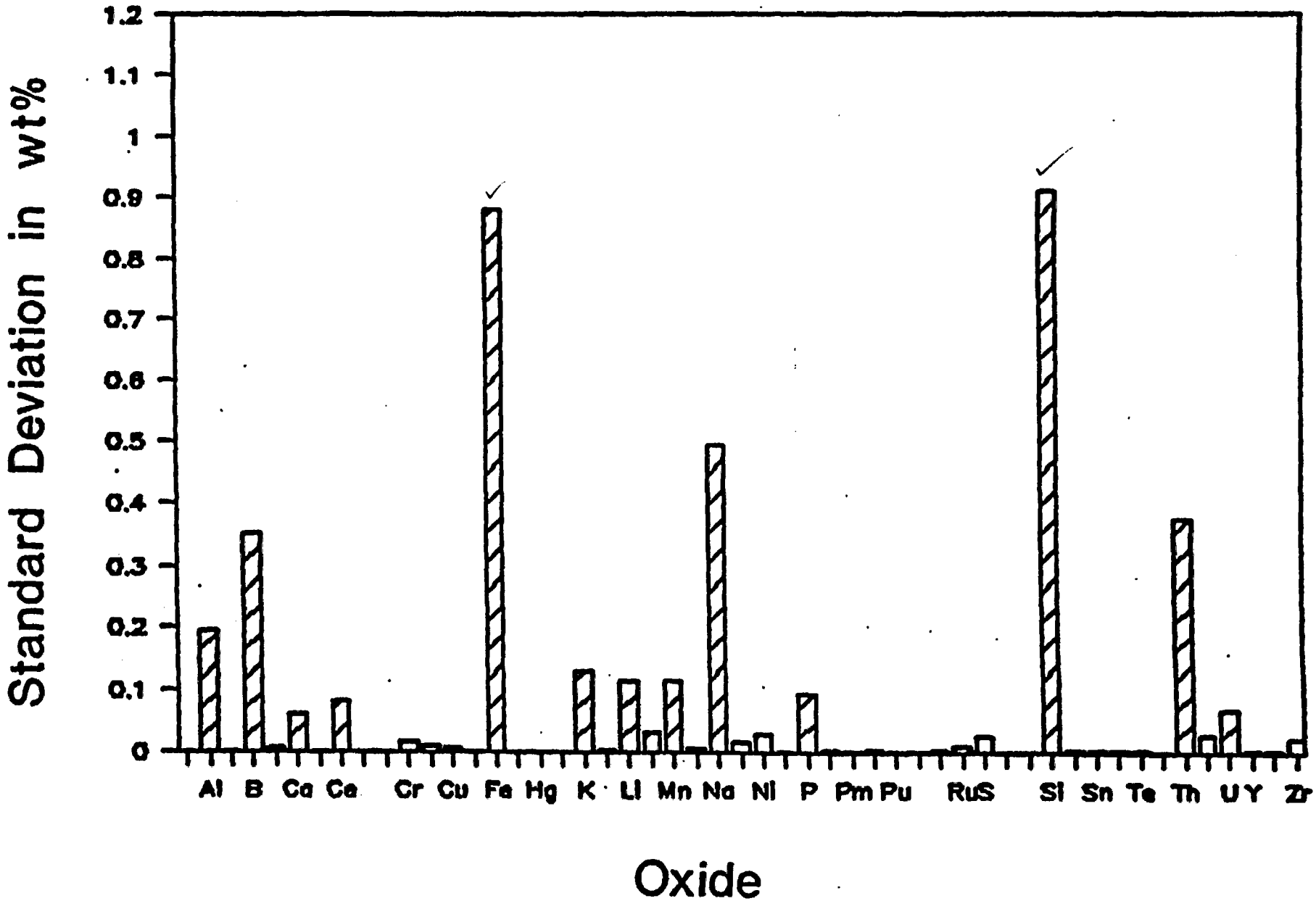


PRESENT WVDP ESTIMATES

$\sigma_V/V = 10\%$
$\sigma_D/D = 2\%$

oxide	σ_c/c	target WVW-RG4 wt%
Al2O3	6%	6.5
B2O3	6%	10.2
Fe2O3	5%	12.1
Na2O	9%	11.4
SiO2	5%	41
ThO2	9%	3.6
others	10%	15.2

PREDICTED PRODUCT VARIABILITY



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III. Statistical Analysis

↓

GOOD PRODUCT

WVDP EXPECTATIONS

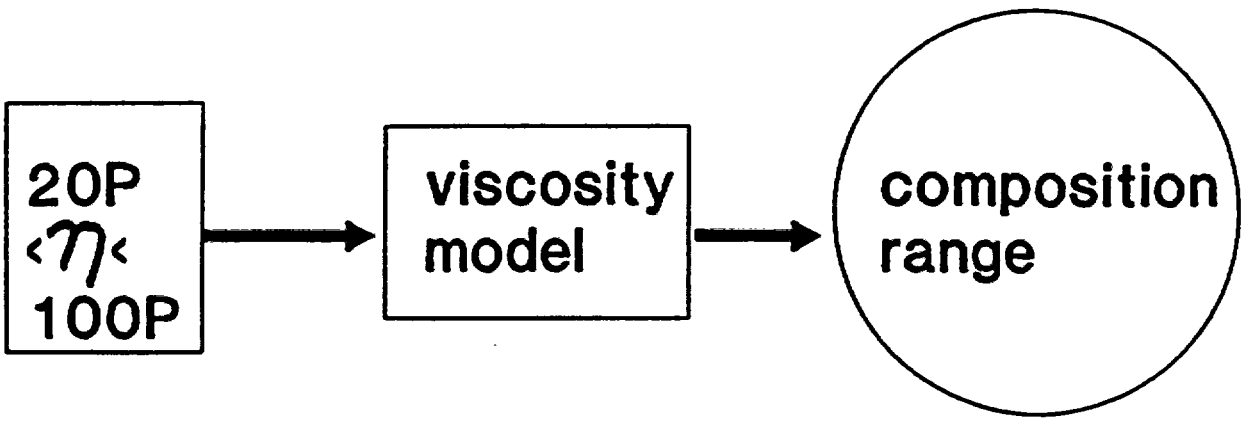
At 1100°C 20P< η <100P is acceptable

ABOVE 100P

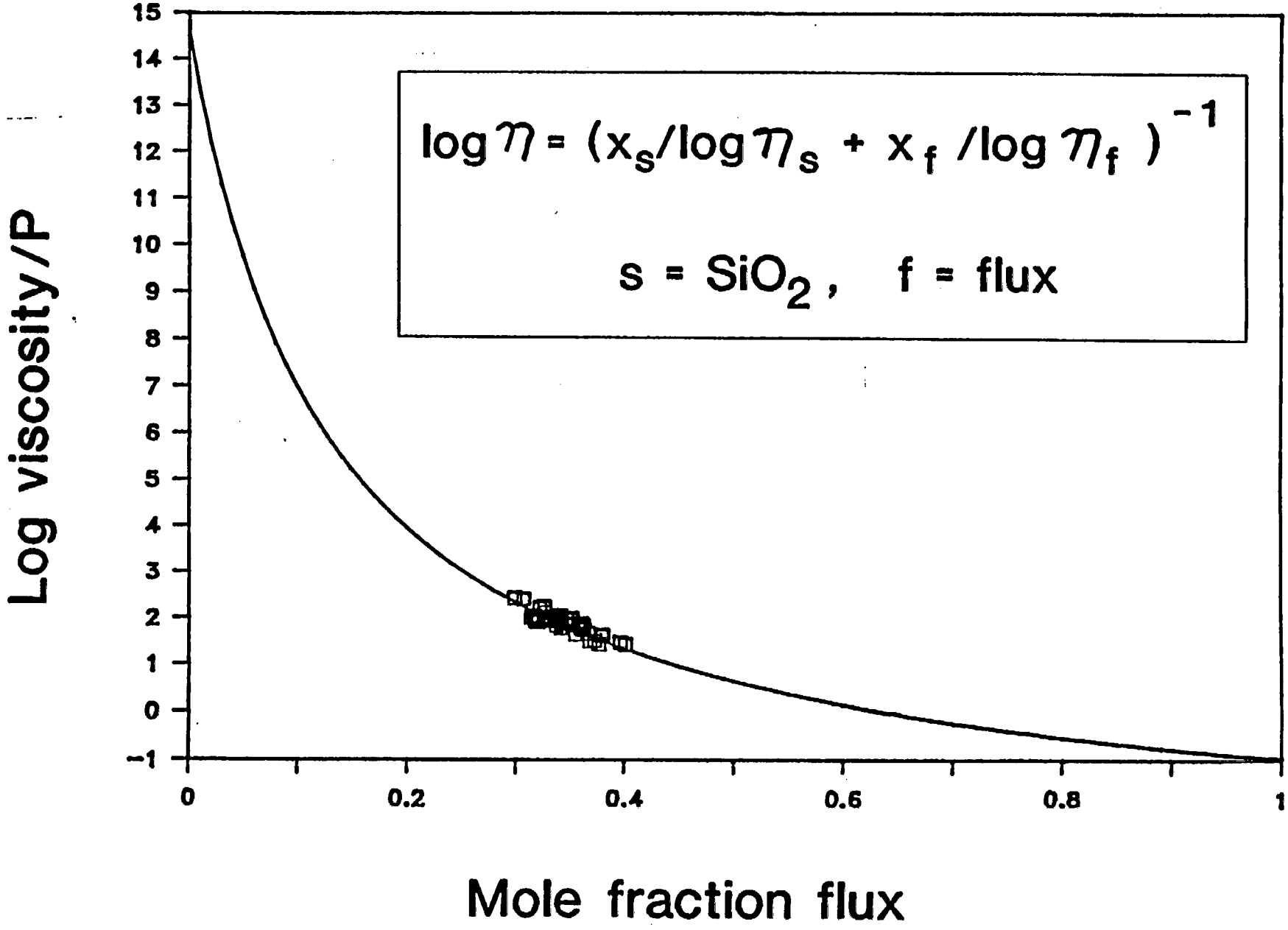
processing rate becomes too slow

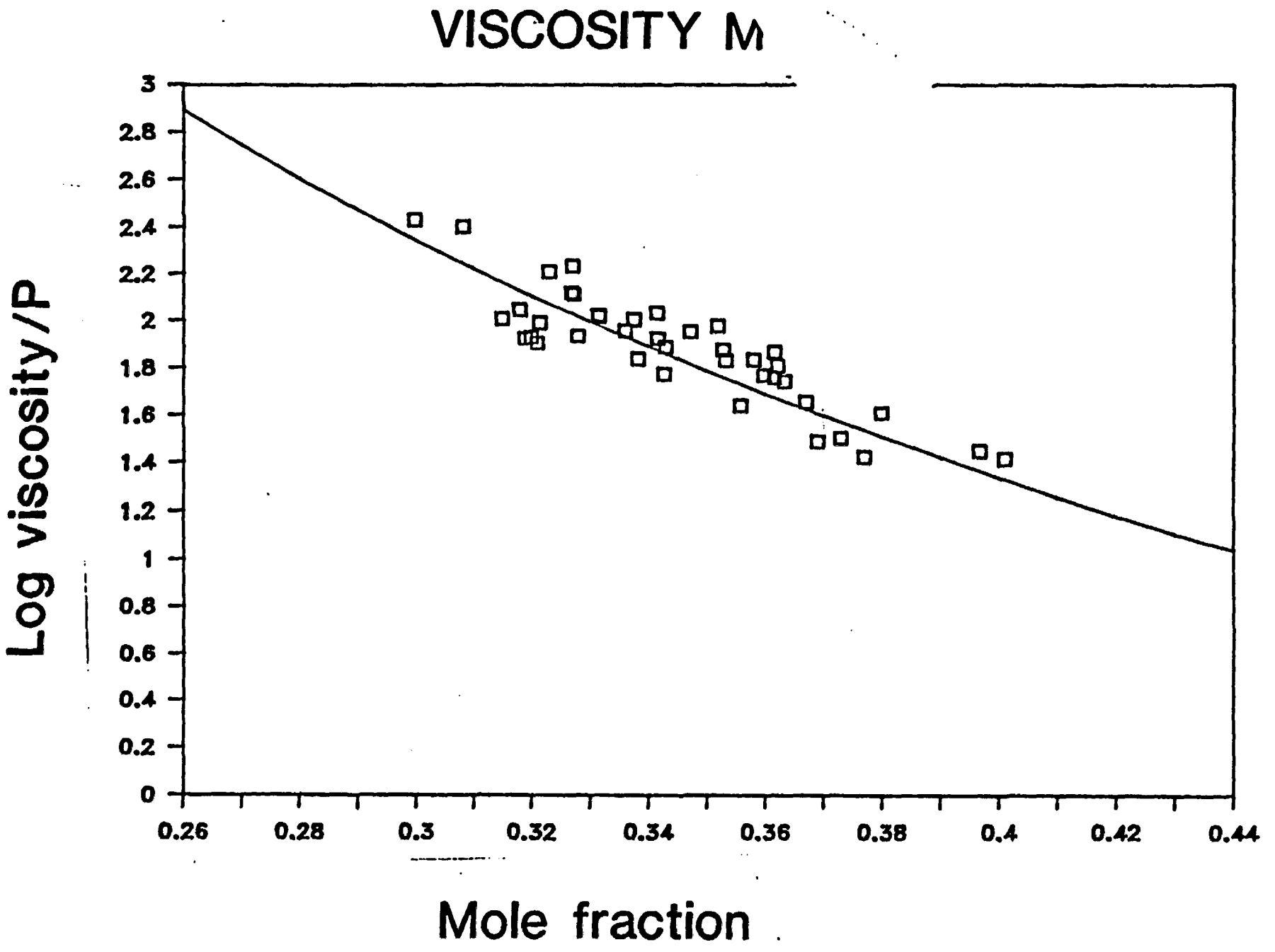
BELOW 20P

melt becomes too corrosive

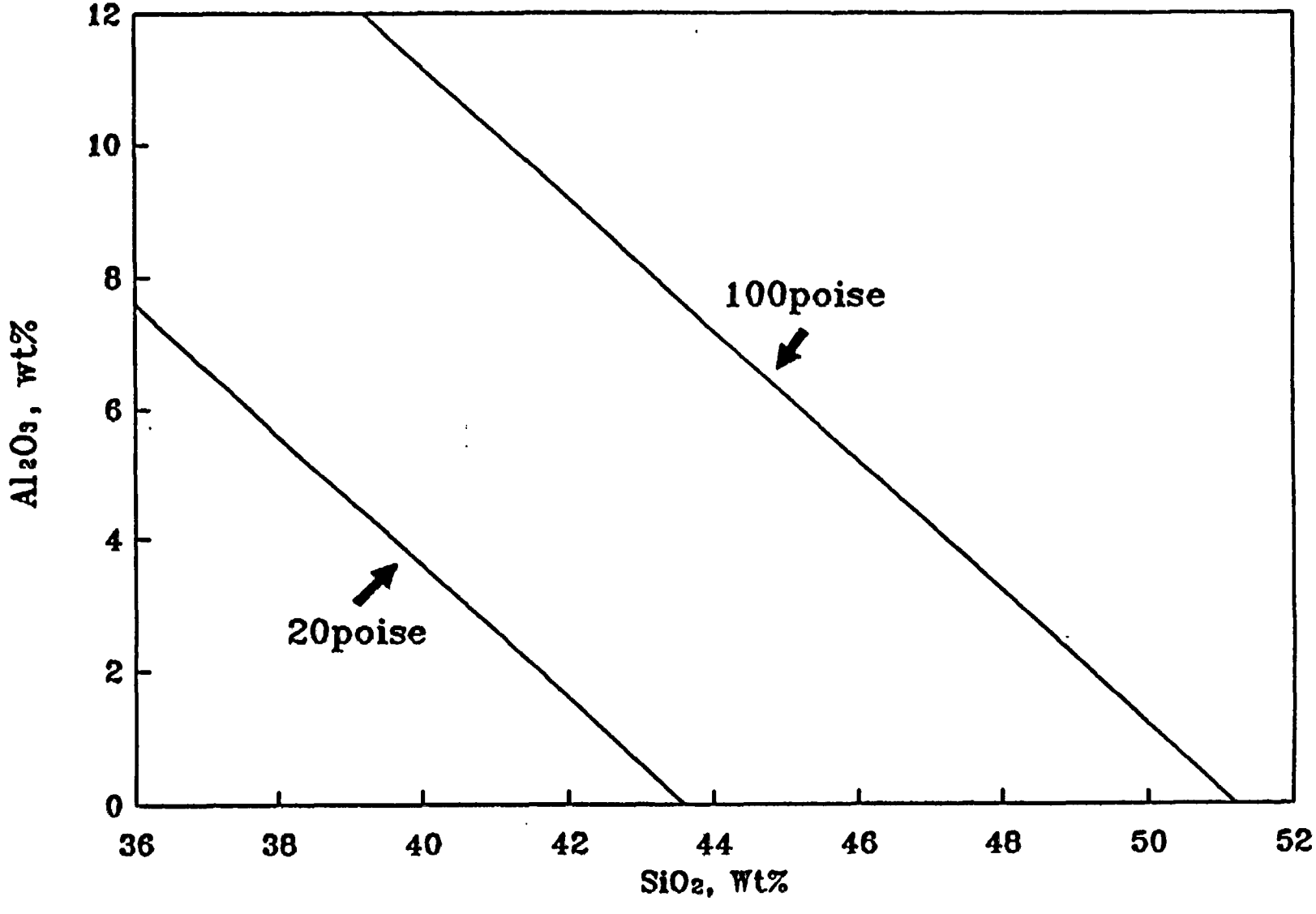


VISCOSITY MODEL

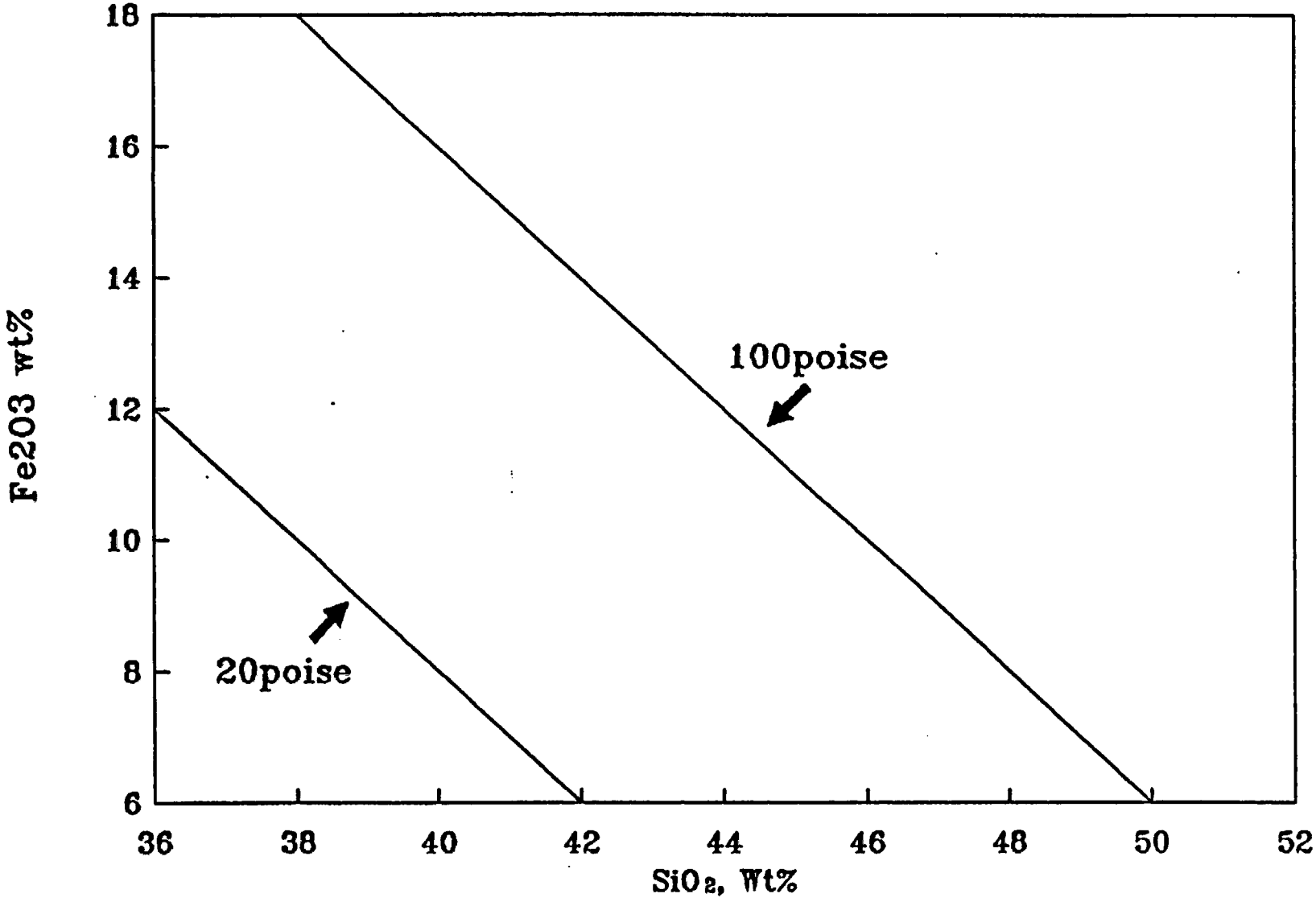



VISCOSITY M
Log viscosity/P
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4
0.42
0.44
Mole fraction

VISCOSITY AT 1100°C



VISCOSITY AT 1100C

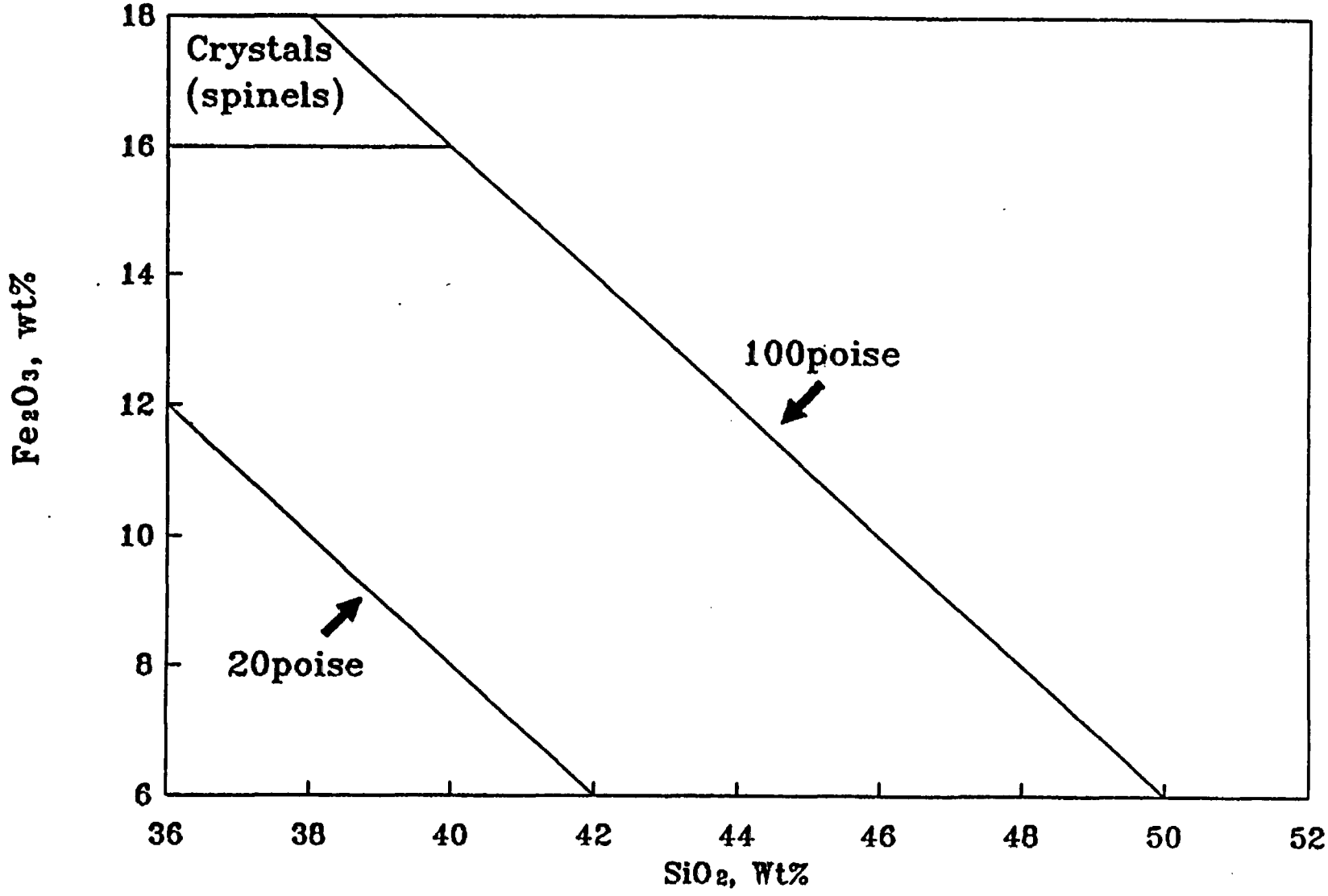


Reference 4

Heat Treated -- 360hrs at 700 C

Yellow -- Augite
Green -- Lithium Phosphate
Red (needles) -- Acmite
Magenta -- Spinels
White -- Thoria/Ceria
Pink -- Glass

PROCESSABLE GLASSES



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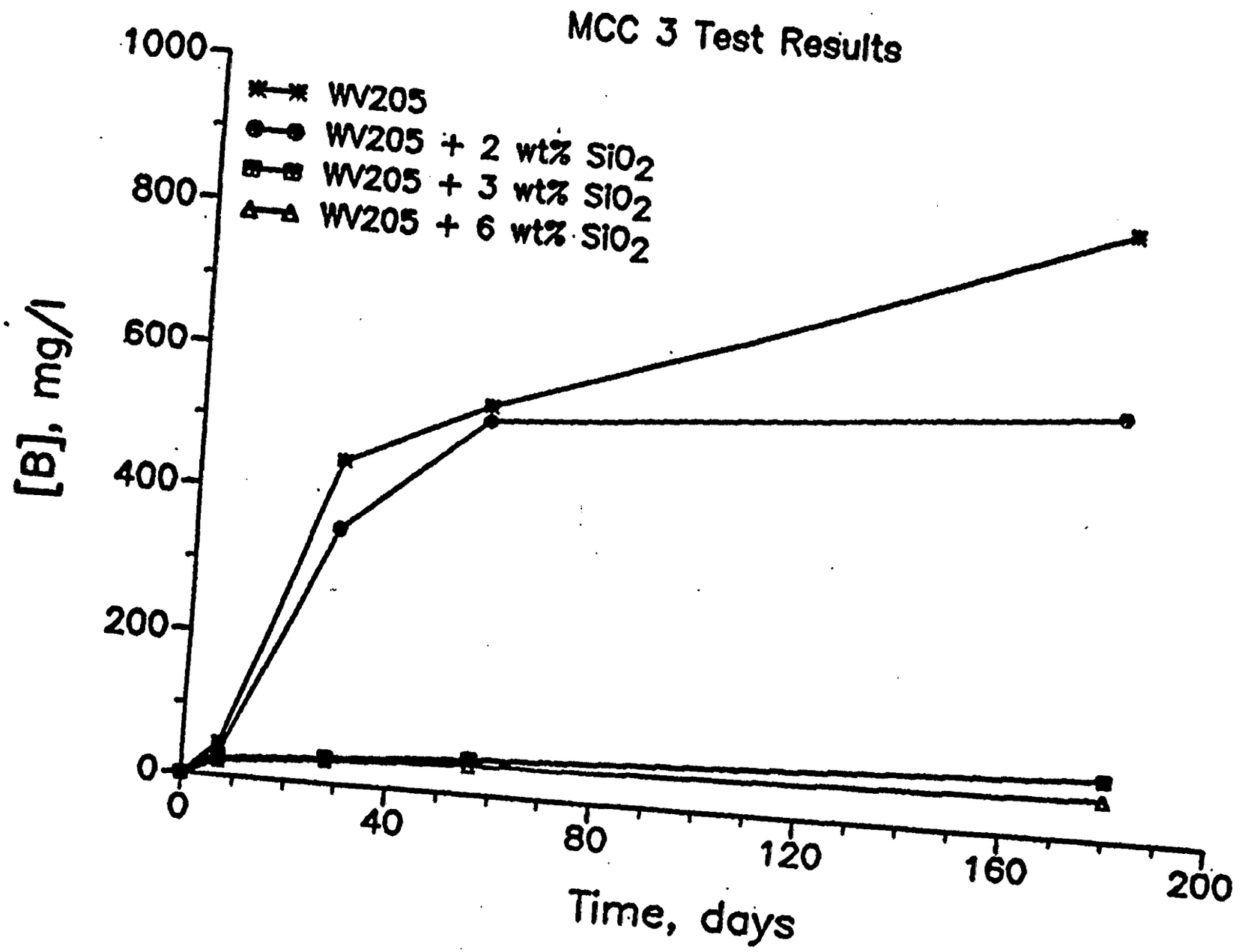
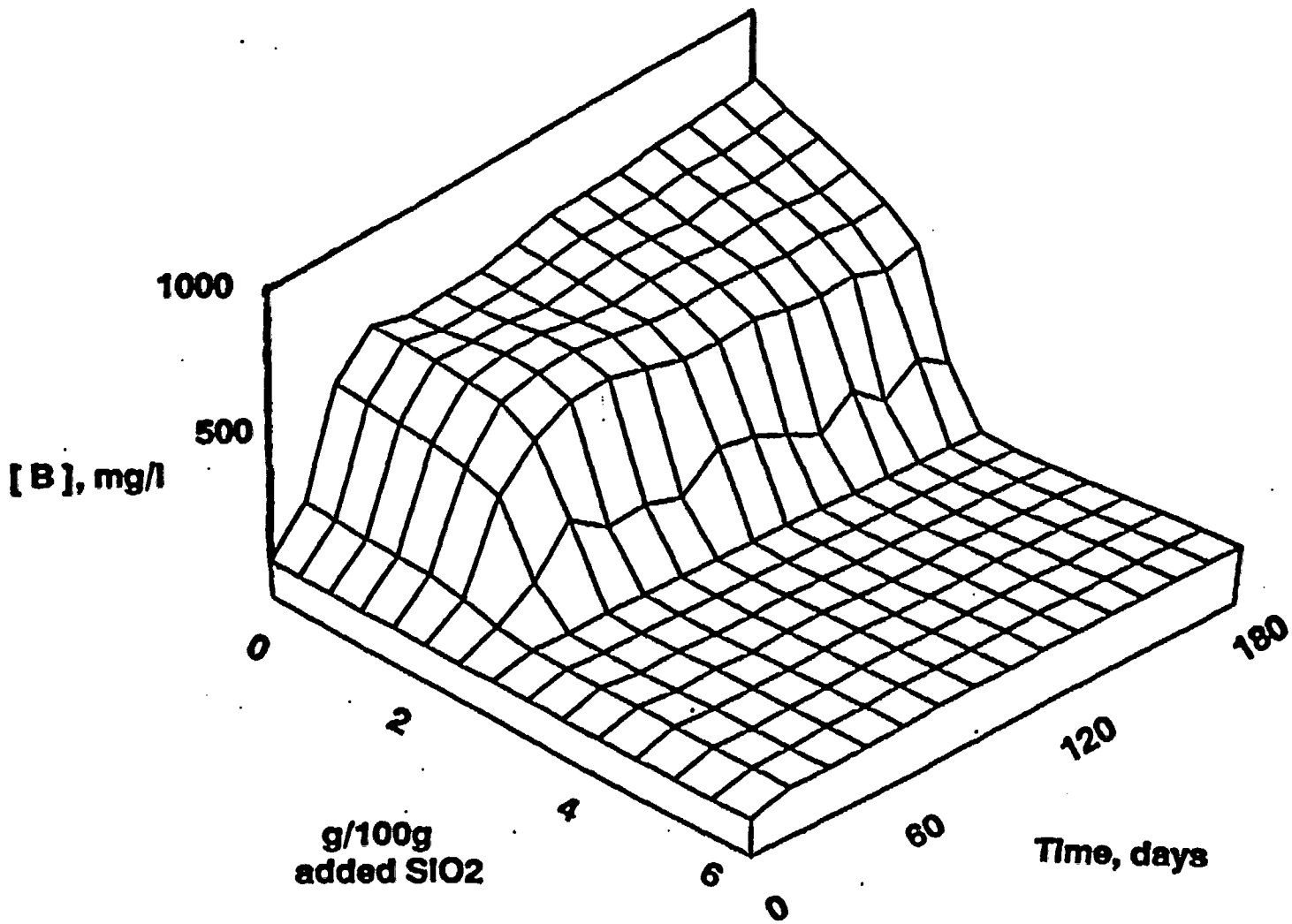
↓

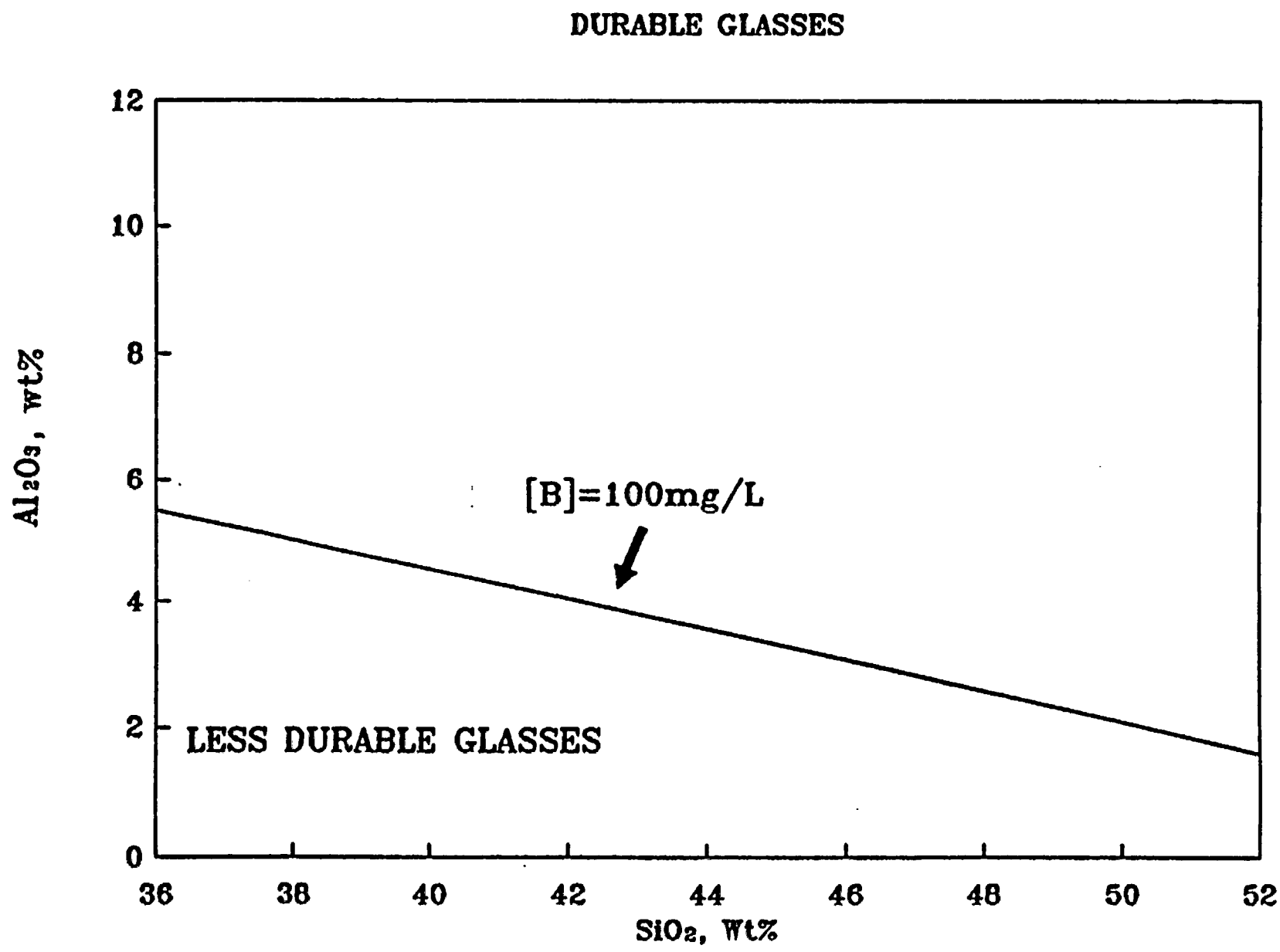
III. Statistical Analysis

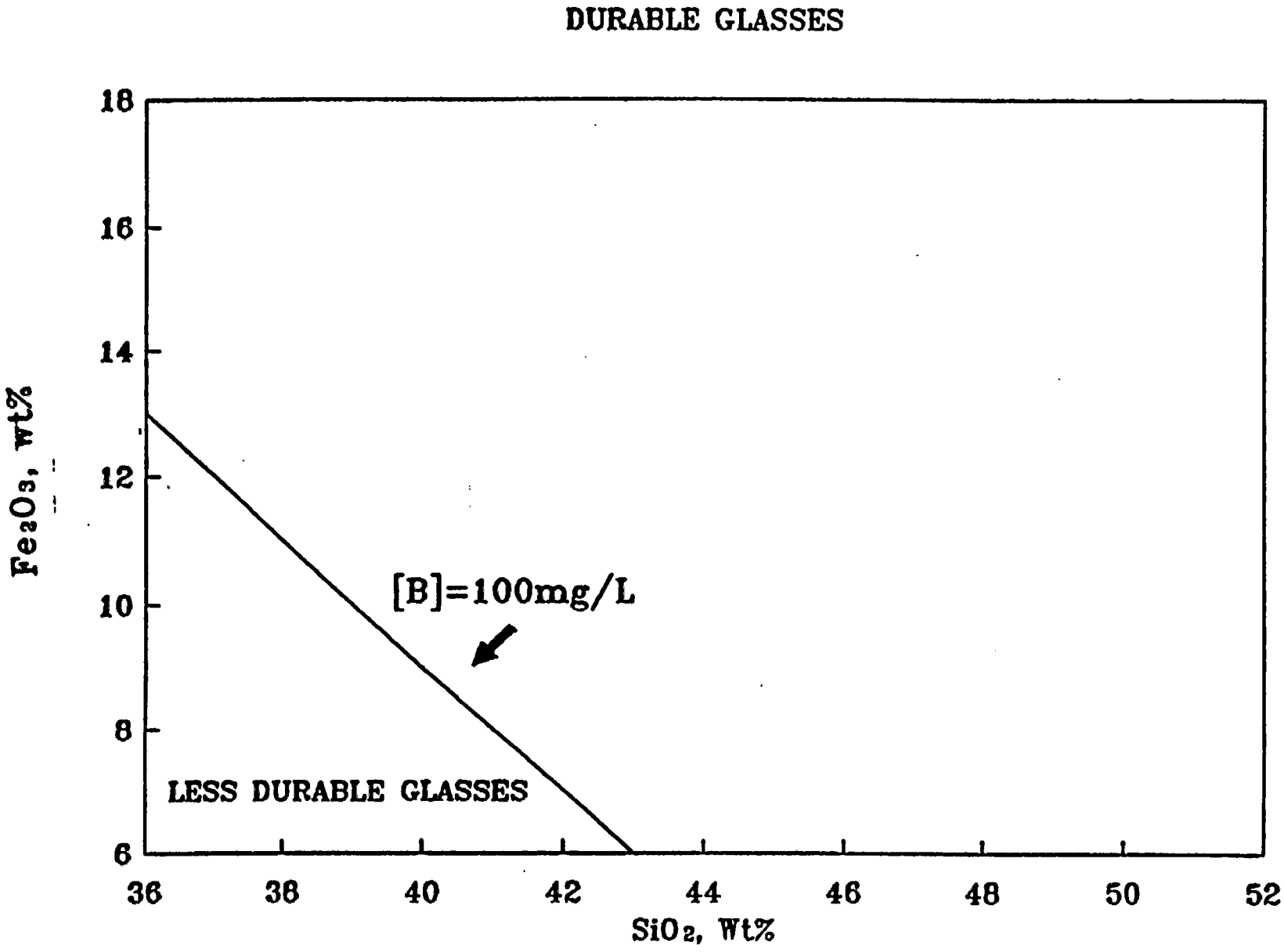
↓

GOOD PRODUCT

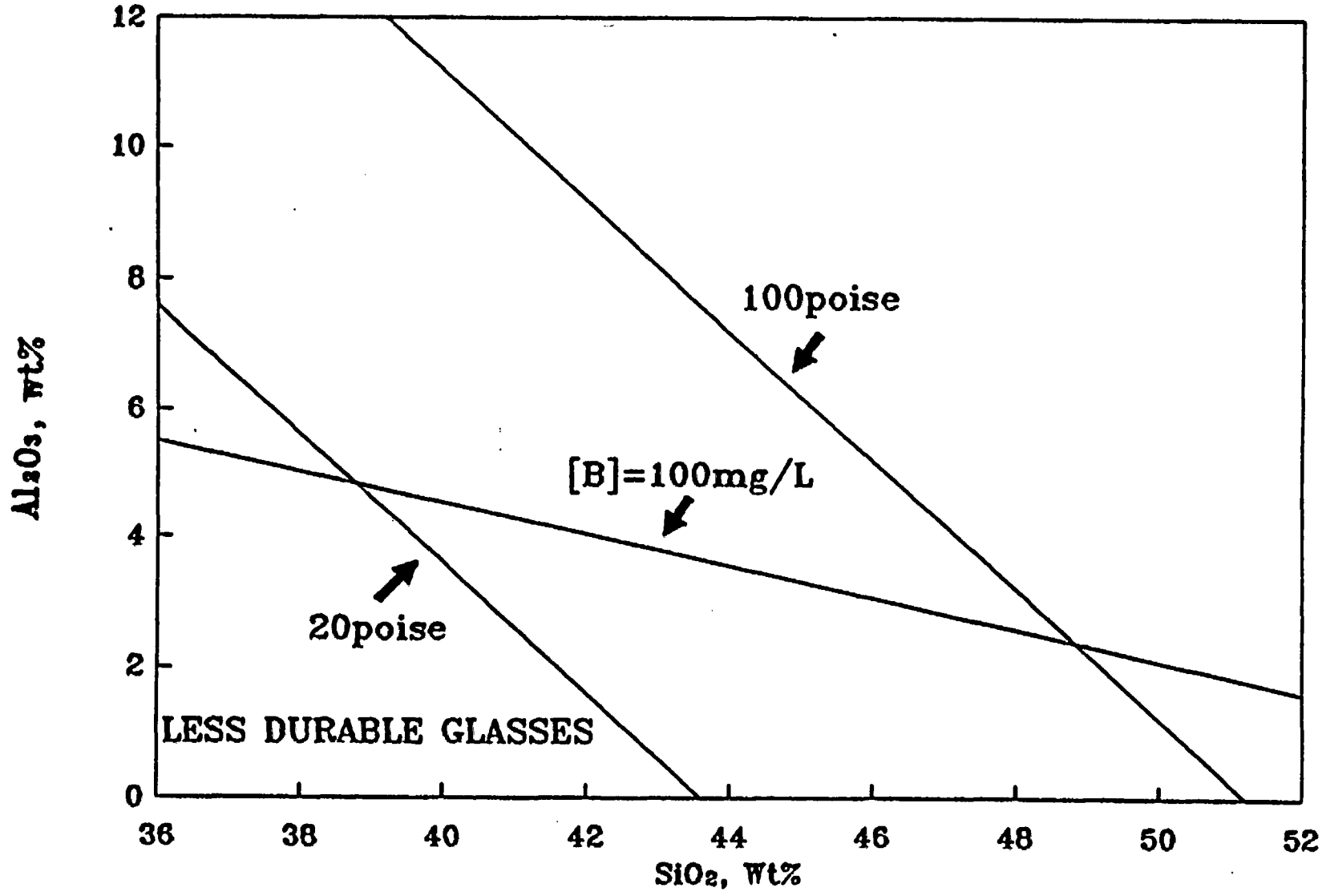

MCC 3 Test Results
WV205
WV205 + 2 wt% SiO2
WV205 + 3 wt% SiO2
WV205 + 6 wt% SiO2
[B], mg/l
1000
800
600
400
200
0
0
40
80
120
160
200
Time, days


1000
500
[B], mg/l
0
2
4
6
g/100g
added SIO2
0
60
120
180
Time, days

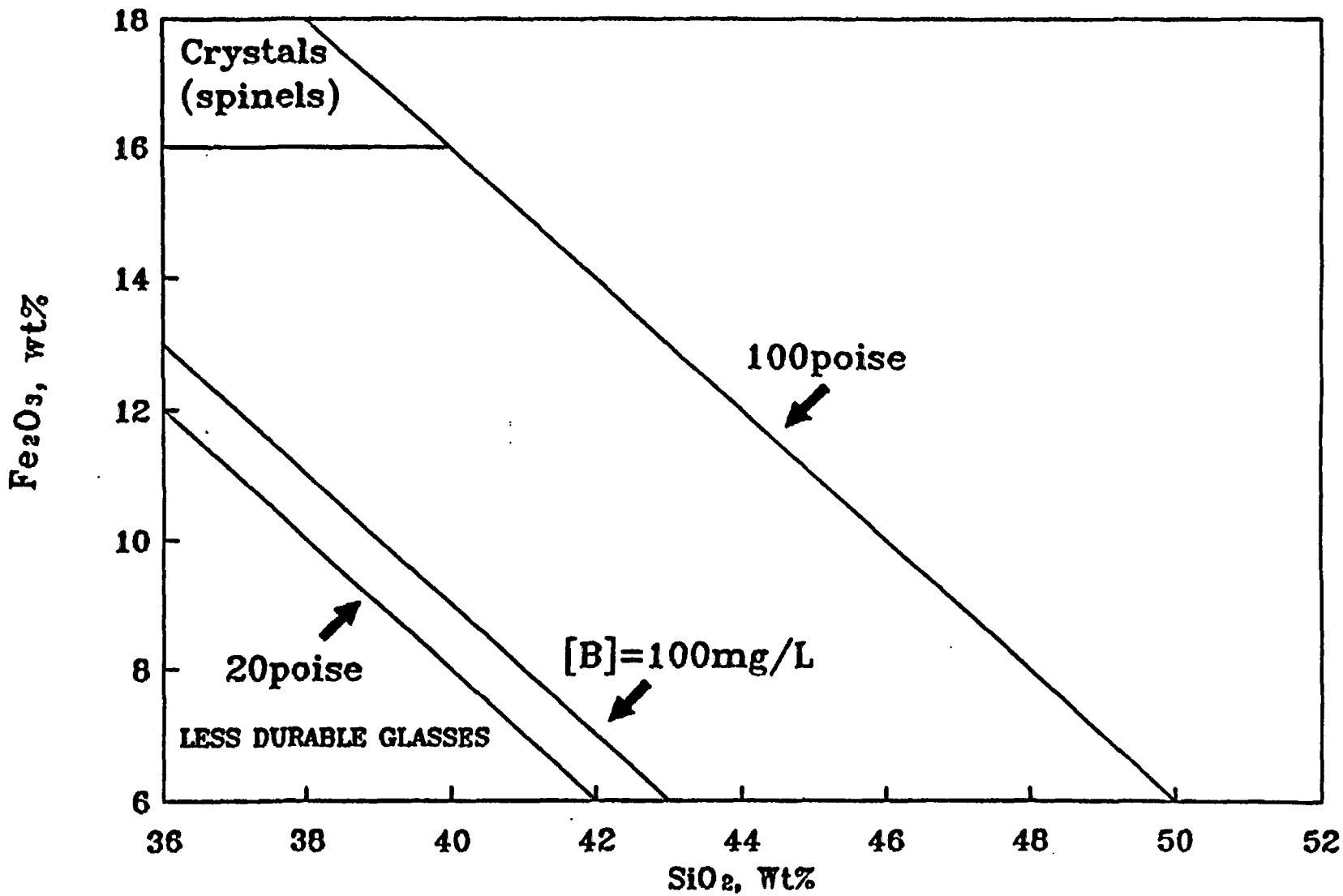

DURABLE GLASSES
12
10
8
6
4
2
0
Al2O3, wt%
[B]=100mg/L
LESS DURABLE GLASSES
36
38
40
42
44
46
48
50
52
SiO2, Wt%


DURABLE GLASSES
18
16
14
12
10
8
6
Fe2O3, wt%
[B]=100mg/L
LESS DURABLE GLASSES
36
38
40
42
44
46
48
50
52
SiO2, Wt%

ACCEPTABLE GLASSES



ACCEPTABLE GLASSES



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   (ii) Long term
      (a) Extended PCT
      (b) Flow tests

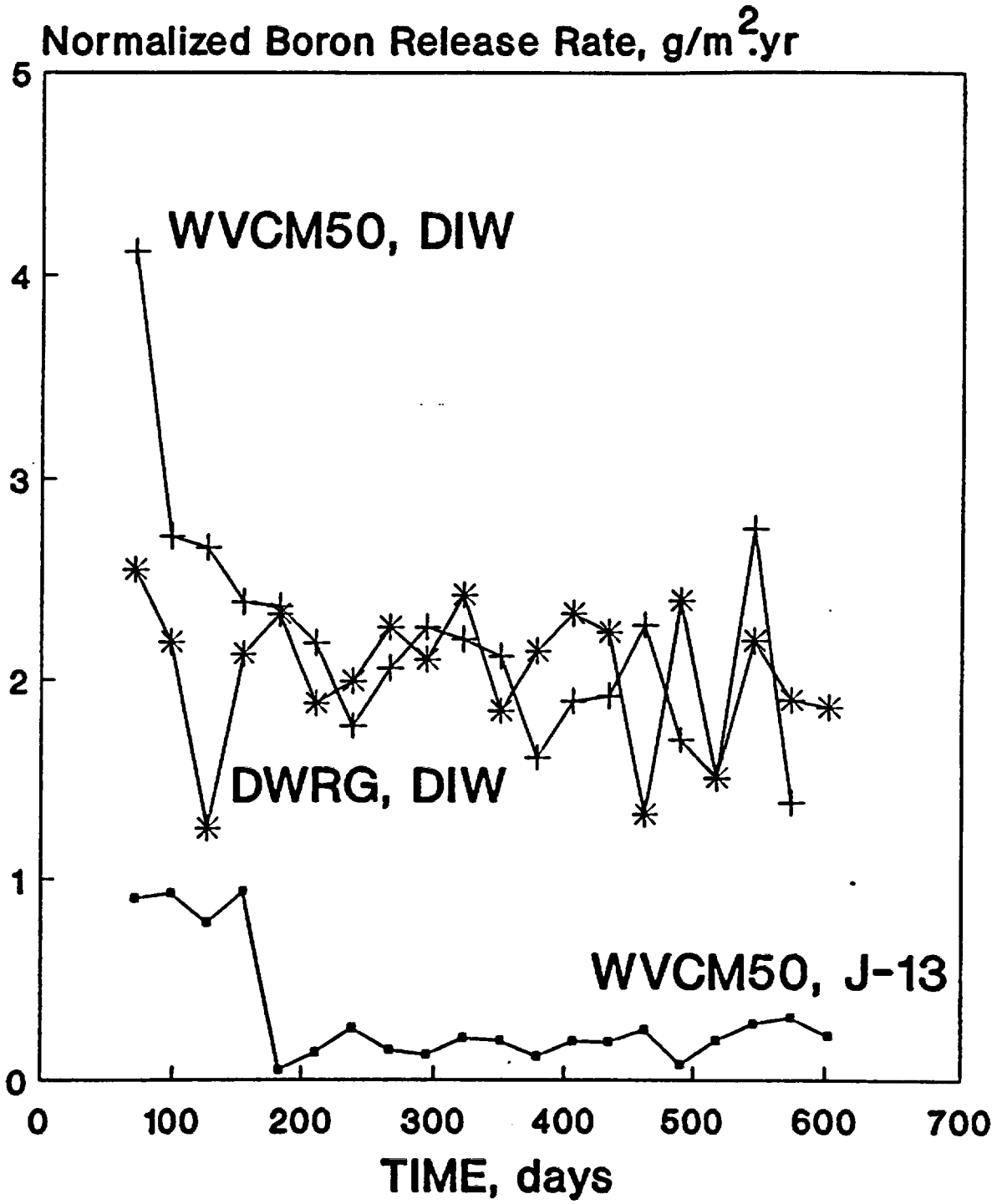
↓

III. Statistical Analysis

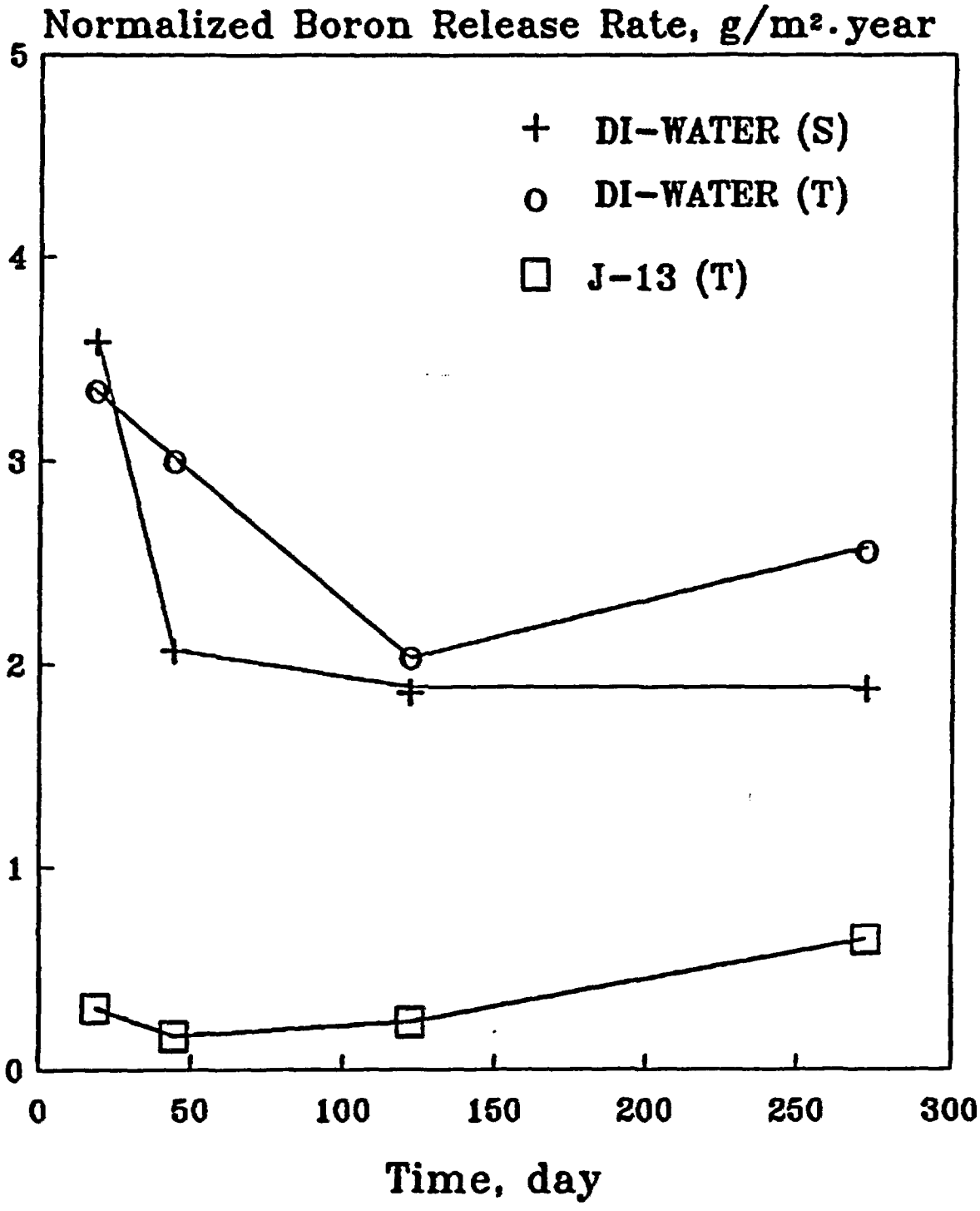
↓

GOOD PRODUCT

Durability of West Valley Glasses



Durability of WVCM50 (MCC3)



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      (a) Extended PCT
      (b) Flow tests

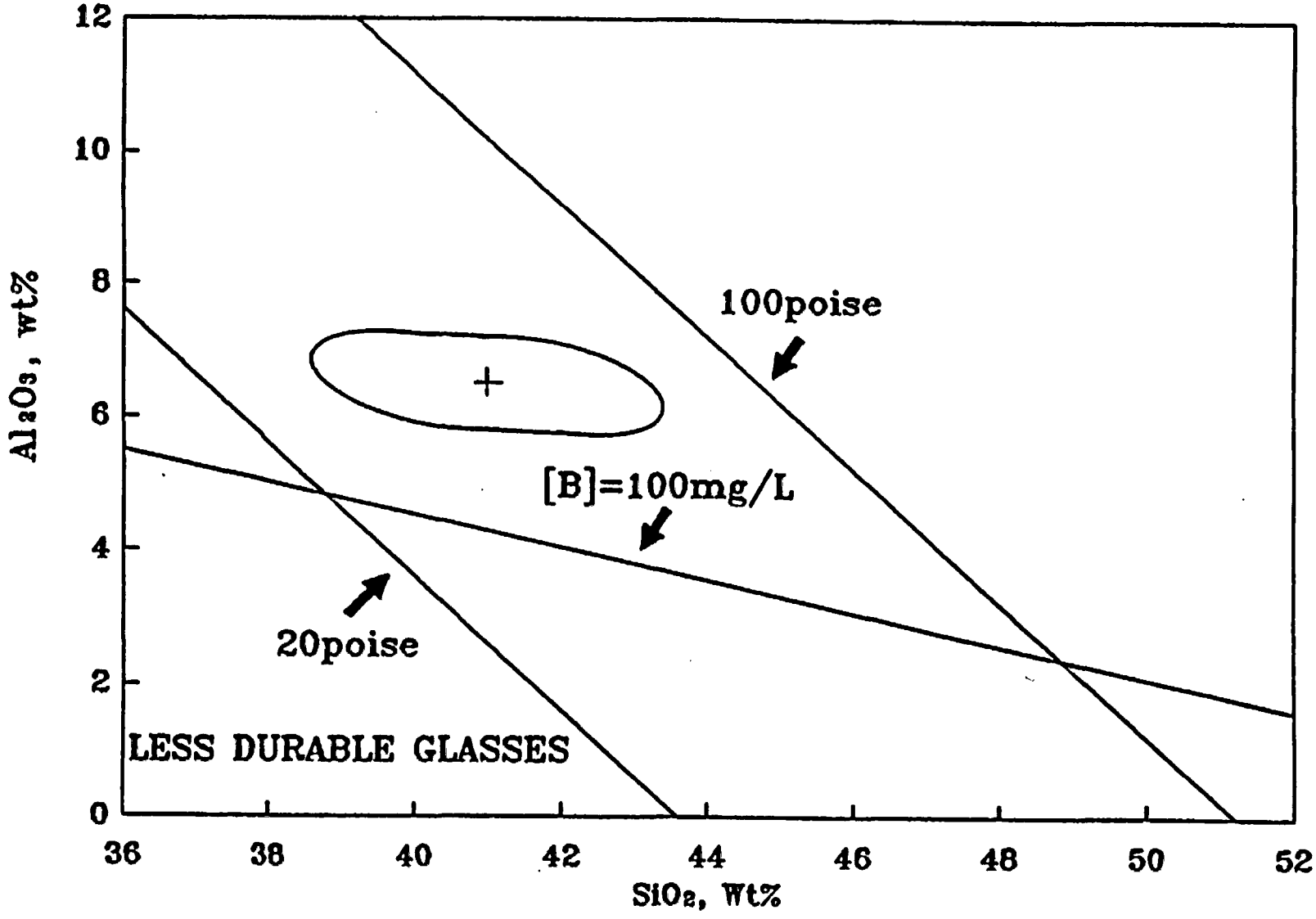
↓

III. Statistical Analysis

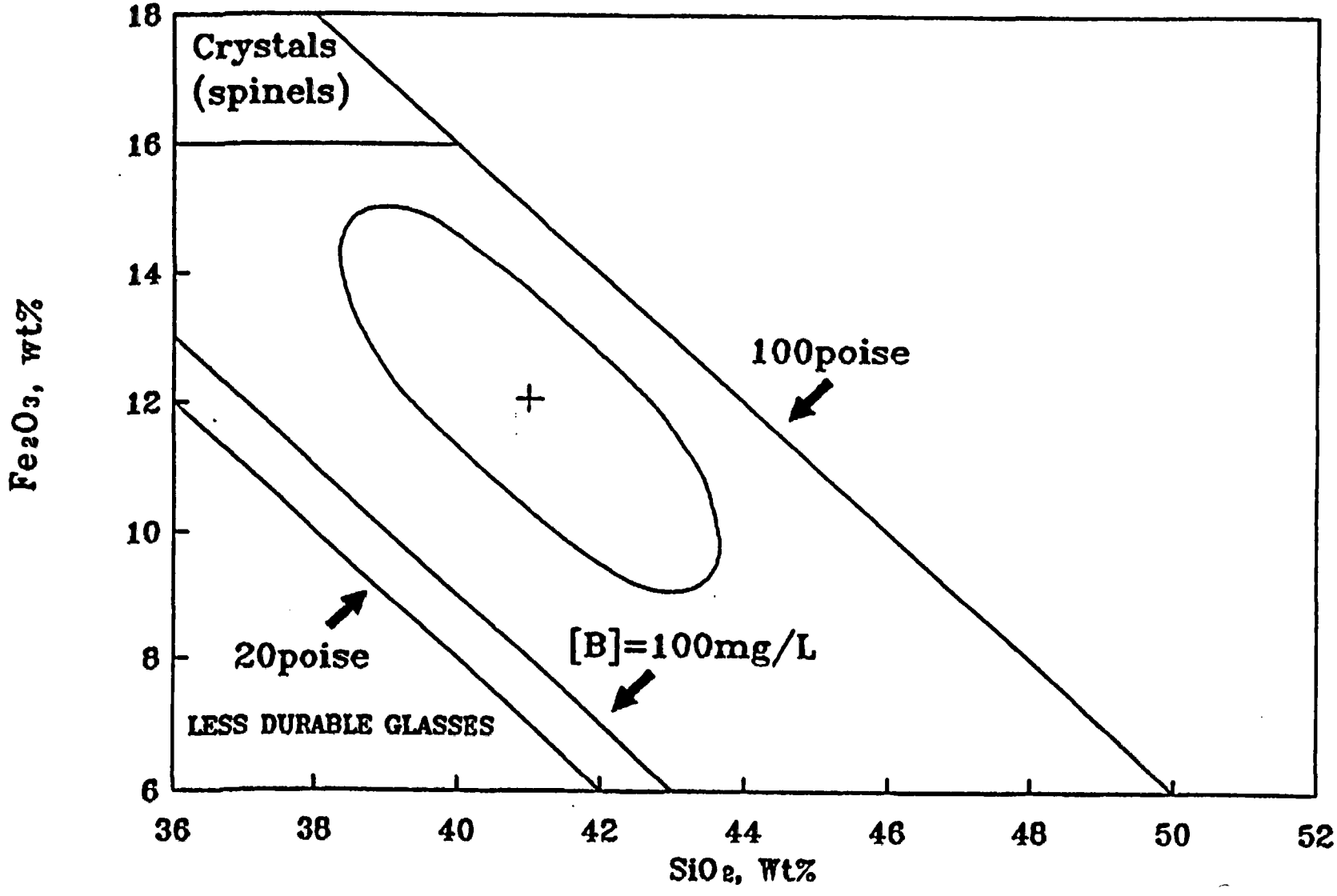
↓

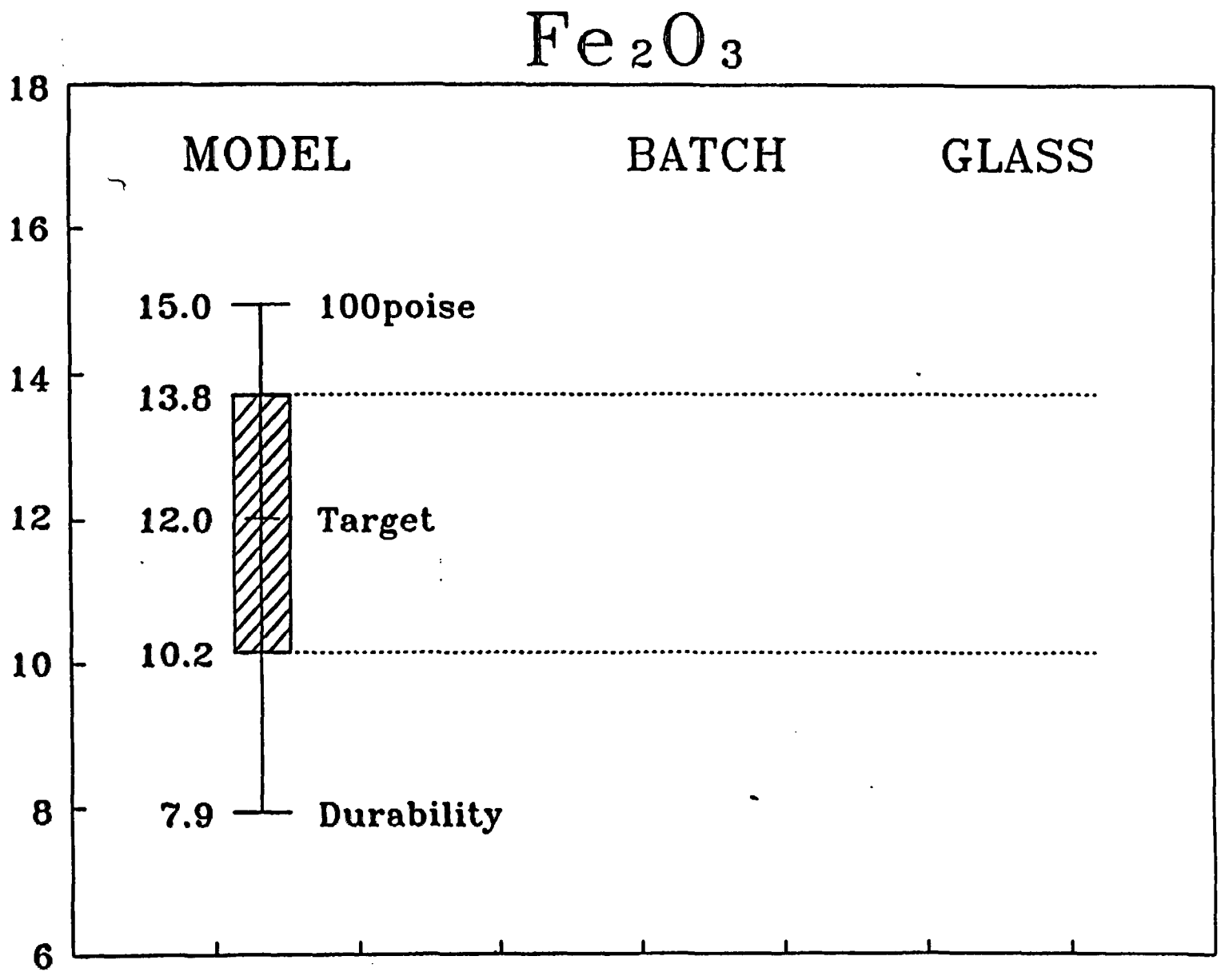
GOOD PRODUCT

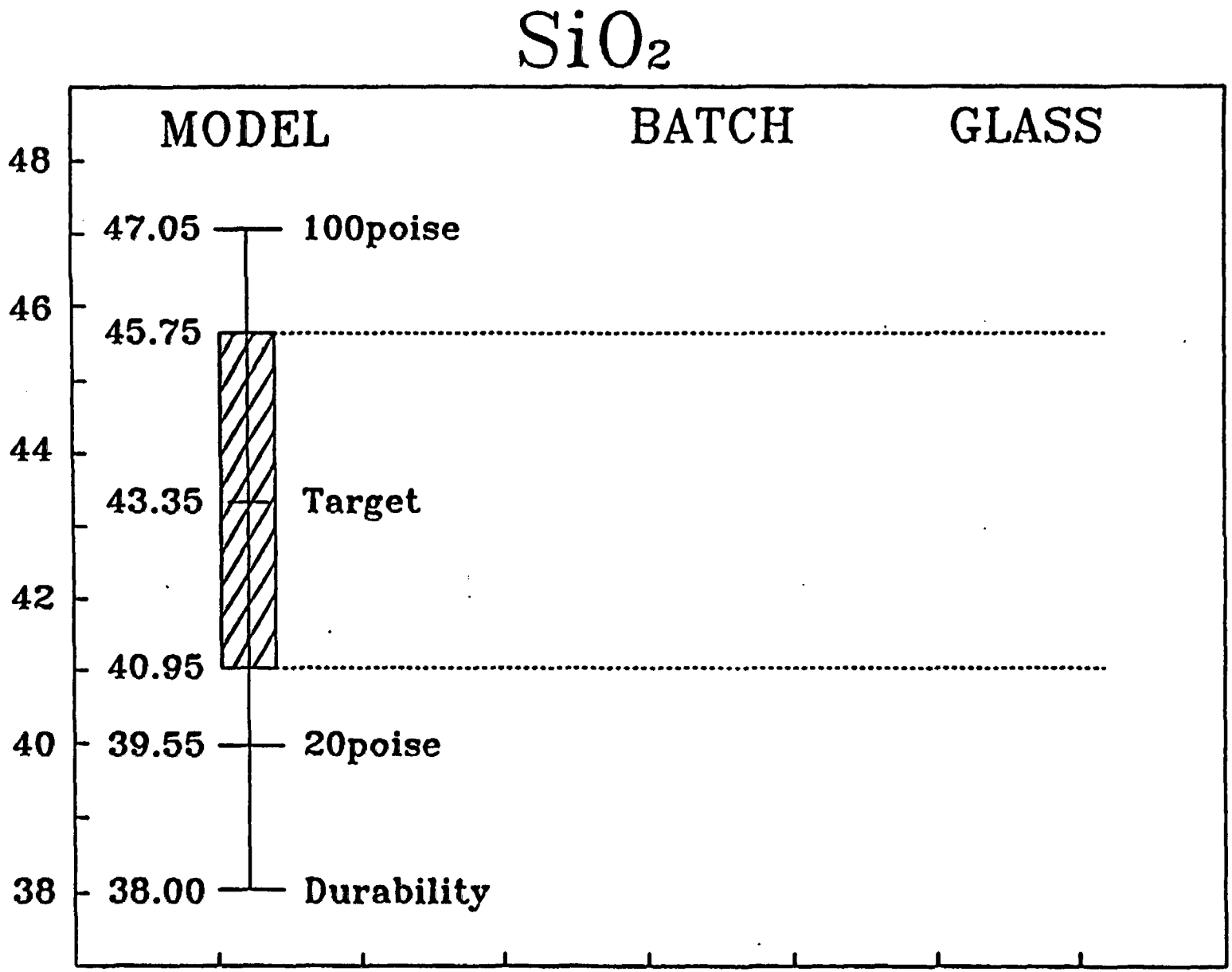
ACCEPTABLE GLASSES

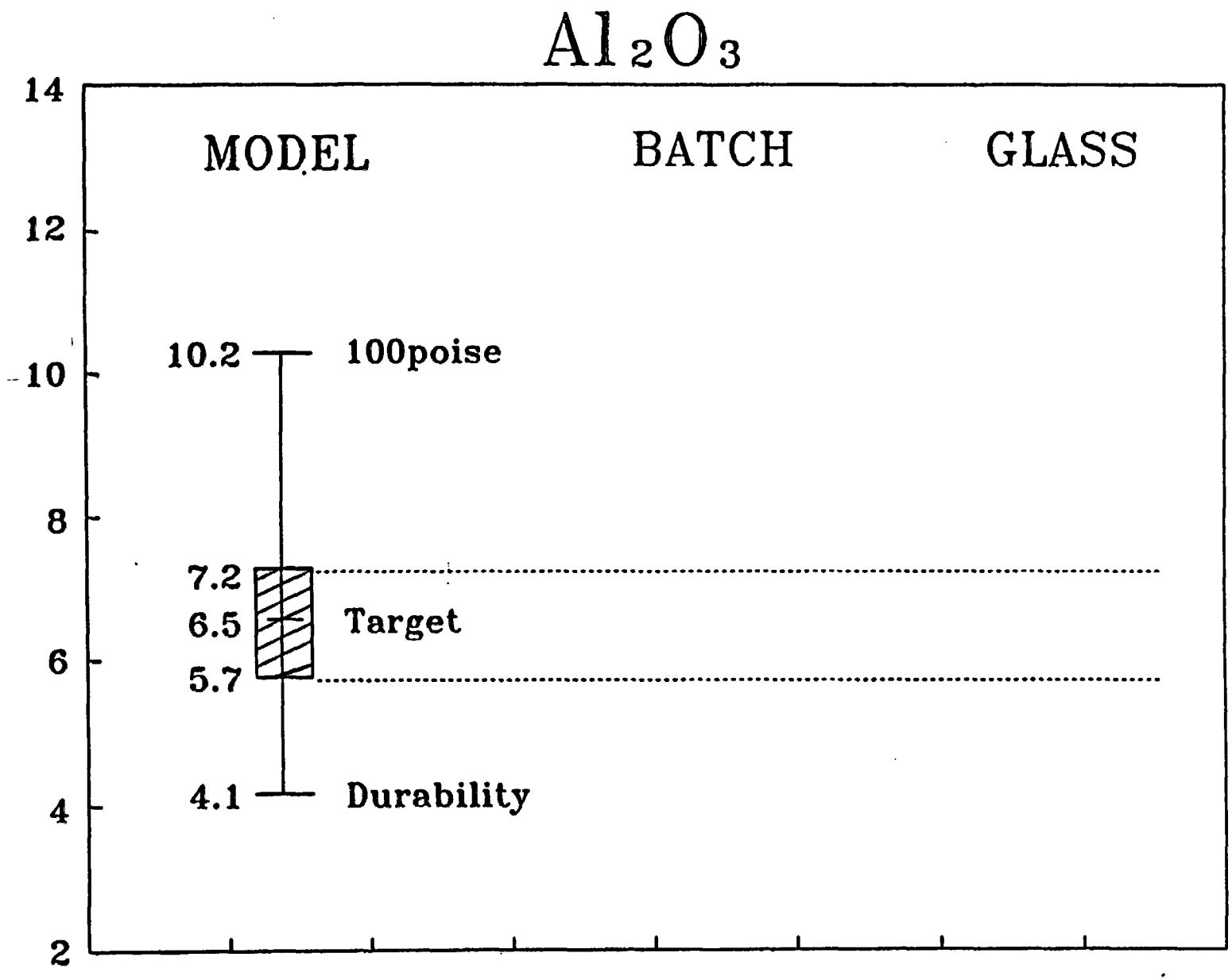


ACCEPTABLE GLASSES




Fe_2O_3
MODEL
BATCH
GLASS
18
16
14
12
10
8
6
15.0
100poise
13.8
12.0
Target
10.2
7.9
Durability


SiO2
MODEL
BATCH
GLASS
48
46
44
42
40
38
47.05
100poise
45.75
43.35
Target
40.95
39.55
20poise
38.00
Durability


Al_2O_3
14
12
10
8
6
4
2
MODEL
BATCH
GLASS
10.2
100poise
7.2
6.5
5.7
Target
4.1
Durability

9

THE CHEMICAL DURABILITY OF NUCLEAR WASTE GLASSES: ACCELERATED TESTING AND PREDICTION OF LONG TERM BEHAVIOR

by

P. B. MACEDO
Aa. BARKATT
I. L. PEGG

Vitreous State Laboratory
The Catholic University of America
Washington, DC 20064

CUA/VSL

- In durability testing alone, produce over 1 million data points per year
- INTERACTION WITH OTHER INSTITUTIONS
- MCC/PNL
  Leach test development
  Durability, comprehesive database
  Analytical round-robins
- SRL
  Long-term flow testing of SRL glasses
- WV
  Target composition optimization
  Process modeling
  Glass property characterization/modeling
  Glass analysis (ICP/MS)
- LLNL
  Durability modeling
- ANL
  Leach testing/surface characterization

- CENTRAL ISSUE:
  Long-term repository performance of wasteform (glass)

- PROBLEM:
  How to demonstrate/prove acceptability
  i.e. <u>Predict</u> long-term performance

Li glass WWIN 88
$k_{eff} = 0.74$
$[Li]_T = 0.1$

DIRECTION OF HIGH-LEVEL WASTE PROGRAM

- Document being prepared by ASTM C26.13 will provide important guidance

- ASTM C26.13
  Purpose:
  Develop a Recommended Practice for Prediction of Long-Term Behavior to Aid in the Performance Assessment of Waste Package Materials for Geologic Disposal of High-Level Nuclear Waste

- Important forum for NRC-DOE dialogue

CONSENSUS OF ASTM 26.07/13 TASK GROUP

(1) Rule out higher order terms by a mechanistic analysis

(2) Validate analysis with historical analog data whenever possible--convert extrapolation to interpolation

(3) Confirm conclusions by conducting as long a term testing as possible--until repository closure

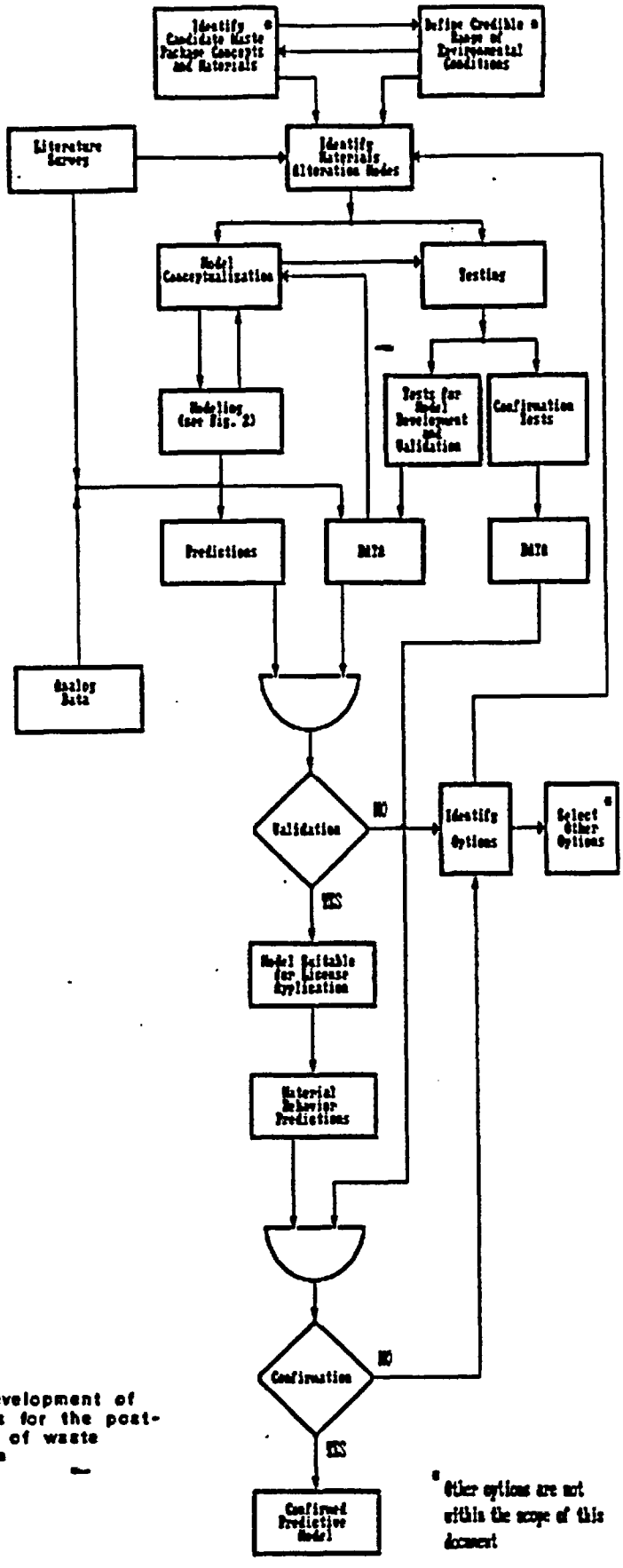
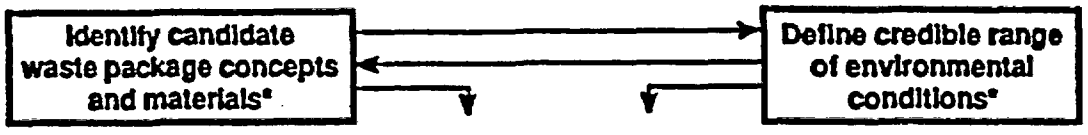
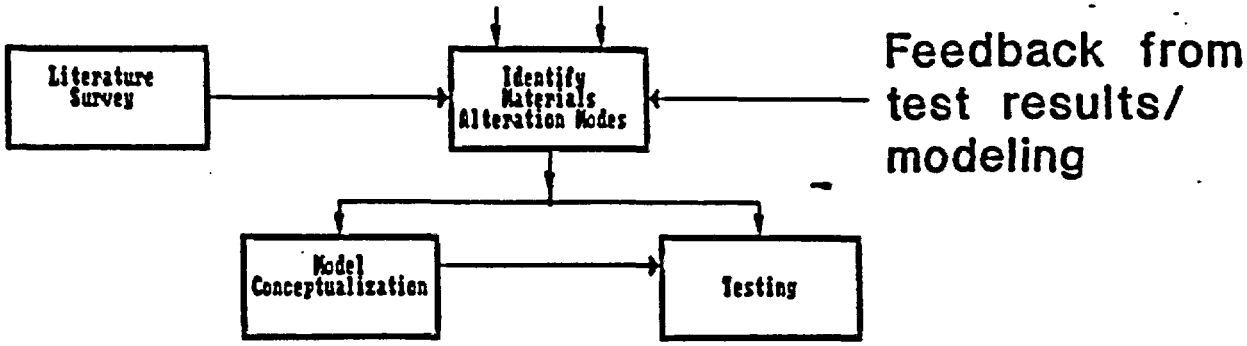


FIGURE 1
Logic for the development of predictive models for the post-closure behavior of waste package materials

Borosilicate glass
304L Canister

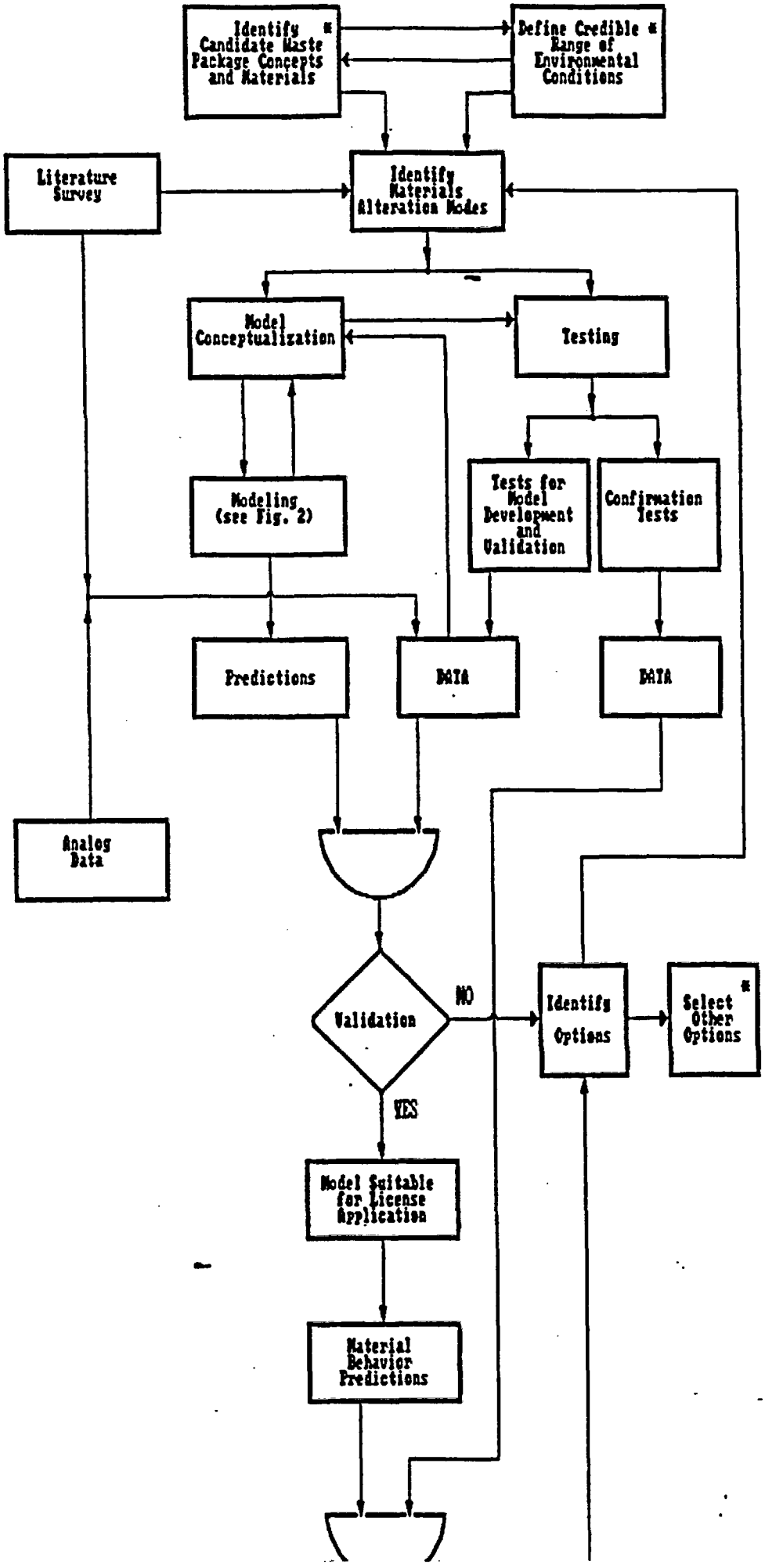
Site characterization:
Temperature, approx. 55 C
Groundwater composition
Flow rate
Atmosphere
Geology





ALTERATION MODES	MODEL CONCEPTS
dealkalization alkali/H_3O^+ interchange	pH rise diffusion, $t^{1/2}$
gel layer	
matrix dissolution, increasing with pH	linear in time
accumulation of insoluable components	protective/ nonprotective layers
	saturation effects (geochemical codes)

- Findings direct testing program
  - Tests for model development
  - Validation tests
  - Confirmation tests


Identify Candidate Waste Package Concepts and Materials *
Define Credible Range of Environmental Conditions *
Literature Survey
Identify Materials Alteration Modes
Model Conceptualization
Testing
Modeling (see Fig. 2)
Tests for Model Development and Validation
Confirmation Tests
Predictions
DATA
DATA
Analog Data
Validation
NO
YES
Identify Options
Select Other Options *
Model Suitable for License Application
Material Behavior Predictions

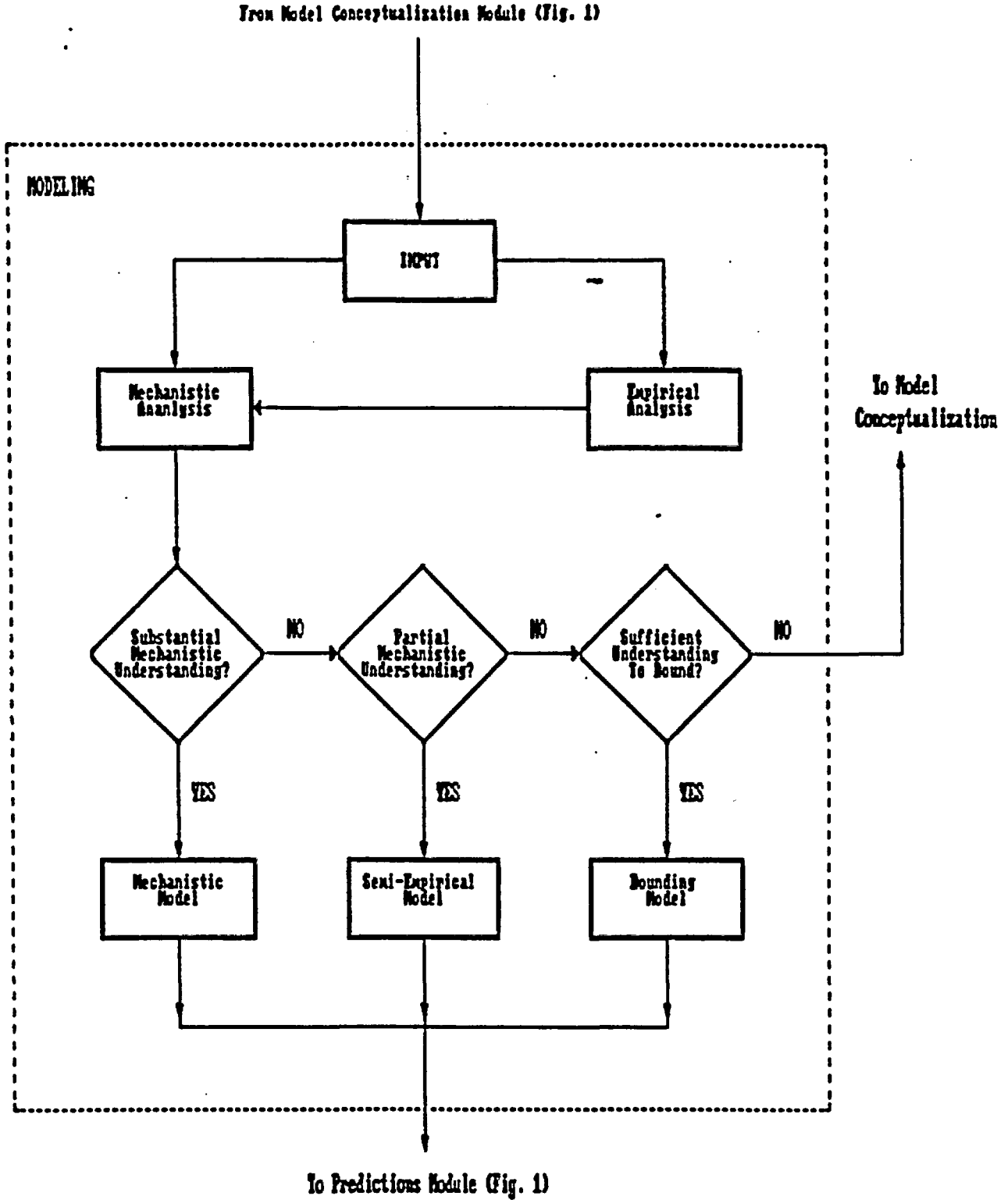


Fig. 2 Initial Model Development

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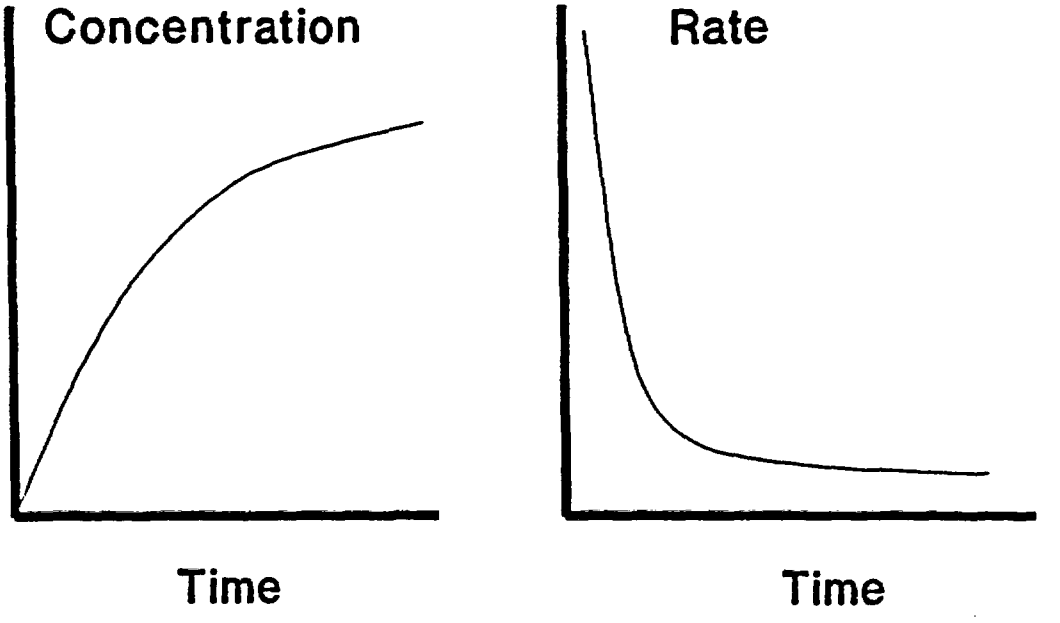
FACT:



WHY?

1) Diffusion through layer
2) Saturation w.r.t. glass
3) Saturation w.r.t. alteration products
4) Combination

$$\text{REACTION RATE} = R\{c_1 \ldots c_n, pH;\ T, t, X, L\}$$

c_i = Concentration of component i in leachant

pH = Leachant pH

T = Temperature

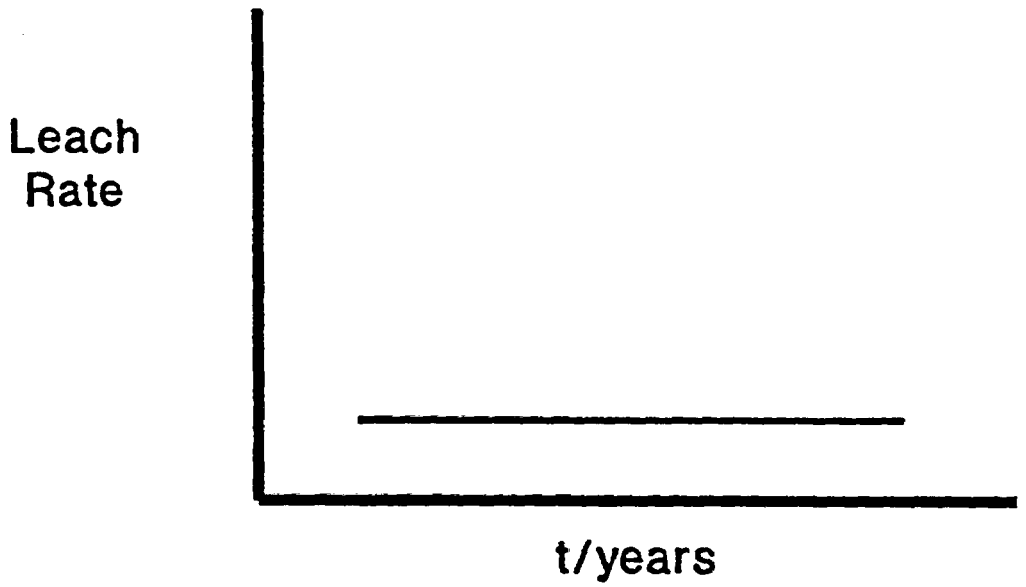
t = Time

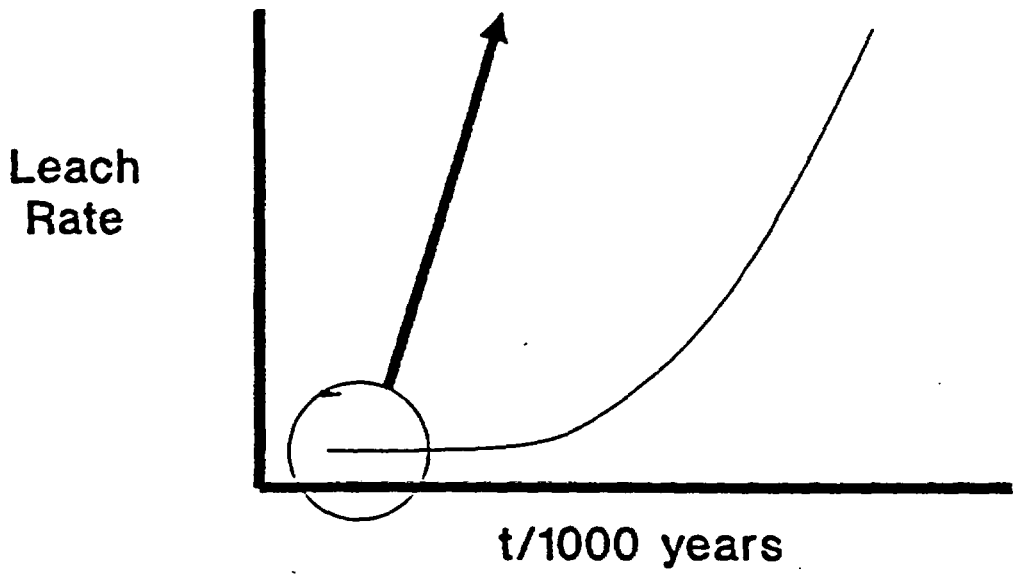
X = Physical properties of layer

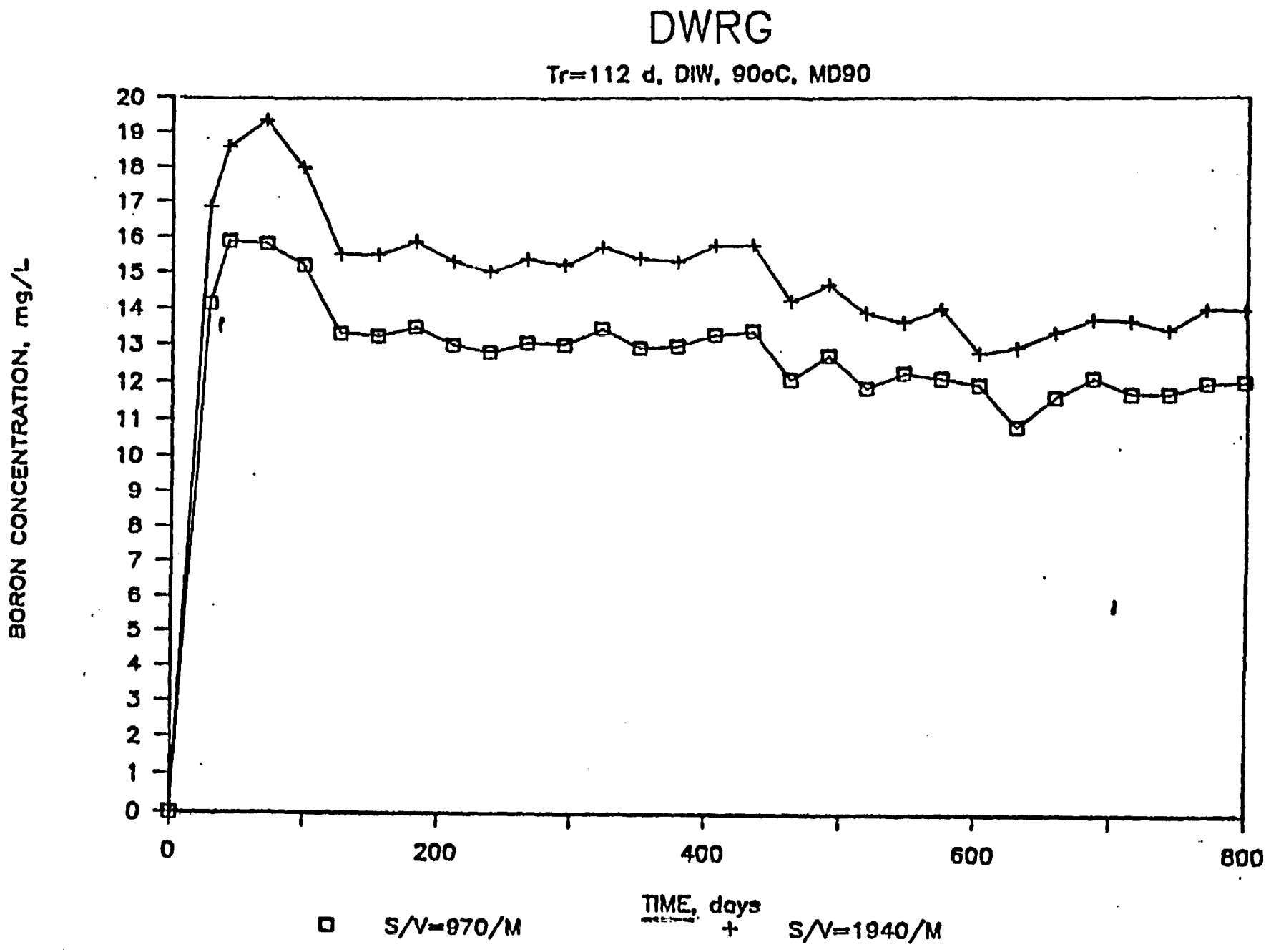
L = Layer thickness

Will the glass continue to meet acceptance criteria?

→ Make defensible predictions of long-term repository performance






DWRG
Tr=112 d, DIW, 90oC, MD90
BORON CONCENTRATION, mg/L
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
200
400
600
800
TIME, days
S/V=970/M
S/V=1940/M

LEACH RATES FROM FLOW TEST DATA

25% exchange

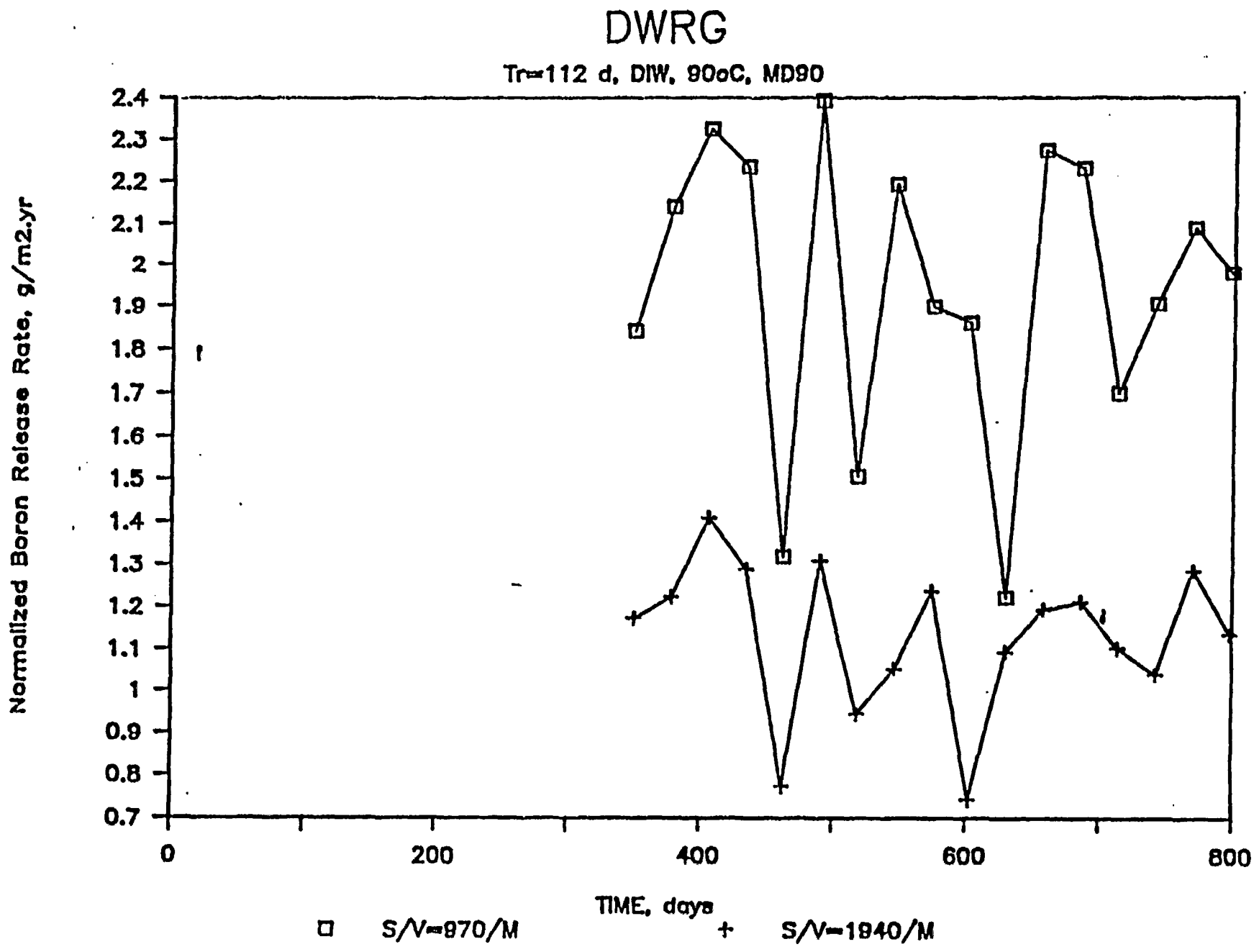
$$C_n = (3/4)\ C_{n-1} + L(S/V)T_e$$

$$L = \frac{C_n - (3/4)\ C_{n-1}}{T_e(S/V)}$$

L = leach rate

C_{n-1}, C_n = leachate concentrations at end of (n-1)th, nth intervals

T_e = (1/4)T_F = exchange interval


DWRG
Tr=112 d, DIW, 90oC, MD90
Normalized Boron Release Rate, g/m2.yr
2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0
200
400
600
800
TIME, days
S/V=970/M
S/V=1940/M

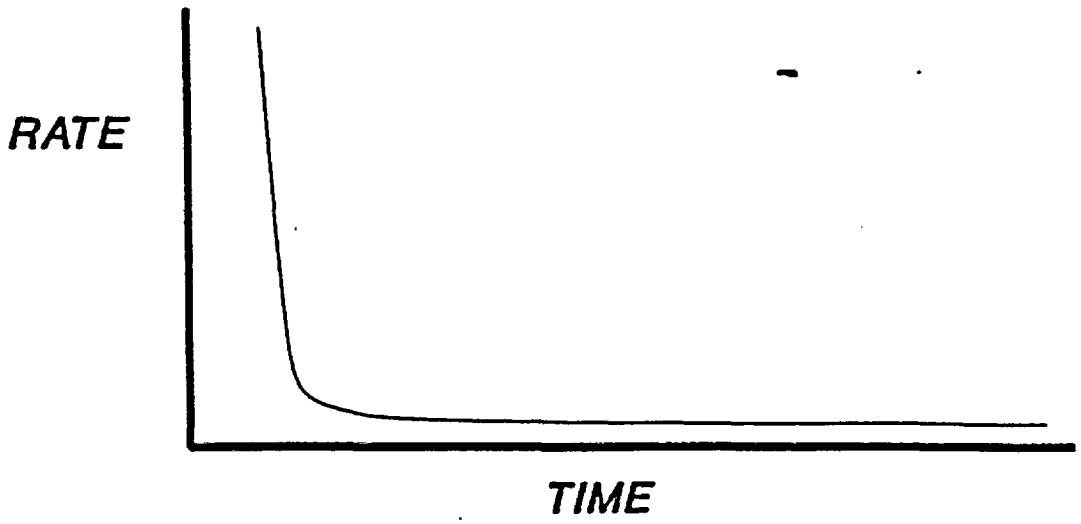
$$\alpha' = -.0\,84\,\beta\,\mu_{-5}/\lambda_{-5}$$

$$\alpha = .056$$

$$\alpha' = -.1\,34\,\beta\,\mu_{-5}\,\lambda_{-5}$$

$$\alpha = .113$$

$$k = \alpha_0 + \alpha' t$$



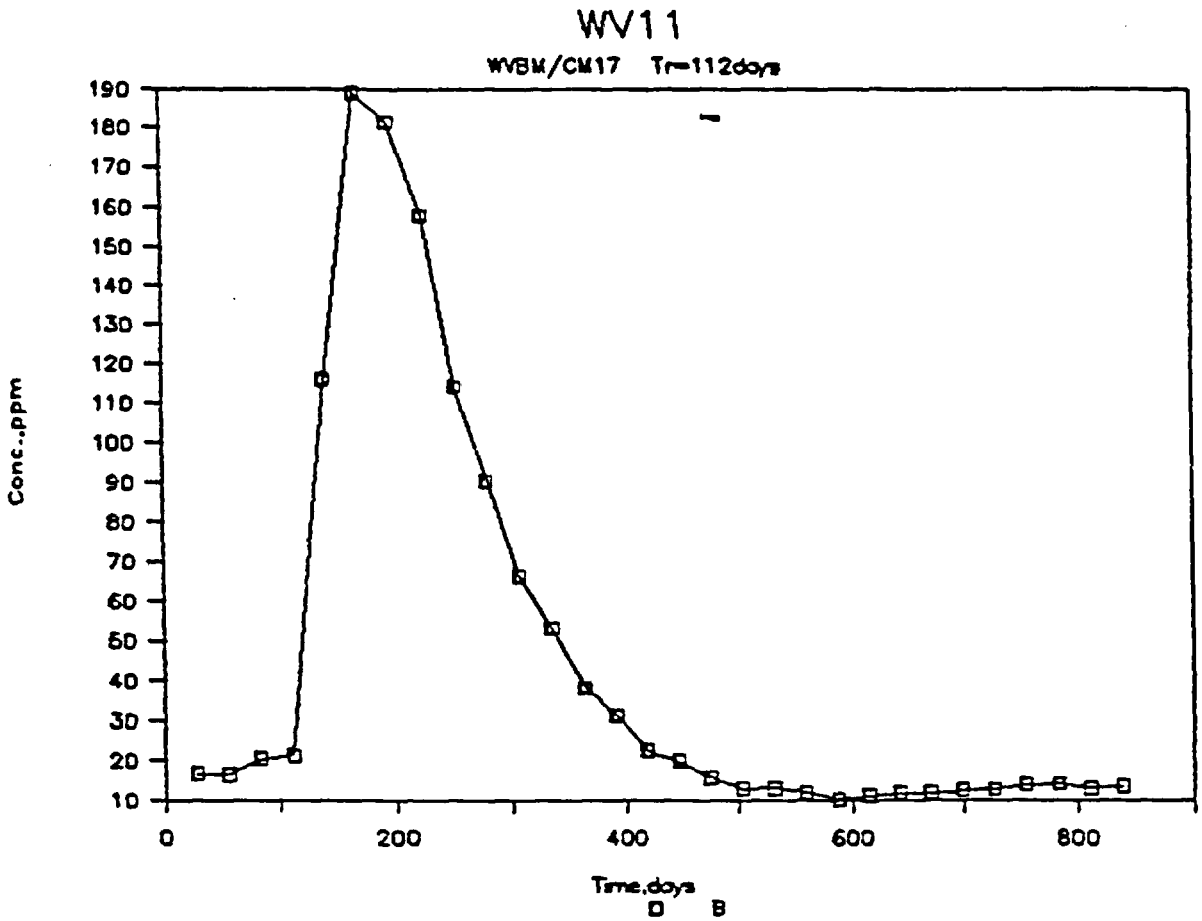
- Leach test data extending over time t_1, approx. a few years, are represented by
  $R = a_0 + a_1 t$
  with standard deviation σ
- Thus $a_2 t^2$ term of order of σ would not be detected
- Possible contribution of this term at 1000yrs is
  $a_2 t_2^2 = \sigma\, t_2^2 / t_1^2 \qquad t_1 = 3\text{yrs} \qquad a_2 t_2^2 = 10^5 \sigma$
- Any terms higher than t^2 blow up faster

MUST RULE OUT HIGHER ORDER TERMS BY OTHER MEANS

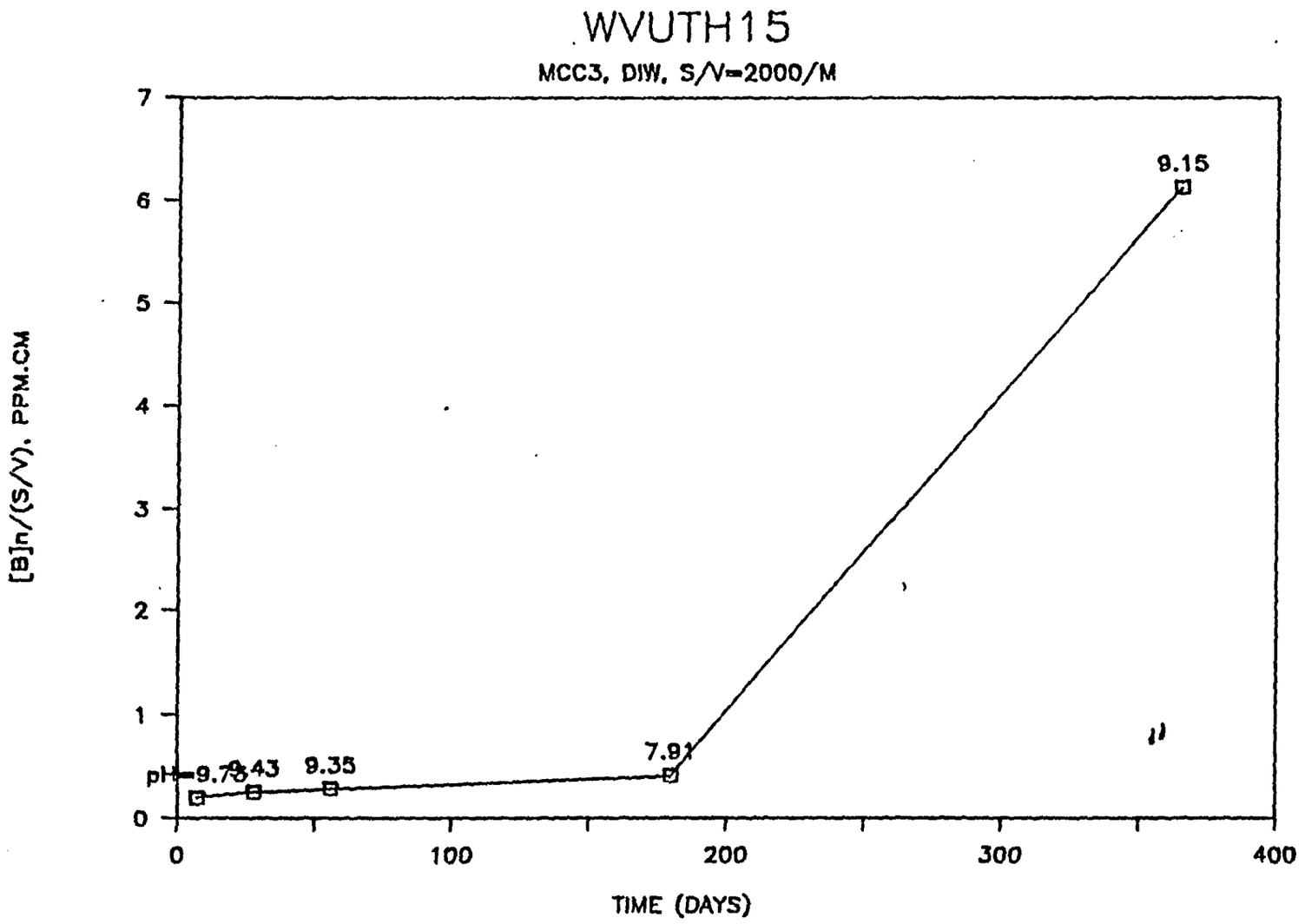
Then:

1) Make t_1 long enough to reduce uncertainties in a_0 and a_1 to levels that permit one to

2) Make reliable long-term predictions


WV11
WVBM/CM17 Tr=112days
Conc.,ppm
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
200
400
600
800
Time,days
D B

M


WVUTH15
MCC3, DIW, S/V=2000/M
[B]n/(S/V), PPM.CM
TIME (DAYS)
0
1
2
3
4
5
6
7
0
100
200
300
400
pH=9.78
9.43
9.35
7.91
9.15

Why Flow Tests?

- Partial exchange technique permits a good determination of leach rates
- Long-term rate data needed for extrapolation
- Variable S/V permits acceleration and gives additional mechanistic information
- Accumulating database permits identification of leaching modes displayed by waste glasses
- With parallel data on analogs can rule out "pathological" mechanisms with rate $\sim t^n$, $n > 1$
- Viable to study many compositions -ensure ranges of glasses are "good"
- Overall approach validatable with analogs

6

MELTER FEED COMPOSITION CONTROL

October 31 - November 2, 1989

Wayne A. Ross

Pacific Northwest Laboratory

OBJECTIVE OF PRESENTATION

Provide the background and bases to show WVDP confidence in the simulated HLW slurry feed composition to be vitrified by the melter.

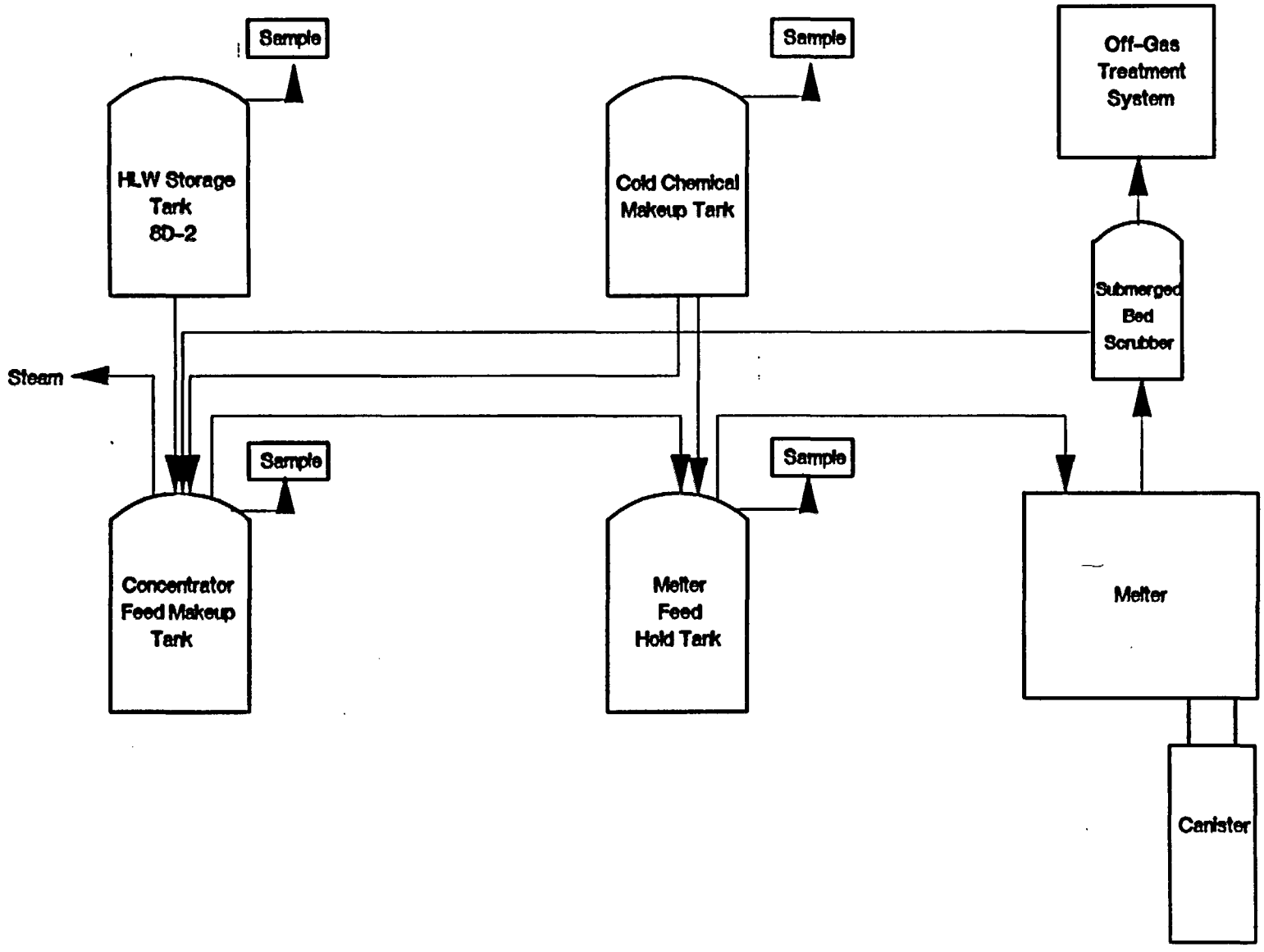
OUTLINE OF PRESENTATION

- PNL Support of West Valley
- WVNS Feed Processing System
- Theoretical Bases for Control
- Process Models
- Uniformity of Feed in Process Vessels
- Accuracy of Sampling
- Analytical Laboratory Control
- Summary

PNL SUPPORT OF WEST VALLEY

- Provided waste management support to NFS for their planned expansion
- Supported NRC in studying alternatives for solidification of WV HLW
- Managed preparation of the Draft Conceptual Design Report which recommended vitrification of the wastes with separation of the sludge and salts
- Flowsheet development with studies on appropriate glass compositions
- Developed the ion exchange process for removal of cesium from the supernatant
- Developed the Submerged Bed Scrubber
- Designed the CTS equipment and built the melter and turntable
- Providing continued support for process and waste form qualification

West Valley Feed System



THEORETICAL BASES FOR CONTROL OF FEED COMPOSITION

- Samples of wastes are being obtained to provide advanced knowledge of its composition
- Flowsheets and computer models have been prepared for projection of the composition in each process vessel
- Uncertainties in composition control have been identified for the feed system:
  - Determination of homogeneity of vessels with mixing
  - Ability to sample accurately
  - Ability to analysis accurately
  - Knowledge of volume of vessels
  - Determination of potential buildup of material in the tanks

PROCESS MODELS USED FOR COMPOSITION CONTROL AND PROJECTION

- MASBAL - Mass balance model which has three functions
  - Predicts the composition of glass produced by the system based on knowledge of the system
  - Allows determination of important variables in composition control
  - Generate simulated data to note potential variability of final glass
- LOTUS 123 Spreadsheet model of the process
  - Provides inventories both chemical and radiochemical as a function of time for any vessel in the process
  - Provides a projection of impacts of changes in the process or materials
- CHEMADD - Provides calculations for glass former batching

MAJOR CONCLUSIONS FROM PROCESS MODELS STUDIES

- Melter mixing and residual heals in tanks dampen compositional shifts
- Analytical and sampling variability were projected to have greatest impact on glass variability
- Glass composition can be controlled

UNIFORMITY OF FEED IN PROCESS VESSELS

- Waste Tank (8D-2) Characterization
- MFHT Homogeneity
- CFMT Homogeneity

UNIFORMITY OF WASTE IN TANK 8D-2

- Analyses of sludge indicates general homogeneity however there is some indications of stratification of sulfur
- Five additional samples have been obtained from the tank for further characterization, sludge washing studies, and glass melting studies
- Sludge to be mobilized and washed three to five times
  - Five sludge mobilization pumps are planned and additional positions are available
  - Grinders are planned for the sludge and zeolite to reduce particle size and increase homogeneity
- THOREX Waste and Zeolite to be added to the tank with long term mixing
- Final mixed waste to be well characterized

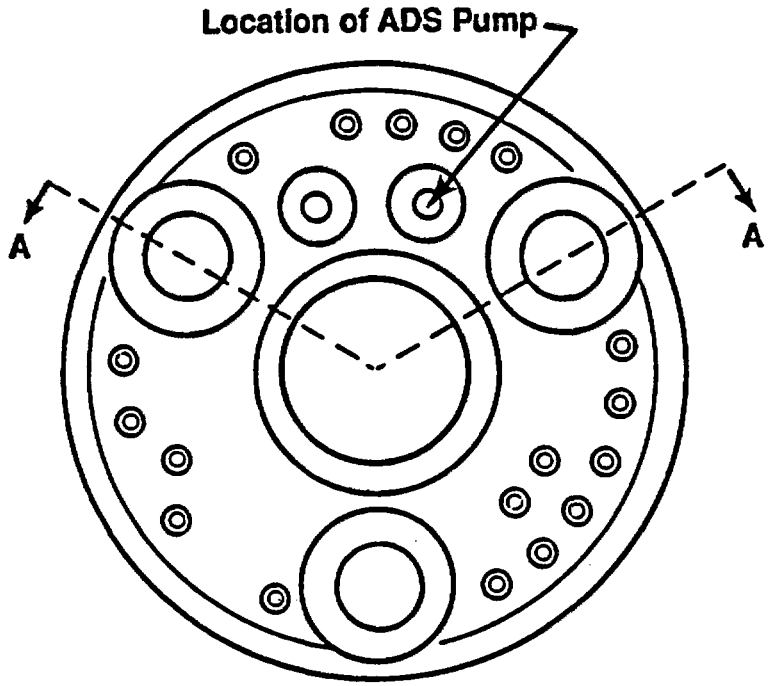
MELTER FEED HOLD TANK HOMOGENEITY TESTING

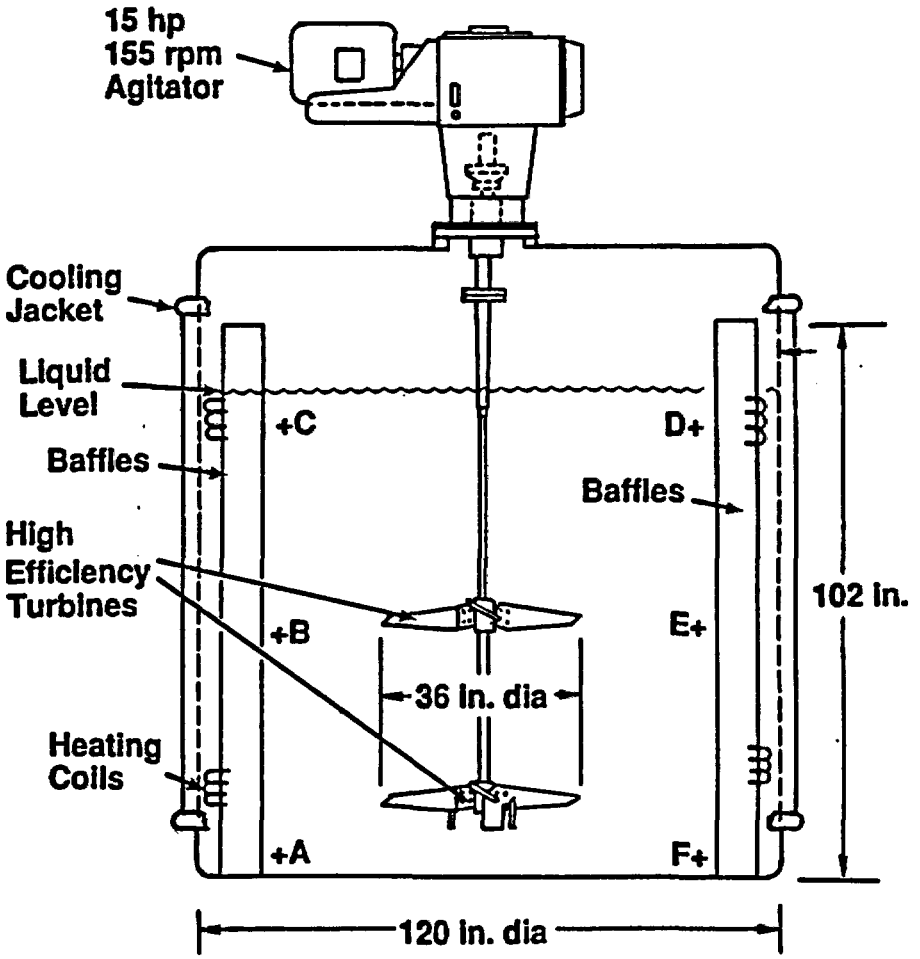
- Tank tested in FY-1987 for homogeneity and shown to be well mixed. Results reported in PNL-6724

Testing Included:

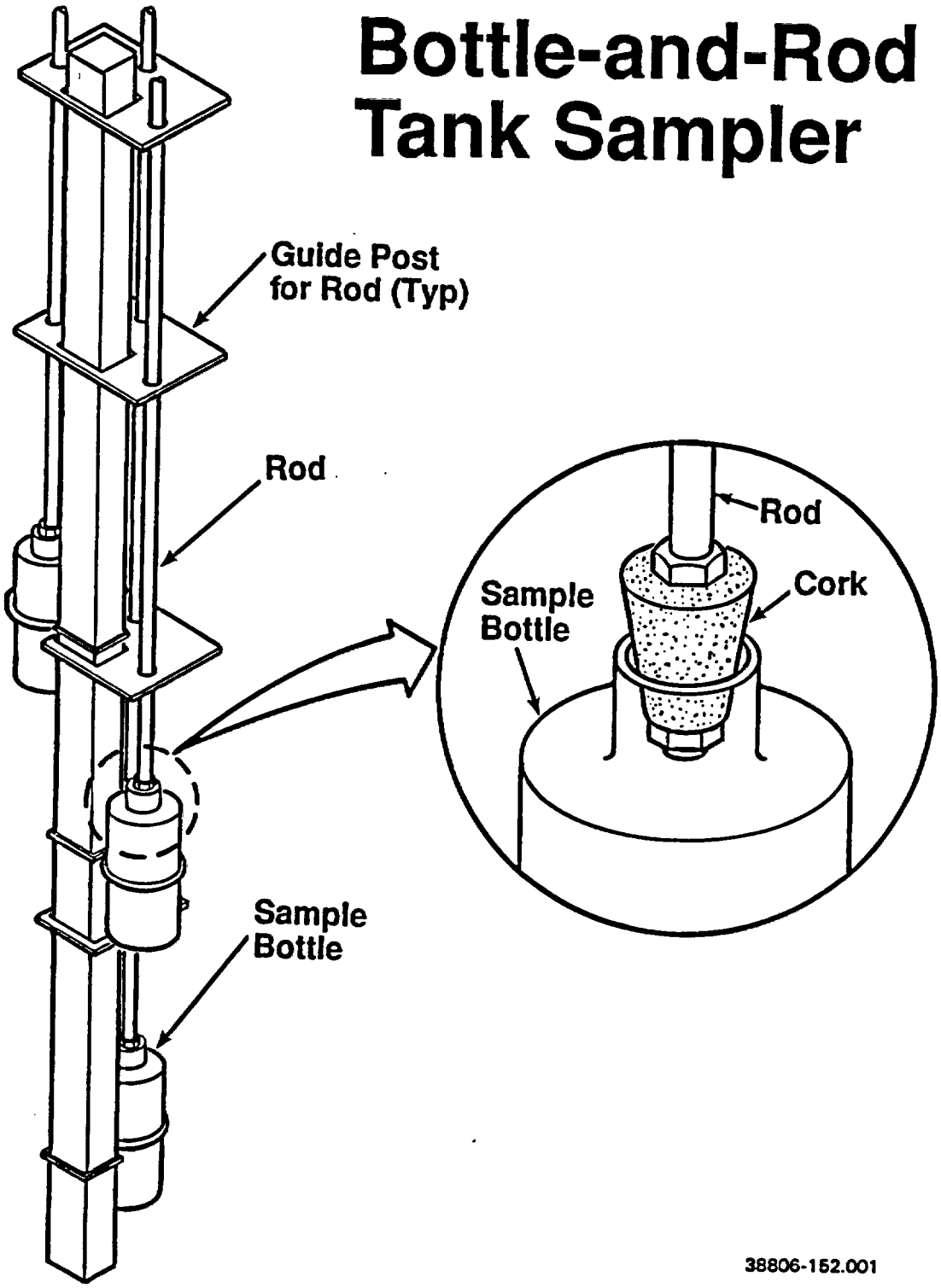
- Three feed concentrations
- Two samplers used - dip and Hydragard with ADS pump
- Samples taken from three different depths and 3 radial locations
- 21 samples at each test location were utilized to attain a 95% confidence level in detecting a difference greater than 4.5%
- Evaluation of sampling and analytical chemistry accuracy
- Agitator resuspending ability (tested by letting tank settle for four days and then restarting)

Melter Feed Hold Tank



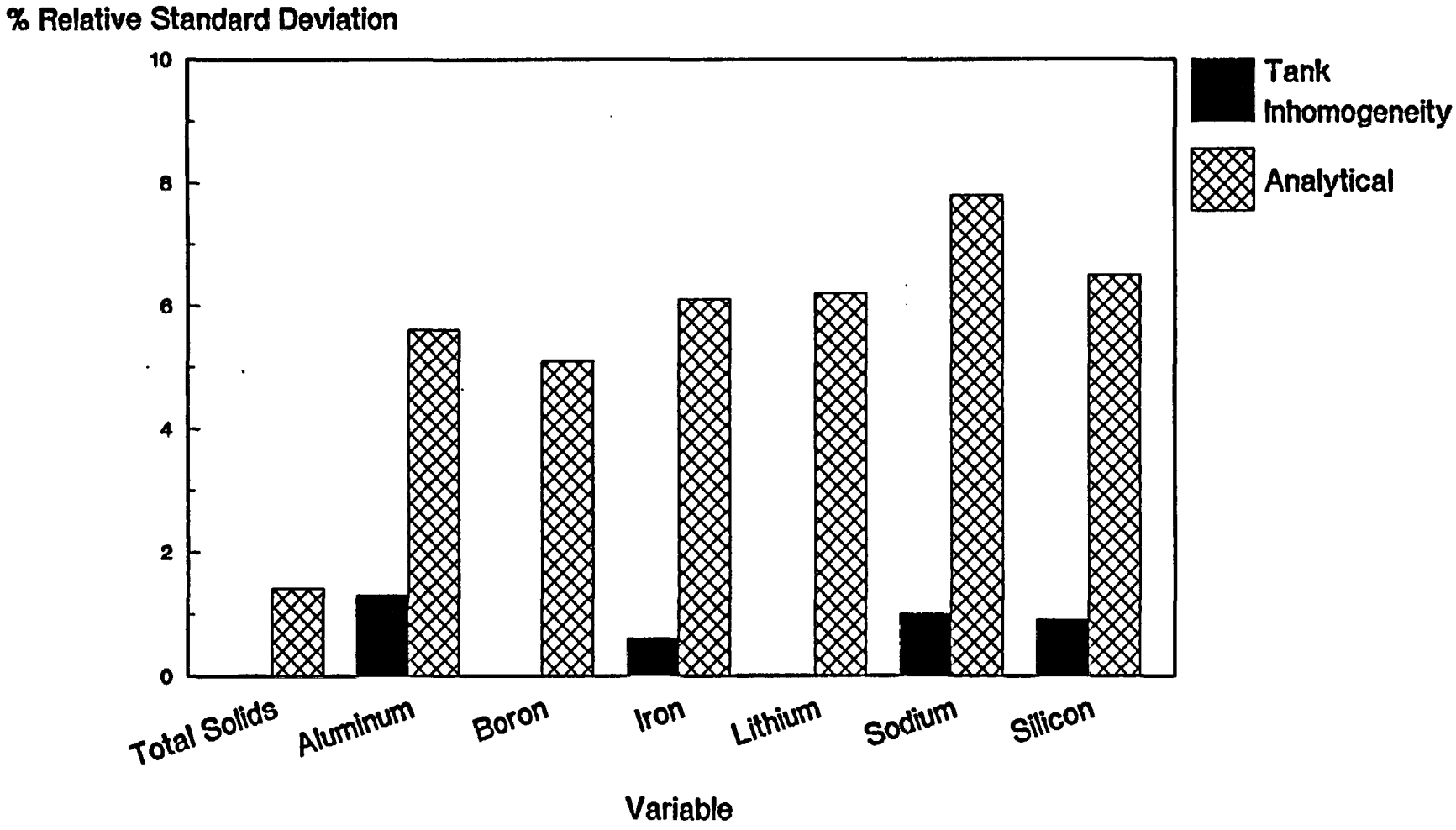


Bottle-and-Rod Tank Sampler



38806-152.001

HOMOGENEITY TEST RESULTS
MELTER FEED HOLD TANK



MAJOR CONCLUSIONS FROM MFHT STUDY

- Agitation is more than adequate to maintain a homogeneous mixture
- Resuspension of solids (accumulated in four days of settling) accomplished in less than two hours of mixing
- A bias of 2.6% higher solids was observed between the Hydragard and bottle-and-rod samplers

CFMT TANK HOMOGENEITY

- Four different tank levels tested with SF-11 feed
- Thirty samples were obtained for each sampling method/tank level
- Revised Hydragard Operating Procedure

SAMPLER RESULTS FROM CFMT TEST

- Samplers included bottle-and-rod, recirculating pump, and Hydragard
- Majority of elemental concentrations showed no significant differences between the various samplers
- Statistically higher boron and lower neodymium was noted in the Hydragard (2.37% vs 2.12% boron and 839 vs 818 ppm neodymium)

CURRENT RESULTS FROM CFMT HOMOGENEITY STUDY

- Averages indicate tank is homogeneous except for heel volume.
- Analytical order (long term instrument variability) has been determined as an important factor
- Hydragard sampler operation improved

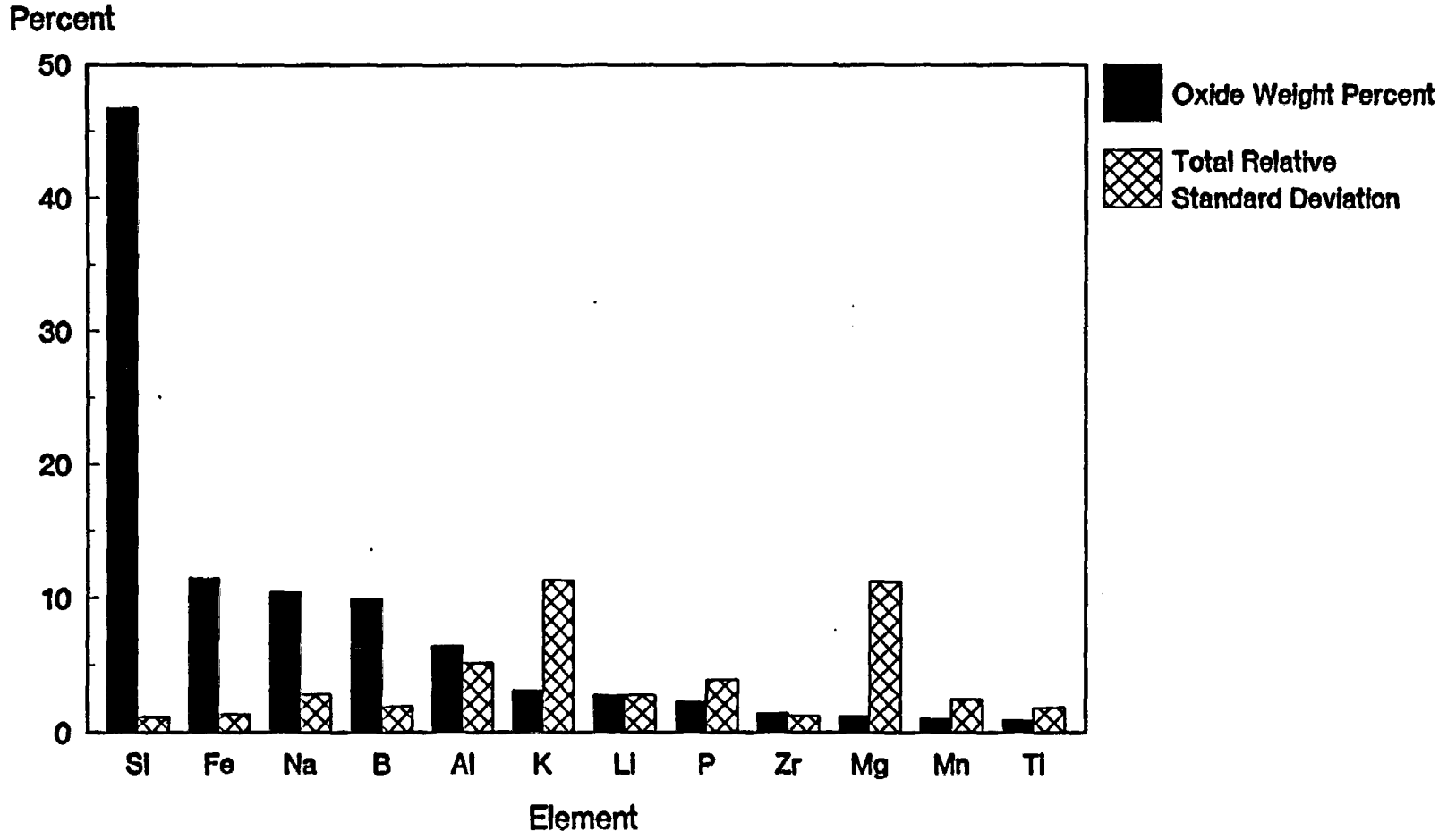
ANALYTICAL LABORATORY ACCURACY AND PRECISION

- Purpose of Studies
  - Identify focus of future efforts to reduce analytical error
  - Obtain precision estimates to be propagated through process models
  - Obtain estimates of accuracy and precision for the WAPS
- Studies conducted
  - Glass samples
  - Feed slurry samples

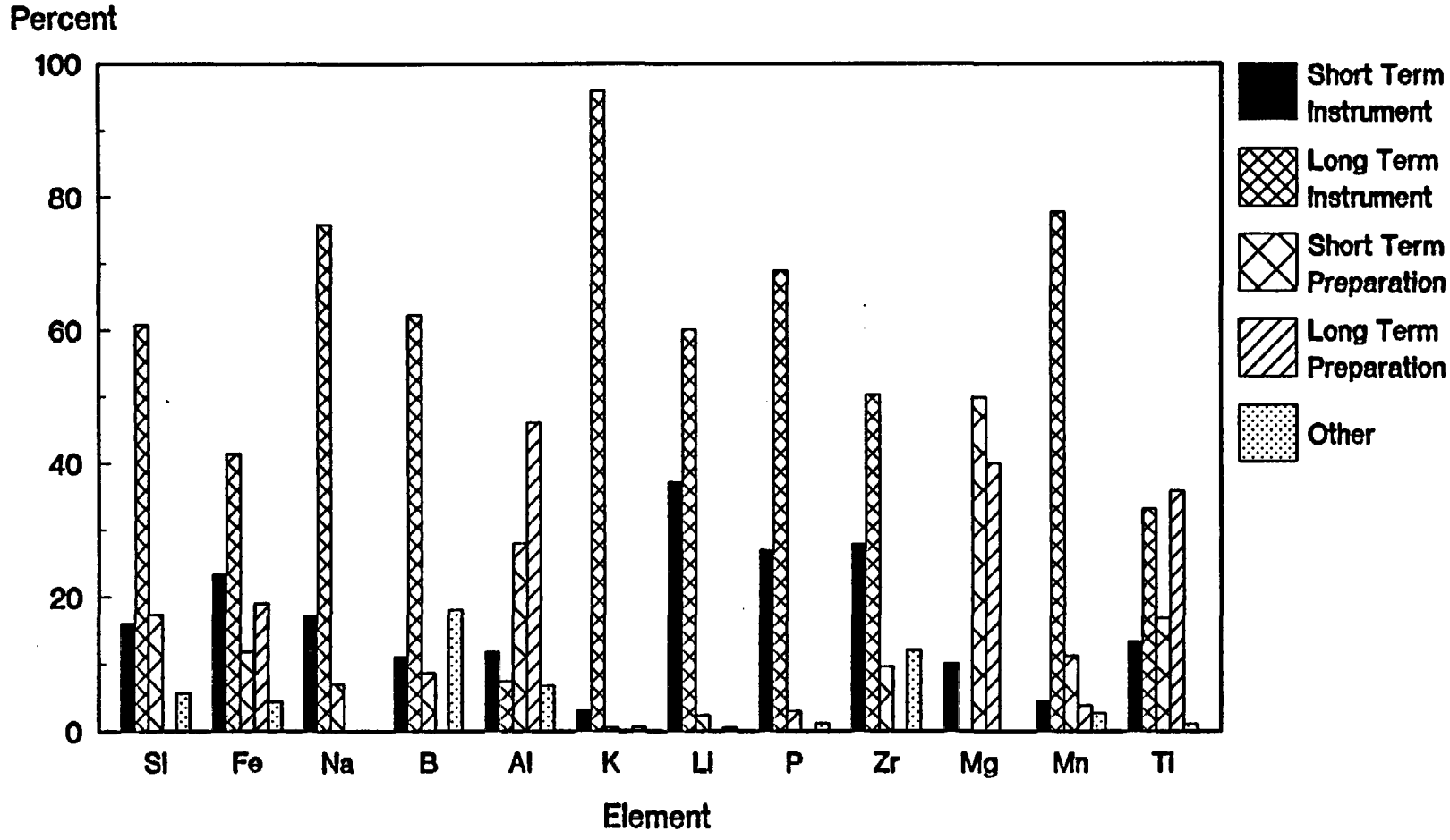
ANALYTICAL VARIATION SOURCES EXAMINED

- Procedural and preparation
  - Grinding
  - Powder subsampling and weighing
  - Digestion
  - Dilution
- Instrument
  - Parameter settings
  - Variations in flame characteristics and flow parameters
  - Calibration uncertainties
- Sampling (subsampling)
- Long- and short-term effects (environmental)

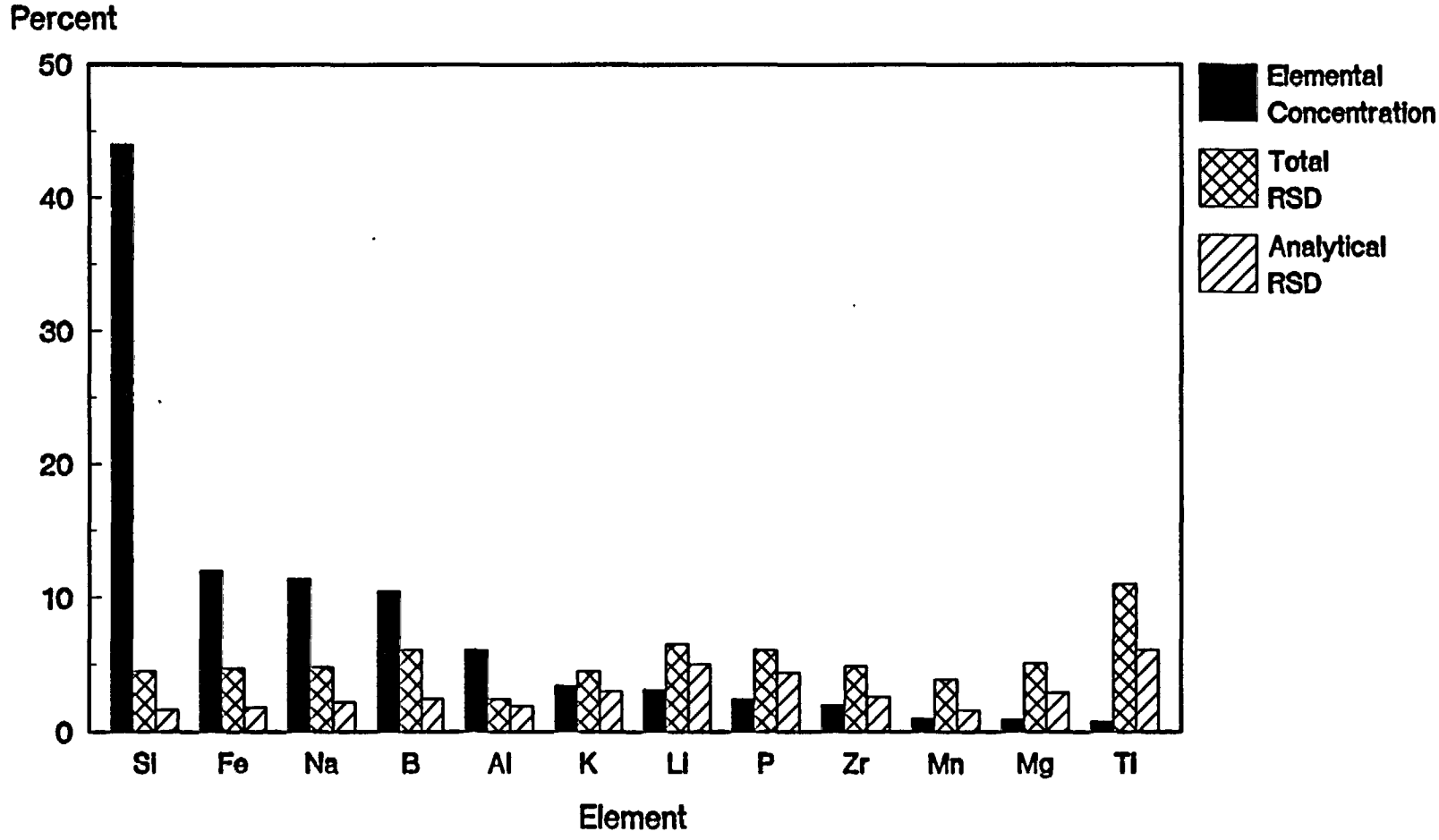
ANALYTICAL LABORATORY UNCERTAINTY ESTIMATES
GLASS ANALYSIS - RSD
NORMALIZED RESULTS



ANALYTICAL LABORATORY UNCERTAINTY ESTIMATES
GLASS ANALYSIS - SOURCES OF VARIANCE
NORMALIZED RESULTS

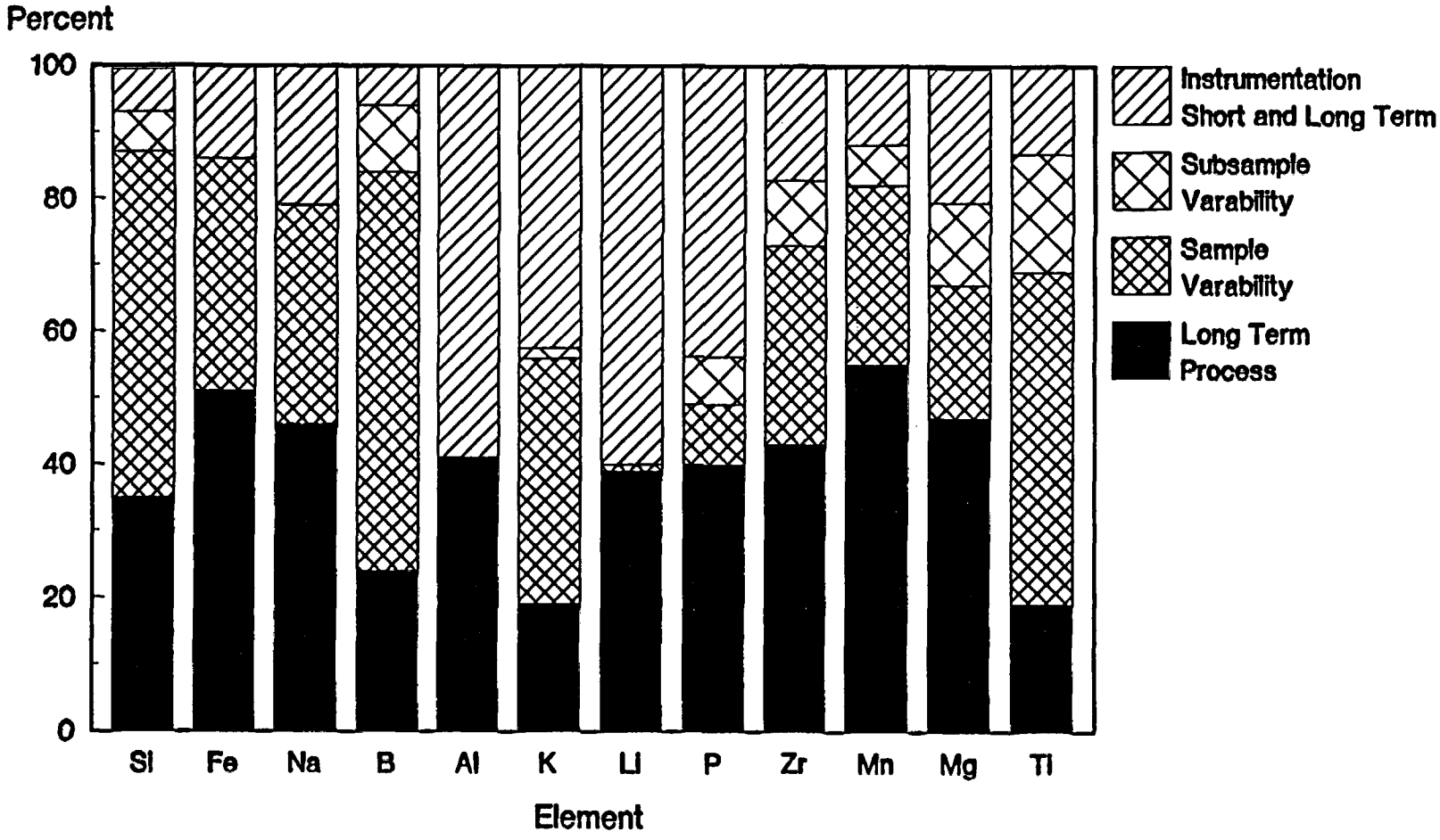


ANALYTICAL LABORATORY UNCERTAINTY ESTIMATES
FEED ANALYSIS – RSD
NORMALIZED RESULTS

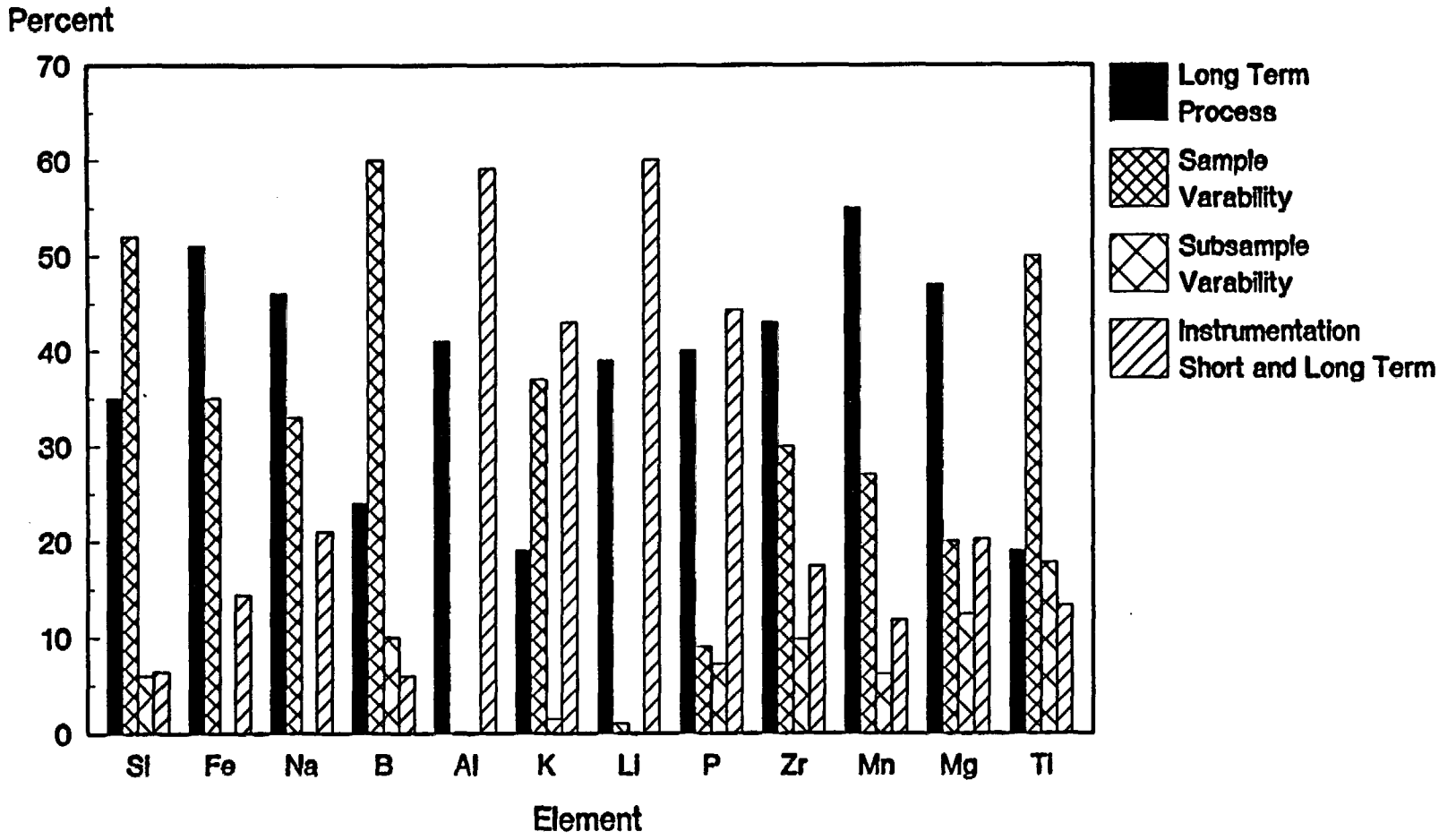


RSD – Relative Standard Deviation

ANALYTICAL LABORATORY UNCERTAINTY ESTIMATES
FEED ANALYSIS - SOURCES OF VARIANCE
NORMALIZED RESULTS



ANALYTICAL LABORATORY UNCERTAINTY ESTIMATES
FEED ANALYSIS - SOURCES OF VARIANCE
NORMALIZED RESULTS



SUMMARY AND STATUS OF ANALYTICAL PRECISION ACTIVITIES

- Analytical Accuracy and Precision for major feed components is within 2% for most elements.
- Long Term Instrument changes are the major source of variability.
- Strategies to reduce variability are continuing to be developed.

SUMMARY

- The flowsheet for West Valley has been established, is understood and has been modeled
- Uncertainties have been identified and are continuing to be quantified
- The "feed system" appears capable of providing a well characterized and controlled composition to the melter

7

WVDP FULL-SCALE TESTING RESULTS FOR THE WASTE QUALIFICATION REPORTS

S.M. Barnes &
Vitrification Process Development Staff

October 31, 1989

QUALIFICATION TESTING STRATEGY

- Tests Conducted with Prototypical Design, Full Scale Equipment:
  - Waste Slurry Tanks
  - Sampling Systems
  - Slurry Delivery System
  - Melter
  - Canisters & Turntable
  - Off-Gas Treatment System

QUALIFICATION TESTING STRATEGY

- The Process/Product Qualification Test is being Conducted under Simulated Remote Processing Conditions.

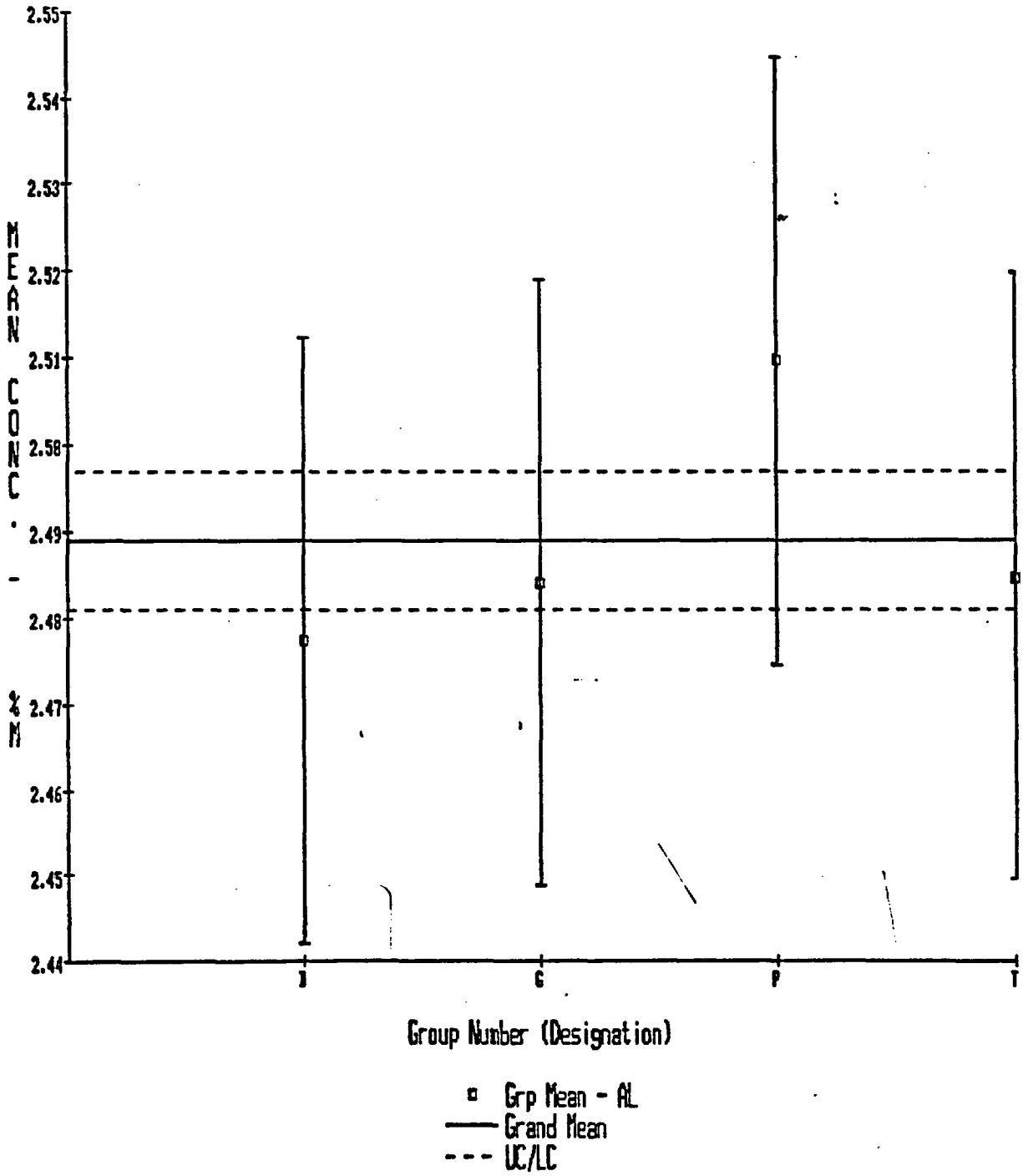
- These testing conditions will be used to Assess the Integrated Process Uncertainties for the Waste Qualification Reports.

'FACTS' EQUIPMENT OPERATION CHARACTERIZATION TESTING

- Testing Examples:
  - Slurry Tank Homogeneity Assessments
  - Slurry Sample Accuracy
  - Melter Mixing Characterization

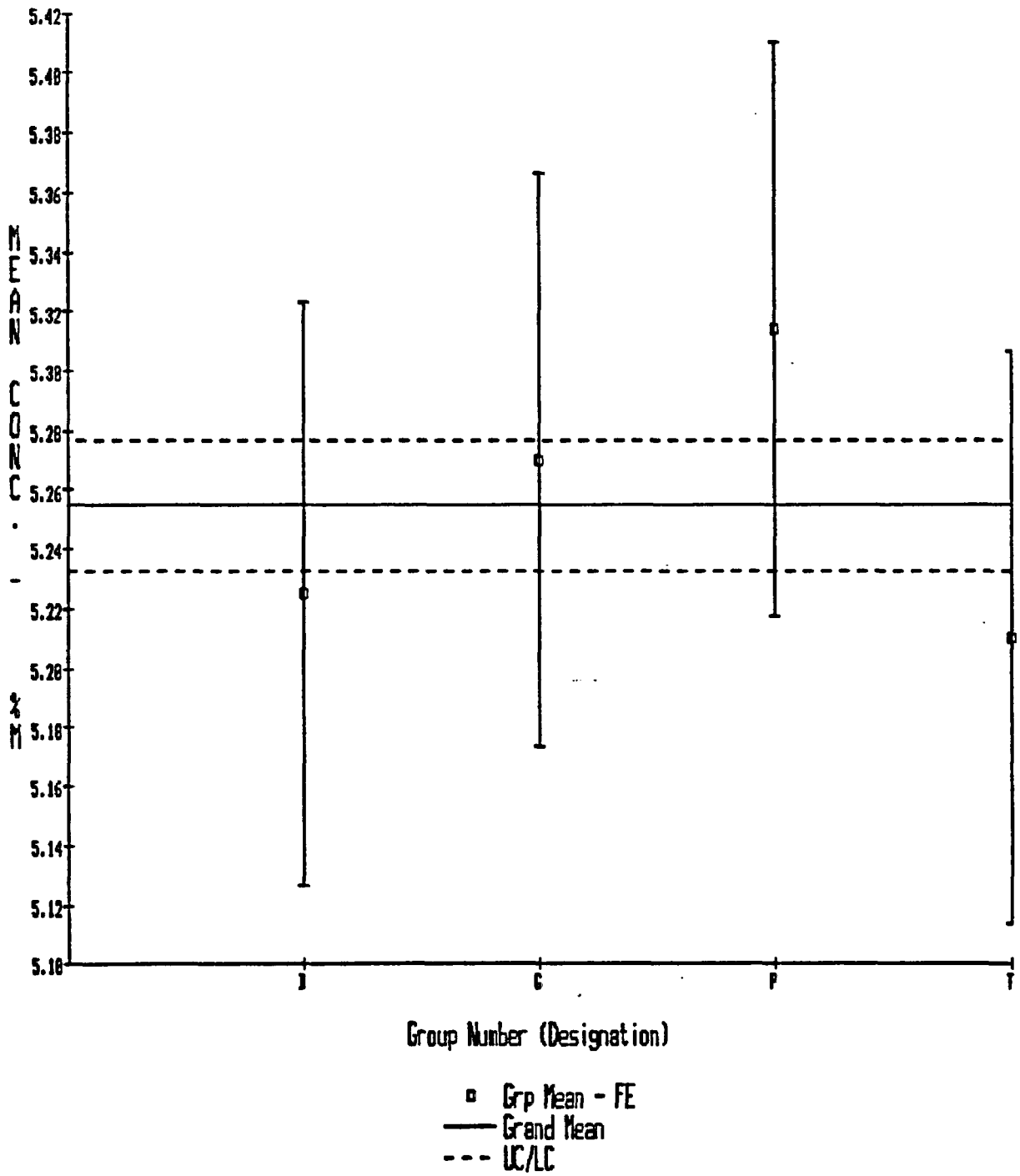
- Data used to Measure Vitrification System Performance and for Comparison to the Models Discussed Previously.

PNLLAB FEED DATA [PNL units[%M or ug/g]] -- BATCH #1
TREND OF Group Means FOR: ALUMINUM (AL)



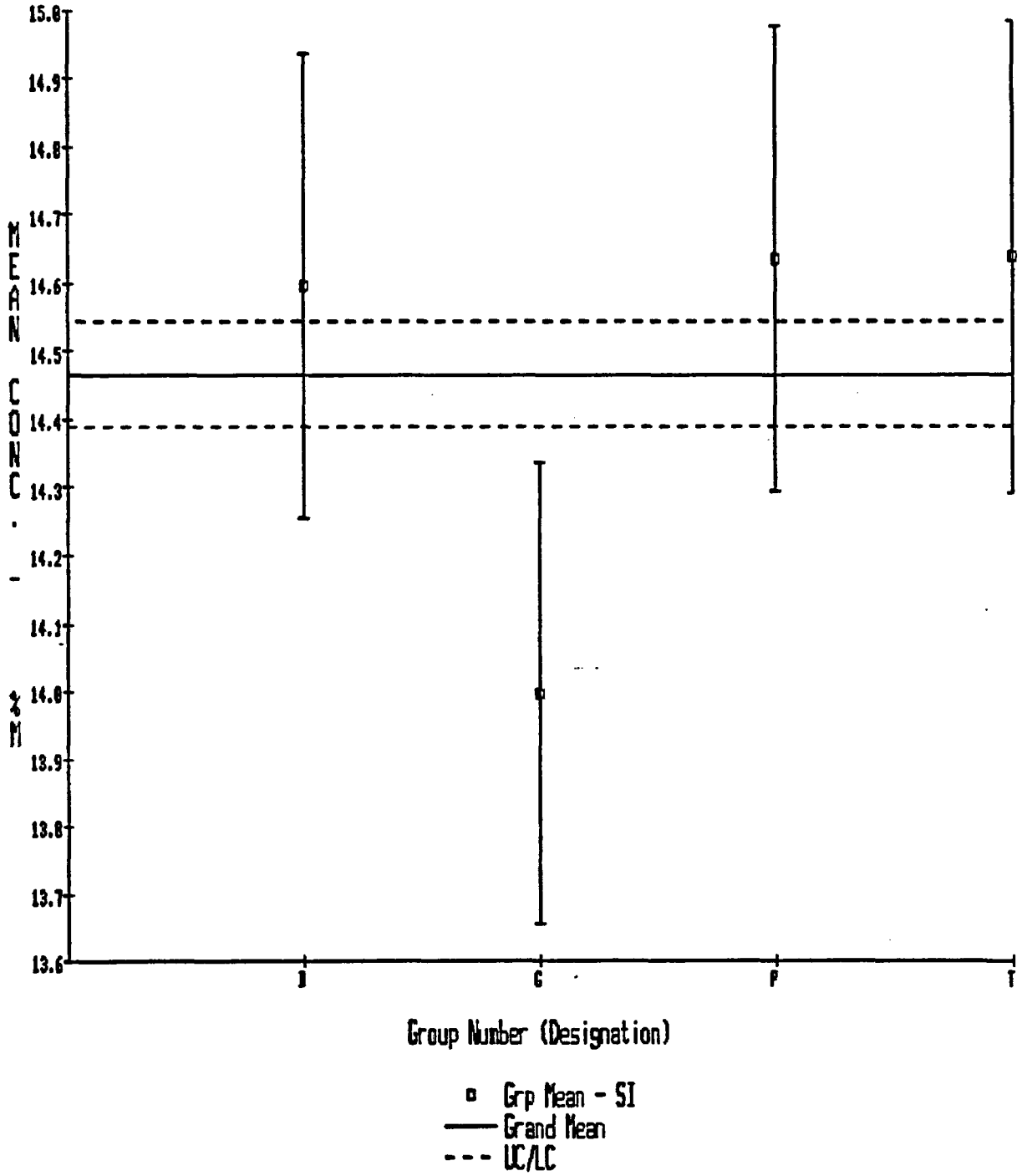
MULTI-COMPARISON : Sig-Level = 0.05 (95% Conf.)
FILENAME IS: CFMUT_BATCH_1_SUBX

PNLLAB FEED DATA [PNL units[%M or ug/g]] -- BATCH #1
TREND OF Group Means FOR: IRON (FE)



MULTI-COMPARISON : Sig-Level = 0.05 (95% Conf.)
FILENAME IS: CFMUT_BATCH_1_SUBX

PNLLAB FEED DATA [PNL units[%M or ug/g]] -- BATCH #1
TREND OF Group Means FOR: SILICON (SI)



MULTI-COMPARISON : Sig-Level = 0.05 (95% Conf.)
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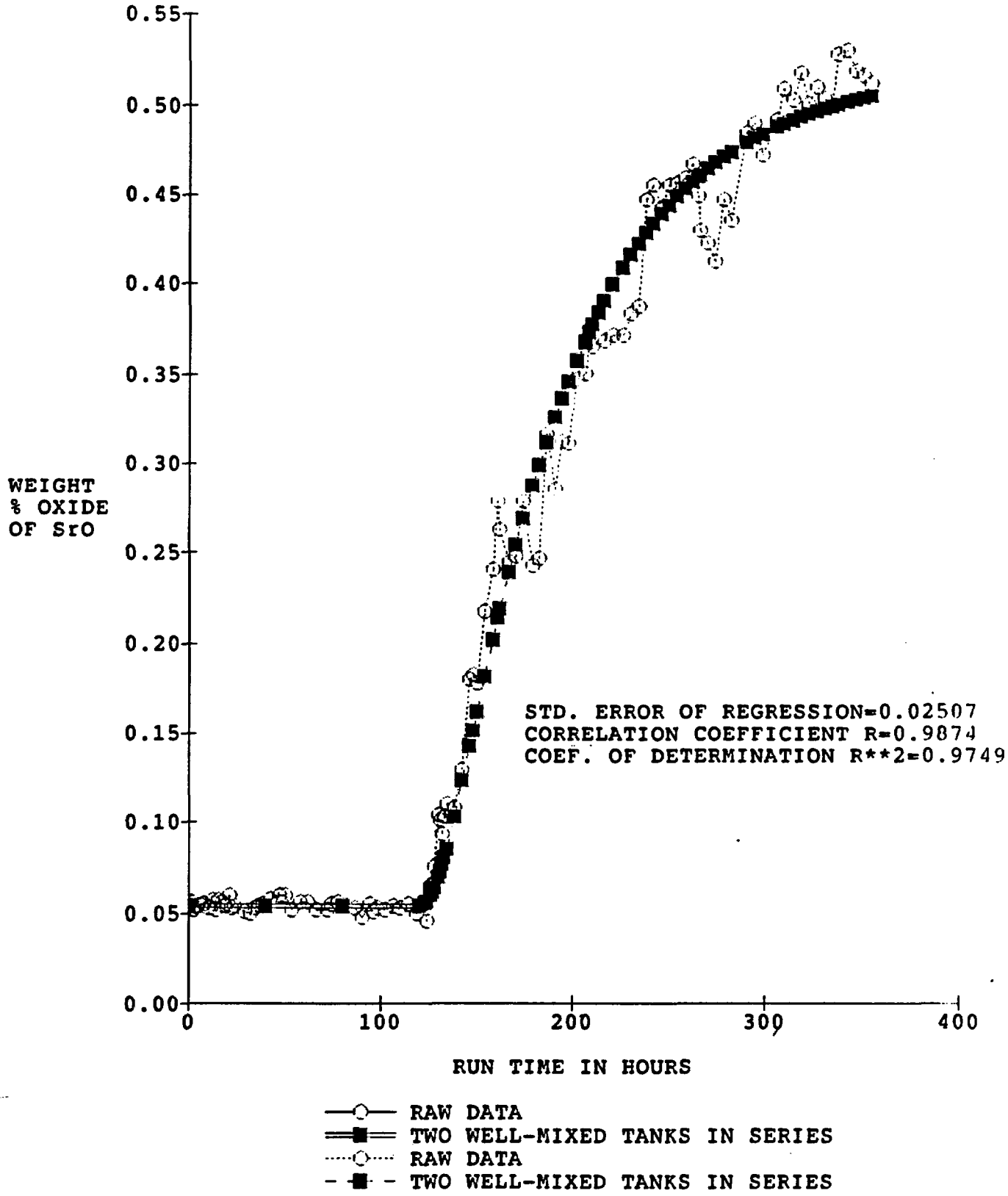
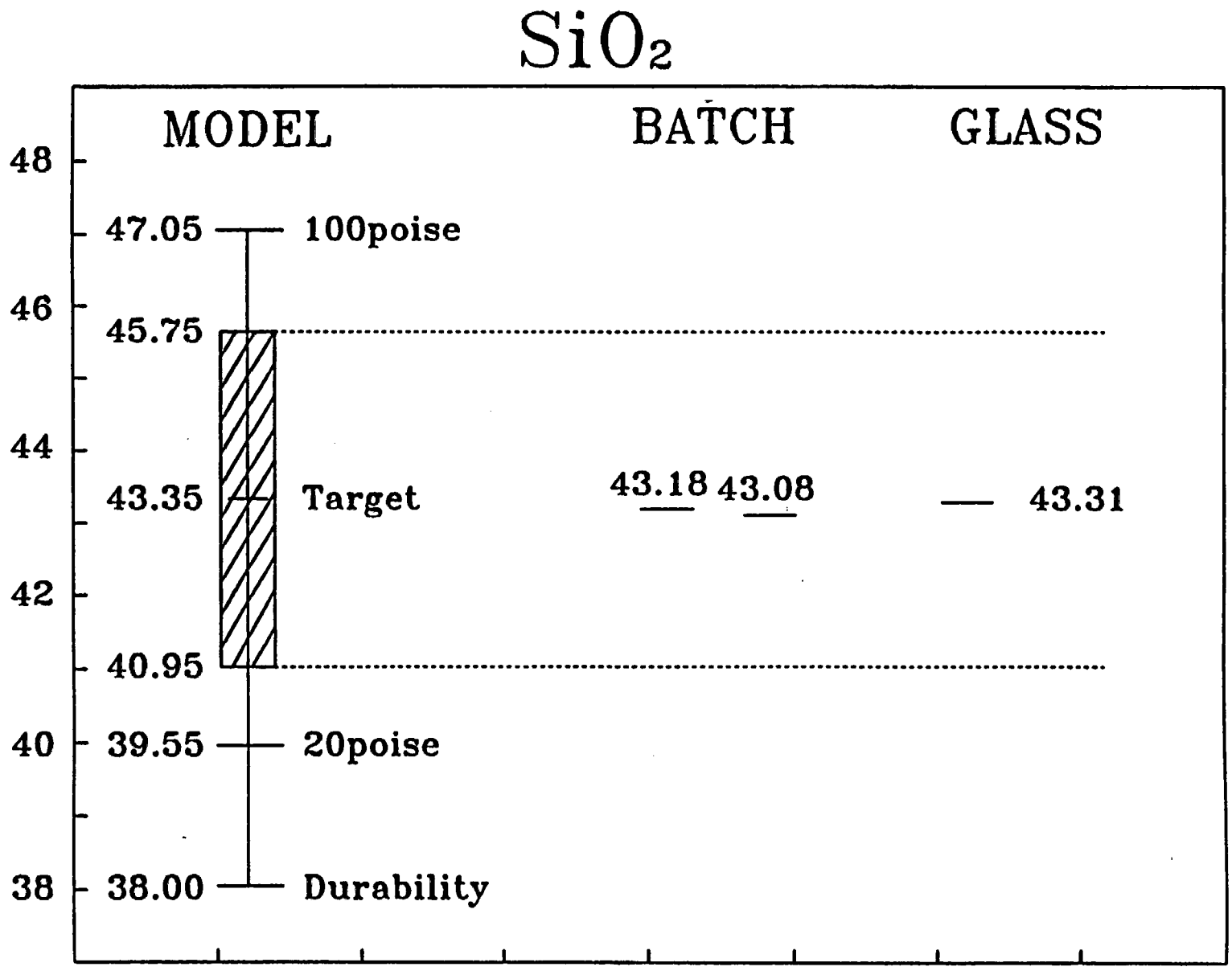
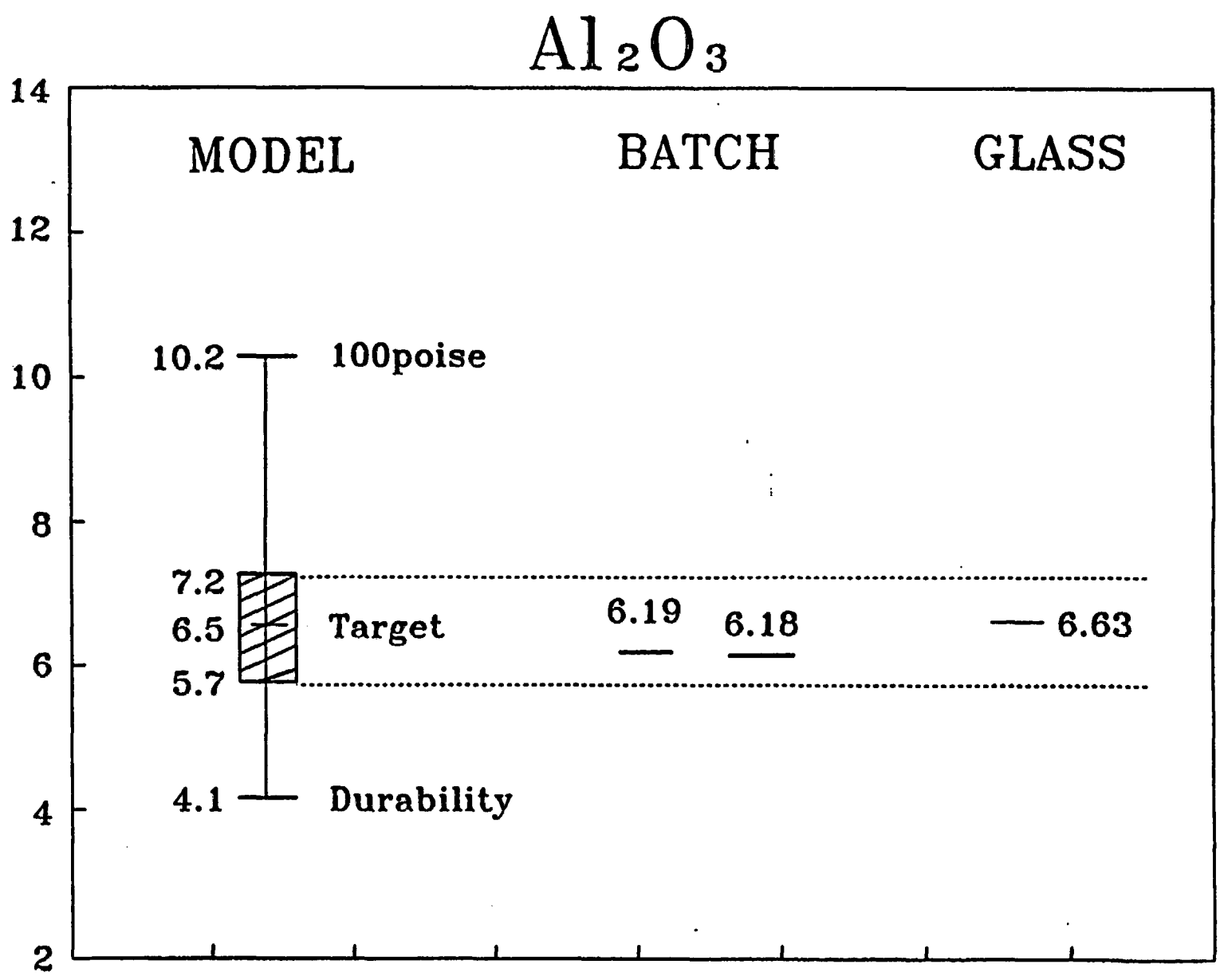


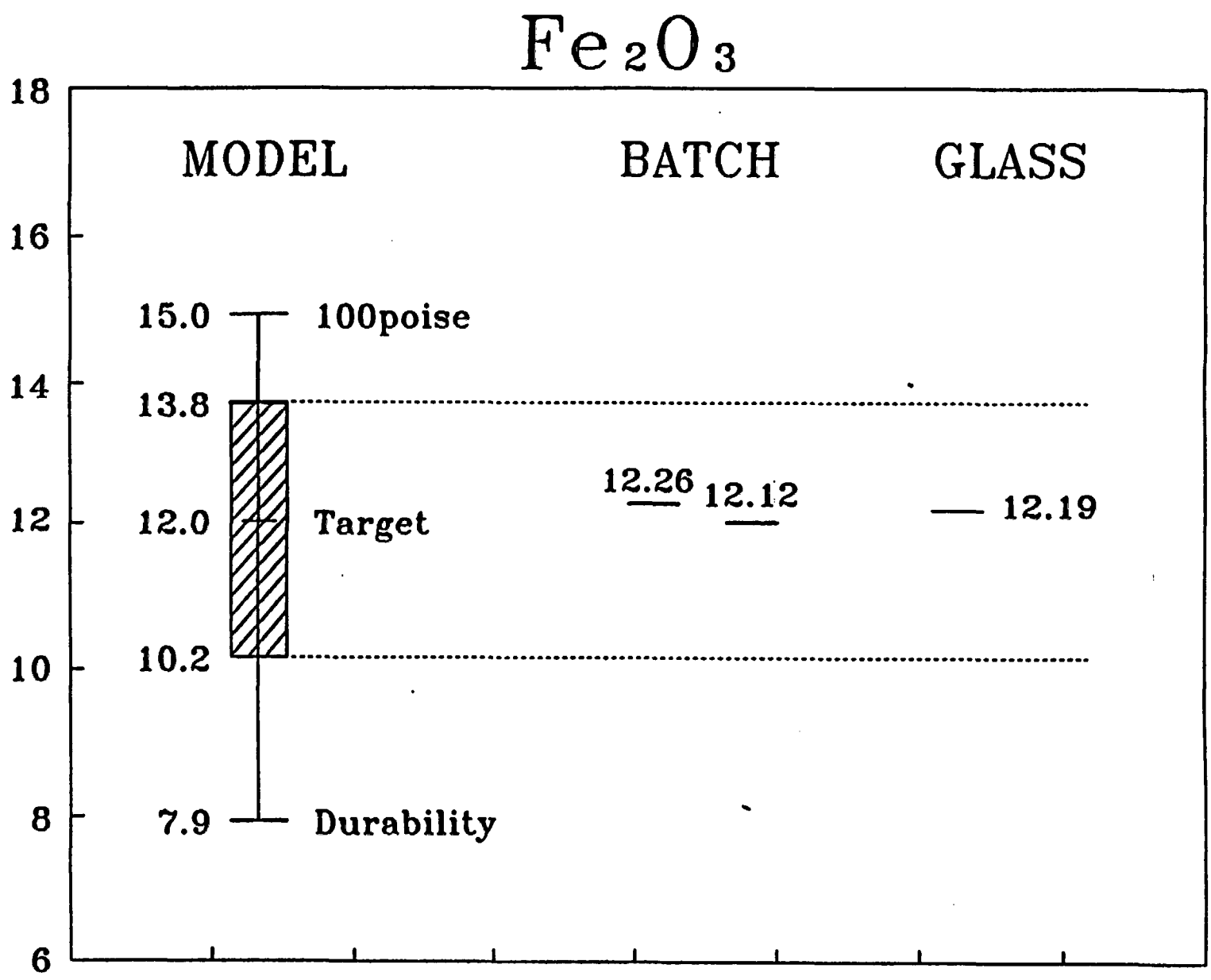
SrO TRACER IN THE MELTER OUTPUT STREAM COMPARED
TO A MODEL OF TWO, WELL-MIXED TANKS IN SERIES

GLASS PRODUCT PROPERTIES CHARACTERIZATION

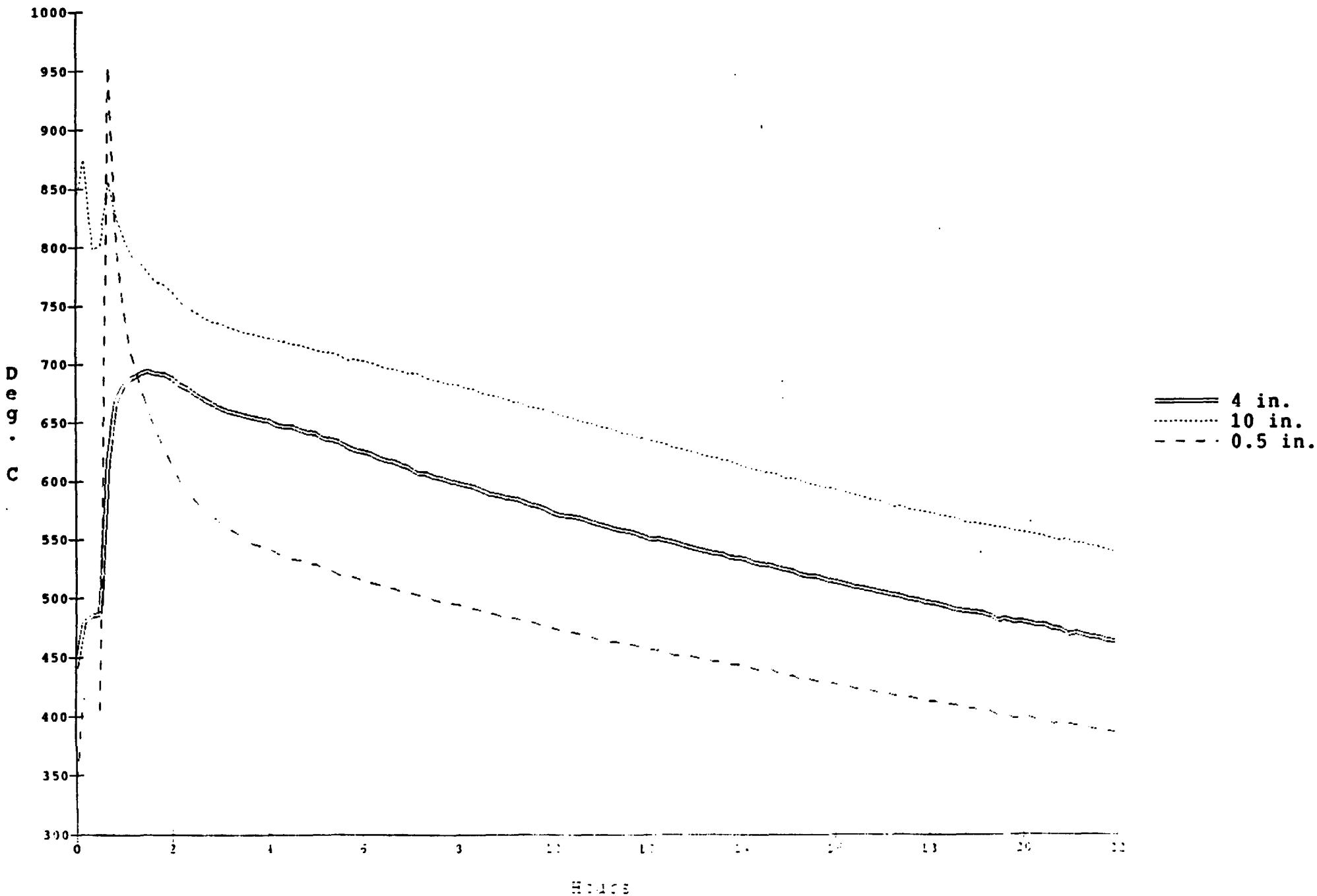
- Product Glass Chemical Composition
- Temperature Response of the Integrated Glass, Canister, and Turntable System
- Glass Crystallization Behavior:
  - As Produced
  - Following the Canister Cooling Period
  - Time-Temperature-Transformation Curves Generated from Isothermal Heat Treatments


SiO2
MODEL
BATCH
GLASS
48
46
44
42
40
38
47.05
100poise
45.75
43.35
Target
40.95
39.55
20poise
38.00
Durability
43.18
43.08
43.31


Al_2O_3
14
12
10
8
6
4
2
MODEL
BATCH
GLASS
10.2
100poise
7.2
6.5
5.7
Target
4.1
Durability
6.19
6.18
6.63

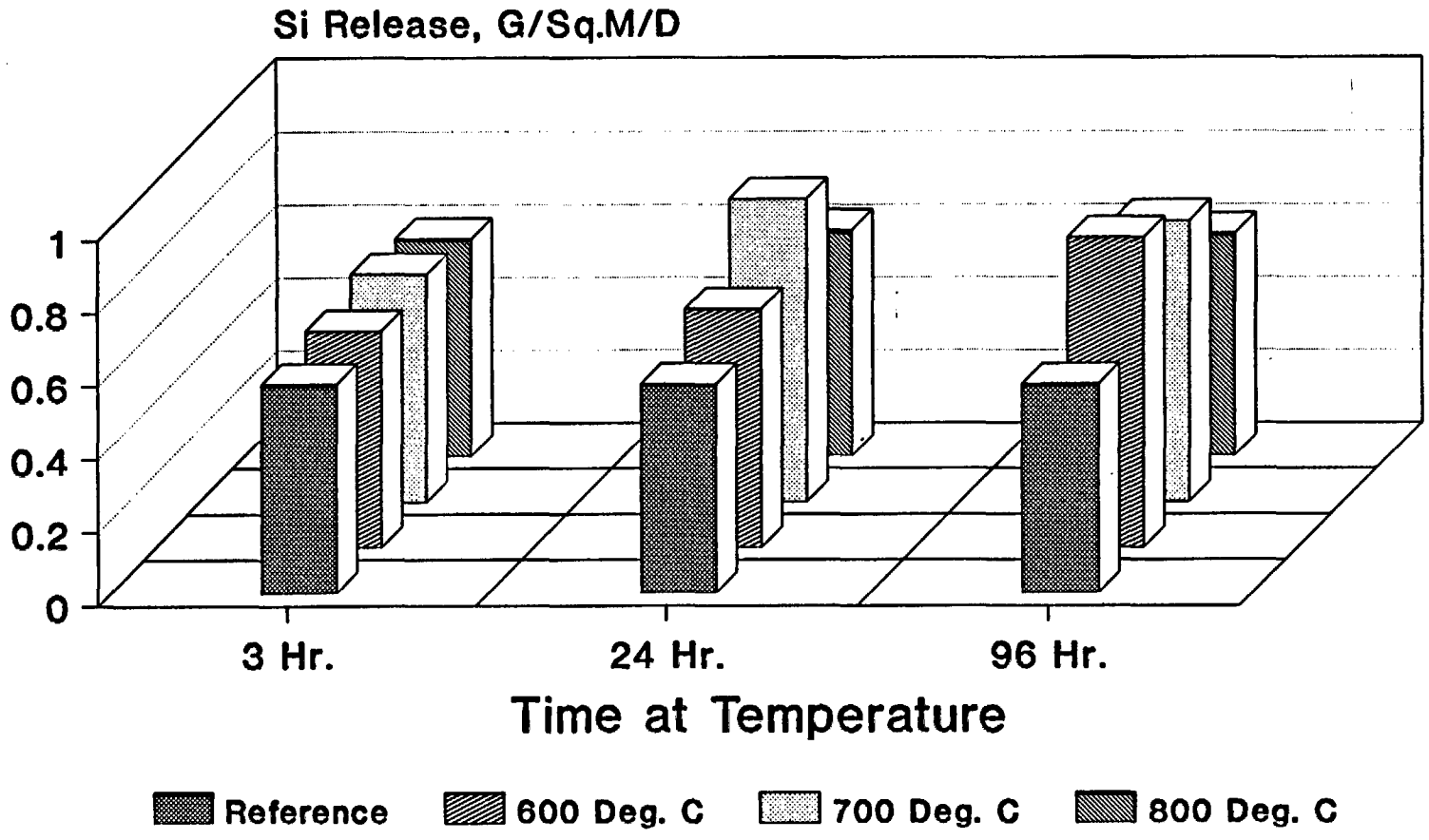

Fe_2O_3
18
16
14
12
10
8
6
MODEL
BATCH
GLASS
15.0
100poise
13.8
12.0
Target
10.2
7.9
Durability
12.26
12.12
12.19

Canister Cooling History, Midpoint



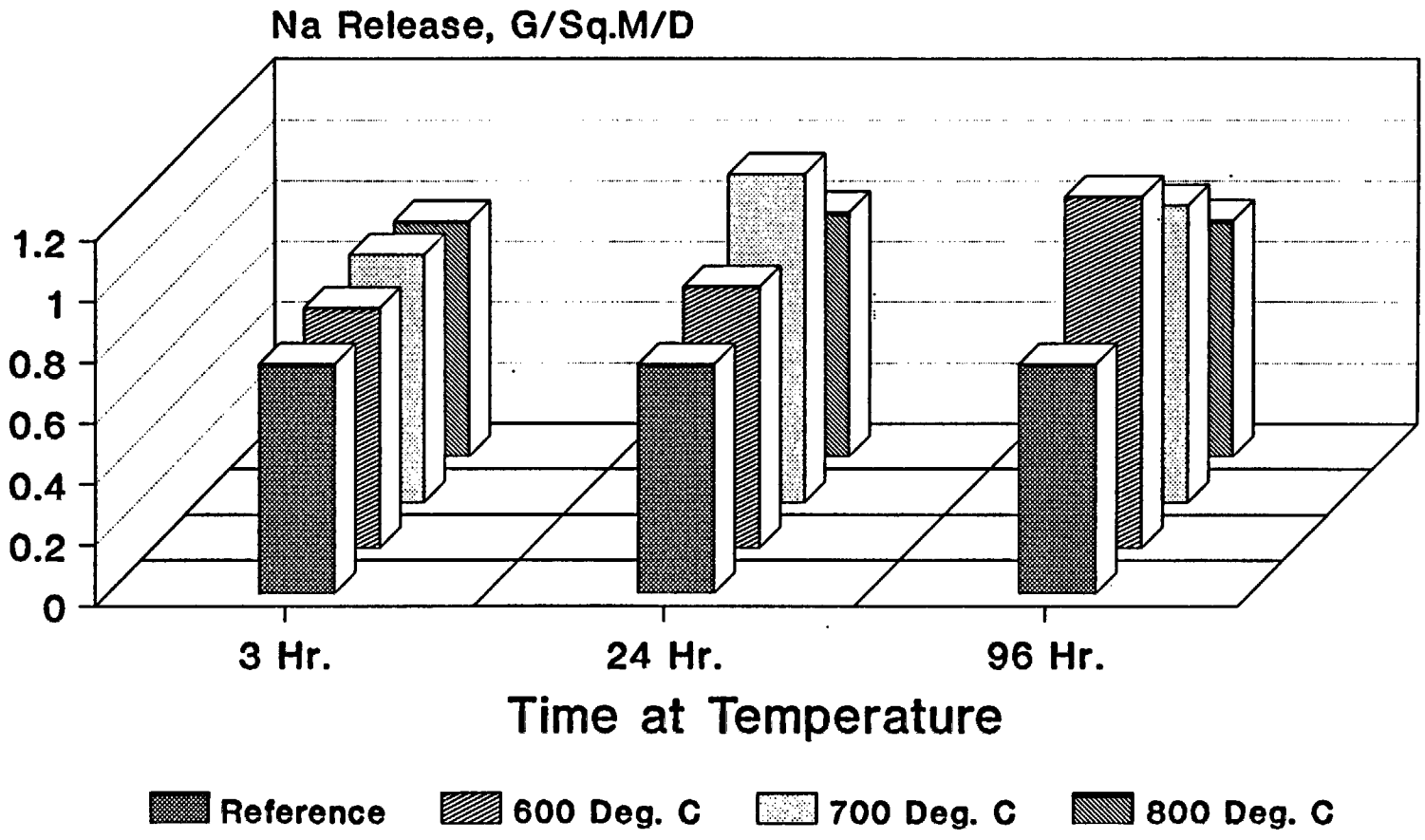
MCC-1 TEST RESULTS

Heat Treated WVDP Reference Glass



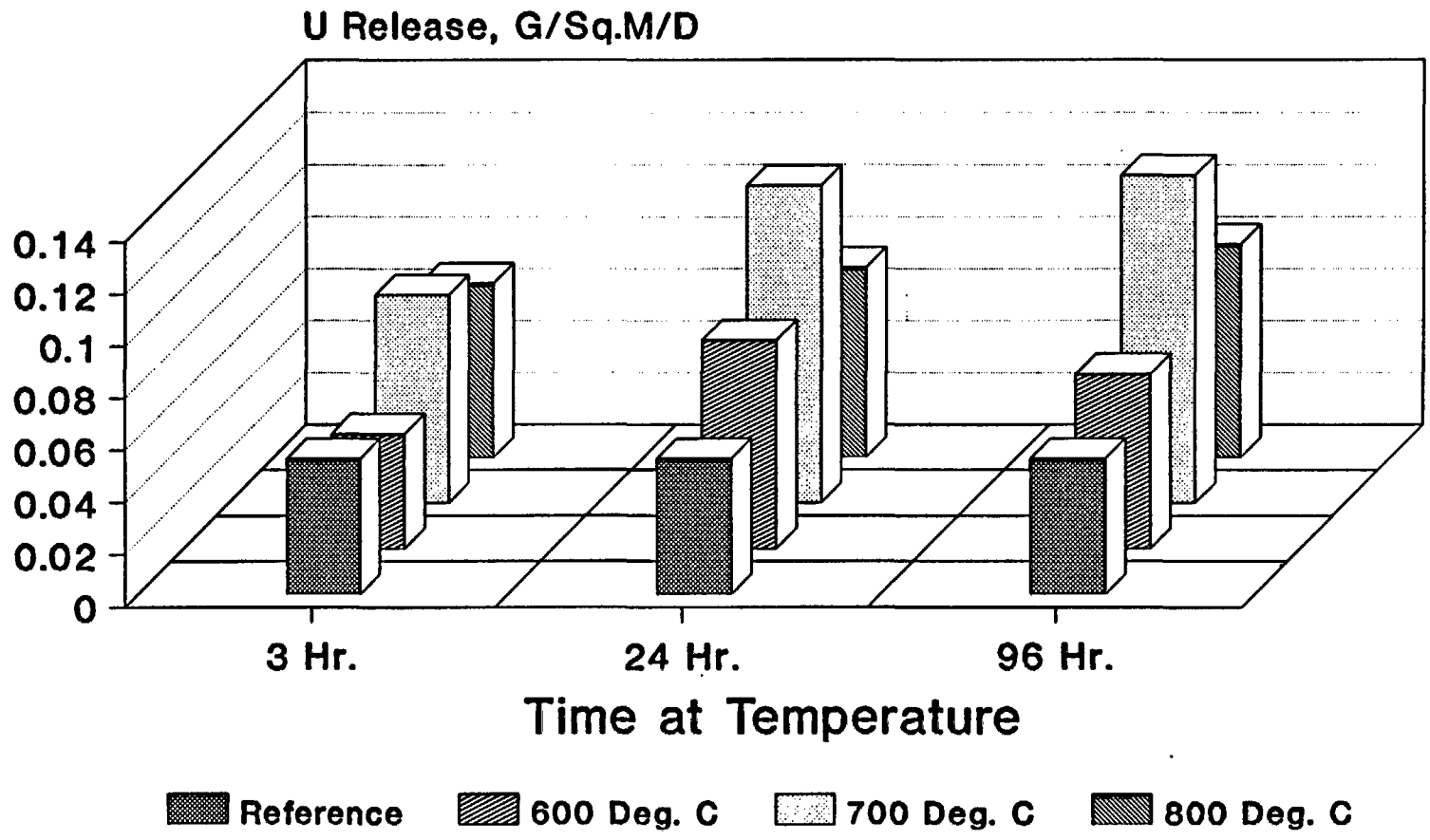
MCC-1 TEST RESULTS

Heat Treated WVDP Reference Glass



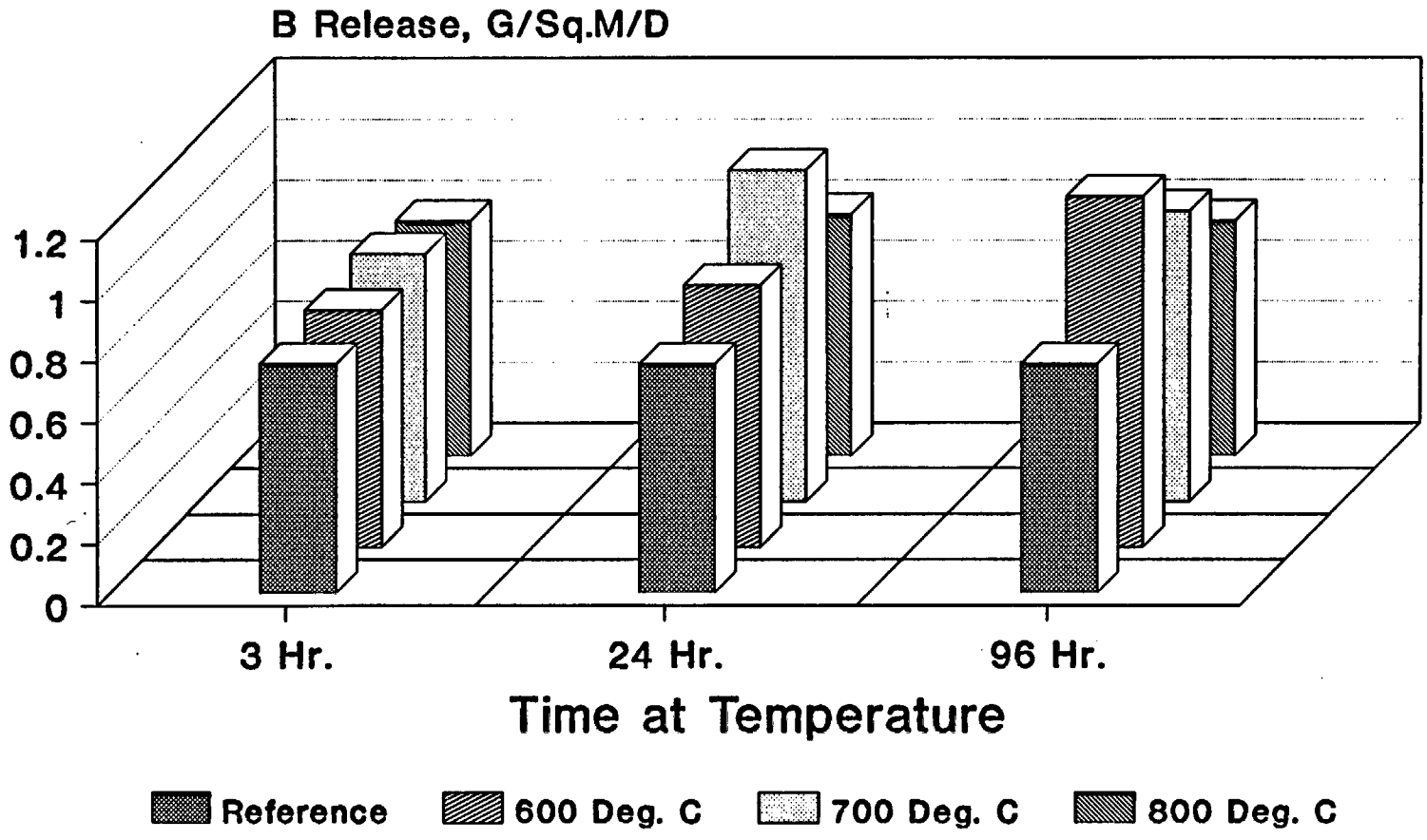
MCC-1 TEST RESULTS

Heat Treated WVDP Reference Glass

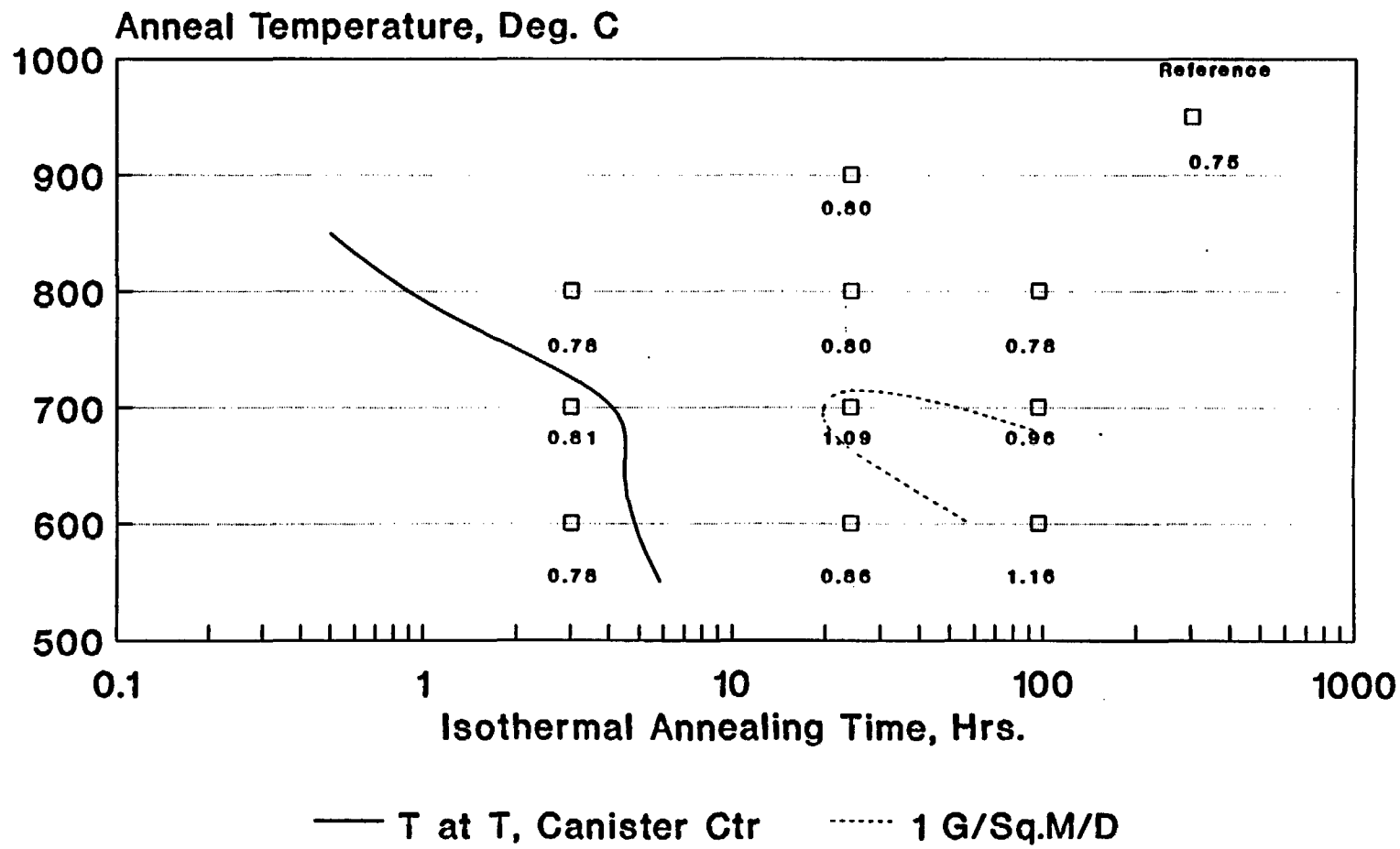


MCC-1 TEST RESULTS

Heat Treated WVDP Reference Glass



WVDP GLASS COOLING AND ESTIMATED DURABILITY BOUNDRY, BORON DATA



CONTINUING ACTIVITIES

- Development of the Data Verifying that the Glass 'Shard' Sample is Representative of the Canister

- Continued Durability Testing of Glasses Produced from Actual PUREX Sludge, THOREX, and Loaded Zeolite

SUMMARY

- The Integrated, Full-Scale Vitrification System is Producing a Glass Product which Achieves the Waste Acceptance Preliminary Specifications Objectives
- The Potential Processing Uncertainties are being Characterized
- Validation of Radionuclide Concentration Assumptions and Radioactive Glass Performance is in Progress

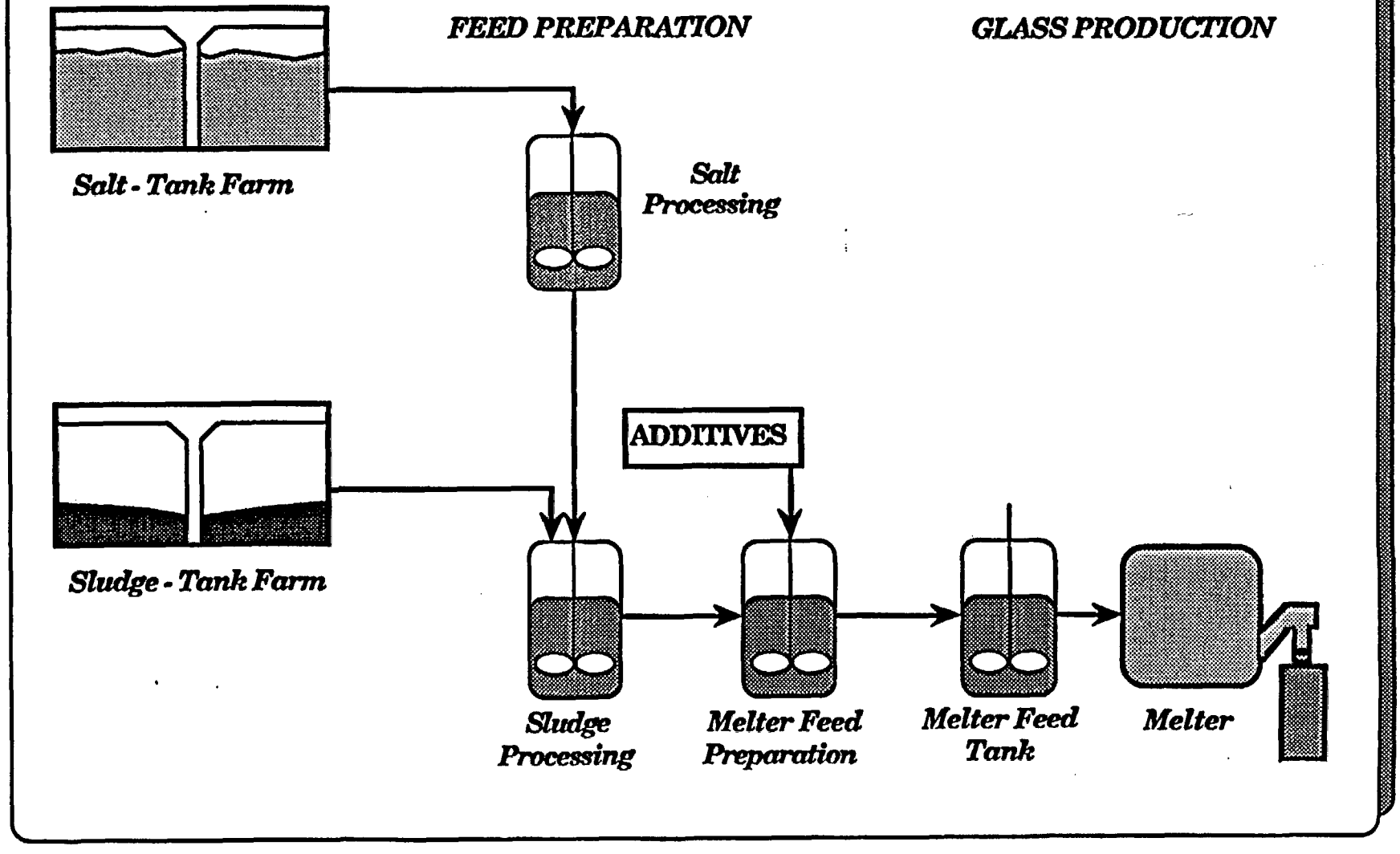
8

Waste Glass

Product Control

M. J. Plodinec
October, 1989

Immobilization of High-Level Waste



Waste Vitrification Objectives

- Conversion of liquid waste into a stable solid form
  - — Congressional action setting up WV program
  - — DOE response to NRDC suit on waste in waste tanks
- Minimization of risk to workers, and sites
- Product suitable for disposal
  - — Do this by meeting specifications
  - — This is the heart of the Waste Acceptance Process

Thus, goal is a reliable process making an acceptable product

Waste Vitrification Constraints

- Reliable process
  - Viscosity
  - Must dissolve the waste
- Acceptable product (= meets repository's specifications)
  - Glass (durability, known characteristics)
  - Canister (material, fabrication and closure, label)
  - Finished product (foreign materials, dimensions, safe handling)
  - Quality assurance (RW-0214)

Glass Specifications

Major focus of the non-radioactive runs is to show that producer can meet specifications on glass

- Can control process so that glass can limit release to < 1 g/m^2-d on MCC-1 leach test
- Can verify to 95 % confidence level, that 95 % of product would be able to meet limit
- Can determine composition of product, for reporting

Glass Specifications

— Bases for Compliance Strategy

- Experience world-wide is that glass quality determined by composition

⇒ Control glass quality by controlling glass composition

- No re-work capability

⇒ Control glass composition by controlling feed composition

- Must determine what is acceptable glass
- Must know that we can make acceptable glass
- During production, must have confidence we have made acceptable glass

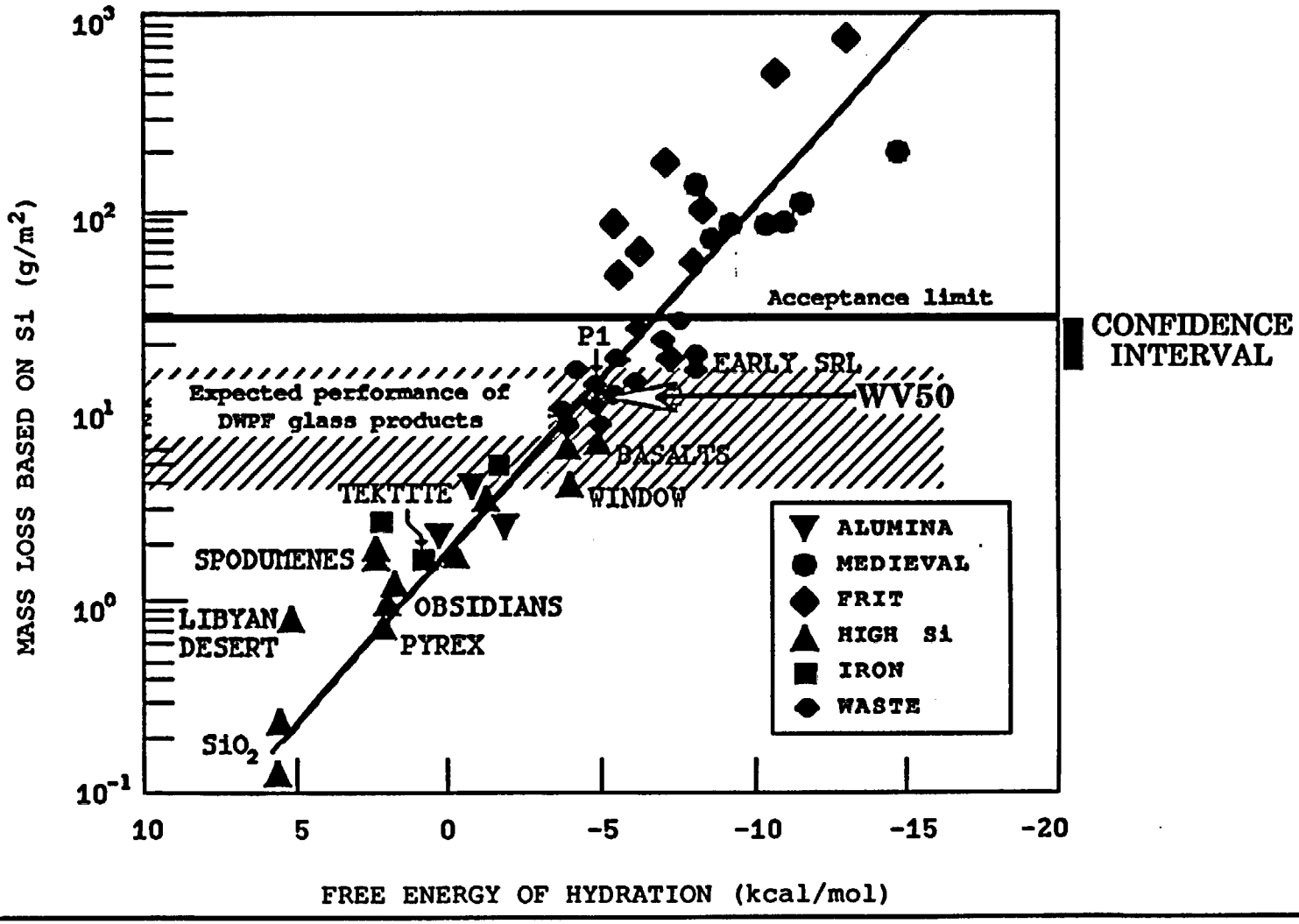
Glass Specifications

— Strategy

DOE - OCRWM		WASTE FORM PRODUCER
SPECIFICATIONS	→	**LABORATORY TESTS**
CONTROL PRODUCT TO MEET LIMIT		• QUALIFY RANGE OF GLASS COMPOSITIONS
VERIFY CONTROL DURING PRODUCTION	→	**COLD RUNS**
		• MEASURE COMPOSITION • CONTROL COMPOSITION
	→	**PRODUCTION**
		• REPORT COMPOSITION • VERIFY ACCEPTABILITY

Acceptable Glasses

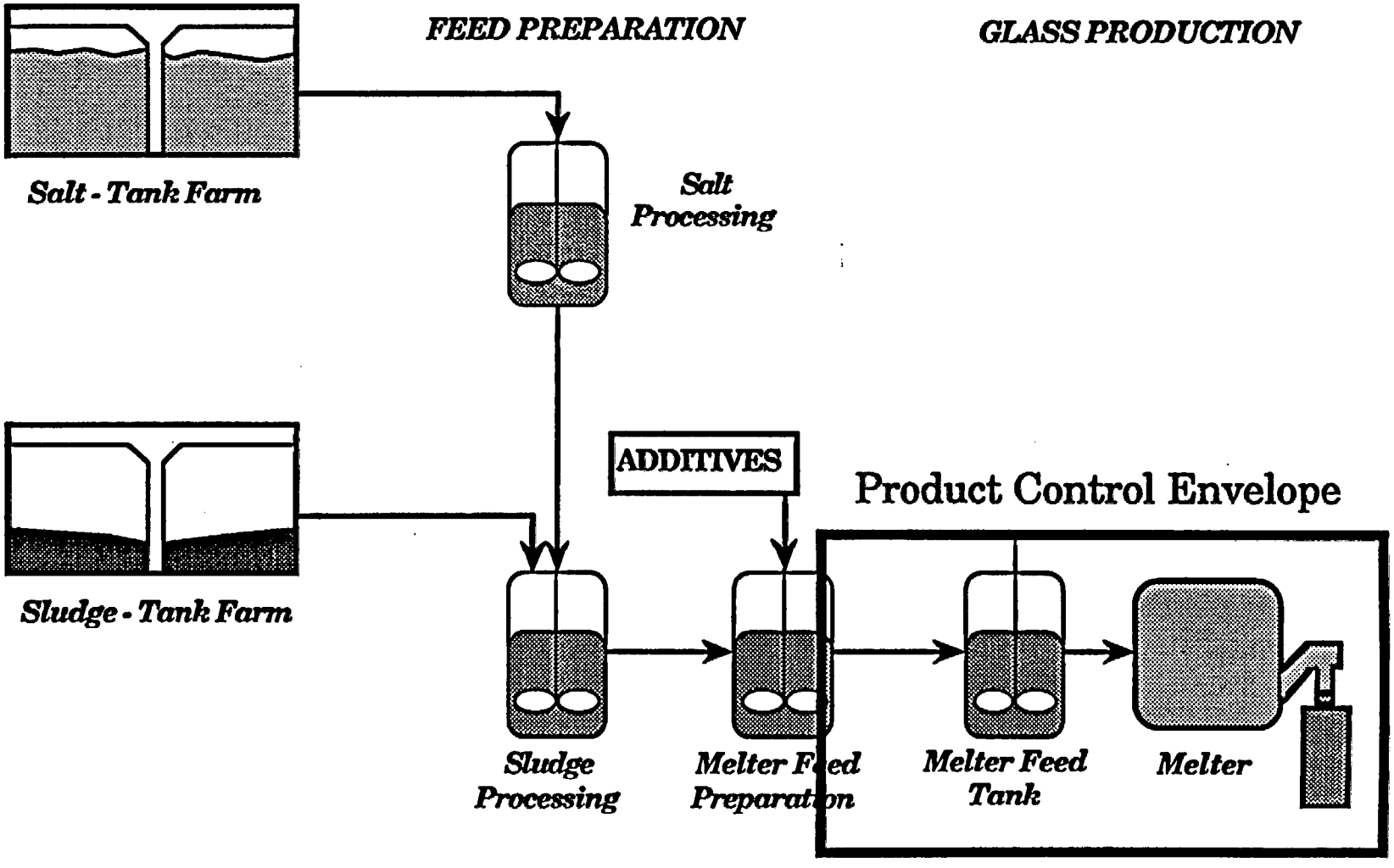
— MCC-1 Tests



MCC-1 test results - glass exposed to deionized water for 28 days, at 90°C.

Control of Radionuclide Release Properties

— Product Control Envelope



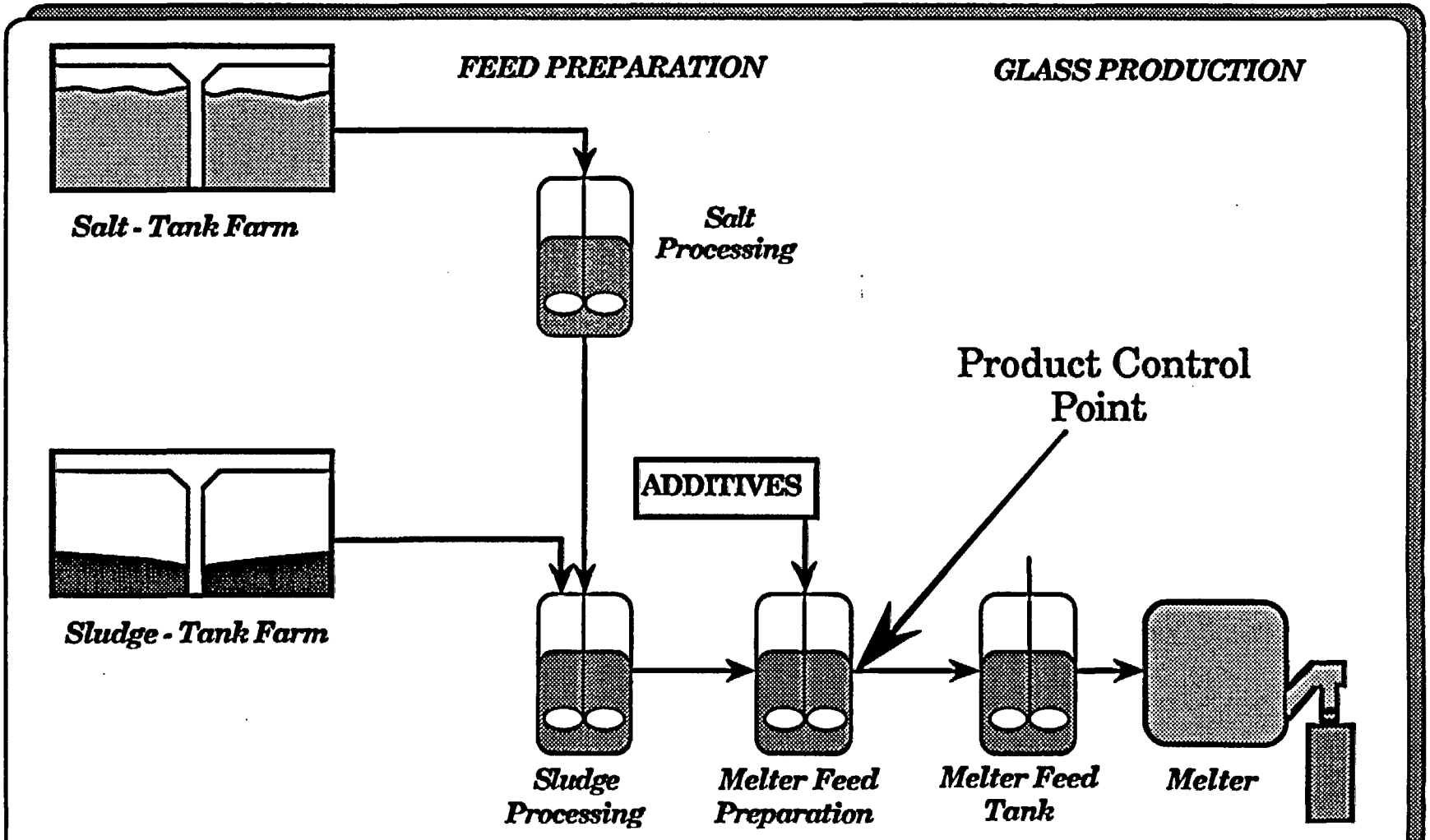
Control of Radionuclide Release Properties

— Glass Composition Control

- Before processing of a "macrobatch":
  - — Based on waste composition, specify additives and waste blending targets to produce acceptable glass, which can be reliably processed
- In vitrification facility:
  - — Determine feed composition in last feed preparation tank, and convert to glass composition
  - — Determine whether it is on target
  - — If necessary, adjust and confirm back on target
  - — Feed will not be transferred to melter feed tank until it will make acceptable glass, and is processible
- This must be demonstrated during cold runs

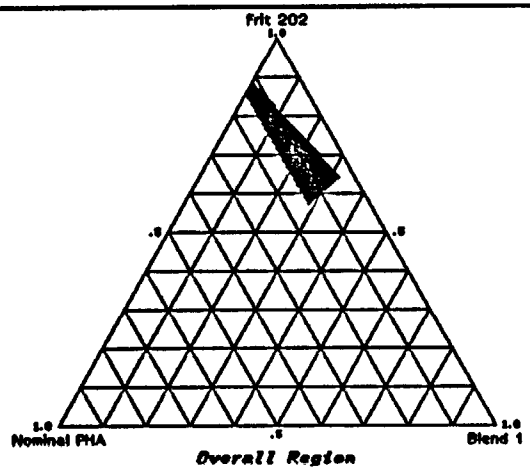
Control of Radionuclide Release Properties

— Product Control Point



Glass Compositions

Select Frit *Select PHA Product* *Select Sludge*

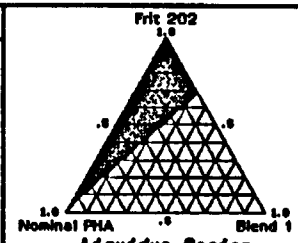


Overall Region

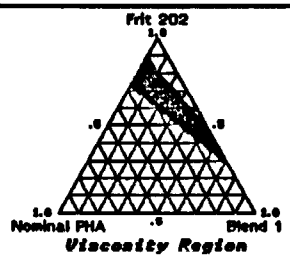
Overall Region Coordinates (Weight Fraction):

PHA	Sludge	Frit
0.03	0.33	0.64
0.15	0.29	0.57
0.15	0.00	0.85
0.11	0.00	0.89

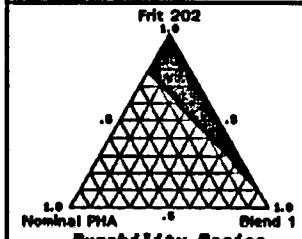
Liquidus (C) ≤ 1050
Viscosity (Poise) ≥ 20
Viscosity (Poise) ≤ 100
Durability (Kcal/Mole) ≥ -7
TiO2 (wt%) ≤ 1.0
SO4 (wt%) ≤ 0.4
P2O5 (wt%) ≤ 3.0
Cr2O3 (wt%) ≤ 0.3



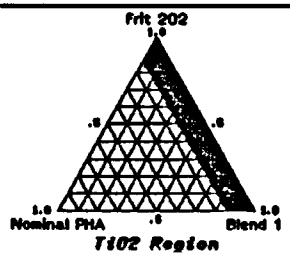
Liquidus Region



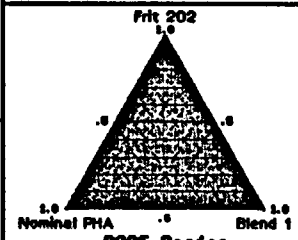
Viscosity Region



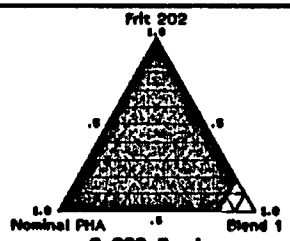
Durability Region



TiO2 Region



P2O5 Region



Cr2O3 Region

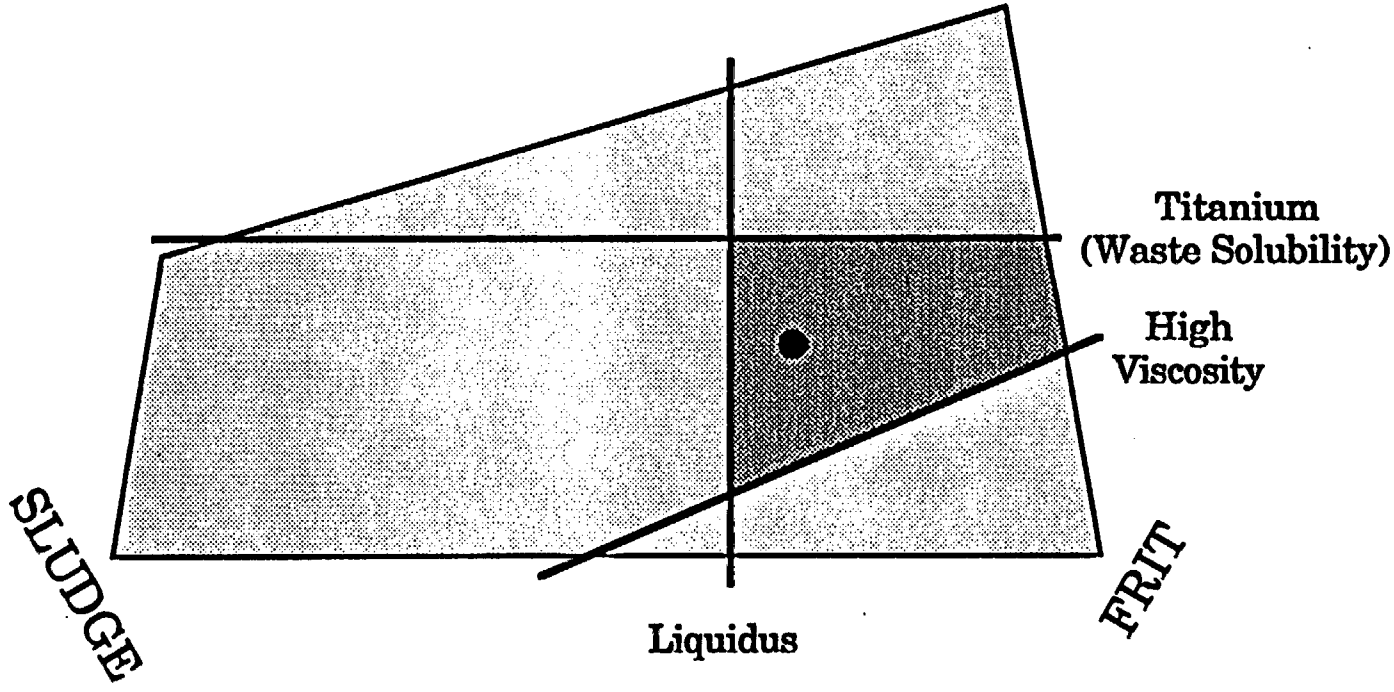
```
Glass Compositions command: Select Pha Nominal Pha
Glass Compositions command: Select Sludge Tank 51    1
Glass Compositions command: Select Sludge Blend 1
Glass Compositions command:
```

Mouse-L: Specify Parameters; Mouse-M: Describe Composition Triangle; Mouse-R: Menu.
To see other commands, press Shift, Control, Meta-Shift, or Super.

(Wed 25 Oct 7:58:26) Keyboard CL USER: User Input

Control of Radionuclide Release Properties

— Constraints



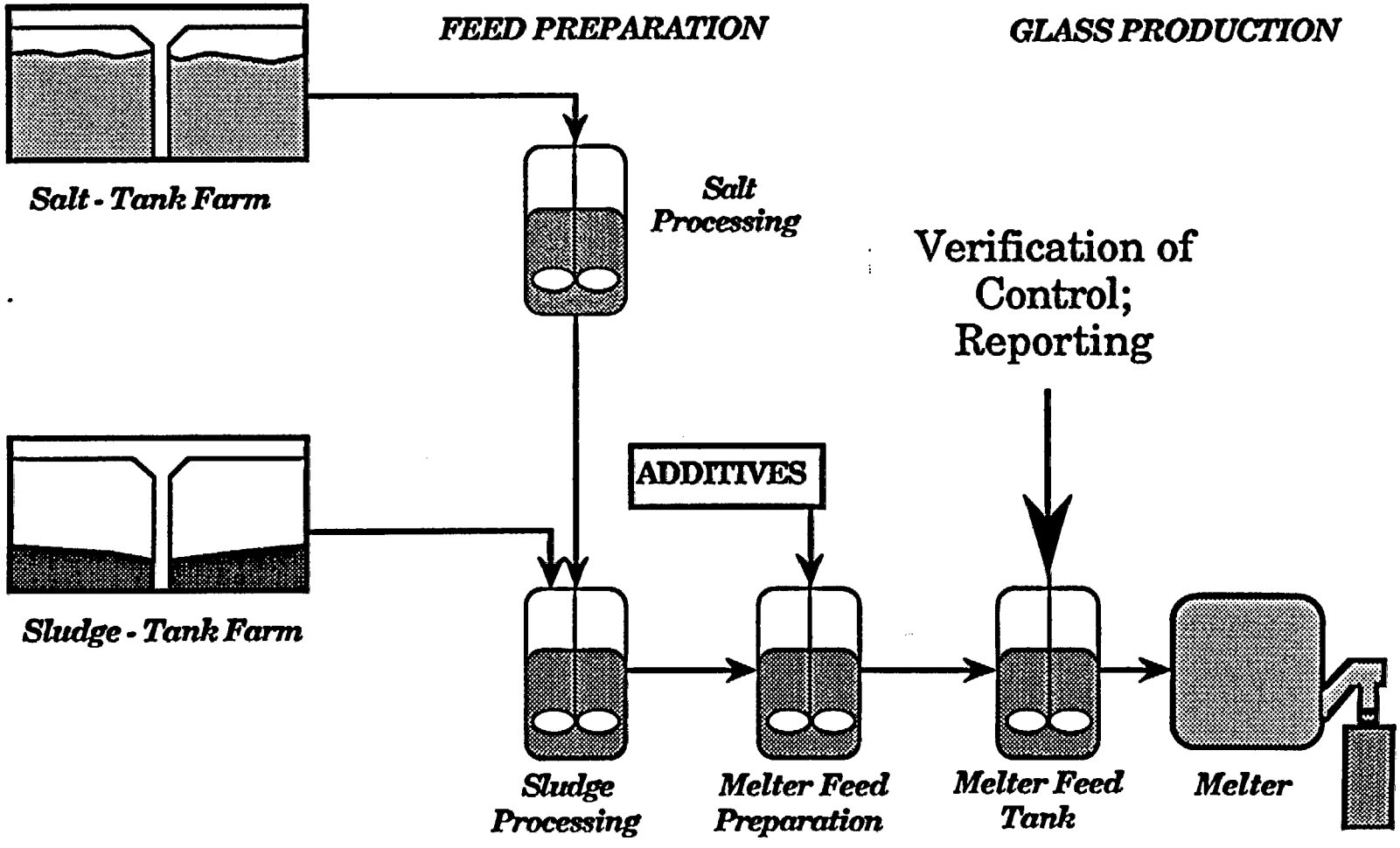
- Processing constraints are more limiting than product specifications

Verification; Reporting of Glass Composition

— Strategy

- Once feed material is in melter feed tank, verify control by analysis; i.e. show feed will make glass in target region
- Use the same analysis for reporting composition
- Periodically confirm acceptability through glass sampling

Verification of Control and Reporting of Glass Composition



Role of Product Control Program (PCP)

PCP ensures that the process makes acceptable glass by controlling the key steps (Sampling, analysis, ...)

- Additives are identified and procured in a controlled manner
- Addition of additives is controlled so that an acceptable glass will result
- Sufficient feed sampling is performed, using the right equipment and procedures, to give needed confidence
- Analysis is done by qualified personnel, using demonstrated procedures and appropriate standards
- Feed is not transferred from feed preparation tank until it is certain it will make acceptable glass

Conclusions

- Waste form producers are beginning qualification of their facilities and procedures
- Though the names and details may be different, WV and DWPF are approaching in a consistent manner
  - Both processing and product constraints
  - Control glass through control of composition
  - Glass sampling only confirmatory
- Control of feed composition is the critical step in making acceptable glass
- Product Control Program is tool to ensure this is done consistently during production

10

SLURRY FEED MAKEUP

by

Dr. K. R. Routt

November 1, 1989

STATISTICAL TERMINOLOGY

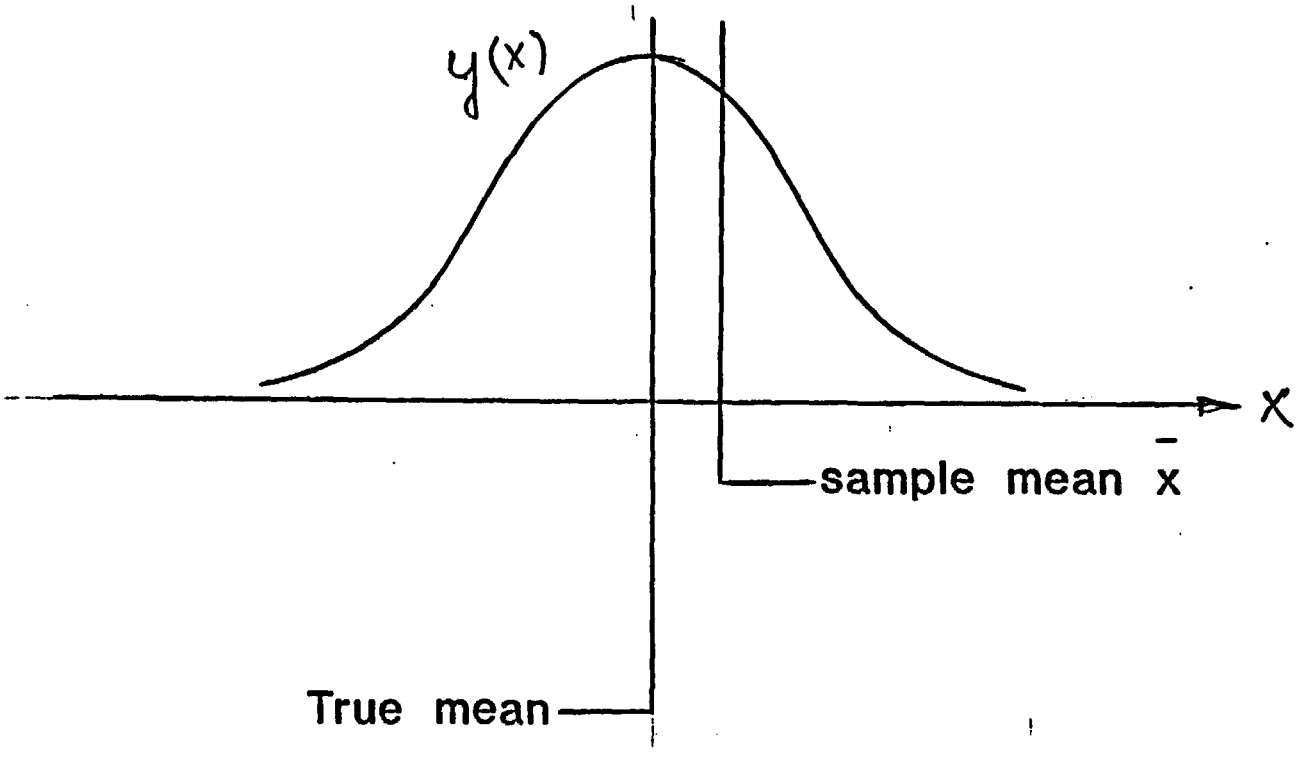
1. Sample mean for arbitrary variable y

$$\bar{y} = \frac{\sum_{i=1}^{N} y_i}{N}$$

2. True mean of an infinite population

$$\eta = \frac{\int y(x)dx}{\int dx}$$

STATISTICAL TERMINOLOGY



RELATIONSHIP OF SAMPLE MEAN TO TRUE MEAN

$$\bar{y} = \eta \pm \frac{t_{\alpha/2}\, s}{\sqrt{n}}$$

$$s = \left[\frac{\sum_{i=1}^{N} (y_i - \bar{y})^2}{N-1} \right]^{1/2}$$

$$\lim_{N \to \infty} \bar{y} = \eta$$

STATISTICAL MODEL

1. $\bar{y} = y_{tar} + (\eta - y_{tar}) + (\bar{y} - \eta)$

2. Random error (RE) in sample mean

   - o RE = $\bar{y} - \eta$
   - o Bounded using t-test

3. Percent error (PE) in sample mean

$$PE = \frac{\pm \left[\frac{t_{\alpha/2} S}{\sqrt{N}} \right]}{\bar{y}} \times 100\%$$

4. Target error (TE)

$$TE = \eta - y_{tar}$$

$$\cong \bar{y} - y_{tar}$$

5. Percent target error (PTE)

$$PTE = \frac{(\bar{y} - y_{tar}) \times 100\%}{y_{tar}}$$

CONSERVATION OF MASS

$$\eta_w + \eta_{gf} - \eta_{mix} = 0$$

Mass Balance Error (MBE)

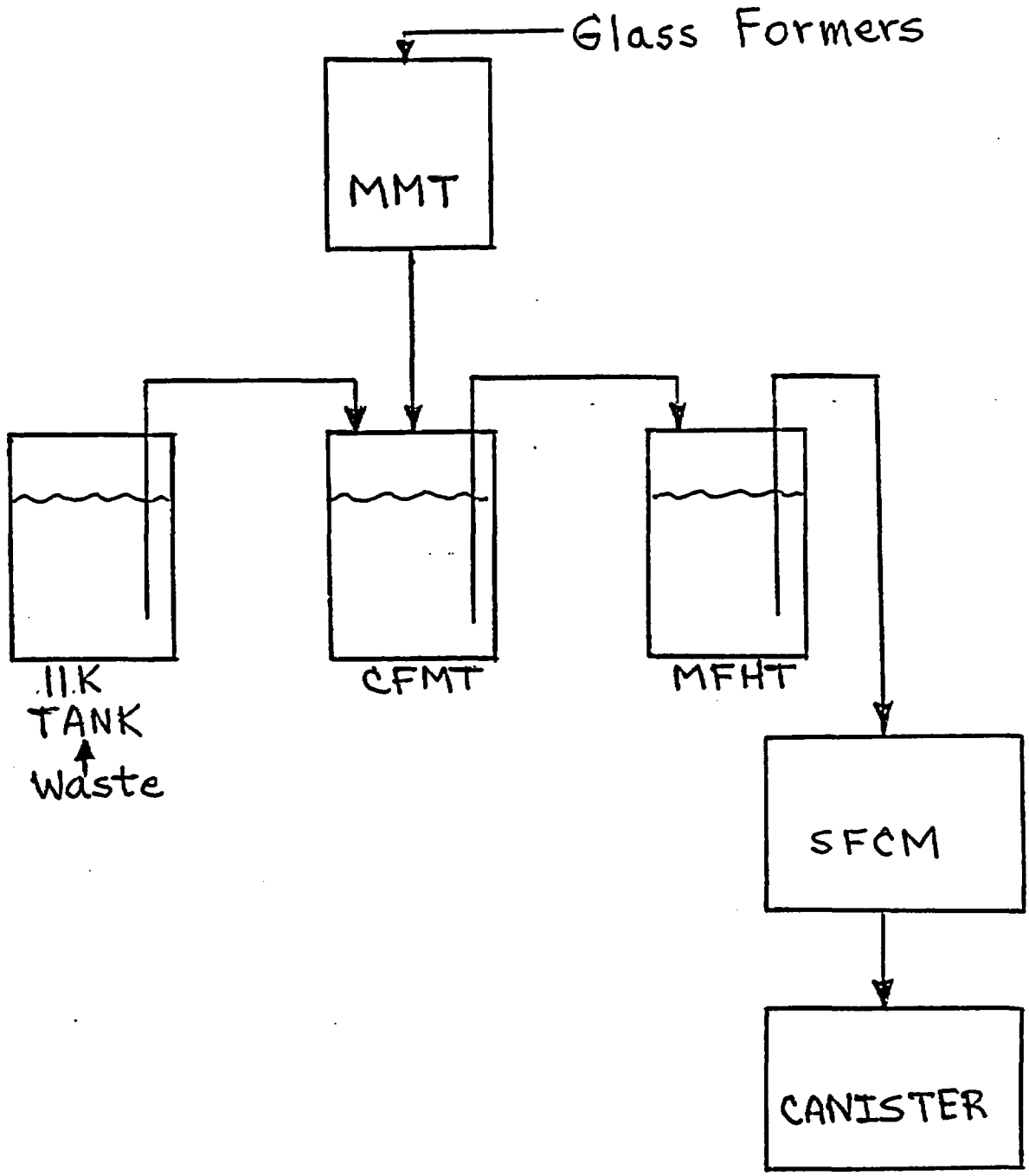
$$MBE = \bar{y}_w + \bar{y}_{gf} - \bar{y}_{mix}$$

or

$$\begin{aligned} MBE = {} & \eta_w + \eta_{gf} - \eta_{mix} \\ & + (\bar{y}_w - \eta_w) \\ & + (\bar{y}_{gf} - \eta_{gf}) \\ & - (\bar{y}_{mix} - \eta_{mix}) \end{aligned}$$

PERCENT MASS BALANCE ERROR (PMBE)

$$\text{PMBE} = \frac{[\,\bar{y}_{w} + \bar{y}_{gf} - \bar{y}_{mix}\,] \times 100\%}{\bar{y}_{mix}}$$


Glass Formers
MMT
11K
TANK
Waste
CFMT
MFHT
SFCM
CANISTER

STEPS IN FEED MAKEUP PROCESS

1. Transfer batch of simulated waste into CFMT.
2. Sample, analyze, and check analyses for random error.
3. Boil waste batch to reduce water content.
4. Compute amounts of glass formers required.
5. Add glass formers to MMT.
6. Sample MMT, analyze, and check analyses for random error and target error.
7. Transfer glass formers to CFMT.

STEPS IN FEED MAKEUP PROCESS (CONT.)

8. Boil CFMT to reduce water content.
9. Sample CFMT, analyze, and check analyses for random error, target error, and mass balance error.
10. Shim as required for water, carbon, nitrates, and metal oxides.
11. Resample, analyze, and check analyses for random error, target error, and mass balance error.
12. Repeat 10 and 11 as required.
13. Transfer batch to MFHT and feed.

TABLE 1 - CFMT LEVEL AND VOLUME DATA FOR THE WASTE+GLASS FORMERS, BATCH #3, SF-12 RUN

	INSTRUMENT	1 TAG	2 LEVEL (IN. OF WC)	3 LEVEL (IN. OF SLURRY)
1	CFMT BUBBLER	LT--0101	106.988000	73.615765
2			106.980000	73.610261
3			106.988000	73.615765
4	CFMT BUBBLER	LT--0103	109.426000	75.293292
5			109.438000	75.301549
6			109.465000	75.320127
7	CFMT COSA	LT--0104	104.035000	71.583880
8			104.047000	71.592137
9			104.043000	71.589384
0	CFMT BUBBLER	LT--0105	106.848000	73.519435
1			106.828000	73.505673
2			106.832000	73.508425
3	DATA POINTS		12.000000	12.000000
4	SAMPLE MEAN		106.826500	73.504641
5	SAMPLE STD DEV		1.997298	1.374291
6	MAX		109.465000	75.320127
7	MIN		104.035000	71.583880
8	95% CONF LIM		1.269355	0.873412
9	PCT ERROR OF SAM MEAN		1.188240	1.188240

	INSTRUMENT	4 VOLUME (LITERS)
1	CFMT BUBBLER	13564.461450
2		13563.454659
3		13564.461450
4	CFMT BUBBLER	13871.281099
5		13872.791286
6		13876.189207
7	CFMT COSA	13192.829612
8		13194.339799
9		13193.836403
0	CFMT BUBBLER	13546.842603
1		13544.325624
2		13544.829020
3	DATA POINTS	12.000000
4	SAMPLE MEAN	13544.136851
5	SAMPLE STD DEV	251.357806
6	MAX	13876.189207
7	MIN	13192.829612
8	95% CONF LIM	159.746983
9	PCT ERROR OF SAM MEAN	1.179455

ATA TAKEN ON 10/19/89 AT 18:04 TO 18:14 HOURS.
OLUME = 182.900*LEVEL(IN. OF SLURRY)+100.138

TABLE 2 - NON-ICP DATA FOR THE WASTE+GLASS FORMER MIXTURE
IN THE CFMT, BATCH #3, SF-12 RUN

LOG NUMBER-ANALYSIS	1 pH	2 DENSITY (G/ML)	3 % TOTAL SOLIDS	4 % SUSPENDED SOLIDS	5 TOC (UG/G)
1 8904350-A	5.050000	1.453000	55.360000	26.770000	29600.000000
2 8904350-A2					28900.000000
3 8904351-A	5.070000	1.454000	55.200000	26.300000	24000.000000
4 8904351-A2					25500.000000
5 8904351-B					24600.000000
6 8904351-C					24500.000000
7 8904351-D					26000.000000
8 8904352-A	5.030000	1.452000	55.610000	27.200000	30400.000000
9 8904352-B	5.060000	1.456000	55.250000	26.870000	29400.000000
10 8904352-C	5.030000	1.452000	55.320000	27.380000	28300.000000
11 8904352-D	5.020000	1.453000	55.380000	27.960000	28300.000000
12 8904352-A2					29400.000000
13 8904352-B2					28500.000000
14 8904352-C2					32100.000000
15 8904352-D2					30200.000000
16 DATA POINTS	6.000000	6.000000	6.000000	6.000000	15.000000
17 SAMPLE MEAN	5.043333	1.453333	55.353333	27.080000	27980.000000
18 SAMPLE STD DEV	0.019664	0.001506	0.142782	0.570509	2466.692407
19 MAX	5.070000	1.456000	55.610000	27.960000	32100.000000
20 MIN	5.020000	1.452000	55.200000	26.300000	24000.000000
21 95% CONF LIM	0.020643	0.001580	0.149889	0.598905	1366.353462
22 PCT ERROR OF SA	0.409305	0.108749	0.270785	2.211615	4.883322

LOG NUMBER-ANALYSIS	6 TIC (UG/G)	7 TOTAL CARBON (UG/G)	8 NO3- (UG/G)
1 8904350-A	1400.000000	31000.000000	114000.000000
2 8904350-A2	2100.000000	31000.000000	119000.000000
3 8904351-A	1200.000000	25200.000000	118000.000000
4 8904351-A2	1100.000000	26600.000000	118000.000000
5 8904351-B			
6 8904351-C			
7 8904351-D			
8 8904352-A	1100.000000	31500.000000	121000.000000
9 8904352-B	1100.000000	30500.000000	122000.000000
10 8904352-C	1500.000000	29800.000000	128000.000000
11 8904352-D	1500.000000	29800.000000	122000.000000
12 8904352-A2	1300.000000	30700.000000	127000.000000
13 8904352-B2	1100.000000	29600.000000	130000.000000
14 8904352-C2	1500.000000	33600.000000	122000.000000
15 8904352-D2	1100.000000	31300.000000	125000.000000
16 DATA POINTS	12.000000	12.000000	12.000000
17 SAMPLE MEAN	1333.333333	30050.000000	122166.666667
18 SAMPLE STD DEV	296.443566	2224.859546	4667.748792
19 MAX	2100.000000	33600.000000	130000.000000
20 MIN	1100.000000	25200.000000	114000.000000
21 95% CONF LIM	188.400615	1413.978761	2966.523287
22 PCT ERROR OF SA	14.130046	4.705420	2.428259

DATA BASED ON NON-DRIED SLURRY SAMPLES.

TABLE 3 - ICP ANALYSIS OF THE WASTE+GLASS FORMERS
IN THE CFMT, BATCH #3, SF-12 RUN

LOG NUMBER-ANALYSIS	1 Al	2 B	3 Ba	4 Ca
1 8904350-A	11907.770000	11184.440000	233.090000	1264.010000
2 8904350-B	11776.930000	11474.480000	248.290000	1235.340000
3 8904350-C	11775.040000	11625.650000	272.580000	1246.040000
4 8904350-D	11741.110000	11185.050000	217.860000	1233.360000
5 8904350-E	11591.110000	10999.070000	199.530000	1238.660000
6 8904350-F	11609.490000	10782.760000	187.510000	1228.670000
7 8904351-A	10632.900000	10185.000000	210.900000	1121.710000
8 8904351-B	10571.160000	10046.810000	200.280000	1122.650000
9 8904351-C	10542.850000	9952.380000	192.280000	1110.470000
0 8904351-D	10588.230000	9948.150000	189.030000	1114.650000
1 8904351-E	10512.570000	9854.930000	179.400000	1117.980000
2 8904351-F	10611.850000	9627.150000	154.680000	1121.280000
3 DATA POINTS	12.000000	12.000000	12.000000	12.000000
4 SAMPLE MEAN	11155.084167	10572.155833	207.119167	1179.568333
5 SAMPLE STD DEV	610.166056	707.621625	32.106115	64.823259
6 MAX	11907.770000	11625.650000	272.580000	1264.010000
7 MIN	10512.570000	9627.150000	154.680000	1110.470000
8 95% CONF LIM	387.782611	449.719152	20.404598	41.197527
9 PCT ERROR OF SAM MEAN	3.476286	4.253807	9.851622	3.492594

LOG NUMBER-ANALYSIS	5 Ce	6 Cr	7 Cs	8 Cu
1 8904350-A	402.980000	319.800000	348.100000	166.270000
2 8904350-B	394.510000	325.140000	342.450000	176.370000
3 8904350-C	427.410000	346.830000	333.040000	184.530000
4 8904350-D	321.140000	261.250000	307.200000	163.990000
5 8904350-E	297.310000	234.320000	287.690000	149.020000
6 8904350-F	353.210000	261.120000	314.860000	146.700000
7 8904351-A	333.880000	261.830000	295.030000	144.490000
8 8904351-B	339.130000	251.770000	289.320000	142.790000
9 8904351-C	290.850000	237.040000	264.760000	138.470000
0 8904351-D	303.880000	248.350000	285.140000	133.200000
1 8904351-E	288.200000	229.980000	283.360000	157.440000
2 8904351-F	256.020000	186.710000	279.150000	129.540000
3 DATA POINTS	12.000000	12.000000	12.000000	12.000000
4 SAMPLE MEAN	334.043333	263.678333	302.508333	152.734167
5 SAMPLE STD DEV	52.222996	45.592281	26.746285	17.166997
6 MAX	427.410000	346.830000	348.100000	184.530000
7 MIN	256.020000	186.710000	264.760000	129.540000
8 95% CONF LIM	33.189604	28.975544	16.998232	10.910248
9 PCT ERROR OF SAM MEAN	9.935718	10.988974	5.619096	7.143292

ATA IN UG/G OF NON-DRIED SLURRY.

TABLE 3 - ICP ANALYSIS OF THE WASTE+GLASS FORMERS
IN THE CFMT, BATCH #3, SF-12 RUN

LOG NUMBER-ANALYSIS	9 Fe	10 K	11 La	12 Li
1 8904350-A	29556.960000	10018.080000	98.550000	5183.540000
2 8904350-B	30226.840000	9943.280000	118.800000	5086.950000
3 8904350-C	30140.590000	9885.760000	140.240000	5105.440000
4 8904350-D	29635.360000	9908.840000	77.290000	5186.870000
5 8904350-E	29481.960000	9824.230000	39.340000	5119.330000
6 8904350-F	29437.110000	9630.600000	47.670000	5101.140000
7 8904351-A	26728.330000	8889.970000	82.670000	4713.720000
8 8904351-B	26910.110000	8820.220000	68.250000	4708.800000
9 8904351-C	26714.280000	9123.800000	54.330000	4702.850000
0 8904351-D	26779.660000	8843.460000	47.450000	4664.000000
1 8904351-E	26779.490000	8752.410000	41.160000	4644.100000
2 8904351-F	26787.760000	8938.810000	14.732000	4630.970000
3 DATA POINTS	12.000000	12.000000	12.000000	12.000000
4 SAMPLE MEAN	28264.870833	9381.621667	69.206833	4903.975833
5 SAMPLE STD DEV	1565.699423	523.581977	36.204469	239.678238
6 MAX	30226.840000	10018.080000	140.240000	5186.870000
7 MIN	26714.280000	8752.410000	14.732000	4630.970000
8 95% CONF LIM	995.058647	332.755295	23.009251	152.324195
9 PCT ERROR OF SAM MEAN	3.520478	3.546885	33.247079	3.106137

LOG NUMBER-ANALYSIS	13 Mg	14 Mn	15 Mo	16 Na
1 8904350-A	1962.020000	2654.610000	112.200000	29861.370000
2 8904350-B	1933.830000	2720.220000	133.080000	30000.000000
3 8904350-C	1969.240000	2713.530000	143.580000	30114.230000
4 8904350-D	1911.570000	2662.710000	110.020000	29963.530000
5 8904350-E	1893.610000	2632.740000	98.610000	29537.460000
6 8904350-F	1888.300000	2622.690000	98.150000	29419.520000
7 8904351-A	1707.880000	2398.240000	96.030000	26903.600000
8 8904351-B	1719.100000	2387.640000	94.470000	26900.740000
9 8904351-C	1703.800000	2388.570000	90.800000	26866.660000
0 8904351-D	1718.840000	2371.880000	90.630000	26959.120000
1 8904351-E	1719.530000	2370.400000	88.540000	26856.860000
2 8904351-F	1723.700000	2370.930000	82.610000	26701.710000
3 DATA POINTS	12.000000	12.000000	12.000000	12.000000
4 SAMPLE MEAN	1820.951667	2524.513333	103.226667	28340.400000
5 SAMPLE STD DEV	112.699297	152.315187	18.526845	1553.563453
6 MAX	1969.240000	2720.220000	143.580000	30114.230000
7 MIN	1703.800000	2370.400000	82.610000	26701.710000
8 95% CONF LIM	71.624482	96.801814	11.774480	987.345799
9 PCT ERROR OF SAM MEAN	3.933354	3.834474	11.406433	3.483881

ATA IN UG/G OF NON-DRIED SLURRY.

TABLE 3 - ICP ANALYSIS OF THE WASTE+GLASS FORMERS
IN THE CFMT, BATCH #3, SF-12 RUN

LOG NUMBER-ANALYSIS	17 Nd	18 Ni	19 P	20 S
1 8904350-A	360.390000	674.770000	3716.990000	166.090000
2 8904350-B	404.820000	733.270000	3783.550000	493.950000
3 8904350-C	470.210000	789.890000	3970.120000	812.910000
4 8904350-D	284.320000	658.060000	3622.600000	93.460000
5 8904350-E	242.920000	601.380000	3482.880000	0.000000
6 8904350-F	342.910000	582.930000	3363.230000	0.000000
7 8904351-A	284.220000	606.230000	3355.400000	301.160000
8 8904351-B	347.280000	590.630000	3252.800000	115.910000
9 8904351-C	278.570000	567.230000	3218.090000	44.010000
.0 8904351-D	269.890000	555.230000	3150.540000	0.000000
.1 8904351-E	245.930000	535.290000	3104.440000	0.000000
.2 8904351-F	202.390000	497.800000	2932.120000	0.000000
3 DATA POINTS	12.000000	12.000000	12.000000	12.000000
4 SAMPLE MEAN	311.154167	616.059167	3412.730000	168.957500
5 SAMPLE STD DEV	76.133520	84.108268	309.501546	253.097114
6 MAX	470.210000	789.890000	3970.120000	812.910000
7 MIN	202.390000	497.800000	2932.120000	0.000000
8 95% CONF LIM	48.385607	53.453848	196.699434	160.852376
9 PCT ERROR OF SAM MEAN	15.550365	8.676739	5.763697	95.202862

LOG NUMBER-ANALYSIS	21 Si	22 Sr	23 Ti	24 Zn
1 8904350-A	71952.980000	87.810000	1736.880000	1037.970000
2 8904350-B	68790.170000	84.400000	1817.580000	1086.010000
3 8904350-C	71880.490000	86.520000	1756.590000	1087.870000
4 8904350-D	66125.790000	83.040000	1662.710000	1034.630000
5 8904350-E	65226.640000	81.230000	1766.880000	1012.950000
6 8904350-F	64529.460000	82.640000	1715.030000	995.600000
7 8904351-A	59591.040000	78.230000	1492.690000	928.820000
8 8904351-B	59466.290000	78.417000	1486.890000	923.500000
9 8904351-C	60400.000000	76.500000	1690.470000	918.760000
0 8904351-D	59770.680000	75.403000	1466.600000	916.650000
1 8904351-E	58897.480000	74.900000	1451.640000	911.890000
2 8904351-F	59799.230000	74.569000	1604.200000	897.320000
3 DATA POINTS	12.000000	12.000000	12.000000	12.000000
4 SAMPLE MEAN	63869.187500	80.304917	1637.346667	979.330833
5 SAMPLE STD DEV	4944.410409	4.612255	131.837274	71.090762
6 MAX	71952.980000	87.810000	1817.580000	1087.870000
7 MIN	58897.480000	74.569000	1451.640000	897.320000
8 95% CONF LIM	3142.351757	2.931255	83.787359	45.180752
9 PCT ERROR OF SAM MEAN	4.919981	3.650156	5.117264	4.613431

ATA IN UG/G OF NON-DRIED SLURRY.

BLE 3 - ICP ANALYSIS OF THE WASTE+GLASS FORMERS
IN THE CFMT, BATCH #3, SF-12 RUN

LOG NUMBER-ANALYSIS	25 Zr
8904350-A	6145.560000
8904350-B	5947.060000
8904350-C	5965.720000
8904350-D	5988.140000
8904350-E	6002.770000
8904350-F	6022.860000
8904351-A	5466.400000
8904351-B	5512.710000
8904351-C	5426.660000
8904351-D	5471.580000
8904351-E	5408.120000
8904351-F	5500.950000
DATA POINTS	12.000000
SAMPLE MEAN	5738.210833
SAMPLE STD DEV	291.225212
MAX	6145.560000
MIN	5408.120000
95% CONF LIM	185.084162
PCT ERROR OF SAM MEAN	3.225468

.TA IN UG/G OF NON-DRIED SLURRY.

TABLE 4 - MASS OF EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	1 SAMPLE MEAN IN UG/G NON-DRIED SLURRY	2 PCT ERROR OF COL 1	3 METAL OXIDE FORMULA
1 Al	11155.084167	3.476286	Al2O3
2 B	10572.155833	4.253807	B2O3
3 Ba	207.119167	9.851622	BaO
4 Ca	1179.568333	3.492594	CaO
5 Ce	334.043333	9.935718	CeO2
6 Cr	263.678333	10.988974	Cr2O3
7 Cs	302.508333	5.619096	Cs2O
8 Cu	152.734167	7.143292	CuO
9 Fe	28264.870833	3.520478	Fe2O3
0 K	9381.621667	3.546885	K2O
1 La	69.206833	33.247079	La2O3
2 Li	4903.975833	3.106137	Li2O
3 Mg	1820.951667	3.933354	MgO
4 Mn	2524.513333	3.834474	MnO
5 Mo	103.226667	11.406433	MoO3
6 Na	28340.400000	3.483881	Na2O
7 Nd	311.154167	15.550365	Nd2O3
8 Ni	616.059167	8.676739	NiO
9 P	3412.730000	5.763697	P2O5
0 S	168.957500	95.202862	SO3
1 Si	63869.187500	4.919981	SiO2
2 Sr	80.304917	3.650156	SrO
3 Ti	1637.346667	5.117264	TiO2
4 Zn	979.330833	4.613431	ZnO
5 Zr	5738.210833	3.225468	ZrO2
6 SLURRY DENSITY(KG/L)	1.453333	0.108749	
7 BATCH VOLUME(L)	13544.136851	1.179455	
8 PCT TOTAL SOLIDS	55.353333	0.270785	
9 TOTALS			

CCEPTANCE CRITERION: IF WPO GE 0.50, THEN THE ABSOLUTE VALUE OF THE ERCENT ERROR IN THE CALCULATED MASS MUST BE LE 10.0% . IF THE ELEMENT S SULFUR, IT MUST BE LE 20.0% .

OOTNOTE A: THE ABS VALUE OF THE PERCENT ERROR IN THE CALCULATED MASS S GT 10.0% .
OOTNOTE B: THE ABS VALUE OF THE PERCENT ERROR IN THE CALCULATED MASS S GT 20.0% .

TABLE 4 - MASS OF EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	4 CALC MASS OF METAL OXIDE(KG)	5 VARIANCE OF COL 4	6 DEG OF FREEDOM OF COL 4
1 Al	414.823153	47.873375	27
2 B	669.955814	180.528669	27
3 Ba	4.551783	0.042086	27
4 Ca	32.484301	0.296047	27
5 Ce	8.076446	0.134739	27
6 Cr	7.585084	0.145004	27
7 Cs	6.312925	0.027113	27
8 Cu	3.763139	0.015318	27
9 Fe	795.377409	180.036577	27
.0 K	222.440892	14.271841	27
:1 La	1.597571	0.058279	27
:2 Li	207.747213	9.837553	27
:3 Mg	59.431085	1.229441	27
.4 Mn	64.159879	1.367639	27
.5 Mo	3.048147	0.025209	27
.6 Na	751.913657	157.907686	27
.7 Nd	7.143971	0.256098	27
.8 Ni	15.430733	0.376726	27
.9 P	153.899275	16.917582	27
20 S	8.303255	12.894427	27
21 Si	2689.085005	3820.224437	27
22 Sr	1.869278	0.001061	27
23 Ti	53.663437	1.639029	27
24 Zn	23.993114	0.269415	27
.5 Zr	152.560464	5.668006	27
6 SLURRY DENSITY(KG/L)			
7 BATCH VOLUME(L)			
.8 PCT TOTAL SOLIDS			
9 TOTALS	6359.217031		

.CCEPTANCE CRITERION: IF WPO GE 0.50, THEN THE ABSOLUTE VALUE OF THE ERCENT ERROR IN THE CALCULATED MASS MUST BE LE 10.0% . IF THE ELEMENT S SULFUR, IT MUST BE LE 20.0% .

OOTNOTE A: THE ABS VALUE OF THE PERCENT ERROR IN THE CALCULATED MASS S GT 10.0% .
OOTNOTE B: THE ABS VALUE OF THE PERCENT ERROR IN THE CALCULATED MASS S GT 20.0% .

TABLE 4 - MASS OF EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	7 PCT ERROR OF COL 4	8 WEIGHT PERCENT OXIDE	9 IS ACCEPTANCE CRITERION MET?
1 Al	3.423167	6.523180	YES
2 B	4.115958	10.535193	YES
3 Ba	9.249757	0.071578	DOES NOT APPLY
4 Ca	3.437562	0.510822	YES
5 Ce	9.327598	0.127004	DOES NOT APPLY
6 Cr	10.303218	0.119277	DOES NOT APPLY
7 Cs	5.353022	0.099272	DOES NOT APPLY
8 Cu	6.749757	0.059176	DOES NOT APPLY
9 Fe	3.462192	12.507474	YES
0 K	3.485535	3.497929	YES
1 La	31.012831	0.025122	DOES NOT APPLY
2 Li	3.098506	3.266868	YES
3 Mg	3.828991	0.934566	YES
4 Mn	3.740815	1.008927	YES
5 Mo	10.690222	0.047933	DOES NOT APPLY
6 Na	3.429870	11.823997	YES
7 Nd	14.538080	0.112340	DOES NOT APPLY
8 Ni	8.163380	0.242651	DOES NOT APPLY
9 P	5.485000	2.420098	YES
0 S	88.755782	0.130570	***** NO *****
1 Si	4.717196	42.286417	YES
2 Sr	3.576988	0.029395	DOES NOT APPLY
3 Ti	4.896197	0.843869	YES
4 Zn	4.439851	0.377297	DOES NOT APPLY
5 Zr	3.202707	2.399045	YES
6 SLURRY DENSITY(KG/L)			
7 BATCH VOLUME(L)			
8 PCT TOTAL SOLIDS			
9 TOTALS		100.000000	

CCEPTANCE CRITERION: IF WPO GE 0.50, THEN THE ABSOLUTE VALUE OF THE CRCENT ERROR IN THE CALCULATED MASS MUST BE LE 10.0% . IF THE ELEMENT S SULFUR, IT MUST BE LE 20.0% .

OOTNOTE A: THE ABS VALUE OF THE PERCENT ERROR IN THE CALCULATED MASS S GT 10.0% .
OOTNOTE B: THE ABS VALUE OF THE PERCENT ERROR IN THE CALCULATED MASS S GT 20.0% .

ABLE 4 - MASS OF EACH METAL OXIDE IN THE WASTE+GLASS FORMERS
IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	10 COMMENTS
1 Al	
2 B	
3 Ba	
4 Ca	
5 Ce	
6 Cr	
7 Cs	
8 Cu	
9 Fe	
.0 K	
.1 La	
.2 Li	
.3 Mg	
.4 Mn	
5 Mo	
6 Na	
7 Nd	
8 Ni	
.9 P	
0 S	FOOTNOTE B
:1 Si	
2 Sr	
:3 Ti	
4 Zn	
5 Zr	
6 SLURRY DENSITY(KG/L)	
7 BATCH VOLUME(L)	
8 PCT TOTAL SOLIDS	
9 TOTALS	

.CCEPTANCE CRITERION: IF WPO GE 0.50, THEN THE ABSOLUTE VALUE OF THE
ERCENT ERROR IN THE CALCULATED MASS MUST BE LE 10.0% . IF THE ELEMENT
S SULFUR, IT MUST BE LE 20.0% .

OOTNOTE A: THE ABS VALUE OF THE PERCENT ERROR IN THE CALCULATED MASS
S GT 10.0% .
OOTNOTE B: THE ABS VALUE OF THE PERCENT ERROR IN THE CALCULATED MASS
S GT 20.0% .

STATUS OF BATCH

OXIDE	RANDOM ERROR OK?
SO_3	NO

ANALYSIS OF THE WASTE BATCH IS SIMILAR TO TABLES 1-4

TABLE 5 - TARGET GLASS COMPOSITION
BATCH #3, SF-12 RUN

0 METAL OXIDE FORMULA	1 TARGET MASS(KG)	2 TARGET WPO
1 Al2O3	434.198019	6.55
2 B2O3	681.458875	10.28
3 BaO	4.640284	0.07
4 CaO	33.144887	0.50
5 CeO2	10.606364	0.16
6 Cr2O3	9.280568	0.14
7 Cs2O	6.628977	0.10
8 CuO	3.977386	0.06
9 Fe2O3	804.757855	12.14
10 K2O	247.923754	3.74
11 La2O3	2.651591	0.04
12 Li2O	208.812788	3.15
13 MgO	60.323694	0.91
14 MnO	65.626876	0.99
15 MoO3	3.314489	0.05
16 Na2O	758.355013	11.44
17 Nd2O3	9.280568	0.14
18 NiO	16.572443	0.25
19 P2O5	157.106764	2.37
20 SO3	15.246648	0.23
21 SiO2	2880.953572	43.46
22 SrO	1.988693	0.03
23 TiO2	53.694717	0.81
24 ZnO	1.325795	0.02
25 ZrO2	153.129378	2.31
26 TOTAL MASS	6625.000000	99.94

WPO VALUES FROM SF-12 TEST PROCEDURE WITH Pr AND Y EXCLUDED.

TABLE 6 - CALCULATED VS TARGET MASS OF EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

METAL OXIDE FORMULA	1 CALC MASS OF METAL OXIDE(KG)	2 PCT ERROR OF COL 1	3 WPO OF CALC MASS	4 TARGET MASS OF METAL OXIDE(KG)
1 Al2O3	414.823153	3.423167	6.523180	434.198019
2 B2O3	669.955814	4.115958	10.535193	681.458875
3 BaO	4.551783	9.249757	0.071578	4.640284
4 CaO	32.484301	3.437562	0.510822	33.144887
5 CeO2	8.076446	9.327598	0.127004	10.606364
6 Cr2O3	7.585084	10.303218	0.119277	9.280568
7 Cs2O	6.312925	5.353022	0.099272	6.628977
8 CuO	3.763139	6.749757	0.059176	3.977386
9 Fe2O3	795.377409	3.462192	12.507474	804.757855
0 K2O	222.440892	3.485535	3.497929	247.923754
1 La2O3	1.597571	31.012831	0.025122	2.651591
2 Li2O	207.747213	3.098506	3.266868	208.812788
3 MgO	59.431085	3.828991	0.934566	60.323694
4 MnO	64.159879	3.740815	1.008927	65.626876
5 MoO3	3.048147	10.690222	0.047933	3.314489
6 Na2O	751.913657	3.429870	11.823997	758.355013
7 Nd2O3	7.143971	14.538080	0.112340	9.280568
8 NiO	15.430733	8.163380	0.242651	16.572443
9 P2O5	153.899275	5.485000	2.420098	157.106764
0 SO3	8.303255	88.755782	0.130570	15.246648
1 SiO2	2689.085005	4.717196	42.286417	2880.953572
2 SrO	1.869278	3.576988	0.029395	1.988693
3 TiO2	53.663437	4.896197	0.843869	53.694717
4 ZnO	23.993114	4.439851	0.377297	1.325795
5 ZrO2	152.560464	3.202707	2.399045	153.129378
6 TOTALS	6359.217031			6625.000000

CCEPTANCE CRITERIA ARE: IF WPO GE 0.50, THEN THE ABS ERROR IN THE ALCULATED MASS AND THE TARGET ERROR MUST BOTH BE LE 10.0%. IF THE LEMENT IS SULFUR, BOTH ERRORS MUST BE LE 20.0%.

OOTNOTES:

: THE PERCENT ERROR OF THE CALCULATED MASS IS OUTSIDE THE TOLERANCE LIMIT.

: THE TARGET ERROR IS OUTSIDE THE TOLERANCE LIMIT.

: BOTH THE PERCENT ERROR OF THE CALCULATED MASS AND THE TARGET ERROR ARE OUTSIDE THE TOLERANCE LIMIT.

: THE TOTAL CALCULATED MASS IS OUTSIDE THE TOLERANCE LIMIT.

TABLE 6 - CALCULATED VS TARGET MASS OF EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

METAL OXIDE FORMULA	5 (CALC MASS-TAR)* 100%/TAR	6 DO ACCEPTANCE CRITERIA APPLY?	7 ARE ACCEPTANCE CRITERIA MET?
Al2O3	-4.462219	YES	YES
B2O3	-1.688005	YES	YES
BaO	-1.907229	NO	DO NOT APPLY
CaO	-1.993024	YES	YES
CeO2	-23.852829	NO	DO NOT APPLY
Cr2O3	-18.269183	NO	DO NOT APPLY
Cs2O	-4.767735	NO	DO NOT APPLY
CuO	-5.386642	NO	DO NOT APPLY
Fe2O3	-1.165623	YES	YES
K2O	-10.278508	YES	**** NO ****
La2O3	-39.750462	NO	DO NOT APPLY
Li2O	-0.510301	YES	YES
MgO	-1.479700	YES	YES
MnO	-2.235360	YES	YES
MoO3	-8.035677	NO	DO NOT APPLY
Na2O	-0.849385	YES	YES
Nd2O3	-23.022265	NO	DO NOT APPLY
NiO	-6.889213	NO	DO NOT APPLY
P2O5	-2.041598	YES	YES
SO3	-45.540453	YES	**** NO ****
SiO2	-6.659898	YES	YES
SrO	-6.004726	NO	DO NOT APPLY
TiO2	-0.058254	YES	YES
ZnO	1709.714543	NO	DO NOT APPLY
ZrO2	-0.371525	YES	YES
TOTALS	-4.011818	YES	YES

:CEPTANCE CRITERIA ARE: IF WPO GE 0.50, THEN THE ABS ERROR IN THE .LCULATED MASS AND THE TARGET ERROR MUST BOTH BE LE 10.0%. IF THE :EMENT IS SULFUR, BOTH ERRORS MUST BE LE 20.0%.

)OTNOTES:

THE PERCENT ERROR OF THE CALCULATED MASS IS OUTSIDE THE TOLERANCE LIMIT.
THE TARGET ERROR IS OUTSIDE THE TOLERANCE LIMIT.
BOTH THE PERCENT ERROR OF THE CALCULATED MASS AND THE TARGET ERROR ARE OUTSIDE THE TOLERANCE LIMIT.
THE TOTAL CALCULATED MASS IS OUTSIDE THE TOLERANCE LIMIT.

ABLE 6 - CALCULATED VS TARGET MASS OF EACH METAL OXIDE IN
HE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

METAL OXIDE FORMULA	8 COMMENTS
1 Al2O3	
2 B2O3	
3 BaO	
4 CaO	
5 CeO2	
6 Cr2O3	
7 Cs2O	
8 CuO	
9 Fe2O3	
0 K2O	FOOTNOTE B
1 La2O3	
2 Li2O	
3 MgO	
4 MnO	
5 MoO3	
6 Na2O	
7 Nd2O3	
8 NiO	
9 P2O5	
0 SO3	FOOTNOTE C
1 SiO2	
2 SrO	
3 TiO2	
4 ZnO	
5 ZrO2	
6 TOTALS	

CCEPTANCE CRITERIA ARE: IF WPO GE 0.50, THEN THE ABS ERROR IN THE
ALCULATED MASS AND THE TARGET ERROR MUST BOTH BE LE 10.0%. IF THE
LEMENT IS SULFUR, BOTH ERRORS MUST BE LE 20.0%.
OOTNOTES:
: THE PERCENT ERROR OF THE CALCULATED MASS IS OUTSIDE THE TOLERANCE LIMIT.
: THE TARGET ERROR IS OUTSIDE THE TOLERANCE LIMIT.
: BOTH THE PERCENT ERROR OF THE CALCULATED MASS AND THE TARGET ERROR ARE OUTSIDE THE TOLERANCE LIMIT.
: THE TOTAL CALCULATED MASS IS OUTSIDE THE TOLERANCE LIMIT.

STATUS OF BATCH

OXIDE	RANDOM ERROR OK?	TARGET ERROR OK?
K_2O	YES	NO
SO_3	NO	NO

ANALYSIS OF THE GLASS FORMER
BATCH IS SIMILAR TO TABLES 1-6

TABLE 7 - MASS BALANCE CHECK FOR EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	1 MET OXIDE FORMULA	2 CALC MASS OF MET OXIDE IN WASTE(KG)	3 VARIANCE OF COL 2	4 DEG OF FREEDOM OF COL 2
1 Al	Al2O3	145.393298	1.726580	27
2 B	B2O3	88.858335	0.281778	27
3 Ba	BaO	4.837338	0.000552	27
4 Ca	CaO	25.393274	0.029106	27
5 Ce	CeO2	3.282992	0.008773	27
6 Cr	Cr2O3	5.439943	0.056624	27
7 Cs	Cs2O	2.917908	0.003412	26
8 Cu	CuO	3.272330	0.000387	27
9 Fe	Fe2O3	800.283555	25.527096	27
0 K	K2O	32.762746	17.653299	27
1 La	La2O3	0.322703	0.000652	27
2 Li	Li2O	23.595366	0.014892	27
3 Mg	MgO	12.620358	0.013896	27
4 Mn	MnO	41.899767	0.058964	27
5 Mo	MoO3	0.721852	0.000232	27
6 Na	Na2O	292.344928	2.900574	27
7 Nd	Nd2O3	5.285908	0.019374	27
8 Ni	NiO	11.287676	0.003964	27
9 P	P2O5	41.031926	0.171001	27
0 S	SO3	10.484486	0.463391	27
1 Si	SiO2	889.171574	608.707889	27
2 Sr	SrO	0.762909	0.000031	27
3 Ti	TiO2	8.182909	0.009536	27
4 Zn	ZnO	0.801319	0.000554	27
5 Zr	ZrO2	147.873250	1.103640	27
6 TOTALS		2598.828647		

CCEPTANCE CRITERIA ARE:
1)IF WPO GE 0.50 OR ELEMENT IS SULFUR, THE ABSOLUTE VALUE OF THE MASS BALANCE ERROR MUST BE LE 10.0% .
2)THE ABSOLUTE VALUE OF THE ERROR IN THE TOTAL MASS MUST BE LE 10.0% .
OOTNOTES:
: ABS VALUE OF MASS BALANCE ERROR EXCEEDS 10 %
: ABS VALUE OF ERROR IN TOTAL MASS EXCEEDS 10 %

TABLE 7 - MASS BALANCE CHECK FOR EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	5 CALC MASS OF MET OXIDE IN GLASS FORMERS(KG)	6 VARIANCE OF COL 5	7 DEG OF FREEDOM OF COL 5
1 Al	280.353018	12.048856	21
2 B	619.289154	57.900511	21
3 Ba	0.215589	0.002676	21
4 Ca	7.439684	0.023232	21
5 Ce	4.512965	0.021077	21
6 Cr	1.465785	0.041541	21
7 Cs	3.915092	0.008548	21
8 Cu	0.803920	0.005868	21
9 Fe	1.181766	0.011880	21
0 K	204.074768	7.865754	21
.1 La	1.518343	0.022357	21
.2 Li	183.661991	5.527198	21
.3 Mg	47.988705	0.337971	20
4 Mn	23.940311	0.096472	21
.5 Mo	2.830096	0.007553	21
6 Na	475.893528	35.199635	21
.7 Nd	1.941476	0.039286	21
8 Ni	5.696938	0.055311	21
.9 P	120.231075	2.175144	21
0 S	4.446889	0.133701	21
.1 Si	1979.221142	903.445314	21
2 Sr	1.073474	0.000251	21
3 Ti	40.418871	0.360841	21
4 Zn	0.345088	0.007589	21
5 Zr	5.317126	0.009584	21
6 TOTALS	4017.776793		

.CCEPTANCE CRITERIA ARE:

1)IF WPO GE 0.50 OR ELEMENT IS SULFUR, THE ABSOLUTE VALUE OF THE MASS BALANCE ERROR MUST BE LE 10.0% .

2)THE ABSOLUTE VALUE OF THE ERROR IN THE TOTAL MASS MUST BE LE 10.0% .

OOTNOTES:

: ABS VALUE OF MASS BALANCE ERROR EXCEEDS 10 %

: ABS VALUE OF ERROR IN TOTAL MASS EXCEEDS 10 %

TABLE 7 - MASS BALANCE CHECK FOR EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	8 WASTE+GLASS FORMERS(KG)	9 VARIANCE OF COL 8	10 PCT ERROR OF COL 8	11 CALC MASS OF METAL OXIDE IN FIN MIX(KG)
1 Al	425.746316	13.775436	1.755184	414.823153
2 B	708.147489	58.182289	2.168665	669.955814
3 Ba	5.052927	0.003227	2.263586	4.551783
4 Ca	32.832958	0.052337	1.402867	32.484301
5 Ce	7.795957	0.029850	4.461902	8.076446
6 Cr	6.905728	0.098165	9.134587	7.585084
7 Cs	6.833000	0.011960	3.224343	6.312925
8 Cu	4.076249	0.006255	3.906266	3.763139
9 Fe	801.465321	25.538976	1.269515	795.377409
0 K	236.837514	25.519054	4.294401	222.440892
1 La	1.841045	0.023009	16.588441	1.597571
2 Li	207.257357	5.542090	2.286902	207.747213
3 Mg	60.609063	0.351868	1.971667	59.431085
4 Mn	65.840077	0.155436	1.205608	64.159879
5 Mo	3.551948	0.007785	5.001337	3.048147
6 Na	768.238455	38.100209	1.617664	751.913657
7 Nd	7.227384	0.058660	6.746987	7.143971
8 Ni	16.984613	0.059275	2.886024	15.430733
9 P	161.263000	2.346145	1.912333	153.899275
0 S	14.931375	0.597092	10.419374	8.303255
1 Si	2868.392715	1512.153202	2.729481	2689.085005
2 Sr	1.836383	0.000282	1.841848	1.869278
3 Ti	48.601780	0.370377	2.521102	53.663437
4 Zn	1.146407	0.008143	15.847718	23.993114
5 Zr	153.190376	1.113224	1.386694	152.560464
6 TOTALS	6616.605441			6359.217031

CCEPTANCE CRITERIA ARE:
1)IF WPO GE 0.50 OR ELEMENT IS SULFUR, THE ABSOLUTE VALUE OF THE MASS BALANCE ERROR MUST BE LE 10.0% .
2)THE ABSOLUTE VALUE OF THE ERROR IN THE TOTAL MASS MUST BE LE 10.0% .
OOTNOTES:
: ABS VALUE OF MASS BALANCE ERROR EXCEEDS 10 %
: ABS VALUE OF ERROR IN TOTAL MASS EXCEEDS 10 %

TABLE 7 - MASS BALANCE CHECK FOR EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	12 VARIANCE OF COL 11	13 DEG OF FREEDOM OF COL 11	14 PERCENT ERROR IN COL 11
1 Al	47.873375	27	3.423167
2 B	180.528669	27	4.115958
3 Ba	0.042086	27	9.249757
4 Ca	0.296047	27	3.437562
5 Ce	0.134739	27	9.327598
6 Cr	0.145004	27	10.303218
7 Cs	0.027113	27	5.353022
8 Cu	0.015318	27	6.749757
9 Fe	180.036577	27	3.462192
0 K	14.271841	27	3.485535
1 La	0.058279	27	31.012831
2 Li	9.837553	27	3.098506
3 Mg	1.229441	27	3.828991
4 Mn	1.367639	27	3.740815
5 Mo	0.025209	27	10.690222
6 Na	157.907686	27	3.429870
7 Nd	0.256098	27	14.538080
8 Ni	0.376726	27	8.163380
9 P	16.917582	27	5.485000
0 S	12.894427	27	88.755782
1 Si	3820.224437	27	4.717196
2 Sr	0.001061	27	3.576988
3 Ti	1.639029	27	4.896197
4 Zn	0.269415	27	4.439851
5 Zr	5.668006	27	3.202707
6 TOTALS			

CCEPTANCE CRITERIA ARE:
1)IF WPO GE 0.50 OR ELEMENT IS SULFUR, THE ABSOLUTE VALUE OF THE MASS BALANCE ERROR MUST BE LE 10.0% .
2)THE ABSOLUTE VALUE OF THE ERROR IN THE TOTAL MASS MUST BE LE 10.0% .
OOTNOTES:
: ABS VALUE OF MASS BALANCE ERROR EXCEEDS 10 %
: ABS VALUE OF ERROR IN TOTAL MASS EXCEEDS 10 %

TABLE 7 - MASS BALANCE CHECK FOR EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	15 MASS BAL DIFF COL 8 - COL 11	16 PERCENT ERROR IN COL 15	17 PCT ERROR IN MASS BALANCE	
1 Al	10.923163	143.226542	2.633210	
2 B	38.191675	80.607793	5.700626	
3 Ba	0.501144	84.636790	11.009833	
4 Ca	0.348657	337.318424	1.073310	
5 Ce	-0.280489	-288.199650	-3.472923	
6 Cr	-0.679356	-144.632328	-8.956476	
7 Cs	0.520075	75.749176	8.238254	
8 Cu	0.313110	93.467189	8.320458	
9 Fe	6.087911	469.274532	0.765412	
0 K	14.396622	87.305339	6.472111	
1 La	0.243474	233.330553	15.240252	
2 Li	-0.489856	-1595.196290	-0.235794	
3 Mg	1.177978	212.753561	1.982091	
4 Mn	1.680198	146.355710	2.618768	
5 Mo	0.503801	71.840431	16.528119	
6 Na	16.324798	170.882867	2.171100	
7 Nd	0.083413	1340.183456	1.167599	
8 Ni	1.553881	84.671100	10.070039	
9 P	7.363726	118.763261	4.784770	
0 S	6.628120	110.420484	79.825555	
1 Si	179.307710	81.146734	6.667982	
2 Sr	-0.032895	-222.036519	-1.759771	
3 Ti	-5.061657	-55.802114	-9.432227	
4 Zn	-22.846706	-4.594759	-95.221932	Tracer
5 Zr	0.629912	823.728419	0.412893	Added
6 TOTALS	257.388409		4.047486	

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TABLE 7 - MASS BALANCE CHECK FOR EACH METAL OXIDE IN THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

ELEMENT	18 WPO OF COL 11	19 IS ACCEPTANCE CRITERION MET?	20 COMMENTS
1 Al	6.523180	YES	
2 B	10.535193	YES	
3 Ba	0.071578	DOES NOT APPLY	
4 Ca	0.510822	YES	
5 Ce	0.127004	DOES NOT APPLY	
6 Cr	0.119277	DOES NOT APPLY	
7 Cs	0.099272	DOES NOT APPLY	
8 Cu	0.059176	DOES NOT APPLY	
9 Fe	12.507474	YES	
0 K	3.497929	YES	
1 La	0.025122	DOES NOT APPLY	
2 Li	3.266868	YES	
3 Mg	0.934566	YES	
4 Mn	1.008927	YES	
5 Mo	0.047933	DOES NOT APPLY	
6 Na	11.823997	YES	
7 Nd	0.112340	DOES NOT APPLY	
8 Ni	0.242651	DOES NOT APPLY	
9 P	2.420098	YES	
0 S	0.130570	***** NO *****	FOOTNOTE A
1 Si	42.286417	YES	
2 Sr	0.029395	DOES NOT APPLY	
3 Ti	0.843869	YES	
4 Zn	0.377297	DOES NOT APPLY	
5 Zr	2.399045	YES	
6 TOTALS	100.000000	YES	

CCEPTANCE CRITERIA ARE:

1)IF WPO GE 0.50 OR ELEMENT IS SULFUR, THE ABSOLUTE VALUE OF THE MASS BALANCE ERROR MUST BE LE 10.0% .

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OOTNOTES:

: ABS VALUE OF MASS BALANCE ERROR EXCEEDS 10 %

: ABS VALUE OF ERROR IN TOTAL MASS EXCEEDS 10 %

STATUS OF BATCH

OXIDE	RANDOM ERROR OK?	TARGET ERROR OK?	MASS BALANCE ERROR OK?
K_2O	YES	NO	YES
SO_3	NO	NO	NO

Action

- o Shim K_2O
- o Combine waste & glass former data with mixture data into single population. Result - SO_3 is OK.

TABLE 8 - CALCULATED VS TARGET NON-ICP VALUES FOR THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

PARAMETER	1 SAMPLE MEAN	2 PCT ERROR IN SAMPLE MEAN	3 TOLERANCE BAND FOR COL 2
1 pH	5.043333	0.409305	20 %
2 DENSITY(KG/L)	1.453333	0.108749	5 %
3 % TOTAL SOLIDS	55.353333	0.270785	5 %
4 % SUS SOLIDS	27.080000	2.211615	10 %
5 BATCH VOLUME(L)	13544.136851	1.179455	5 %
6 JET DILUTION FACTOR	1.020000		
7 CFMT TARGET GLASS YIELD(KG/L)	0.433500		
8			

9 PARAMETER	SAMPLE MEAN(UG/G)	PCT ERROR OF SAMPLE MEAN	CALCULATED MASS(KG)
0 NO3-	122166.666667	2.428259	2404.746449
1 TOTAL CARBON	30050.000000	4.705420	591.508574
2 H2O	446466.666667	0.270785	8788.314853

OOTNOTES:
: THE RANDOM ERROR IN THE SAMPLE MEAN IS OUTSIDE THE TOLERANCE LIMITS.
: THE TARGET ERROR IN THE CALC MASS IS OUTSIDE THE TOLERANCE LIMITS.
: BOTH THE RANDOM ERROR AND THE TARGET ERROR ARE OUTSIDE THE TOLERANCE LIMITS.

TABLE 8 - CALCULATED VS TARGET NON-ICP VALUES FOR THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

PARAMETER	4 TARGET VALUE	5 (SAM MEAN-TAR) *100% /TAR	6 TOLERANCE BAND FOR COL 5
pH	4.550197	10.357403	20 %
DENSITY(KG/L)	1.412979	2.856012	5 %
% TOTAL SOLIDS	53.073950	4.294731	5 %
% SUS SOLIDS	25.885000	4.616573	20 %
BATCH VOLUME(L)	15282.583622	-11.375346	5 %
JET DILUTION FACTOR			
CFMT TARGET GLASS YIELD(KG/L)			

PARAMETER	PERCENT ERROR OF COL 3	TOLERANCE BAND FOR COL 4	TARGET MASS (KG)
NO3-	2.518038	5 %	2692.939815
TOTAL CARBON	4.522966	5 %	627.043981
H2O	1.150375	5 %	9934.503376

OTNOTES:
THE RANDOM ERROR IN THE SAMPLE MEAN IS OUTSIDE THE TOLERANCE LIMITS.
THE TARGET ERROR IN THE CALC MASS IS OUTSIDE THE TOLERANCE LIMITS.
BOTH THE RANDOM ERROR AND THE TARGET ERROR ARE OUTSIDE THE TOLERANCE LIMITS.

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TABLE 8 - CALCULATED VS TARGET NON-ICP VALUES FOR THE WASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

PARAMETER	7 ARE ACCEPTANCE CRITERIA MET?	8 COMMENTS	9
- pH	YES		
2 DENSITY(KG/L)	YES		
3 % TOTAL SOLIDS	YES		
4 % SUS SOLIDS	YES		
5 BATCH VOLUME(L)	*** NO ***	FOOTNOTE B	
5 JET DILUTION FACTOR			
7 CFMT TARGET GLASS YIELD(KG/L)			
3			

9 PARAMETER	(CALC MASS - TAR) *100% /TAR	TOLERANCE BAND FOR COL 7	ARE ACCEPTANCE CRITERIA MET?
0 NO3-	-10.701812	5 %	*** NO ***
1 TOTAL CARBON	-5.667132	5 %	*** NO ***
2 H2O	-11.537452	5 %	*** NO ***

OTNOTES:
THE RANDOM ERROR IN THE SAMPLE MEAN IS OUTSIDE THE TOLERANCE LIMITS.
: THE TARGET ERROR IN THE CALC MASS IS OUTSIDE THE TOLERANCE LIMITS.
BOTH THE RANDOM ERROR AND THE TARGET ERROR ARE OUTSIDE THE TOLERANCE LIMITS.

ABLE 8 - CALCULATED VS TARGET NON-ICP VALUES FOR THE ASTE+GLASS FORMERS IN THE CFMT, BATCH #3, SF-12 RUN

PARAMETER	10
1 pH	
2 DENSITY(KG/L)	
3 % TOTAL SOLIDS	
4 % SUS SOLIDS	
5 BATCH VOLUME(L)	
6 JET DILUTION FACTOR	
7 CFMT TARGET GLASS YIELD(KG/L)	
8	
9 PARAMETER	COMMENTS
0 NO3-	FOOTNOTE B
1 TOTAL CARBON	FOOTNOTE B
2 H2O	FOOTNOTE B

OOTNOTES:
: THE RANDOM ERROR IN THE SAMPLE MEAN IS OUTSIDE THE TOLERANCE LIMITS.
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STATUS OF BATCH

VARIABLE	RANDOM ERROR OK?	TARGET ERROR OK?
VOLUME	YES	NO
NO	YES	NO
TOTAL CARBON	YES	NO
H O	YES	NO

- o Target errors are deliberate at this point.
- o Action - Shim batch to obtain acceptable target errors for each variable.

CONCLUSIONS

1. Feed makeup involves simultaneous control of 28 chemicals plus 4 physical properties in each batch.
2. Rigorous attention to detail is required.
3. Close cooperation among process operators, lab personnel, and engineering staff is required.
4. Process is labor intensive but viable.

D. L. Shugars

Quality Assurance Manager

Vitrification Test Control

- A Disciplined, Proceduralized Program for Control of the Vitrification Process in a Testing Mode to the Requirements for High Level Waste Form Qualification

Test Operation Control

- Consists of:
  - Control of Test Operational Activities
  - Control of Analyses
  - Control of Data
  - Control of Records

Test Activity Control

- Test Description
  - Test Request TR-019
  - Test Procedure TP-019, SOPs, Work Orders
  - Test Surveillance Plan
  - Test Report EP-11-003
    - To Be Developed After Test Completion

Analyses Control

- Defined By:
  - Laboratory QA Program
  - Approved Analytical Chemistry Methods
- Documented by:
  - Completed Analytical Request Forms
  - Transferred Electronically for Precision Review per EP-3-022 Data Base Control (DFT)

Elements of Data Control

- Test Data is Controlled Per:
  - EP-11-003 Test Control
  - EP-3-021 Calculations (DFT)
  - SOP-002 Work Orders
- Analytical Data is Controlled Per:
  - ACM Procedure for Hard Data
  - EP-3-022 For Electronic Control of Data

Elements of Data Control (Continued)

- Software is Controlled Per:
  - EP-3-013, Rev. 0 Determination of Software Requirements 07/03/89 (NUREG-0856)
  - EP-3-014, Rev. 0 Final Internal Development Review of Software and Documentation (FIDR) 07/03/89 (NQA-2 Part 2.7)
  - EP-3-015, Rev. 0 Transfer of Software, Data, and/or Documentation 07/03/89 (RW-0214)
  - EP-3-016, Rev. 1 Software Configuration Management 10/02/89 (RW-0214)
  - EP-3-017, Rev. 0 Conversion Testing, Verification and/or Validation of Software 07/03/89 (NQA -1 Supplement 35-1)
  - EP-3-018, Rev. 0 Software Application Control 07/03/89 (NQA-1 Supplement 35-1)

Records

- Records are Controlled Per:
  - EP-11-003, Experimental and Developmental Test Control
  - ACP 5.1, Laboratory Record System
  - WV- 730, Records Management and Storage
- All Records are Forwarded to WVNS MRC for Protected Storage