Westinghouse Electric Corporation Energy Systems

Box 355
Pittsburgh Pennsylvania 15230-0355

AW-95-865

August 1, 1995

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: MR. T. R. QUAY

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT: **PRESENTATION MATERIAL FROM THE JUNE 20, 1995 MEETING ON AP600 ASSESSMENT OF pH OF CONTAINMENT WATER POOLS DURING SEVERE ACCIDENTS**

Dear Mr. Quay:

The application for withholding is submitted by Westinghouse Electric Corporation ("Westinghouse") pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10CFR Section 2.790, Affidavit AW-95-865 accompanies this application for withholding setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-95-865 and should be addressed to the undersigned.

Very truly yours,

N. J. Liparulo, Manager
Nuclear Safety Regulatory And Licensing Activities

/nja

cc: Kevin Bohrer NRC 12H5

2534A

AW-95-865

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Brian A. McIntyre, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Corporation ("Westinghouse") and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

Sworn to and subscribed
before me this 7 day
of August, 1995

Rose Marie Payne

Notary Public

Notarial Seal
Rose Marie Payne, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Nov. 4, 1996
Member, Pennsylvania Association of Notaries

2535A

(1) I am Manager, Advanced Plant Safety And Licensing, in the Advanced Technology Business Area, of the Westinghouse Electric Corporation and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Energy Systems Business Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Energy Systems Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to

sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) Enclosed is Letter NTD-NRC-95-4520, August 1, 1995 being transmitted by Westinghouse Electric Corporation (W) letter and Application for Withholding Proprietary Information from Public Disclosure, N. J. Liparulo (W), to Mr. T. R. Quay, Office of NRR. The proprietary information as submitted for use by Westinghouse Electric Corporation is in response to questions concerning the AP600 plant and the associated design certification application and is expected to be

applicable in other licensee submittals in response to certain NRC requirements for justification of licensing advanced nuclear power plant designs.

This information is part of that which will enable Westinghouse to:

(a) Demonstrate the design and safety of the AP600 Passive Safety Systems.

(b) Establish applicable verification testing methods.

(c) Design Advanced Nuclear Power Plants that meet NRC requirements.

(d) Establish technical and licensing approaches for the AP600 that will ultimately result in a certified design.

(e) Assist customers in obtaining NRC approval for future plants.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for advanced plant licenses.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar advanced nuclear power designs and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing analytical methods and receiving NRC approval for those methods.

Further the deponent sayeth not.

ENCLOSURE 2

Enclosure 2

AP600 ASSESSMENT OF pH OF CONTAINMENT WATER POOLS DURING SEVERE ACCIDENTS

Presented by

R. J. Hammersley

Presented to

U.S. NRC
Rockville, MD

June 20, 1995

AP600

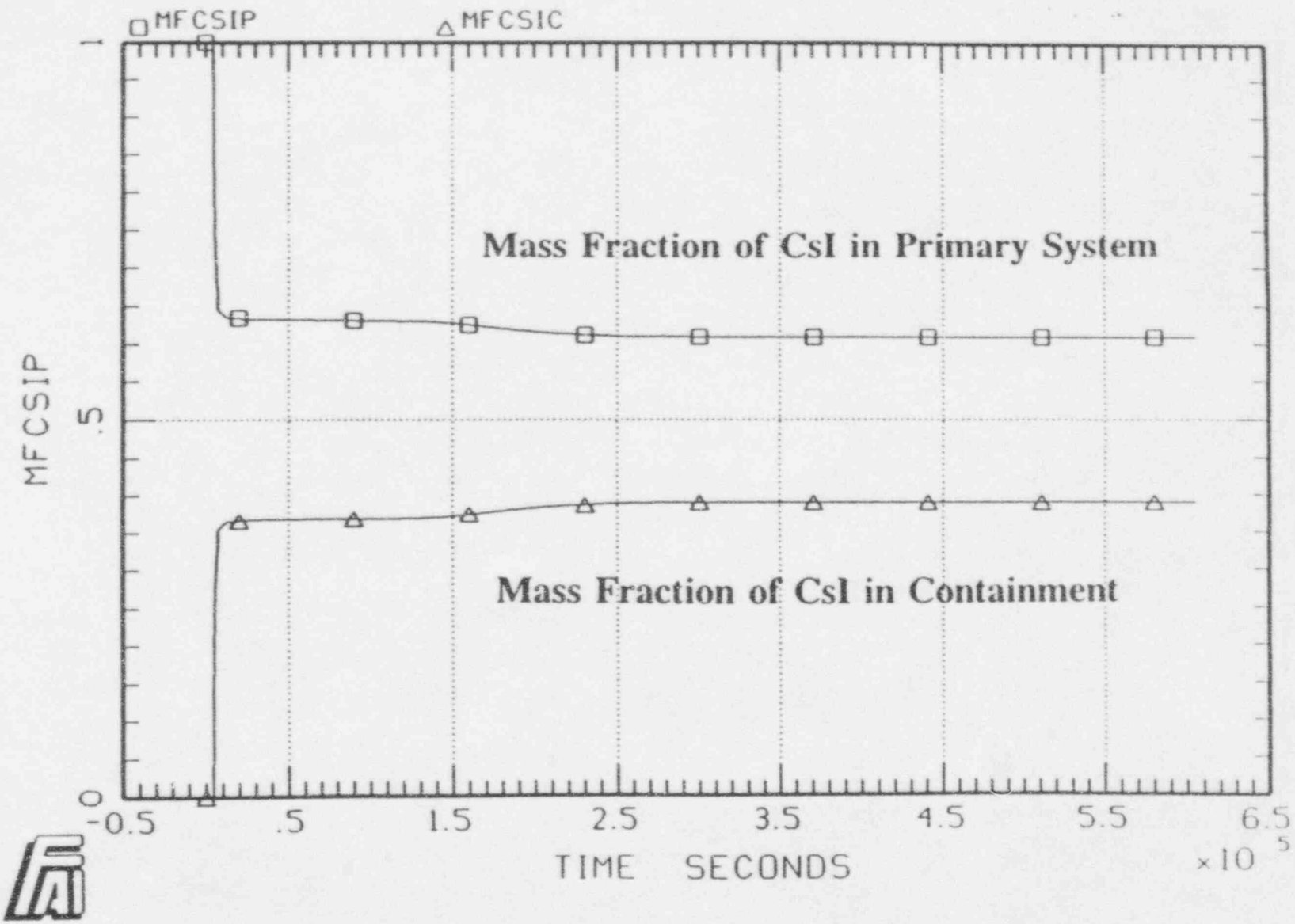
OBJECTIVE OF ASSESSMENT

Assess effectiveness of NaOH addition and mixing during containment floodup for severe accidents where core damage has occurred and core radioactivity has been released from RCS into containment.

Mixing of NaOH between the several containment water pools is considered effective if the pH of each pool is maintained at a value of 7 or higher.

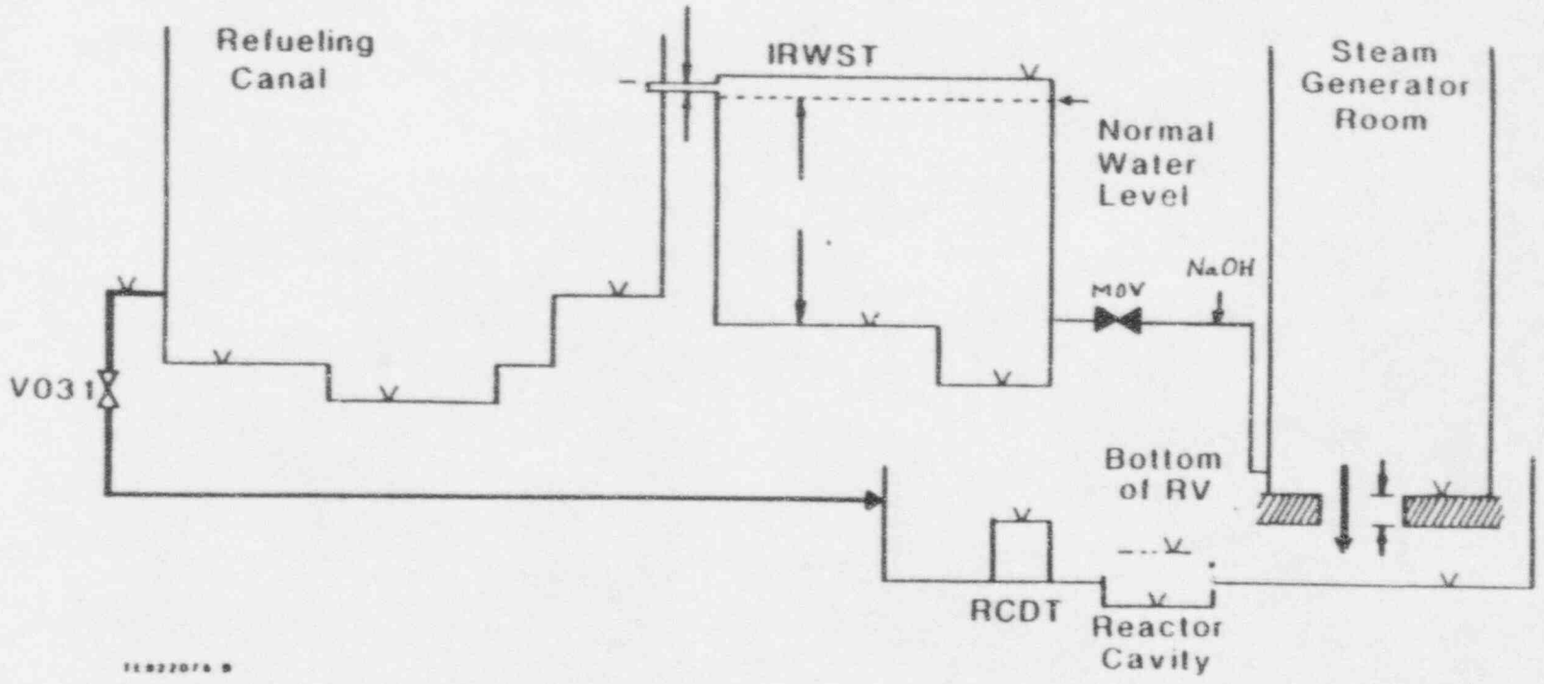
AP600
ASSESSMENT APPROACH

- MAAP4 Models
  - Track inventory of H_3BO_3, CsOH, NaOH, HNO_3 in containment water pools
  - Transport these chemical species in water flows between pools
  - Calculate radiolytic production of nitric acid (HNO_3) in water pools due to deposited fission products
  - Calculate pool pH based on the concentrations of these four chemical species
- SEVERE ACCIDENT SEQUENCE
  - Sequence 3BE from AP600 PRA
  - 3BE is DVI LOCA with gravity injection failure
  - 3BE accident class is highest (~30%) contributor to core damage frequency
  - Extensive core damage and large fission product release to containment
  - 10.1 kg of CsI of initial core inventory of 26 kg CsI released to containment

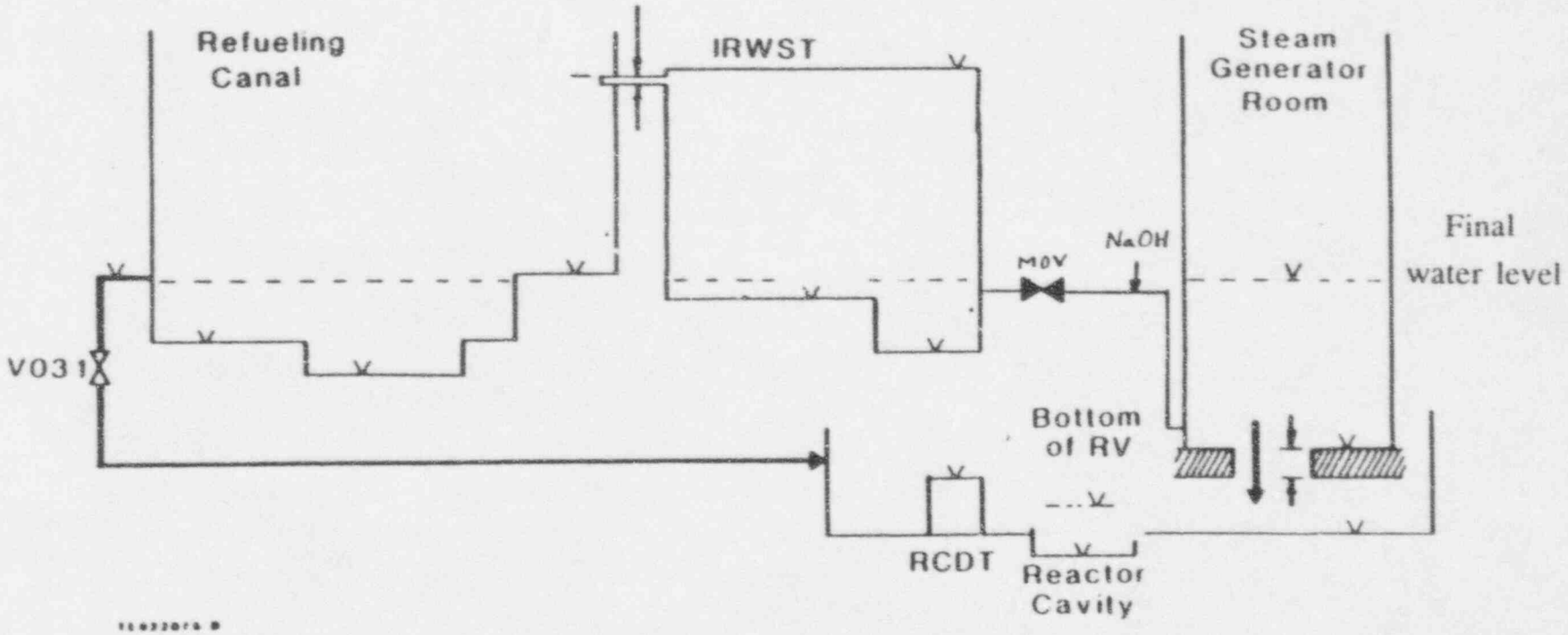

□MFCSIP
△MFCSIC
Mass Fraction of CsI in Primary System
Mass Fraction of CsI in Containment
MFCSIP
1
.5
0
-0.5
.5
1.5
2.5
3.5
4.5
5.5
6.5
TIME SECONDS
×10 5

AP600

- SEVERE ACCIDENT SEQUENCE (cont.)
  - Seven day sequence quantified
  - Basic sequence of events
    - Initiating event - DVI break
    - CMTs and accumulators inject and ADS is actuated so RCS is depressurized
    - Coolant boils-off through break and ADS such that core uncovery and heatup begins in about 1 hr
    - At core exit temperature of 1366°K (2000°F) operator opens MOV to drain IRWST into containment sumps (SG compartments)
    - When IRWST level drops to 8.8 m, NaOH injection to SG compartment is initiated
    - Containment floodup is complete once IRWST and NaOH have drained
    - PCCS is active during sequence to control containment pressure. Condensate returned to IRWST
  - Long term end state:
    - Damaged core in lower head of RPV
    - Containment flooded so RPV is submerged and intact
    - NaOH injected
    - PCCS controlling containment conditions



Initial containment water level.



Final containment water level.

- SEVERE ACCIDENT SEQUENCE (cont.)
  - Nominal boron concentrations used for each borated water source

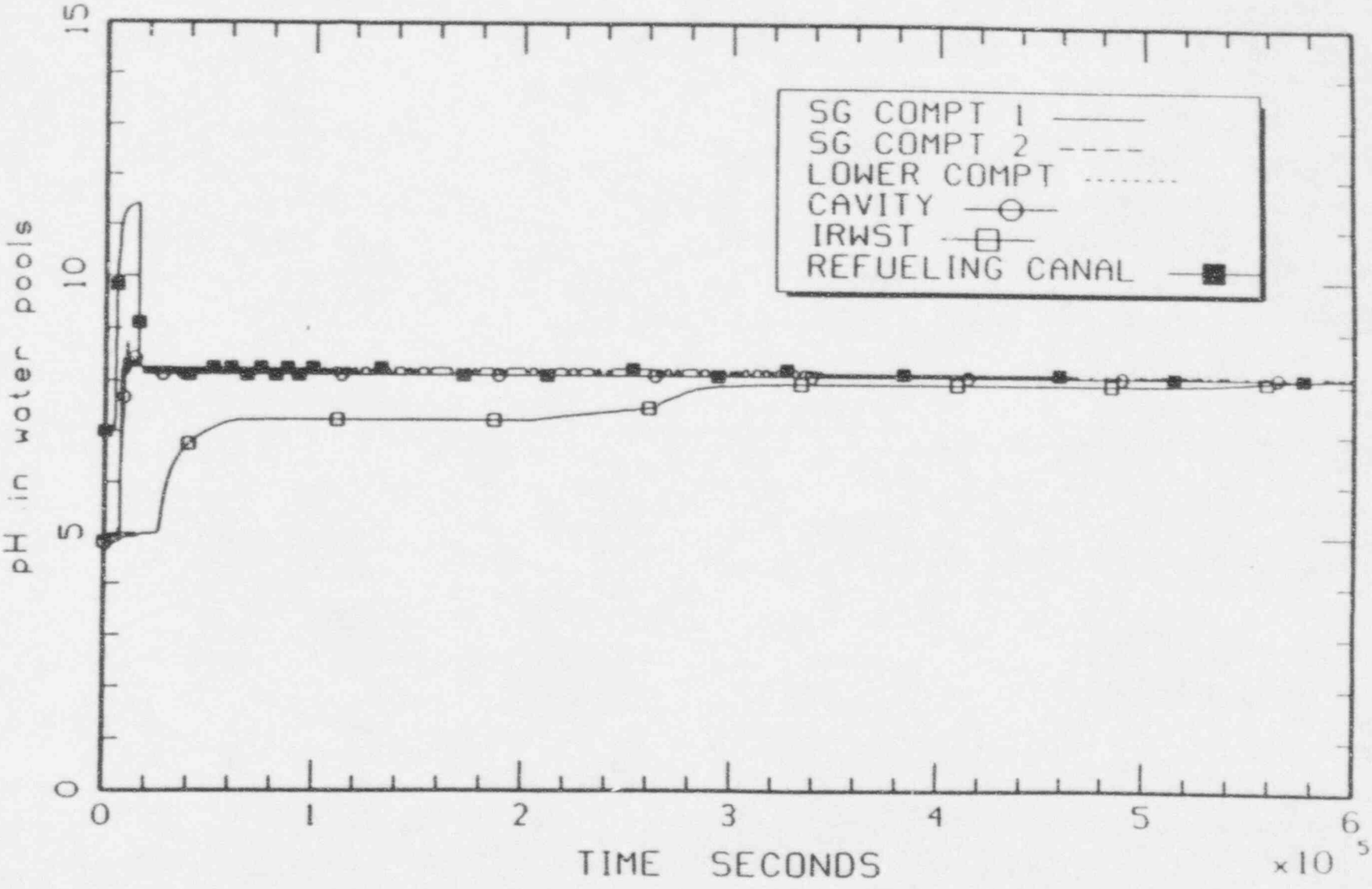
IRWST	2700 PPM B
RCS (W/PZR)	1200 PPM B
ACCUMULATOR	2700 PPM B
CMT	3500 PPM B

  - NaOH injection rate assumed constant (two rates quantified)
  - Sensitivity case with upper bound B concentrations

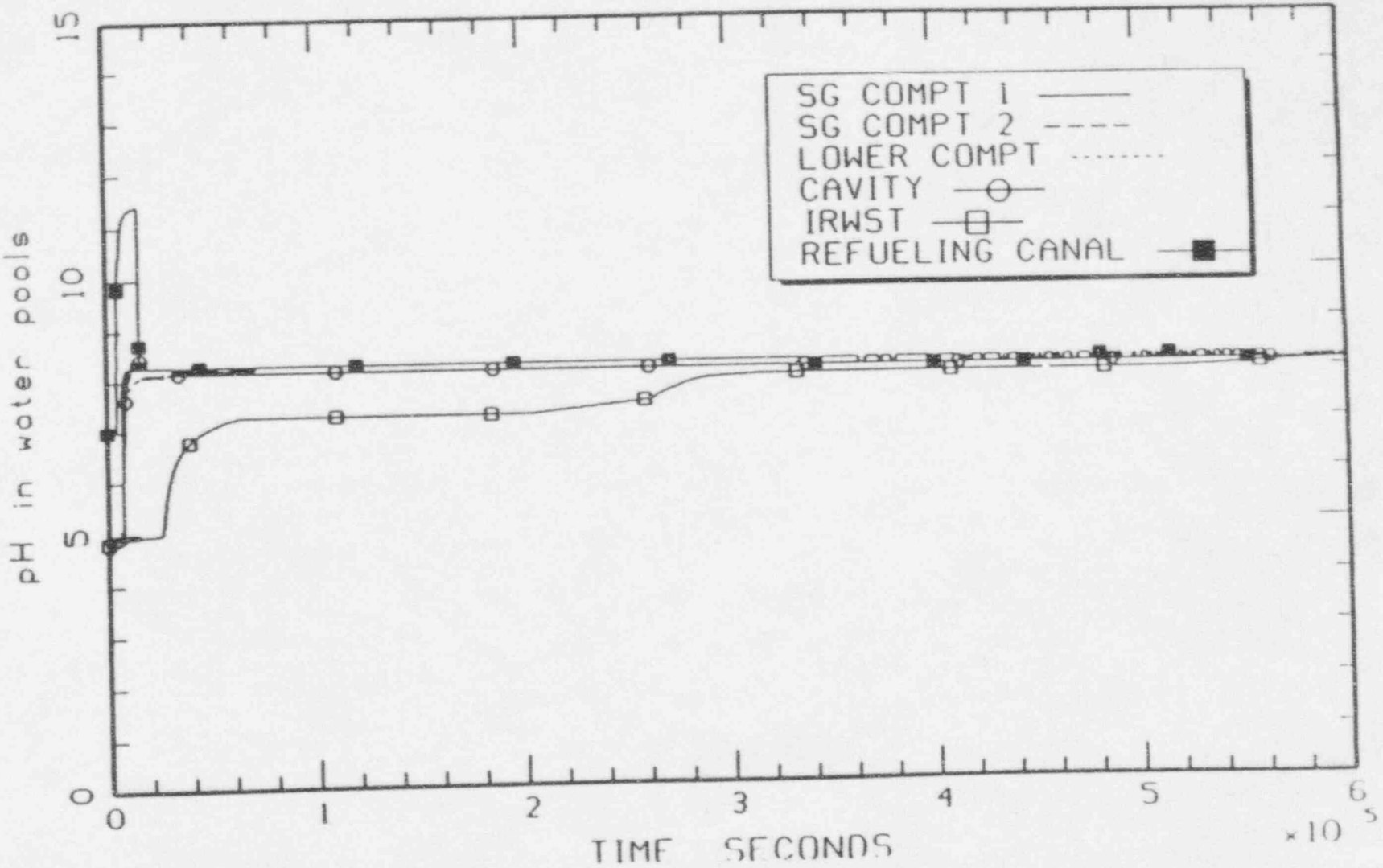
AP600

ASSESSMENT RESULTS

- Long Term Response
  - pH in each containment region is maintained at 7 or higher for extended (7 day) period
  - Results are not sensitive to NaOH flowrate (nominal PPM B)
  - Sensitivity case with maximum PPM B produced the same result
  - Once NaOH is delivered to a given containment pool, its pH becomes basic and remains so for entire sequence. Good mixing is produced.
- Short Term Response
  - Refueling canal pH is very high until it is flooded with borated water and NaOH
  - All other compartments are acidic due to borated water until NaOH is injected.
  - Rapid NaOH injection and mixing is observed in reactor cavity, steam generator compartments, and lower compartment.



Long term response.
(Lower NaOH flowrate.)



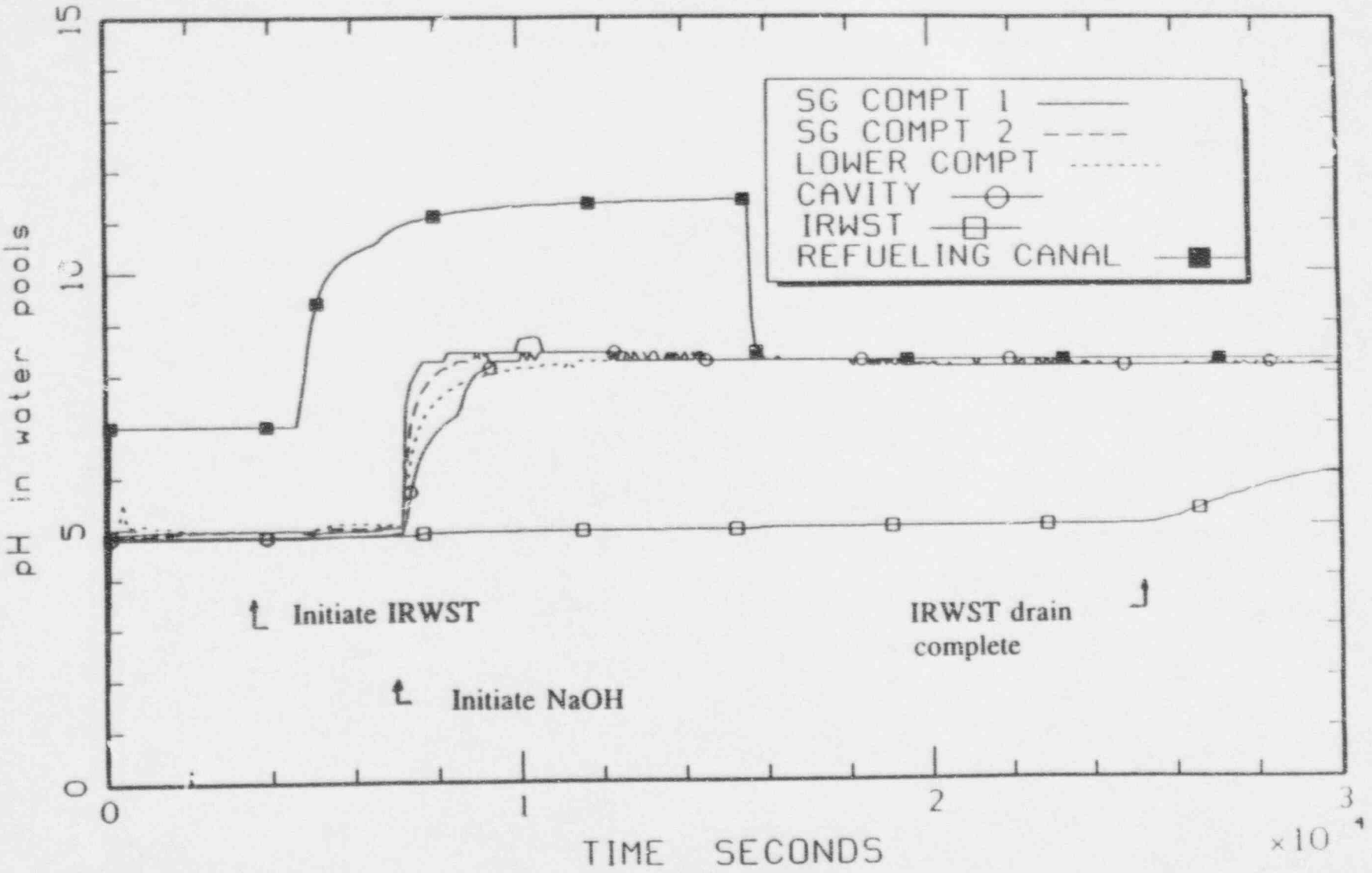
Long term response.
(Higher NaOH flowrate.)

AP600

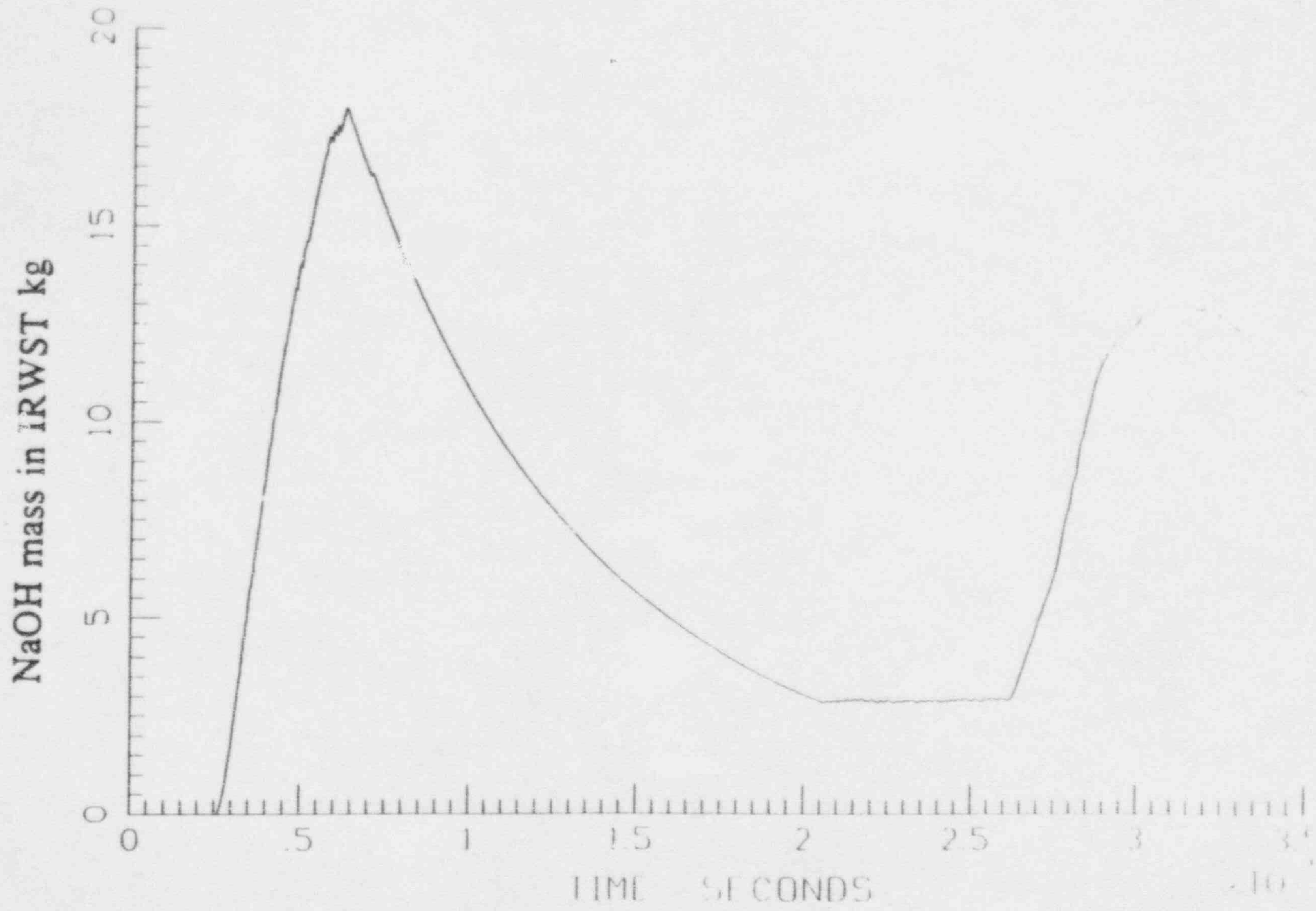
ASSESSMENT RESULTS

- Short Term Response (cont.)
  - NaOH mixing in IRWST lags until initial gravity drain down is complete and essentially static water level exists in flooded containment.
  - NaOH mixing in IRWST is produced by natural circulation (buoyancy driven) flow that delivers NaOH from SG compartment to remaining IRWST pool.
  - Only limited NaOH (a strong base) is needed to control pH of reduced inventory of borated (weak acid) IRWST water pool.

- IRWST Mixing
  - Long term have two types of flows in line between IRWST and SG compartment
    - A) Unidirectional
    - B) Counter current



Short term response.

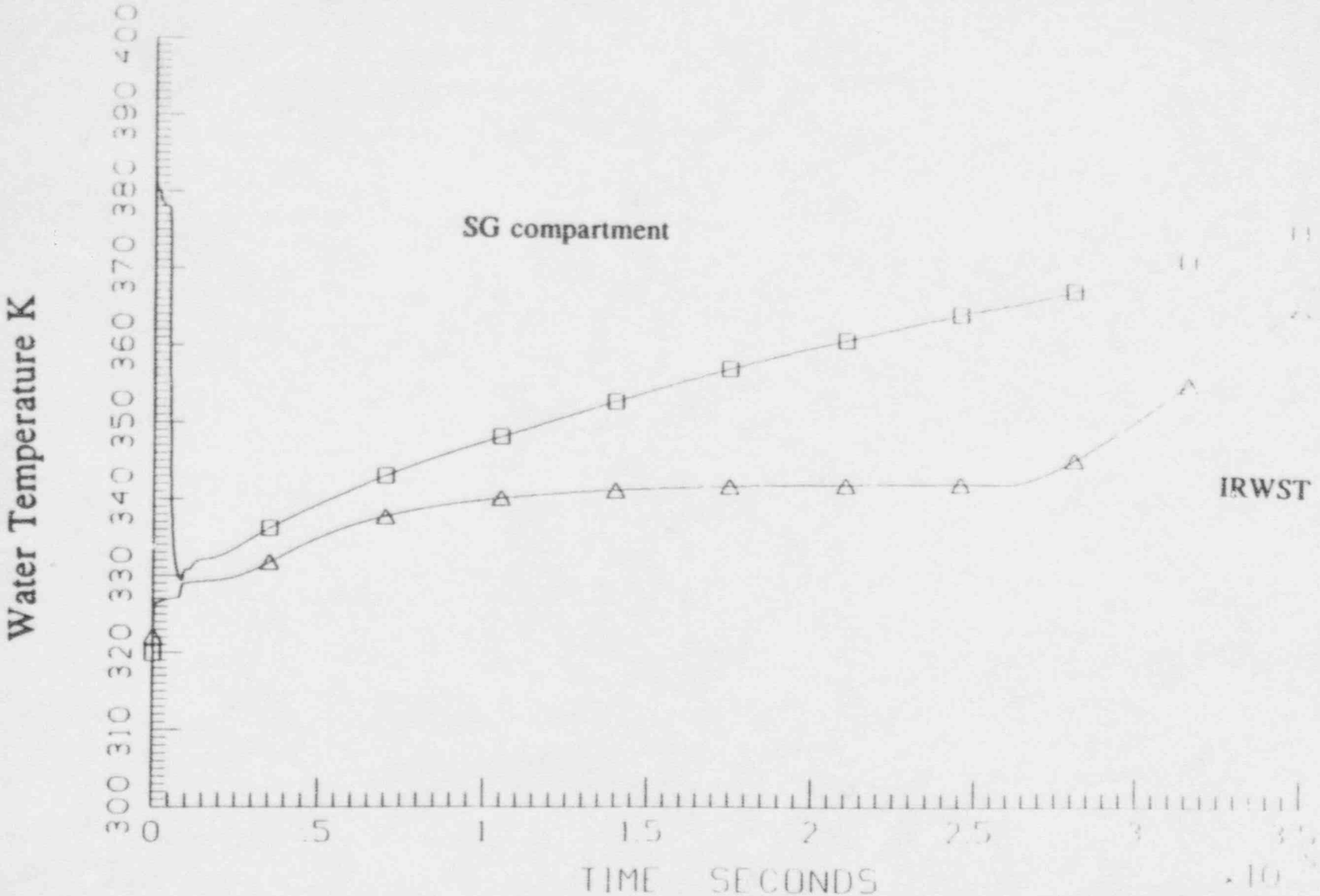


NaOH mass in IRWST kg
0
5
10
15
20
0
.5
1
1.5
2
2.5
3
TIME SECONDS

AP600

ASSESSMENT RESULTS

- IRWST Mixing (cont.)
  - Unidirectional Flow
    - PCCS condenses steam in containment and condensate is returned to IRWST
    - Static water head causes water to drain from IRWST into SG compartment
    - Submerged RPV with core debris is the heat source (decay heat)
  - Counter Current Flow
    - Temperature difference of water pools in SG compartment and IRWST produce density difference - buoyant forces
    - Lower density water in SG compartment flows through IRWST drain line into IRWST
    - Water from SG compartment contains NaOH which is delivered to IRWST pool


Water Temperature K
300 310 320 330 340 350 360 370 380 390 400
SG compartment
IRWST
0 .5 1 1.5 2 2.5 3
TIME SECONDS
-10

AP600

DEMONSTRATION OF COUNTER CURRENT FLOW

- HORIZONTAL PATH

$$q_H = 0.75\ C_D \sqrt{D^5\ g \Delta\rho/\bar{\rho}}$$ (Epstein & Kenton, 1989)

where

q_H = volumetric flowrate, m^3/s

C_D = discharge coefficient (.6)

D = line diameter, m (0.152)

$\Delta\rho$ = density difference, kg/m^3 (2.03 kg/m^3)

$\bar{\rho}$ = mean density, kg/m^3 (983.6 kg/m^3)

- Values correspond to conditions at about 25,000 sec (T_{SG} = 57°C; T_{IRWST} = 61°C)

$q = 5.8E\text{-}4\ m^3/s$

$\dot{m} = q\ \bar{\rho} = 0.57\ kg/s$

AP600

DEMONSTRATION OF COUNTER CURRENT FLOW
(cont)

- VERTICAL PATH

$$q_v = \frac{\pi}{4} K^{3/2} \sqrt{D^5 g \Delta\rho/\bar{\rho}} \; (L/D)^{-3/2} \qquad \text{(Epstein, 1988)}$$

where

q_v = volumetric flowrate, m^3/s

K = turbulent diffusion coefficient (0.35)

L = length of junction, m (1.0 - 6.0)

- Values correspond to conditions at about 25,000 sec as given above.

$q = 8.7E\text{-}7\ m^3/s$

$\dot{m} = q\bar{\rho} = 122$ to 8.3E-4 kg/s

AP600

ASSESSMENT CONCLUSION

Mixing of NaOH between the several interconnected water pools in the AP600 containment is sufficient to maintain pH $\geq$ 7 for extended intervals.