GE Nuclear Energy

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Attention: Robert C. Pierson, Director
Standardization and Non-Power Reactor Project Directorate

Subject: **GE Response to Agenda Items Discussed During the GE/NRC Reactor Systems Branch Meeting on November 20-21, 1991**

Reference: GE Response to Agenda Items Discussed During the GE/NRC Reactor Systems Branch Meeting on November 20-21, 1991, Proprietary Information, Dated February 14, 1991, MFN No. 039-92

Enclosed are thirty-four (34) copies of the GE response to the subject discussion items, numbered 3,6,7 and 17.

A portion of Item 3 contains proprietary information and is submitted under separate cover (see reference).

It is intended that GE will amend the SSAR, where appropriate, with these responses in a future amendment.

Sincerely,

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RESPONSE TO AGENDA ITEM 3

The automatic start text changes are provided on pages 7.4.-1, 7.4-2, 7.4-3, 9.3-2 and 9.3-3 (attached).

The SLCS P&ID has been updated to reflect the automatic start. This P&ID, Figure 9.3-1, was transmitted under letter, R.C. Mitchell to Robert C. Pierson, "Updated ABWR Piping and Instrumentation and Process Flow Drawings," February 3, 1992, MFN No. 030-92.

The SLCS IBD has also been updated to reflect the automatic start. This is GE Proprietary Information and is provided under separate cover.

7.4 SYSTEMS REQUIRED FOR SAFE SHUTDOWN

7.4.1 Description

This section examines and discusses the instrumentation and control aspects of the following plant systems and functions designed to assure safe and orderly shutdown of the ABWR:

(1) Alternate rod insertion function (ARI)

(2) Standby liquid control system (SLCS)

(3) Reactor shutdown cooling mode (RHR)

(4) Remote shutdown system (RSS)

See Subsection 7.1.2.4 which addresses the design basis information required by Section 3 of IEEE 279.

7.4.1.1 Alternate Rod Insertion Function-Instrumentation and Controls

The alternate rod insertion (ARI) function is accomplished independently and diversely from the reactor protection system (RPS). Independent sensors (i.e., ECCS sensors) provide reactor trip signals, via the recirculation flow control system (RFCS), both to ARI valves (part of the control rod drive system) and to the rod control and information system (RC&IS). The ARI valves, (seperate from the scram valves), cause reactor shut-down by hydraulic scram of the control rods. The RC&IS, acting upon the same ARI signals that are provided to ARI valves, cuases reactor shut-down by electromechanical (i.e., through the usage of FMCRD motors) insertion of control rods.

The RC&IS, including the active run-in function of the FMCRD motors and the ARI valves are not required for safety, nor are these components qualified in accordance with safety criteria. However, the FMCRD components associated with hydraulic scram are qualified in accordance with safety criteria.

The inherent diversity of ARI provides mitigation of the consequences of ATWS (anticipated transient without scram) events.

7.4.1.2 Standby Liquid Control System-Instrumentation and Controls

(1) Function

The instrumentation and controls for the SLCS are designed to initiate and continue injection of a liquid neutron absorber into the reactor when manually or automatically called upon to do so. This equipment also provides the necessary controls to maintain this liquid chemical solution well above saturation temperature in readiness for injection. The system P&ID is shown in Figure 9.3-5. The interlock block diagram (IBD) is shown in Figure 7.4-1.

(2) Classification

The SLCS is a backup method to ~~manually~~ automatically shut down the reactor to cold subcritical conditions by independent means other than the normal method by the control rod system. Thus, the system is considered a safe shutdown system. The standby liquid control process equipment, instrumentation, and controls essential for injection of the neutron absorber solution into the reactor are designed to withstand Seismic Category I earthquake loads. Any nondirect process equipment, instrumentation, and controls of the system are not required to meet Seismic Category I requirements; however, the local and control room mounted equipment is located in seismically qualified panels.

(3) Power Sources

The power supply to one motor-operated injection valve, storage tank discharge valve, and injection pump is powered from Division I, 480VAC. The power supply to the other motor-operated injection valve, storage tank outlet valve, and injection pump is powered from Division II, 480VAC. The power supply to the tank heaters and heater controls is connectable to a standby AC power source. The standby power source is Class 1E from an onsite source and is independent of the offsite power. The power supply to the main control room benchboard indicator lights and the level and pressure sensors is powered from a Class 1E instrument bus.

function of the SLCS. It is included for a number of special consideration events:

(a) Plant capability to shut down the reactor without control rods from normal operation (Chapter 15).

(b) Plant capability to shut down the reactor without control rods from a transient incident (Chapter 15).

Although this system has been designed to a high degree of reliability with many safety system features, it is not required to meet the safety design basis requirements of the safety-related systems.

(5) Initiating Circuits

The standby liquid control system is manually initiated in the main control room by turning a keylocking switch for system A or a different keylocking switch for system B to the RUN position.

The standby liquid control system is automatically initiated upon receiving an anticipated transient without scram (ATWS) signal.

(6) Logic and Sequencing

When one division of SLCS is initiated, one injection valve and one tank discharge valve start to open immediately. The pump that has been selected for injection will not start until its associated tank discharge valve is at the fully open position. In order to provide maximum MOV availability when the SLCS is in normal standby readiness, the overloads for the storage tank outlet valves are bypassed by a contact from a test switch in its NORMAL position. When the TEST position is selected, the overload short is removed, thus allowing motor protection during test operation of the valves.

(7) Bypasses and Interlocks

Pumps are interlocked so that either the storage tank discharge valve or the test tank discharge valve must be fully open for the pump to run. When the SLCS is initiated to inject the neutron absorber into the reactor, the outboard isolation valve of the reactor water cleanup system is automatically closed from the Division I logic and the inboard valve from Division II logic.

(8) Redundancy and Diversity

Under special shutdown conditions, the SLCS is functionally redundant to the control rod drive system in achieving and maintaining the reactor subcritical. Therefore, the SLCS as a system by itself is not required to be redundant, although the active components and control channels are redundant for serviceability.

The SLCS provides a diverse means for shutting down the reactor using a liquid neutron absorber in the event of a control rod drive system failure.

The method of identifying redundant power cables, signal cables, and cable trays and the method of identifying non-safety-related cables as associated circuits are discussed in Subsection 8.3.1.3.

(9) Actuated Devices

(A)

When the SLCS is initiated to inject a liquid neutron absorber into the reactor, the following devices are actuated:

(a) one of the two injection valves is opened;

(b) one of the two storage tank discharge valves is opened;

(c) one of the two injection pumps is started; and

(d) one of the reactor water cleanup isolation valves is closed.

Additionally, the pressure and tank level sensing equipment indicates that the SLCS is pumping liquid into the reactor.

(10) Separation

The SLCS is separated both physically and electrically from the control rod drive system. The SLCS electrical control channels are separated in accordance with the requirements of Subsection 8.3.1.4.

INSERT (A)

When the SLCS is automatically initiated to inject a liquid neutron absorber into the reactor, the following devices are actuated:

(a) the two injection valves are opened;

(b) the two storage tank discharge valves are opened;

(c) the two injection pumps are started; and

(d) the reactor water cleanup isolation valves are closed.

(11) Testability

The SLCS is capable of being tested by manual initiation of actuated devices during normal operation. In the test mode, demineralized water is circulated in the SLCS loops rather than sodium pentaborate. During reactor shutdown, demineralized water may be injected into the reactor vessel for the injection test mode.

(12) Environmental Considerations

The environmental considerations for the instrument and control portions of the SLCS are the same as for the active mechanical components of the system (Section 3.11). The instrument and control portions of the SLCS are seismically qualified not to fail during, and to remain functional following, a safe shutdown earthquake (SSE) (see Section 3.10 for seismic qualification aspects).

(13) Operational Considerations

The control scheme for the SLCS can be found in the interlock block diagram (Figure 7.4-1). The SLCS is manually initiated in the control room by inserting the key in the A or B keylocking switch and turning it to the "pump run" position. It will take between 50 and 150 minutes to complete the injection and for the storage tank level sensors to indicate that the storage tank is dry. When the injection is completed, the system may be manually turned off by turning the keylocking switch counterclockwise to the STOP position.

automatically initiated upon receiving an ATWS signal or can be

is automatically shutdown on low tank level or

(14) Reactor Operator Information

(a) The following items are located in the control room for operation information:

(1) Analog Indication

(i) Storage tank level and temperature;

(ii) System pressures;

(2) Status Lights

(i) Pump or storage tank outlet valve overload trip or power loss;

(ii) Position of injection line manual service valve;

(iii) Position of storage tank outlet valve and in-test status;

(iv) Position of test tank discharge manual service valve;

(v) SLCS manually out of service;

(vi) Pump auto trip.

(3) Annunciators

The SLCS annunciators indicate:

(i) Manual or automatic out-of-service condition of SLCS A and/or B due to:

- operation of manual out-of-service switch;

- storage tank outlet valve in test status; or

- overload trip or power loss in pump or storage tank outlet valve controls;

(ii) Standby liquid storage tank high or low temperature;

(iii) Standby liquid tank high or low level;

(iv) Standby liquid pump A (B) auto trip.

(b) The following items are located locally at the equipment for operator utilization:

9.3.3 Equipment and Floor Drainage System

The system which collects and transfers all radioactive liquid wastes is discussed in Subsection 9.3.8. The drainage systems for non-radioactive liquid wastes are not discussed because they are not a part of the ABWR Standard Plant.

9.3.4 Chemical and Volume Control System(PWR)

(Not applicable to a BWR)

9.3.5 Standby Liquid Control System

9.3.5.1 Design Bases

9.3.5.1.1 Safety Design Bases

The standby liquid control system (SLCS) has a safety-related function and is designed as a Seismic Category I system. It shall meet the following safety design bases:

(1) Backup capability for reactivity control shall be provided, independent of normal reactivity control provisions in the nuclear reactor, to be able to shut down the reactor if normal control ever becomes inoperative.

(2) The backup system shall have the capacity for controlling the reactivity difference between the steady-state rated operating condition of the reactor with voids and the cold shutdown condition, including shutdown margin, to assure complete shutdown from the most reactive conditions at any time in core life.

(3) The time required for actuation and effectiveness of the backup control shall be consistent with the nuclear reactivity rate of change predicted between rated operating and cold shutdown conditions. A fast scram of the reactor or operational control of fast reactivity transients is not specified to be accomplished by this system.

(4) Means shall be provided by which the functional performance capability of the backup control system components can be verified periodically under conditions approaching actual use requirements. Demineralized water, rather than the actual neutron absorber solution, can be injected into the reactor to test the operation of all components of the redundant control system.

(5) The neutron absorber shall be dispersed within the reactor core in sufficient quantity to provide a reasonable margin for leakage or imperfect mixing.

(6) The system shall be reliable to a degree consistent with its role as a special safety system; the possibility of unintentional or accidental shutdown of the reactor by this system shall be minimized.

9.3.5.2 System Description

The SLCS (Figure 9.3-1) is automatically initiated or can be manually initiated through ~~a single~~ the keyboard switches in the main control room to pump a boron neutron absorber solution into the reactor if the operator determines the reactor cannot be shut down or kept shut down with the control rods. Once the operator decision for initiation of the SLCS is made, the design intent is to simplify the manual process by providing dual keylocked switches. This prevents inadvertent injection of neutron absorber by the SLCS. However, the insertion of the control rods is expected to assure prompt shutdown of the reactor should it be required.

The keylocked control room switch is provided to assure positive action from the main control room should the need arise. Procedural controls are applied to the operation of the keylocked control room switch.

The SLCS is required only to shut down the reactor and keep the reactor from going critical again as it cools.

The SLCS is needed only in the improbable event that not enough control rods can be inserted in the reactor core to accomplish shutdown and cooldown in the normal manner.

The boron solution tank, the test water tank, the two positive displacement pumps, the two motor-operated injection valves, the two motor-operated pump suction valves, and associated local valves, panel, and controls are located in the secondary containment outside the drywell and wetwell. The liquid is piped into the reactor vessel throughout the high pressure core flooder (HPCF) line downstream of the HPCF inboard check valve.

The boron absorbs thermal neutrons and thereby terminates the nuclear fission chain reaction in the uranium fuel.

The specified neutron absorber solution is sodium pentaborate ($Na_2B_{10}O_{16} \cdot 10H_2O$). It is prepared by dissolving stoichiometric quantities of borax and boric acid in demineralized water. An air sparger is provided in the tank for mixing. To prevent system plugging, the tank outlet is raised above the bottom of the tank.

At all times when it is possible to make the reactor critical, the SLCS shall be able to deliver enough sodium pentaborate solution into the reactor (Figure 9.3-2) to assure reactor shutdown. This is accomplished by placing sodium pentaborate in the standby liquid control tank and filling it with demineralized water to at least the low level alarm point. The solution can be diluted with water to within 14 inches of the overflow level volume to allow for evaporation losses or to lower the saturation temperature.

The minimum temperature of the fluid in the tank and piping shall be consistent with that obtained from Figure 9.3-3 for the solution temperature. The saturation temperature of the recommended solution is 59°F at the low level alarm volume and a lower temperature at 14 inches below the tank overflow volume (Figures 9.3-2 and 9.3-3). The equipment containing the solution is installed in a room in which the air temperature is to be maintained within the range of 50 to 100°F. An electrical resistance heater system provides a backup heat source which maintains the solution temperature at 75°F (automatic operation) to 85°F (automatic shutoff) to prevent precipitation of the sodium pentaborate from the solution during storage. High or low temperature, or high or low liquid level, causes an alarm in the control room.

Each positive displacement pump is sized to inject the solution into the reactor in 60 to 150 minutes, independent of the amount of solution in the tank. The pump and system design pressure between the injection valves and the pump and system design pressure between relief valves are approximately 1560 psig. To prevent bypass flow from one pump in case of relief valve failure in the line from the other pump, a check valve is installed downstream of each relief valve line in the pump discharge pipe.

The SLCS is actuated by either of two keylocked, spring-return switches on the control room console. This assures that switching from the OFF position is a deliberate act. Changing either switch status to RUN starts an injection pump, opens one motor-operated injection valve, opens one pump suction motor-operated valve, and closes both of the reactor cleanup system outboard isolation valves to prevent loss of boron.

¶ ← (B)

A light in the control room indicates that power is available to the pump motor contactor and that the contactor is deenergized (pump not running). Another light indicates that the contactor is energized (pump running).

Storage tank liquid level, tank outlet valve position, pump discharge pressure, and injection valve position indicate that the system is functioning. If any of these items indicates that the liquid may not be flowing, the operator shall immediately change the other switch to the RUN mode, thereby activating the redundant train of the SLCS. The local switch will not have a STOP position. This prevents the isolation of the pump from the control room. Pump discharge pressure and valve status are indicated in the control room.

Equipment drains and tank overflow are not piped to the radwaste system but to separate containers (such as 55 gallon drums) that can be removed and disposed of independently to prevent any trace of boron from inadvertently reaching the reactor.

Instrumentation consisting of solution temperature indication and control, solution level

{automatically initiated after receiving an anticipated transient without scram (ATWS) signal or can be manually

INSERT (B)

An ATWS condition exists when either of the following occurs:

(a) High RPV pressure (1125 lpsig) and average power range monitor (APRM) not down scale for 3 minutes, or

(b) Low RPV level (Level 2) and APRM not down scale for 3 minutes.

RESPONSE TO AGENDA ITEM 6

Since ABWR will incorporate an automatic ADS inhibit following an ATWS, there is no operation action required. Therefore, the 29 second delay in the actuation of ADS following a Low Water Level 1 signal is acceptable. This delay is used to confirm that Low Water Level 1 signal is present and is consistent with the low pressure ECCS pump start-up time.

RESPONSE TO AGENDA ITEM 7

An 8 minute high drywell pressure bypass timer has been added to the ADS initiation logic to address TMI action item II.K.3.18. This timer will initiate on a Low Water Level 1 signal. When it times out, it bypasses the need for a high drywell signal to initiate the standard ADS initiation logic.

For all LOCAs inside the containment, a high drywell signal will be present and ADS will actuate 29 seconds after a Low Water Level 1 signal is reached. All LOCAs outside the containment become rapidly isolated and any one of the three high pressure ECCS can control the water level. The high drywell pressure bypass timer in the ADS initiation logic will only affect the LOCA response if all high pressure ECCS fail following a break outside the containment. For this case the ADS will automatically intiate within 509 seconds (8 minute timer plus 29 second standard ADS logic delay) following a Low Water Level 1 signal.

An analysis was performed to evaluate the adequacy of the 8 minute bypass timer. As discussed above this analysis involves multiple failures. Therefore it is part of the PRA success criteria realistic LOCA evaluation. The main difference between the input assumptions for this case and those in Section 6.3.3 of the SSAR is the use of a realistic decay heat curve (i.e. ANS 5.1). A complete circumferential break of the main steamline outside the containment (which is representive of those LOCA cases where no high drywell signal is present.) was evaluated. The key results from this analysis are given in Figures 7-1 through 7-7. The peak cladding temperature (PCT), refer to Figure 7-7, for this case is less than 1100°F which is well below the 2200 °F licensing limit. This PCT is due to the initial voiding in the core at the beginning of the event as in the case of the design basis evaluation. The heatup caused by the core uncovery late in the event is negligible. These results confirm the acceptability of the 8 minute high drywell pressure bypass timer.

The corresponding text changes are attached.
(pages 7.3-5, 7.3-6 & 7.3-7)

Figure 7-1 WATER LEVEL IN FUEL CHANNELS FOLLOWING A MAIN STEAMLINE BREAK OUTSIDE CONTAINMENT, NO HIGH PRESSURE ECCS AVAILABLE (REALISTIC ANALYSIS ASSUMPTIONS)

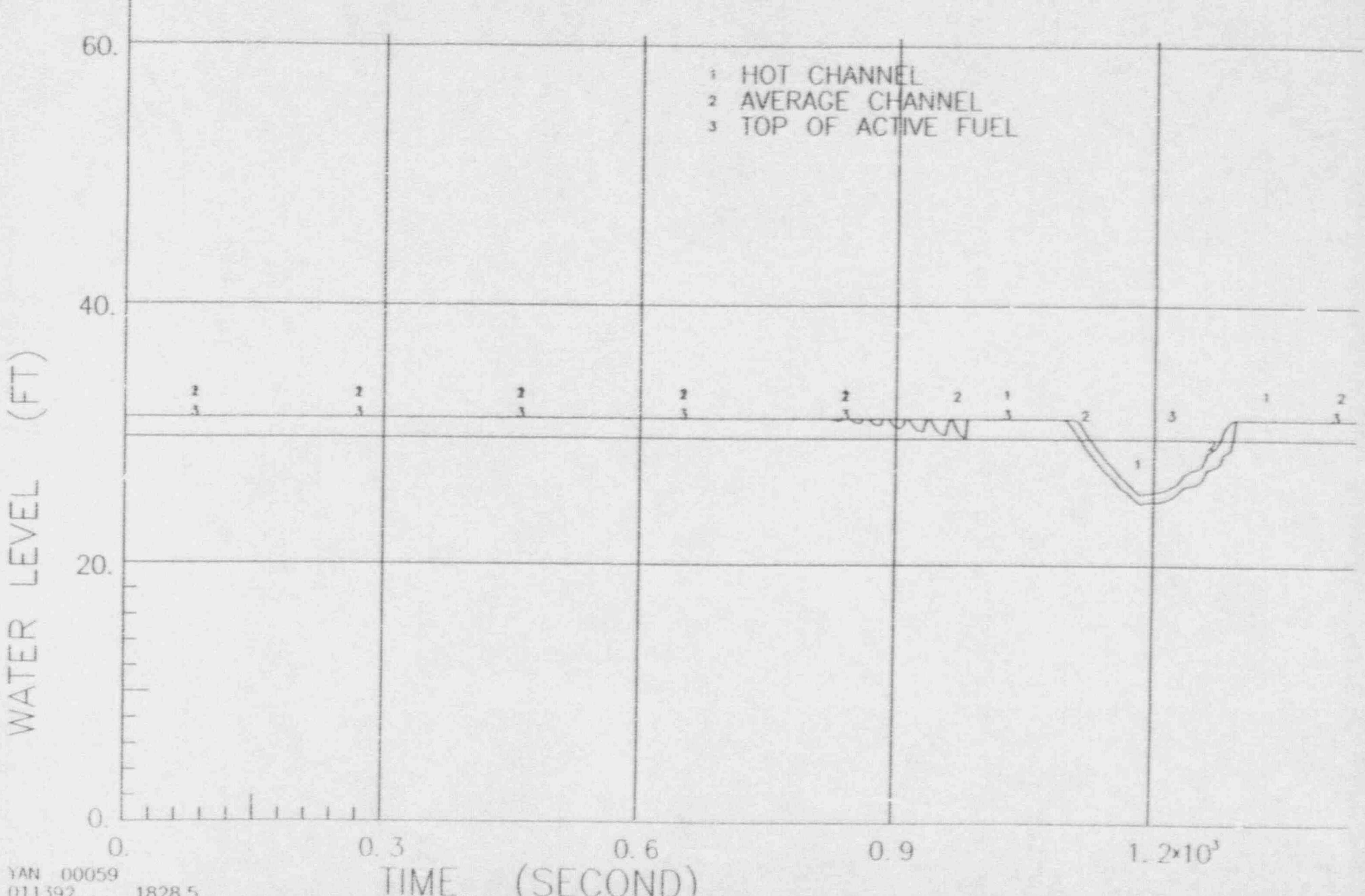

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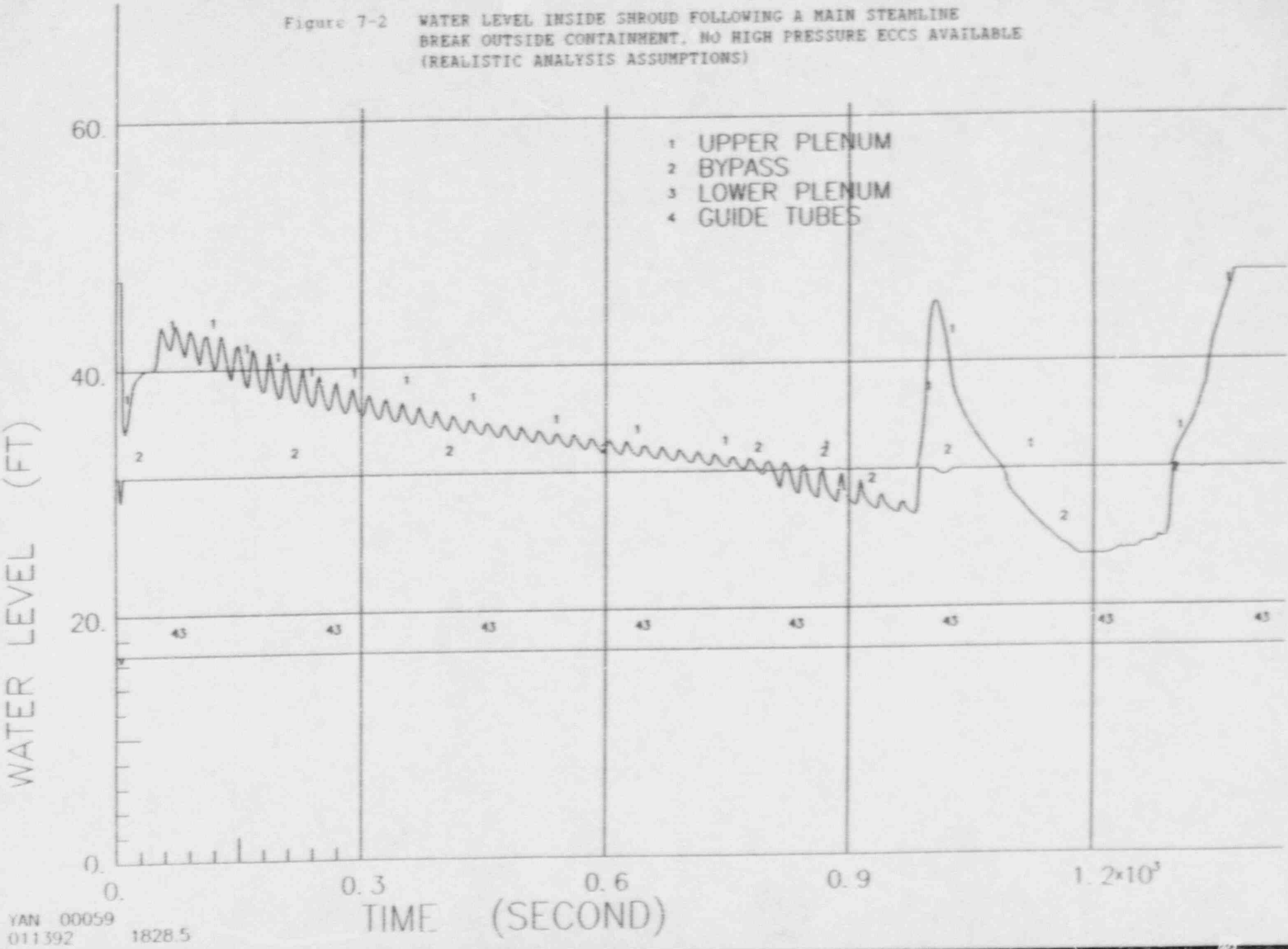
Figure 7-2 WATER LEVEL INSIDE SHROUD FOLLOWING A MAIN STEAMLINE BREAK OUTSIDE CONTAINMENT, NO HIGH PRESSURE ECCS AVAILABLE (REALISTIC ANALYSIS ASSUMPTIONS)



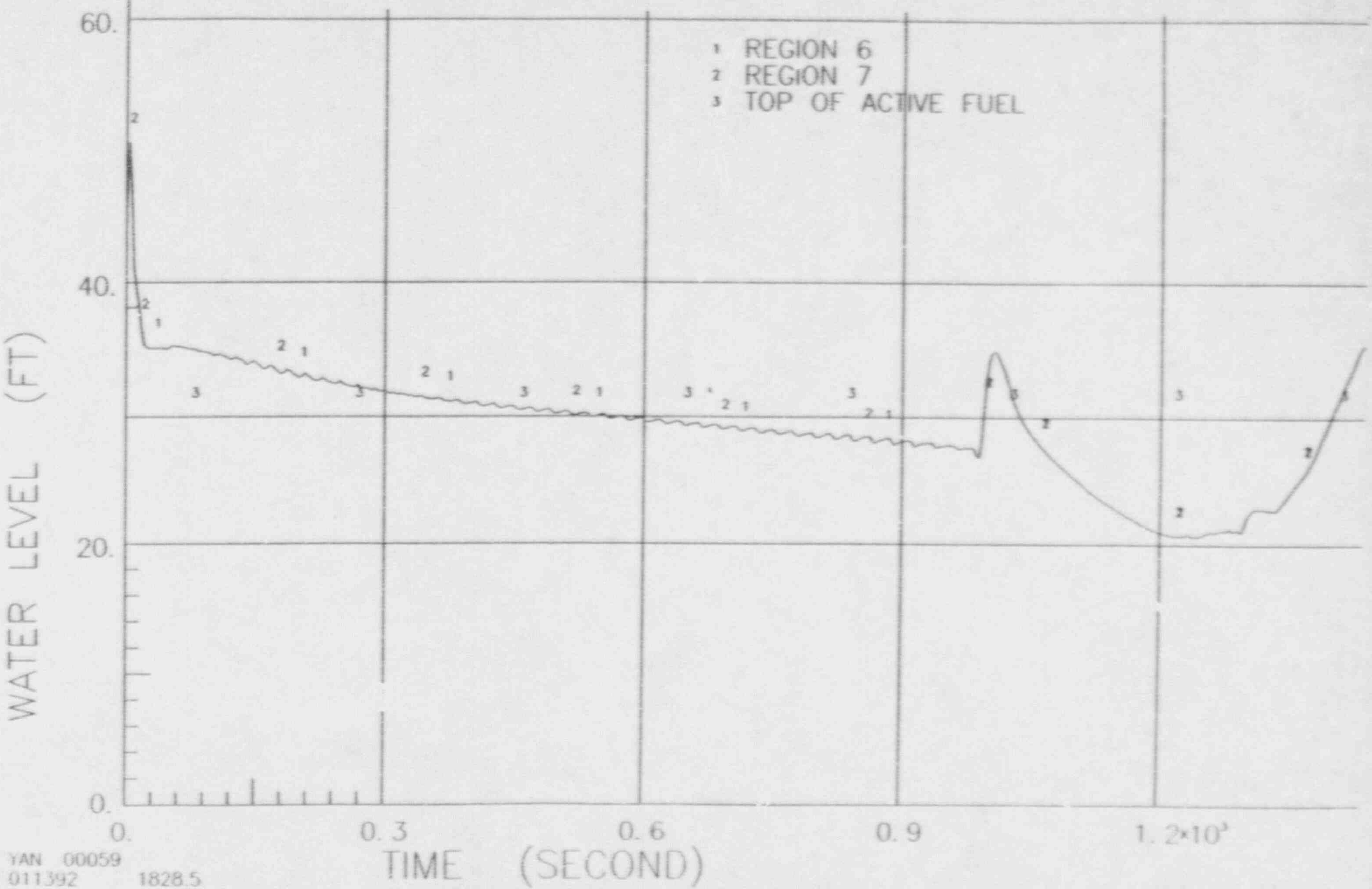


Figure 7-3 WATER LEVEL OUTSIDE SHROUD FOLLOWING A MAIN STEAMLINE BREAK OUTSIDE CONTAINMENT, NO HIGH PRESSURE ECCS AVAILABLE (REALISTIC ANALYSIS ASSUMPTIONS)

Figure 7-4 VESSEL PRESSURE FOLLOWING A MAIN STEAMLINE BREAK OUTSIDE CONTAINMENT, NO HIGH PRESSURE ECCS AVAILABLE (REALISTIC ANALYSIS ASSUMPTIONS)

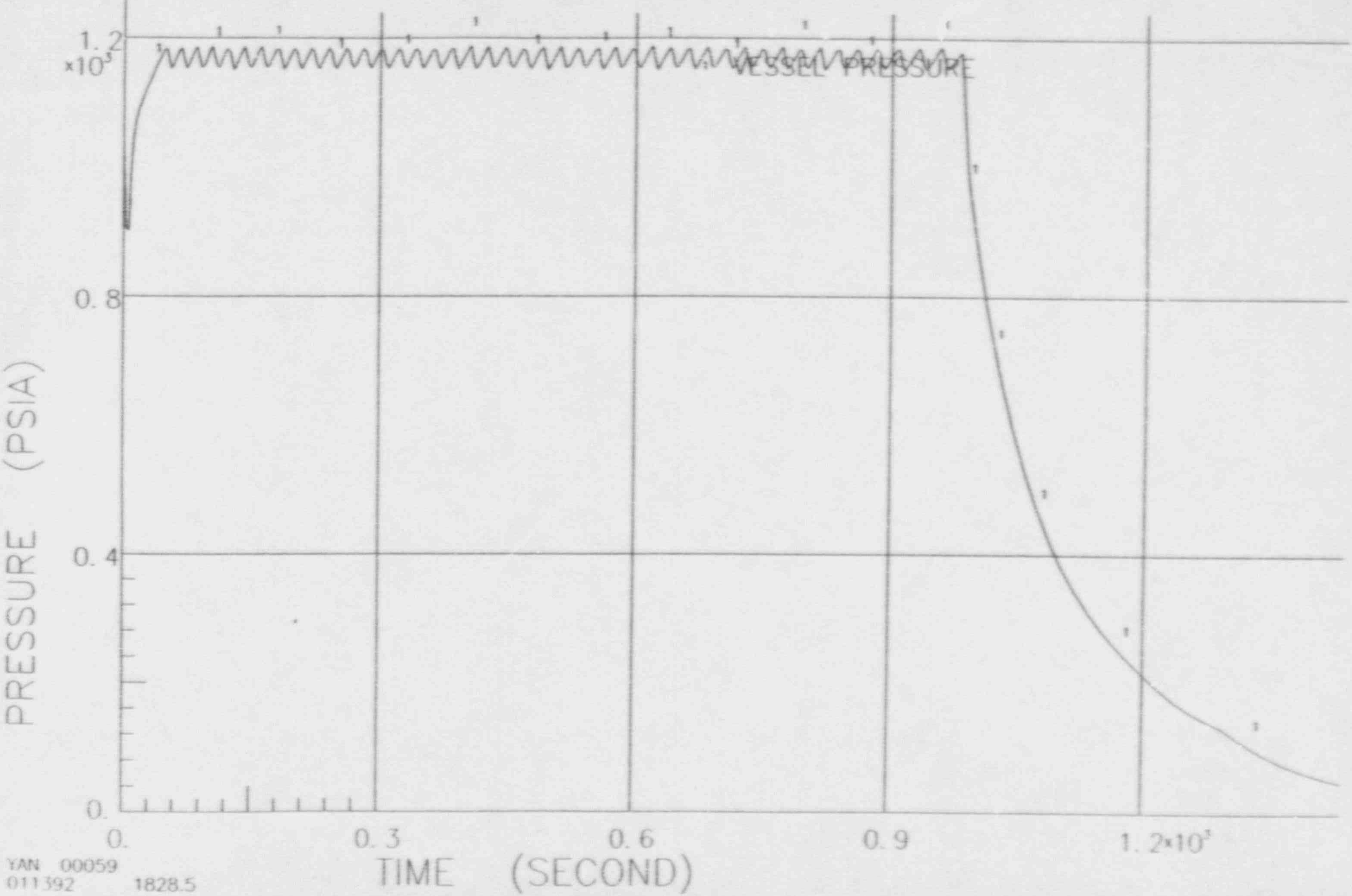


Figure 7-5 FLOW OUT OF VESSEL FOLLOWING A MAIN STEAMLINE BREAK OUTSIDE CONTAINMENT, NO HIGH PRESSURE ECCS AVAILABLE (REALISTIC ANALYSIS ASSUMPTIONS)

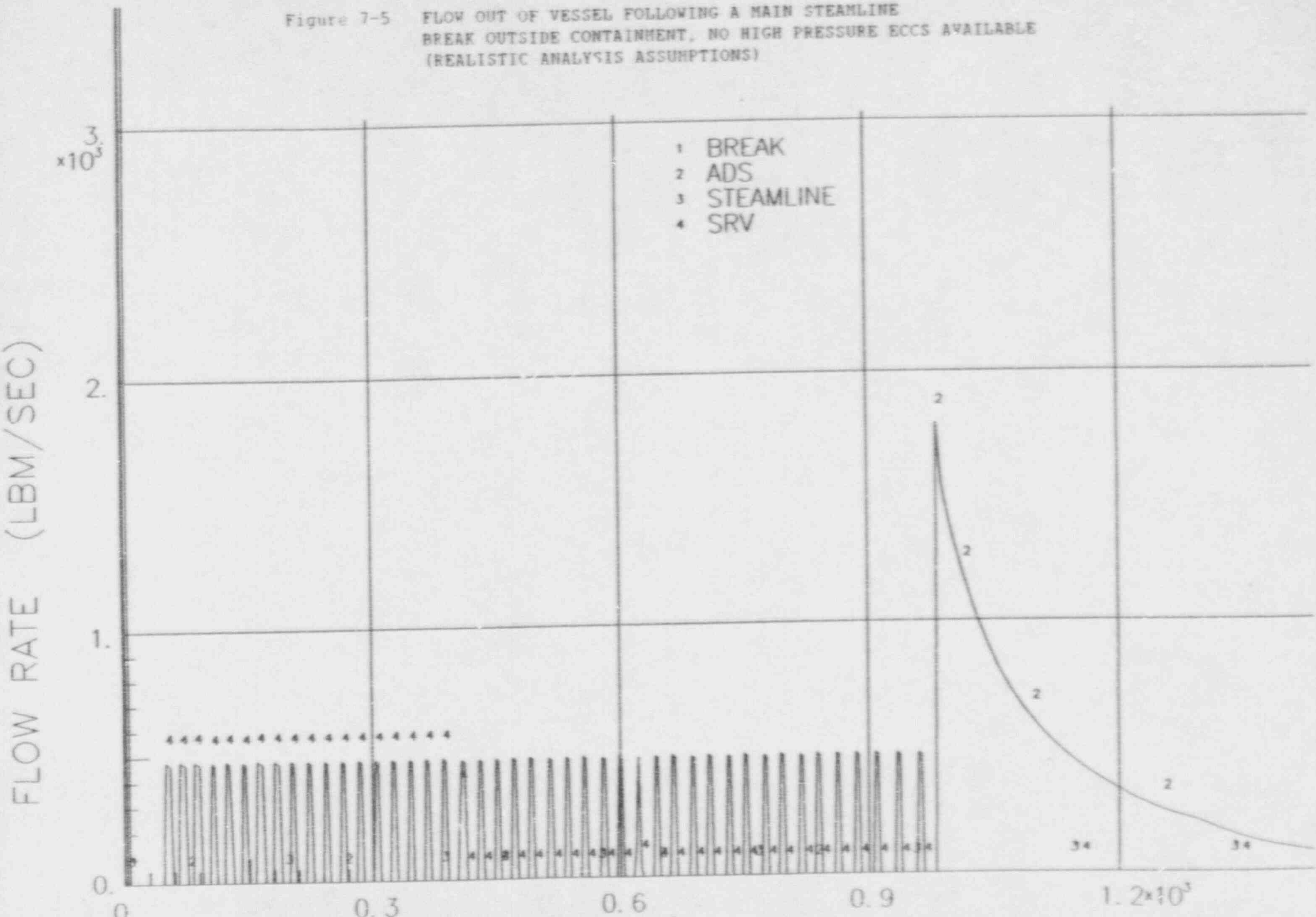


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Figure 7-6 FLOW INTO VESSEL FOLLOWING A MAIN STEAMLINE BREAK OUTSIDE CONTAINMENT, NO HIGH PRESSURE ECCS AVAILABLE (REALISTIC ANALYSIS ASSUMPTIONS)

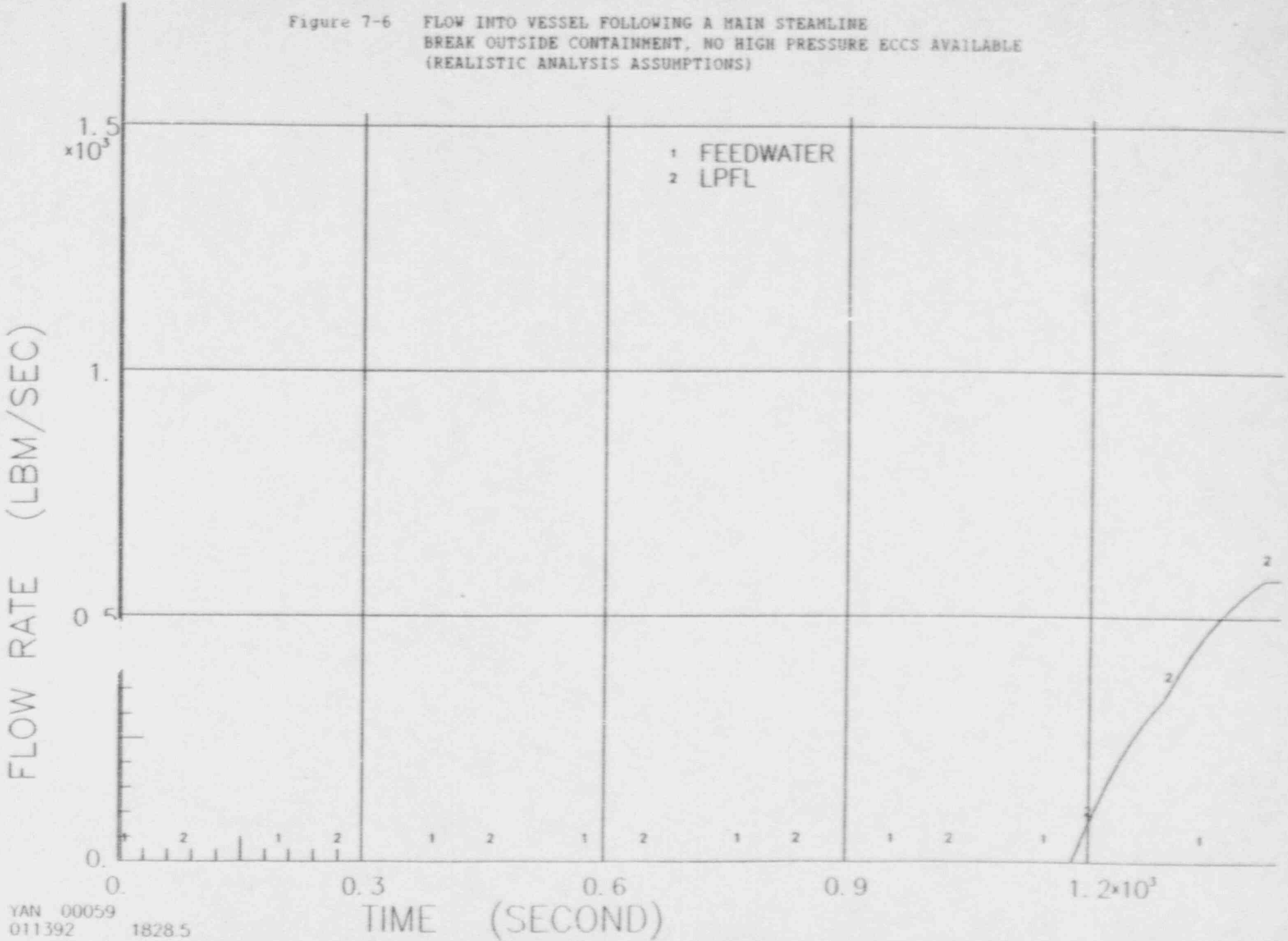

Figure 7-7 PEAK CLADDING TEMPERATURE FOLLOWING A MAIN STEAMLINE BREAK OUTSIDE CONTAINMENT, NO HIGH PRESSURE ECCS AVAILABLE (REALISTIC ANALYSIS ASSUMPTIONS)

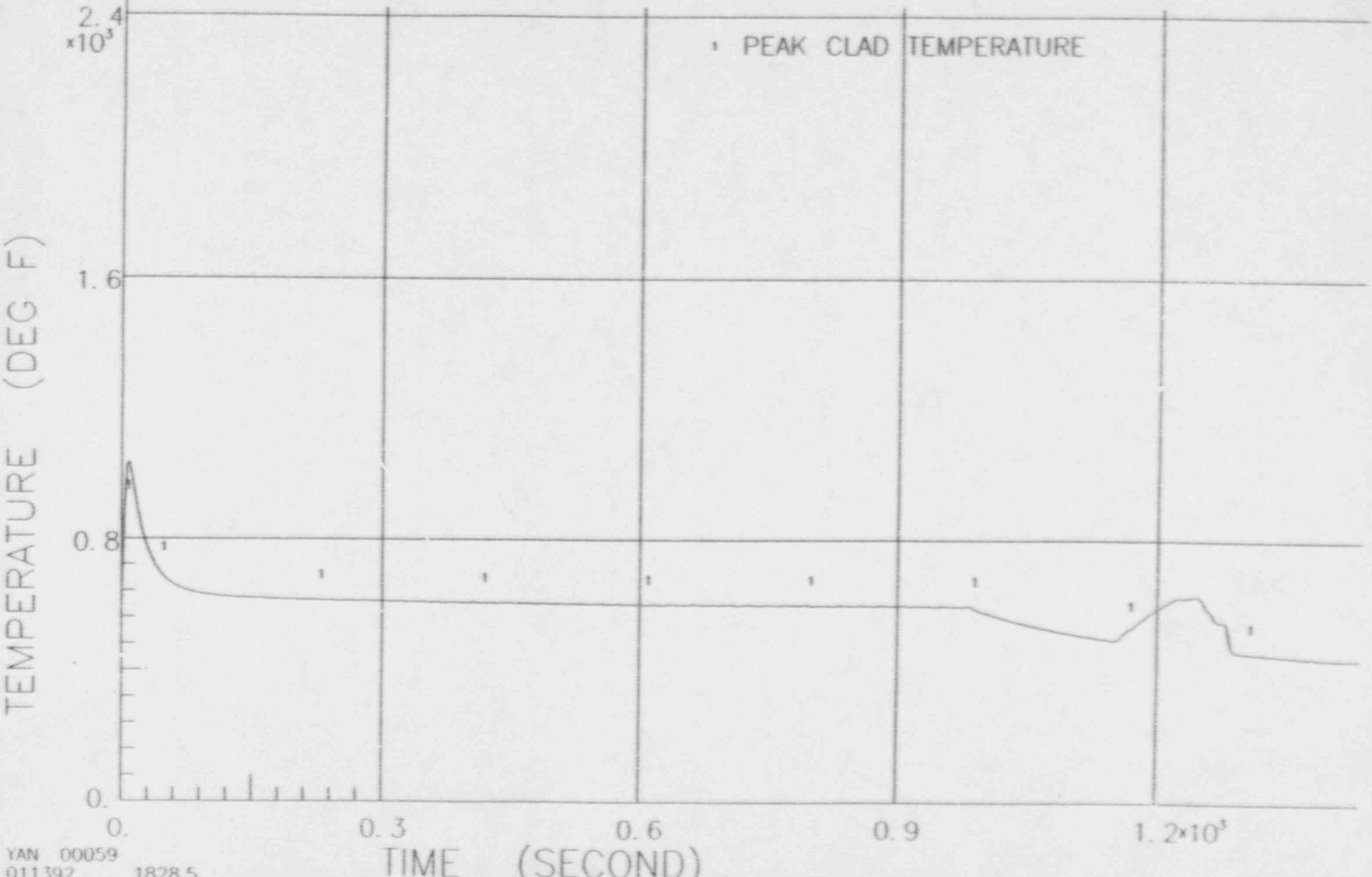

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Table 6.3-1

SIGNIFICANT INPUT VARIABLES USED IN THE LOSS-OF-COOLANT ACCIDENT ANALYSIS (Continued)

Variable	Units	Value
Initiating Signals		
Low Water Level	ft above TAF	≤0.6
and		
High Drywell Pressure	psig	≥2.0
Delay Time from All Initiating Signals Completed to the Time Valves are Open	sec	≤29

C. **FUEL PARAMETERS**

Variable	Units	Value
Fuel Type	-------	Initial Core
Fuel Bundle Geometry	-------	8x8
Lattice	-------	C
Number of Fueled Rods	-------	62
Peak Technical Specification Linear Heat Generation Rate	kw/ft	13.4
Initial Minimum Critical Power Ratio	-------	1.13
Design Axial Peaking Factor	-------	1.40

~~Initiating signals~~

Low water level	ft above TAF	≤0.6
and		
High drywell pressure or	psig	≥2.0
High drywell pressure bypass timer timed out	sec	≤480

ways; they will relieve pressure by actuation with electrical power or by mechanical actuation without power. The suppression pool provides a heat sink for steam relieved by these valves. Relief valve operation may be controlled manually from the control room to hold the desired reactor pressure. Eight of the eighteen SRVs are designated as automatic depressurization system (ADS) valves and are capable of operating from either ADS logic or safety/ relief logic signals. The safety/relief logic is discussed in Paragraph (4). Automatic depressurization by the ADS is provided to reduce the pressure during a loss-of-coolant accident in which the HPCF and/or RCIC are unable to restore vessel water level. This allows makeup of core cooling water by the low pressure makeup system (RHR/LP flooding mode).

(2) Supporting System (Power Supplies)

Supporting systems for the ADS C&I include the instrumentation, logic, control and motive power sources. The instrumentation and logic power is obtained from the SSLC Division I and II, 120-VAC buses F1 and G1. The control power is from the Division I and II, 125-VDC battery buses F and G (see Figure 8.3-1). The motive power for the electrically operated gas pilot solenoid valves is from local accumulators supplied by the high pressure nitrogen gas supply systems (Divisions I and II) (see Chapter 6).

(3) Equipment Design

The automatic depressurization system (ADS) consists of redundant trip channels arranged in two separated logics that control two separate solenoid-operated gas pilots on each ADS valve. Either pilot valve can operate its associated ADS valve. These pilot valves control the pneumatic pressure applied by accumulators and the high pressure nitrogen gas supply system. The operator can also control the SRV's manually. Separate accumulators are included with the control equipment to store pneumatic energy for relief valve operation.

The ADS accumulators are sized to operate the safety relief valve two times with the drywell at 70% of design gage pressure following failure of the pneumatic supply to the accumulator. Sensors provide inputs to local multiplexer units which perform signal conditioning and analog-to-digital conversion. The formatted, digitized sensor inputs are multiplexed with other sensor signals over an optical data link to the logic processing units in the main control room. All four transmitter signals are fed into the two-out-of-four logic for each of two divisions either of which can actuate the ADS. Station batteries and SSLC power supplies energize the electrical control circuitry. The power supplies for the redundant divisions are separated to limit the effects of electrical failures. Electrical elements in the control system energize to cause the relief valves to open.

(a) ADS Initiating Circuits

Two ADS subsystems for relief valve actuation, ADS 1 and ADS 2 are provided (see Figure 7.3-2). Sensors from all four divisions and division I control logic for low reactor water level and high drywell pressure initiate ADS 1, and sensors from all four divisions and division II control logic initiate ADS 2. The division I logic is mounted in a different cabinet than the division II logic.

The reactor vessel low water level initiation setting for the ADS is selected to depressurize the reactor vessel in time to allow adequate cooling of the fuel by the RHR (LP flooding mode) system following a loss-of-coolant accident in which the HPCF and/or RCIC fail to perform their functions adequately. Timely depressurization of the reactor vessel is provided if the reactor water level drops below acceptable limits together with an indication that high drywell pressure has occurred, which signifies there is a loss of coolant into the containment with insufficient high pressure makeup to maintain reactor water level. Reactor isolation occurs on loss of coolant outside the containment.

The HPCF and RHR-LPFL discharge pressure settings are used as a permissive for depressurization and are selected to assure that at least one of the three RHR pumps, or one of the two HPCF pumps, has received electrical power, started, and is capable of delivering water into the vessel. The pressure setting is high enough to assure that the pump will deliver at or near rated flow without being so high as to fail to show that the pump is actually running.

The level transmitters used to initiate one ADS logic are separated from those used to initiate the other ADS logic. Reactor vessel low water level is detected by eight transmitters that measure differential pressure. Drywell high pressure is detected by four pressure transmitters. All the vessel level and drywell high pressure transmitters are located in the primary containment outside the drywell. The drywell high pressure signals are arranged to "seal-in" the control circuitry. They must be manually reset to clear.

Time delay logic is used in each ADS control division. The time delay setting before actuation of the ADS is long enough that the HPCF and/or RCIC have time to restore water level, if capable, yet not so long that the RHR (LPFL-mode) is unable to adequately cool the fuel if the HPCF fails to prevent low water level. An annunciator in the control room is actuated when either of the timers is timing. Resetting the ADS initiating signals has no effect on the timers if the initiating signals are still present.

If the reactor level is restored sufficiently to reset the previous actuation setpoints before the timer times out, the timer automatically resets and auto-depressurization is aborted. Should additional level dips occur across the setpoints, the timer resets with each one.

(b) Logic and Sequencing

Two parameters of initiation signals are used for the ADS: drywell high pressure, and rector vessel low-low water level (Level 1). Two-out-of-four of each set of signals must be present throughout the timing sequence to cause the safety/relief valves to open. Each parameter separately seals itself in and annunciates following the two-out-of-four logic confirmation. Low water level 1 is the final sensor to initiate the ADS.

A permissive signal of RHR (LP flooder mode) or HPCF pump discharge pressure is also used. Discharge pressure on any one of the three RHR pumps or one of the two HPCF pumps is sufficient to give the permissive signal which permits automatic depressurization when the RHR or HPCF systems are operable.

After receipt of the initiation signals and after a delay provided by time delay elements, each of the two solenoid pilot gas valves is energized. This allows pneumatic pressure from the accumulator to act on the gas cylinder operator. The gas cylinder operator opens and holds the relief valve open. Lights in the main control room indicate when the solenoid-operated pilot valves are energized to open a safety/relief valve. Linear variable differential transformers (LVDT's) mounted on the valve operators verify each valve position to the performance monitoring and control system (PMCS), and the annunciators.

The ADS Division I control logic actuates a solenoid pilot valve on each ADS valve. Similarly, the ADS Division II control logic actuates a second separate solenoid pilot valve on each ADS valve. Actuation of either solenoid-pilot valve causes the ADS valve to open to provide depressurization.

Manual reset circuits are provided for

the ADS initiation signal and the two parameter sensor input logic signals. An attempted reset has no effect if the two-out-of-four initiation signals are still present from each parameter (high drywell pressure and low-low reactor water level). However, a keylocked inhibit switch is provided for each division which can be used to take one ADS division out of service for testing or maintenance during plant operation. This switch is ineffective once the ADS timers have timed out and thus cannot be used to abort and reclose the valves once they are signalled to open. The inhibit mode is continuously annunciated in the main control room.

Manual actuation pushbuttons are provided to allow the operator to initiate ADS immediately (no time delay) if required. Such initiation is performed by first rotating the collars surrounding the pushbuttons for each of two channels within one of the two divisions. An annunciator will sound to warn the operator that ADS is armed for that division. If the two pushbuttons are then depressed, the ADS valves will open, provided the ECCS pump(s) running permissives are present. Though such manual action is immediate, the rotating collar permissives and duality of button sets combined with annunciators assure manual initiation of ADS to be a deliberate act.

A control switch is available in the main control room for each safety/relief valve including the ones associated with the ADS. Each switch is associated with one of the four electrical divisions and maintains electrical separation consistent with the required operability though its function is not required for safety. The switches are three-position keylock-type, OFF-AUTO-OPEN, located on the main control board. The OPEN position is for manual safety/relief valve operation. Manual opening of the relief valves provides a controlled nuclear system cooldown under conditions where the normal heat sink is not available.

(c) Bypasses and Interlocks

Before the ADS timers time out, it is possible for the operator to manually delay the depressurizing action by the manual inhibit switches (although the time for this is very short, i.e., only 29 seconds). This action resets the time delay logic to zero seconds and prevents depressurization for another timer cycle. The operator would make this decision based on an assessment of other plant conditions. The primary purpose of the inhibit switch is to remove one of the two ADS logic and control divisions from service for testing and maintenance during plant operation. Automatic ADS is interlocked with the HPCF and RHR by means of pressure sensors located on the discharge of these pumps. Manual ADS bypasses these interlocks and the timers and immediately opens the ADS valves. The rotating collar permissives and duality of button sets combined with annunciators assure manual initiation of ADS to be a deliberate act.

Change per attached Item #2

(d) Redundancy and Diversity

The ADS is initiated by high drywell pressure and low reactor vessel water level. The initiating circuits for each of these parameters are redundant as described by the circuit description of this section. Diversity is provided by HPCF.

Change per attached Item #2

(e) Actuated Devices

Safety/relief valves are actuated by any one of four methods.

(1) ADS Action

Automatic action after high drywell pressure followed by 29 seconds at low water level (L1), plus makeup pumps running, resulting from the logic chains in either Division I or Division II control logic actuating;

Change per attached Item #

Make the following changes to Chapter 7, Section 7.3.1.1.1.2 "Automatic Depressurization System Instrumentation and Controls.

1. The second paragraph in Subsection (a) "ADS Initiating Circuits" in Sub-Section (1) "System Identification" in Section 7.3.1.1.1.2 "Automatic Depressurization System Instrumentation and Controls" in Chapter 7 of the United States (US) Advanced Boiling Water Reactor (ABWR) Certification Program's Standard Safety Analysis Report (SSAR) reads as follows:

   The reactor vessel low water level initiation setting for the ADS is selected to depressurize the reactor vessel in time to allow adequate cooling of the fuel by the RHR (LP flooding mode) System following a loss-of-coolant accident in which the HPCF and/or RCIC fail to perform their functions adequately. Timely depressurization of the reactor vessel is provided if the reactor vessel water level drops below acceptable limits together with an indication that high drywell pressure has occurred, which signifies there is a loss of coolant into the containment with insufficient high pressure makeup to maintain reactor water. level. Reactor isolation occurs on loss of coolant outside containment.

   Change this paragraph to read:

   The reactor vessel low water level initiation setting for the ADS is selected to depressurize the reactor vessel in time to allow adequate cooling of the fuel by the RHR (LP flooding mode) System following a loss-of-coolant accident in which the HPCF and/or RCIC fail to perform their functions adequately. Timely depressurization of the reactor vessel is provided if the reactor vessel water level drops below acceptable limits together with an indication that high drywell pressure has occurred, which signifies there is a loss of coolant into the containment with insufficient high pressure makeup to maintain reactor water level. <u>For breaks outside the containment, timely depressurization of the reactor vessel is provided if the reactor vessel water level drops below acceptable limits for a time period sufficient for the ADS high drywell pressure bypass timer and the ADS timer to time-out.</u> Reactor isolation occurs on loss of coolant outside containment.

2. Subsection (c) "Bypasses and interlocks" in Sub-Section (3) "Equipment Design" in Section 7.3.1.1.1.2 "Automatic Depressurization System Instrumentation and Controls" in Chapter 7 of the US ABWR Certification Program's SSAR reads as follows:

(c) Bypasses and Interlocks.

Before the ADS timers time out, it is possible for the operator to manually delay depressurization action by the manual inhibit switches (although the time for this is very short, i.e., only 29 seconds). This action resets the time delay logic to zero and prevents the depressurization for another time cycle. The operator would make this decision based on an assessment of other plant conditions. The primary purpose of the inhibit switch is to remove one of the two ADS logic and control divisions from service for testing and maintenance during plant operation. Automatic ADS is interlocked with the HPCF and RHR by means of pressure sensors located on the discharge of these pumps. Manual ADS bypasses these interlocks and the timers immediately opens the ADS valves. The rotating collars permissives and dualityof buttons sets combine with annunciators assure manual initiation of ADS to be a deliberate act.

Change this paragraph to read:

(c) Bypasses and Interlocks.

There is one manual ADS inhibit switch in the control room for each ADS logic and control division which will inhibit ADS initiation, if ADS has not initiated. The primary purpose of the inhibit switch is to remove one of the two ADS logic and control divisions from service for testing and maintenance during plant operation. Automatic ADS is interlocked with the HPCF and RHR by means of pressure sensors located on the discharge of these pumps. Manual ADS bypasses these interlocks and the timers immediately opens the ADS valves. The rotating collars permissives and duality of buttons sets combine with annunciators assure manual initiation of ADS to be a deliberate act.

3. Subsection (d) "Redundancy and Diversity" in Sub-Section (3) "Equipment Design" in Section 7.3.1.1.1.2 "Automatic Depressurization System Instrumentation and Controls" in Chapter 7 of the US ABWR Certification Program's SSAR reads as follows:

   (d) Redundancy and Diversity.

   The ADS is initiated by high drywell pressure and low reactor water level. The initiating circuits for each of these parameters are redundant as described by the circuit description of this section. Diversity is provided by the HPCF.

   Change this paragraph to read:

   (d) Redundancy and Diversity.

   The ADS is initiated by high drywell pressure and/or low reactor water level. The initiating circuits for each of these parameters are redundant as described by the circuit description of this section. Diversity is provided by the HPCF.

4. Paragraph (1) "ADS Action" in Subsection (e) "Actuated Devices" in Sub-Section (3) "Equipment Design" in Section 7.3.1.1.1.2 "Automatic Depressurization System Instrumentation and Controls" in Chapter 7 of the US ABWR Certification Program's SSAR reads as follows:

   (1) ADS Action.

   Automatic action after high drywell pressure followed by 29 seconds at low water level (L1), plus make up pumps running, resulting from the logic chains in either Division I or Division II control logic actuating;.

   Change this paragraph to read:

   (1) ADS Action.

   Automatic action after high drywell pressure followed by 29 seconds at low water level (L1) or low water level (L1) for 8 minutes (ADS high drywell pressure bypass timer) and 29 seconds (ADS timer), plus make up pumps running, resulting from the logic chains in either Division I or Division II control logic actuating;.

RESPONSE TO DISCUSSION ITEM 17

The attached text modifications clarify the effective break areas for the maximum vessel bottom head drain line break and the maximum RHR shutdown suction line break.

(9) peak cladding temperature as a function of time.

A conservative assumption made in the analysis is that all offsite AC power is lost simultaneously with the initiation of the LOCA. As a further conservatism, all reactor internal pumps were assumed to trip at the start of LOCA event even though this in itself is considered to be an accident (See Subsection 15.3.1). The resulting rapid core flow coastdown produces a calculated departure from nucleate boiling in the hot bundles within the first few seconds of the transient.

LOCA analyses using break areas less than the maximum values were also considered for the steamline, feedwater line, and RHR shutdown suction line locations. The cases analyzed are indicated on the break spectrum plot (refer to Figure 6.3-10). In general, the largest break at each location is the worst in terms of minimum transient water level in the downcomer.

6.3.3.7.5 Intermediate Line Breaks Inside Containment

A

For this case the maximum RHR/LPFL injection line break (0.221 ft^2) was analyzed. Important variables from this analysis are shown in Figures 6.3-37 through 6.3-43.

6.3.3.7.6 Small Line Breaks Inside Containment

C

For these cases the maximum high presure core flooder line break (0.099 ft^2) and the maximum bottom head drain line break (0.0218 ft^2) were analyzed. Important variables from these analyses are shown in Figures 6.3-44 through 6.3-59. A break in a reactor internal pump would involve either the welds or the casing. If the weld from the pump casing to the PRV stub tube breaks, the stretch tube will prevent the pump casing from moving. The stretch tube clamps the diffuser to the pump casing, where its nut seats. The land is located below the casing attachment weld and therefore the stretch tube forms a redundant parallel strength path to the pump casing restraint which is designed to provide support in the event of weld failure. In case the pump casing and the stretch tube break, the pump and motor will move downward until stopped by the casing restraints. The pump is part of the stretch tube. In either case the break flow would be much less than the drainline break case. Therefore, the drainline break analysis is also bounding for any credible break within the reactor internal pump recirculation system and its associated motor housing and cover.

As expected, the core flooder line break is the worst break location in terms of minimum transient water level in the downcomer. In elevation it is the lowest break on the vessel except for the drainline break. Furthermore, the worst break/failure combination leaves the fewest number of ECC systems remaining and no high pressure core flooder systems. LOCA analyses using break areas less than the maximum values were also considered. The cases analyzed are indicated on the break spectrum plot (refer to Figure 6.3-10). From these results it is clear that the overall most limiting break in terms of minimum transient water level in the downcomer, is the maximum core flooder line break case.

6.3.3.7.7 Line Breaks Outside Containment

This group of breaks is characterized by a rapid isolation of the break. Since a maximum steam line break outside the containment produces more vessel inventory loss before isolation than other breaks in this category, the results of this case are bounding for all breaks in this group. Important variables from these analyses are shown in Figure 6.3-60 through 6.3-66.

C

As discussed in Subsection 6.3.3.7.4, the trip of all reactor internal pumps at the start of the LOCA produces a calculated departure from nucleate boiling for all LOCA events. Furthermore, the high void content in the bundles following a large steamline break produces the earliest times of loss of nucleate boiling for any LOCA event. Thus, the summary of results in Table 6.3-4 show that, though the PCTs for all break locations are similar, the steamline breaks result in higher calculated PCTs and the outside steamline break is the overall most limiting case in terms of the highest calculated PCT. Results of the analysis of this break will be provided for each bundle design for information by the utility referncing the ABWR design.

INSERTS FOR ITEM 17

(A) Since the bottom head drain line ties into the RHR shutdown suction line, the total break flow for the maximum RHR shutdown suction line break includes flow from the vessel through RHR shutdown suction vessel nozzle as well as through the bottom head drain line.

(B) ,based on a 2 inch penentration in the vessel bottom head

(C) Since the bottom head drain line ties into the RHR shutdown suction line, the total break flow for the maximum bottom head drain line break includes flow from the vessel through the bottom head drain line penetration as well as through the RHR shutdown suction line.