STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

Caution *If RWST level reaches (1), align SI system for cold leg recirculation per ES-1.3, TRANSFER TO COLD LEG RECIRCULATION FOLLOWING LOSS OF REACTOR COOLANT.*

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
1	**Check Accumulator Isolation Valve Status:**	
	a. Power available to isolation valve	a. Restore power to isolation valves.
	b. Isolation valves - OPEN	b. Open isolation valve.
2	**Check RCP Support Conditions:**	
	a. Conditions available for running an RCP - [Enter plant specific list]	a. Try to establish conditions for running an RCP.
3	**Reestablish High Pressure SI Flow To RCS:**	
	a. Charging/SI pump breaker indicator lights - LIT	a. Try to start pumps.
	b. High-head SI pump breaker lights - LIT	b. Try to start pumps.
	c. SI valves - PROPER EMERGENCY ALIGNMENT - [Enter plant specific list]	c. Manually open or close valves as appropriate.
	d. Try to start - [Enter plant specific list]	

(1) Enter plant specific value corresponding to RWST switchover alarm, in plant specific units.

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PDR ADOCK 05000423
A PDR

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

Caution *Alternate water sources for AFW pumps will be necessary if CST level is low.*

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
4	**Check Steam Generator Levels:**	
	a. Narrow range level - GREATER THAN (1) %	a. IF less than (1) %, THEN maintain full AFW flow until narrow range level is greater than (1) %.
	b. Throttle AFW flow to maintain narrow range level at (2) %	
5	**Check Low-head SI Pump Status:**	
	a. Low-head SI pump breaker indicator lights - LIT	a. Manually start pumps.
	b. SI valves - PROPER EMERGENCY ALIGNMENT - [Enter plant specific list]	b. Manually open or close valves as appropriate.

Caution *Low-head pumps should not be run longer than (3) without CCW.*

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
6	**Check Core Exit TCs:**	
	a. Temperature - LESS THAN 1200°F	a. IF greater than 1200°F, THEN go to step 10.
7	**Check Containment Conditions:**	
	a. Containment pressure - NORMAL	a. IF high, THEN go to step 8.
	b. Containment radiation - NORMAL	b. IF high, THEN go to step 8.
	c. Containment recirculation sump level - NORMAL	c. IF high, THEN go to step 8.
	d. IF all containment conditions normal, THEN go to E-0, REACTOR TRIP OR SAFETY INJECTION, STEP 18	

(1) Enter plant specific value showing level just in narrow range including allowances for normal channel accuracy, post-accident transmitter errors and reference leg process errors.

(2) Enter plant specific value corresponding to no-load steam generator level including allowances for post-accident transmitter errors and reference leg process errors.

(3) Enter plant specific time.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
8	**Check RVLIS Narrow Range Indication:**	
	a. RVLIS narrow range - LESS THAN *(1)*	a. IF greater than *(1)*, THEN go to E-1, LOSS OF REACTOR COOLANT, STEP 1.
9	**Check Core Exit TCs:**	
	a. Temperature - GREATER THAN 700°F	a. IF less than 700°F, THEN go to E-1, LOSS OF REACTOR COOLANT, STEP 1.

NOTE *Continue with this guideline while obtaining hydrogen sample in step 10.*

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
10	Check Containment Hydrogen Concentration:	
	a. Dispatch plant chemist to obtain hydrogen sample	
	b. Hydrogen concentration - LESS THAN 4% IN DRY AIR	b. Consult TSC for further recovery actions.

NOTE *Steps 11 through 21 provide instructions for depressuring RCS using steam generator secondary depressuration.*

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
11	**Check Accumulator Status:**	
	a. Accumulator isolation valve - OPEN	a. IF accumulators have been previously isolated, THEN go to step 17.
	b. Accumulator gas - HAS NOT BEEN VENTED	b. IF accumulators have been previously vented, or are being vented, THEN go to step 16.

(1) Enter plant specific value which is 3½ feet above bottom of active fuel in core with zero void fraction, plus uncertainties.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
12	**Check RCS Vent Paths**	
	a. Power available to PORV block valves	a. Restore power to block valves.
	b. PORVs - CLOSED	b. Manually close PORVs. IF any valve cannot be closed, THEN manually close its block valve.
	c. Block valves - OPEN	c. Open block valve unless it was closed to isolate a faulty PORV.
	d. Other RCS vent paths - CLOSED	d. Manually close any open RCS vent path.
13	**Rapidly Decrease Steam Generator Pressure To (1) Psig:**	
	a. Dump steam to condenser 1) [Enter plant specific steps]	a. Dump steam with steam generator PORVs. IF steam generator pressure cannot be decreased to (1) psig, THEN go to step 22. *OBSERVE NOTES PRIOR TO STEP 22.*
14	**Check RCS Hot Leg Temperatures:**	
	a. At least two temperatures - LESS THAN 400°F	a. IF NOT less than 400°F, THEN go to step 22. *OBSERVE NOTES PRIOR TO STEP 22.*
15	**Stop All RCPs.**	
16	**Isolate All Accumulators:**	
	a. Close all accumulator isolation valves	a. For any accumulator that can not be isolated, vent accumulator gas to less than (2) psig. Do not proceed to step 17 until the venting is completed. Continue to monitor core exit TCs. IF temperature exceeds 1200°F, THEN go to step 22. *OBSERVE NOTES PRIOR TO STEP 22.*

(1) Enter plant specific value which is 200 psig plus instrument uncertainties.

(2) Refer to background document.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
17	**Rapidly Decrease Steam Generator Pressure To Atmospheric Pressure:**	
	a. Dump steam to condenser [Enter plant specific steps]	a. Dump steam with steam generator PORVs.
18	**Verify Low-head SI Flow:**	
	a. [Enter plant specific steps]	a. Manually start pumps and align valves as appropriate.
19	**Check RCP Status:**	
	a. All RCPs – STOPPED	a. Stop all RCPs.
20	**Check Core Cooling:**	
	a. Core exit TCs – LESS THAN 400°F	a. Do not proceed until core exit TCs less than 400°F.
	b. RVLIS narrow range indication – GREATER THAN (1)	b. Do not proceed until RVLIS narrow range greater than (1).
21	**Go To E-1, LOSS OF REACTOR COOLANT, STEP 13.**	

(1) Enter plant specific value which is top of core plus instrument uncertainties.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE
- *Steps 22 through 31 provide a method for depressurizing the RCS in the event secondary depressurization is not effective.*
- *If the capability for dumping steam is restored while performing steps 22 through 31; then, return to step 11.*
- *Normal conditions are desired but not required for starting RCPs.*

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
22	**Check Core Exit TCs:**	
	a. Temperature – LESS THAN 1200°F	a. Start RCPs as necessary until core exit TCs less than 1200°F. IF core exit TCs greater than 1200°F and all available RCPs running, THEN open all pressurizer PORVs and block valves. IF core exit TCs greater than 1200°F and all pressurizer PORVs and block valves are open, THEN open all other RCS vent paths to containment.
23	**Initiate Depressurization Of Steam Generators To Atmospheric Pressure:** [Enter plant specific steps]	
24	**Check Steam Generator Levels:**	
	a. Narrow range level – GREATER THAN (1) %	a. IF less than (1) %, THEN maintain full AFW flow until narrow range level is greater than (1) %.
	b. Throttle AFW flow to maintain narrow range level at (2) %	

(1) Enter plant specific value showing level just in narrow range including allowances for normal channel accuracy, post-accident transmitter errors and reference leg process errors.

(2) Enter plant specific value corresponding to no-load steam generator level including allowances for post-accident transmitter errors and reference leg process errors.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
25	**Verify Low-head SI Flow:**	
	a. [Enter plant specific steps]	a. Manually start pumps and align valves as appropriate. Do not proceed until at least intermittent low-head SI flow is verified.
26	**Isolate All Accumulators:**	
	a. Close all accumulator isolation valves	a. For any accumulator that can not be isolated, vent accumulator gas to less than (1) psig. Do not proceed until the venting is completed.
27	**Check RCS Hot Leg Temperatures:**	
	a. At least two temperatures – LESS THAN 350°F	a. IF NOT less than 350°F, THEN do not proceed until at least two temperatures less than 350°F.
28	**Stop All RCPs.**	
29	**Verify Low-head SI Flow:**	
	a. [Enter plant specific steps]	a. IF continuous low-head SI flow cannot be verified, THEN return to step 22. *OBSERVE NOTES PRIOR TO STEP 22.*
30	**Check Core Cooling:**	
	a. Core exit TCs – LESS THAN 400°F	a. Do not proceed until core exit TCs less than 400°F.
	b. RVLIS narrow range indication – GREATER THAN (2)	b. Do not proceed until RVLIS narrow range greater than (2).
31	**Go To E-1, LOSS OF REACTOR COOLANT, STEP 13.**	

— END —

(1) Refer to background document.
(2) Enter plant specific value which is top of core plus instrument uncertainties.

BACKGROUND INFORMATION
FOR
WESTINGHOUSE
EMERGENCY RESPONSE GUIDELINES

FR-C.1
RESPONSE TO INADEQUATE CORE COOLING
Revision: HP-Basic
September 1, 1982

SECTION I - Introduction

The purpose of this guideline is to restore adequate core cooling and to minimize possible core damaged. First, an attempt is made to provide high head safety injection. If this is successful, the operator is instructed to return to the emergency operating guidelines. If some source of high pressure water cannot be made available, the operator is instructed to reduce the primary system pressure by depressurizing the secondary. Initially, this will provide accumulator water for core recovery and later, low-head SI will be injected, to provide long term core cooling. If the steps of this procedure are successful, the operator will return to the ERGs to complete the cooldown of the plant.

SECTION II - Symptoms

This section describes the symptoms used to determine the onset of inadequate core cooling. First, the most direct method of determining inadequate core cooling is described. This method requires five core exit thermocouples to be hotter than 1200^{o}F. The second and third methods of determining the onset of inadequate core cooling use vessel level. These symptoms are referred to as anticipatory symptoms since they predict inadequate core cooling, prior to its occurrance.

Symptom 1 - Core Exit Thermocouples greater than 1200^{o}F (FR-C.1)

This symptom alone, is sufficient to diagnose a condition of inadequate core cooling. For this symptom, five centrally located thermocouples must have a temperature exceeding 1200^{o}F. This guideline assumes that the core exit thermocouple temperature indications will be available to the operator. These thermocouples should be located above the hottest regions of the core. The following criteria should be used to determine which thermocouples to use.

1. One thermocouple should be located as close as possible to the geometric center of the core.

2. The other four thermocouples should be located one per quadrant over the highest power assemblies in each quadrant. The outer two rows of assemblies should be excluded, since they can receive significant cooling from steam generator drainage due to refluxing. The thermocouples should be selected at each refueling to assure that the highest power assemblies are always being used.

The hot leg RTDs cannot be solely used to determine a condition of inadequate core cooling. Analyses presented in the inadequate core cooling WCAPs[1,2], show that the hot leg RTDs react too slowly to determine that the core is not being adequately cooled. This occurs for three reasons. First, the steam entering the upper plenum mixes with water returning from the steam generator tubes. This cooler steam then passes into the hot legs. Secondly, the water flowing through the hot legs could interfere with the RTD temperature measurements. Lastly, the RTDs at best would determine the average core exit temperature. The core exit thermocouples would determine the local core exit temperature above the hottest regions of the core. Therefore, the hot leg RTDs should not be used to determine the onset of inadequate core cooling. However, a high reading (greater than the normal operating temperature) with the reactor tripped, would be an indication that the operator should pay close attention to the core exit thermocouples.

Symptom 2 - Anticipatory Symptom on Vessel Level with RCPs Running (FR-C.2)

This symptom requires that two conditions exist with at least one reactor coolant pump running. These conditions are:

1. The containment conditions must be abnormal. (This step is used to determine if the RCS conditions are the result of a LOCA. If a LOCA has occurred the containment conditions would be abnormal, since considerable amounts of RCS inventory would be lost to the containment. Since this guideline is written assuming that a LOCA has occurred, its use for a non-LOCA transient would not be effective and may result in increased core damage.)

2. The narrow range vessel level must have a reading of just less than 100 percent. (This is only applicable to plants having a Westinghouse design Reactor Vessel Level Instrumentation System (RVLIS).) Each plant should review its specific RVLIS design and modify the guidelines accordingly. A narrow range indicated level of 100 percent is equivalent to an average system void fraction of 50 percent, with all RCPs running.)

Under these conditions the core would be completely covered by a two-phase mixture at a pressure just above the secondary pressure. Thus, the thermocouples would be reading saturation temperature and show no signs that inadequate core cooling could occur in a few minutes. The core would remain adequately cooled under these conditions as long as the pumps continued to run. However, if the pumps were tripped or if they failed, the core could be totally uncovered in a matter of minutes. Thus it is imperative that the operator proceed immediately to the inadequate core cooling guideline as soon as these conditions occur.

Symptom 3 - Anticipatory Symptom on Vessel Level with RCPs Stopped (FR-C.1)

This symptom requires that three conditions exist with all reactor coolant pumps stopped.

1. The containment conditions must be abnormal. (This step is used to determine if the RCS conditions are the result of a LOCA. If a LOCA

has occurred the containment conditions would be abnormal, since considerable amounts of the RCS inventory would be lost to the containment. Since this guideline is written assuming that a LOCA has occurred, its use for a non-LOCA transient would not be effective and may result in increased core damage.)

2. The narrow range vessel level must have a reading of less than about 35 percent. (This is only applicable to plants having Westinghouse design Reactor Vessel Level Instrumentation System (RVLIS)). Each plant should review its specific RVLIS design and modify the guidelines accordingly. A narrow range indicated level of about 35 percent with all RCPs stopped is equivalent to a collapsed liquid level in the core of 3.5 feet plus uncertainties. This level is sufficient, under nominal conditions to result in a collapsed liquid level at the midplane of the core, assuming an instrument inaccuracy of 2.5 feet. Assuming a mixture void fraction of 50 percent, the resulting mixture would just cover the entire core.)

3. The core exit thermocouples must have readings greater than 700°F. (This is to assure that the core has uncovered slowly and that the level gauge is not giving an erroneous indication.)

Unless all of these conditions exist, the operator should not proceed to the inadequate core cooling guidelines. However, under these conditions the core can quickly become completely uncovered and inadequate core cooling could occur in a matter of minutes. Thus, if these conditions exist, the operator should immediately proceed to the inadequate core cooling guideline.

An inadequate core cooling transient can occur for various sizes of breaks and over various time frames, depending upon equipment failure. The analyses presented, in the inadequate core cooling WCAPs for UHI and NON-UHI plants(1,2), assumed that high-head safety injection was lost. In addition, for the four inch break, the accumulators were

assumed to be isolated. The possible transients that could result in this condition could never be totally described in any document due to the many possible combinations of break sizes and equipment failures that could occur. Therefore, this document will only describe the effects of the recovery actions on the RCS. These effects will be described in terms of instrument response. If further information is desired about the transients used to develop the inadequate core cooling guidelines, the WCAPs contain all pertinent information. These reports include information about the transients from the time the break opens until the core is completely recovered. This document addresses recovery from inadequate core cooling, rather than the possible transients that could lead to this condition.

Each recovery technique will be discussed along with the expected instrument responses in the paragraphs below. The most important instruments in terms of this guideline, are the core exit thermocouples and the vessel level gauge. The core exit thermocouples are important because they quickly respond to core heat-up and cool-down. The vessel level gauge shows the amount of inventory remaining in the reactor vessel. The first recovery technique to be discussed is the high-head SI recovery.

If the high-head SI system was shut-off inadvertently or failed to start or the system wasn't aligned properly, the high-head SI system could result in immediate core recovery. If some other high-pressure source of water can be aligned quickly, this could also result in a fast recovery of the core. In this case water would be added to the cold legs and then flow to the downcomer. Since the core had just reached 1200^{o}F, this water will soon quench and recover the core. The effects of this recovery technique on system instruments will be discussed below.

The core exit thermocouples should initially show a slight increase in temperature as steam, in the hottest portions of the core, is forced past the thermocouple by an advancing two-phase mixture. When the

two-phase mixture reaches the thermocouples they will cool rapidly. The vessel level will behave erratically until the core is completely covered by a two-phase mixture. Then, the level should increase slowly. However, it is possible that the high-head SI could condense a sufficient amount of steam to cause the accumulators to partially inject. If this occurs, the operator may see a very rapid increase in the level indication.

The second method of core recovery is secondary depressurization. As the secondary depressurizes, the steam in the steam generator tubes on the primary side is condensed. This results in a depressurization of the primary system. As the steam condenses in the tubes, the local pressure drops. This causes more steam to be pulled into the tubes, where it is and condensed. This continues and the pressure in the upper plenum begins to drop. This, in turn, causes the fluid located in the lower plenum and the downcomer to be pulled into the core. When this occurs, the core is quenched. Later the primary pressure reaches the set-point pressure of the accumulators and they begin to inject and add water to the system. This will provide sufficient cooling until the pressure can be reduced below the shut-off head of the low-head safety injection system.

In terms of instrument response, the operator should notice a rapid decrease in the core exit TCs. In addition the operator should notice a rapid rise in the vessel level. Both of these indications give strong evidence that the core has been recovered. The hot leg RTDs can also be used to determine if the core has been cooled by the depressurization.

The third method of recovery is to start reactor coolant pumps, in order to force the remaining fluid inventory through the core. The system can operate for a very long time under these condtions before problems would arise. Even when the RCS contains only steam, the RCPs can keep the core cool indefinitely. Figure 1 presents a series of curves showing hot leg temperatures at various system pressures with all RCPs running

and the secondary at 1106 psig. This figure also shows the time required for the system to loose all of its liquid inventory for various break sizes. It is easy to see, that even for a four inch break, the core temperature will remain below 1200^{0}F unless the system pressure drops below the low-head shut-off pressure of about 150 psig. In that case, low-head SI will inject prior to reaching 1200^{0}F. However, this method does not supply a permanent recovery since reactor coolant pumps cannot be run indefinitely at very low pressures. For this reason the secondary pressure must eventually be reduced in order to assure long term core cooling.

This transient will look considerably different from the other recovery transients in terms of instrument response. The core exit thermocouples should cool rapidly cool rapidly and then start to rise again very slowly. The vessel level indication should increase to a value less than full scale, and then start to decrease slowly as inventory is depleted. When the accumulators begin to inject, the additional water will only serve to slow the inventory loss. Thus the RCS will depressurize more slowly and the instrument responses will slow.

The last recommended method of recovery is the opening of pressurizer PORVs. This step will only work in a very few cases. This is an attempt to increase the release from the RCS sufficiently to allow the RCS to depressurize. In most cases the PORVs will not remove a sufficient amount of steam to aid in the depressurization. However, opening the PORVs may allow the accumulators to inject momentarily. This may give the operator additional time to depressurize the secondaries and provide long term core cooling.

The instruments in this case will respond similiarly to the secondary depressurization, only at a much slower rate. However, the core exit temperature may increase significantly before the accumulators are able to inject w-ter into the RCS. When this occurs, the core will quench and the RCS will repressurize, terminating accumulator injection. The

core will again heat-up as the RCS depressurizes. This behavior will continue until the break and the PORVs can remove all of the decay heat being generated in the core, or until some other recovery method is sucessful.

In conclusion, the most direct approach is best, that is, restarting the high-head SI system or supplying the RCS with high-pressure injection from some other source. The second choice is to depressuize the secondary in order to depressurize the primary and establish low-head safety injection. The third choice provides forced convection core cooling, using the remaining inventory, by starting the RCPs. The last method is to directly depressurize the primary by opening the PORVs. These last two methods are only temporary measures for many break sizes and will not provide for long term cooling. In addition, the operator is only instructed to use these methods when the core exit TCs exceed 1200°F, since both of these methods increase system inventory losses and could result in worse conditions, if not activated at the proper time.

SECTION III - Description of Specific Guideline Steps, Notes & Cautions
Guideline FR-C.1

Caution Preceding Step 1

This caution instructs the operator to align the SI system for cold leg recirculation, using guideline ECA-1 (The Transfer to Recirculation Guideline), when the Refueling Water Storage Tank (RWST) level reaches the switchover alarm. If the sprays are running and the RCS is fairly empty, the RWST level may decrease rapidly when the system is depressurized. However, if the spray pumps are not running and if the RCS is nearly full, the RWST level will decrease very slowly. Thus, the operator must carefully watch the RWST level and initiate switchover to cold leg recirculation, when the low level alarm is reached.

Step 1

This step instructs the operator to check the accumulator isolation valve status. The valves should be open and operable. If power is not currently available to the accumulator isolation valves, power must be restored. If the isolation valves are closed the valves should be opened as soon as possible. However, the operator should proceed with subsequent steps of this guideline, while attempting to restore power or open valves.

The accumulator isolation valves will be used in later steps of the guideline and they must be operable. In addition the accumulator water will be used in following steps in order to recover the reactor core. Thus, the isolation valves should be open.

Step 2

This step instructs the operator to check the RCP support conditions. The operator should verify that the support conditions are available to run the reactor coolant pumps. If these conditions are not available, the operator should attempt to establish them, while proceeding with subsequent steps of this guideline.

It should be noted that the RCPs may not be needed in this guideline. In addition, if the RCPs are required, they will be started even if all of the support conditions are not available. Thus, the operator should only attempt to establish minimum required systems for operating the RCPs. Each plant should review it's specific equipment requirements and incorporate them into the guidelines.

Step 3

This step instructs the operator to reestablish High Pressure SI flow to the RCS. If the makeup system is functioning correctly, the

core would be inadequately cooled. Thus, this system should be checked to identify any malfunctions. First, the charging and high-head SI pumps should be checked to assure that they are operating. If they are stopped, they should be started. If the pumps are running, the operator should check for proper emergency valve alignment. If the system is not aligned properly the operator should attempt to manually open and close valves to supply the RCS with water. If this cannot be accomplished immediately, the operator should proceed with subsequent steps while attempting to complete this step.

In addition, the operator is instructed to start alternate pumps which could possibly supply the RCS with high pressure water. One example of a high pressure pump would be a PD pump. Each plant should review its available equipment and enter a plant specific list into this step of the guidelines.

Caution Preceeding Step 4

This caution warns the operator that he may be required to find alternate sources of Auxiliary Feed Water (AFW), if his Condensate Storage Tank (CST) level is low.

This is extremely important, in this guideline, since the secondary will be used to recover the core. If AFW is lost, the steam generators will dry out and the RCS will repressurize. Since high-head SI is unavailable, the RCS will also dry out.

Step 4

This step instructs the operator to check the steam generator levels. Since the secondary system will be used to recover the core, it is important to maximize primary to secondary heat transfer. This is done by keeping the steam generator tubes covered at all times.

Therefore, the operator is instructed to maintain full AFW flow until a narrow range indication is obtained. Then, the AFW flow should be throttled to maintain no-load steam generator level. The operator should proceed with subsequent steps, of this guideline, while attempting to complete this step.

Step 5

This step instructs the operator to check the low-head SI pump status. Since the RCS will be depressurized in the subsequent steps, the low-head SI pumps should be running. If they are stopped, they should be started. At the same time the operator should check to see that valves are in proper alignment for injection. If this is not the case, valves should be manually opened and closed to provide RCS injection. The operator should proceed with subsequent steps while attempting to complete this step.

This guideline assumes that some low-head injection water can be supplied to the RCS. If water cannot be delivered to the RCS and if the RCS continues to loose inventory, it's obvious that significant core damage will eventually occur.

Caution After Step 5

This caution warns the operator that the low-head SI pumps should not be run indefinitely without cooling. In some plants the low-head SI pumps can be run for only twenty minutes without cooling. In other plants these pumps can be run for days without cooling. Thus, a plant specific value of time should be entered in this caution. It is expected that the low-head SI pumps will be injecting before they would have to be stopped.

Steps 6 through 9

These steps check the symptoms of inadequate core cooling. If one of the preceeding steps has resulted in core recovery, the operator should return to step 18 of E-0 (The Reactor Trip or Safety Injection Guideline) or step 1 of E-1 (The Loss of Reactor Coolant Guideline). The subsequent recovery steps of this guideline could cause severe damage to many major pieces of equipment including the RCPs and the reactor vessel. Thus, this guideline should not be used unless the core is in danger of severe damage.

Step 6

This step instructs the operator to check the core exit thermocouples. If the core is still hot (1200^{o}F) the operator is instructed to continue with step 10 of this guideline. However, if the core is relatively cool (less than 1200^{o}F) the operator should determine if one of the preceding steps has recovered the core. This will be done in steps 7 through 9 of this guideline.

Step 7

This step instructs the operator to check the containment conditions. If the containment conditions are normal, the previous steps have sufficiently cooled the core and the operator is instructed to return to step 18 of E-0 (The Reactor Trip or Safety Injection Guideline). If the containment conditions are abnormal, one of the anticipatory symptoms may have been used to send the operator to this guideline. Thus the operator should check to see if the anticipatory symptoms still exist. This will be done in steps 8 through 9 of this guideline.

Step 8

This step instructs the operator to check the narrow range vessel level. If the level is indicated to be greater than 3.5 feet above the bottom of the active fuel plus uncertainties, the vessel has been refilled, to some extent, by one of the preceeding steps and the operator is instructed to return to step 1 of E-1 (The Loss of Reactor Coolant Guideline). If the level is still below 3.5 feet plus uncertainties, the operator is instructed to check the core exit thermocouples, to determine if the fluid leaving the core is superheated.

Step 9

This step instructs the operator to check the core exit thermocouples to determine if the fluid leaving the core is superheated. If the core exit thermocouples are reading greater than 700°F, the fluid leaving the core is superheated. If this is the case, the operator will continue with this guideline. If the core exit thermocouples are reading less than 700°F, the core has been recovered and the operator is instructed to return to step 1 of E-1 (The Loss of Reactor Coolant Guideline).

Note Preceeding Step 10

This note tells the operator to continue with recovery actions while obtaining a hydrogen sample from the containment. This may take a substantial amount of time and the hydrogen will continue to be produced until the core is cooled. Thus the operator should procede with following steps of the guideline to recover the core.

Step 10

This step instructs the operator to obtain a sample of hydrogen from the containment. When the zirconium fuel cladding reaches very high

temperatures, it reacts with water and produces hydrogen. The hydrogen then travels through the RCS and is eventually released through the break. When the hydrogen level reaches a concentration of about 4% it becomes very explosive. If a spark would occur under these conditions the containment could possibly be "ruptured". When a sufficiently large leak path is opened the radioactive gases in the containment would be released into the atmosphere. While this is very unlikely to occur, consideration must be given to the possible consequences of this event and therefore the plant TSC should be contacted to determine the appropriate actions.

Note Preceeding Step 11

This note points out that steps 11 through 21 provide instructions for depressurizing the RCS, by depressurizing secondary.

As the steam generator secondary sides depressurize, steam will be pulled into the tubes on the primary side and condensed. This will rapidly drop primary system pressure and the two-phase mixture in the lower plenum and downcomer will be pulled into the core. This will quench a large portion of the core, prior to accumulator injection. As the secondary continues to depressurize, the primary pressure will closely follow the secondary pressure. This is due to the extremely high heat transfer associated with steam condensation. Thus, if the accumulators are available, a large amount of water will be added to the core, as soon as, the secondary pressure drops below the accumulator setpoint.

Step 11

This step instructs the operator to check the accumulator status. If the accumulators are ready to inject, the operator is instructed to continue in the guideline. If the accumulators have been isolated, the operator is instructed to skip to step 17. If the

accumulator gas has been or is being vented, the operator is instructed to skip to step 16.

This is done for two reasons. First, the steps from 12 through 16 are intended to establish accumulator injection. If the accumulators can not inject, there is no reason to execute these steps. Secondly, it is possible, that steps 12 though 16 may have been executed earlier and the operation was not successful. If this occurs, the operator is sent to another portion of this guideline which may return the operator to this step. In that case, there is no reason to repeat steps 12 through 16, if the primary has previously depressurized to 200 psig.

It should be noted, that if the isolation valves are closed, the operator is instructed to proceed to step 17, but if the accumulator is vented, the operator is instructed to proceed to step 16. Step 16 will assure that most of the nitrogen is vented from the accumulator, before allowing the operator to continue to step 20. If the isolation valves are closed, the nitrogen doesn't have to be vented.

Step 12

This step instructs the operator to check the RCS vent paths. Since the RCS is loosing inventory, the vent paths should be checked to determine if this loss can be isolated. First, the operator is instructed to assure that the PORV block valves can be operated. This is done to assure that a leaking PORV can be isolated. In addition one of the subsequent recovery actions may call for the operator to open the PORVs in order to reduce the primary system pressure. Thus, the block valves may also have to be opened. The remaining portion of this step instructs the operator to isolate all vent paths from the RCS.

Step 13

This step instructs the operator to rapidly decrease steam generator pressure to 200 psig plus instrument uncertainties. The operator should use condenser steam dump, if available. If the condenser isn't available, the secondary PORVs should be used. If the secondary cannot be depressurized, the operator is instructed to go to step 22.

The operator should use either method to dump steam at a maximum rate. However, the steam should be dumped in a controlled manner so that the secondaries don't drop below the desired pressure of 200 psig plus instrument inaccuracies. The purpose of this step is to cause the accumulators to inject a maximum amount of water, without injecting any nitrogen. Thus, the RCS pressure must not drop below 200 psig.

If any of the steam generators are known to have significant leakage, and if the steam generators can be depressurized separately, only intact steam generators should be depressurized. If all steam generators have some leakage, the one which is believed to have the smallest leak, should be used for depressurization.

Step 14

This step instructs the operator to check the RCS hot leg temperature. The hot leg temperature is used, in this step, to determine the effectiveness of the secondary depressurization. If a temperature of 400^{0}F is indicated, on at least two RTDs, the core has been recovered and the RCS has been depressurized.

The operator should check, at this point, to be sure that the secondary pressure has been reduced properly. If the secondary isn't depressurized sufficiently, step 16 should be repeated. If

the secondary is depressurized, then the depressurization step did not recover the core. This could be for either of two reasons. First, the RCS may not have depressurized or secondly, the depressurization may not have brought in a sufficient amount of accumulator water. In either case the operator is instructed to proceed to step 25 of the guideline.

Step 16 should cause a large amount of accumulator water to be injected into the core. Thus, the hot legs should contain a two-phase mixture, at about the same pressure as the secondary. If the hot leg temperature is still above 400°F, either the hot legs contain a saturated mixture at a higher pressure, or they contain superheated vapor.

If the RCS didn't depressurize, the primary to secondary heat transfer has been effected. This may be due to hydrogen in the primary side of steam generator tubes. Hydrogen would be formed during a reaction between the zirconium fuel cladding and water, at high temperatures. With hydrogen in the steam generator tubes, the primary pressure will drop very slowly or it may start to rise. If the primary pressure is dropping slowly, it is possible that the core will recover without further actions. However, if the RCS pressure begins to rise, the operator will only be able to cool the core by starting the reactor coolant pumps. The pumps will force the hydrogen to flow out of the steam generator tubes and re-establish primary to secondary heat transfer. This should cause the primary system to depressurize and the accumulators to inject.

If the RCS did depressurize when the secondary was depressurized, and the hot leg temperatures remained above 400°F, then the accumulators didn't inject a sufficient amount of water to cool the core. If this happens, the operator may be able to isolate the accumulators and depressurize the RCS to obtain low-head SI water.

In either of the two cases above, the operator will be instructed to proceed to step 22 of this guideline, so that he can start RCPs, if necessary.

Two RTDs are used to determine the success of the depressurization, to assure that one RTD is not giving an erroneous reading.

Step 15

This step instructs the operator to stop the RCPs. This is done to prevent the pumps from being damaged by the next depressurization.

During the next depressurization the RCS pressure will drop well below the minimum pressure required for RCP operation. In addition, accumulator injection could possibly damage the pumps if slug flow occurs.

Step 16

This step instructs the operator to isolate all of the accumulators. The operator should attempt to close the accumulator isolation valves. If this cannot be done, the operator should attempt to vent the accumulator nitrogen to atmosperic pressure. The operator should not proceed with subsequent steps of this guideline until the accumulators have been isolated or vented. Each plant should determine if the accumulator pressure measurement would be available. If it isn't available, alternate means of determining accumulator vent, should be incorporated in this guideline.

The operator is instructed to proceed to step 22, if the core exit thermocouples exceed 1200°F while the accumulators are being vented.

The accumulators should be vented to atmospheric pressure. This prevents nitrogen from being injected into the RCS. During the next step of this guideline, the secondary will be depressurized to atmospheric pressure. The RCS will eventually refill and reach an equilibrium pressure where the low-head SI flow is equal to the flow through the break. However, the RCS pressure could approach atmospheric pressure before it reaches equilibrium. Therefore, to eliminate the possibility of nitrogen injection, the accumulators must be depressurized to atmospheric pressure.

This step is of extreme importance due to the nature of this transient. For large LOCAs, the accumulators inject nitrogen into the RCS, which is then released through the break with little consequence.

In small LOCAs with high-head SI, the RCS pressure never drops sufficiently for the nitrogen to be injected. The following steps of this guideline depressurize the RCS to the point where nitrogen would be injected. Nitrogen injected into the RCS may accumulate in the steam generator tubes and greatly reduce primary to secondary heat transfer. If this happens, the reactor coolant pumps must be started in order to re-establish heat transfer, and must continue to run until the nitrogen is removed through the break, the vessel head vent, or the pressurizer PORVs. This could take a considerable amount of time. Thus, caution should be exercised to minimize the possibility of injecting nitrogen into the RCS.

Step 17

This step instructs the operator to depressurize the secondary to atmospheric pressure. The operator should use condenser steam dump, if it's available. If not, he should use the secondary PORVs. The operator should dump steam at a maximum rate until the RCS is placed on the Residual Heat Removal (RHR) system. When the RHR system is put into use, the secondary valves can be closed.

Step 18

This step instructs the operator to verify low-head SI flow. If low-head SI flow cannot be verified, the operator is instructed to manually start the low-head SI pumps and to align valves as appropriate to supply the RCS with water.

The low-head flow should be verified by either direct flow indication or by the low-head SI pump discharge pressure being less than the shut-off head of the low-head SI pump. Each plant should evaluate the preferred indication and define this in the guideline, along with the shut-off pressure of the low-head SI pumps.

Initially, the low-head SI flow should be near runnout, then the flow will reduce to match break flow. If the break is very small, the flow required to match break flow may be so small that the RCS pressure could approach the shut-off head of the low-head SI pumps. If this occurs the low-head flow is verified.

Step 19

This step instructs the operator to check the RCP status. If the operator has followed this guideline without having to go to step 22, the pumps will be stopped and the operator can continue to step 20. However, if the operator had to go to step 22 during the execution of these guidelines, the pumps may be running and, at this time they should be stopped.

If the RCS pressure increases above the shut-off pressure of the low-head SI pumps, after the RCPs are stopped, the core exit thermocouples should be monitored very closely.

Step 20

This step instructs the operator to check for adequate core cooling. If the core exit thermocouples are reading less than 400^{O}F and the reactor vessel narrow range level indication is greater than the top of the core plus instrument inaccuracies, the operator is instructed to go to step 14 of E-1 (The Loss of Reactor Coolant Guideline) in step 21. The operator must monitor these conditions until the criteria are met before proceeding to step 21.

If the core temperature should rise above 1200^{O}F, the operator is instructed to go to step 22 of this guideline.

The vessel level indication of the top of the core plus instrument inaccuracies assures that the core is completely covered, since the core is filled with a two-phase mixture. In addition core exit thermocouples at 400^{O}F, assure that there is little superheated steam in even the hottest regions of the core.

Step 21

This step instructs the operator to go step 14 of E-1 (The Loss of Reactor Coolant Guideline). This is done, when the core has been returned to a stable and cool condition.

First Note Preceeding Step 22

This note points out that steps 22 through 31 provide instructions for using reactor coolant pumps to keep the reactor core cool, while attempting to depressurize the secondary. The pumps should not be started unless the core is in danger of being damaged (core exit thermocouples reading greater than 1200^{O}F).

Running RCPs does provide very effective core cooling. Even with the entire RCS containing only steam, the RCPs can keep the core well below 1200°F. However, as more inventory is lost from the RCS, the pressure will drop below the value required to keep the pumps running. If this occurs the reactor coolant pump bearings and seals may be destroyed. This will have two effects. First, the pumps will stop running and the core temperature will increase rapidly. Secondly, due to the seals and bearings being destroyed, the leak path through the pump may increase sufficiently to allow the RCS to depressurize and low-head SI may begin to flow into the core.

Second Note Preceeding Step 22

This note informs the operator that if the capability for dumping steam is restored, while performing steps 22 through 31 the operator should return to step 11.

Third Note Preceeding Step 22

This note informs the operator that normally required conditions for starting a reactor coolant pump are not a necessity for this guideline. Pumps may have to be started to save the core, under conditions where their life expectancy will be greatly reduced. The operator may have to bypass interlocks normally used to protect the pump and he may have to start the pump at very low pressures It should be clear that in this case, the core may be damaged severely, if the RCPs are not started.

Step 22

This step instructs the operator to check the core exit thermocouples. If their temperature exceeds 1200°F, during the remaining steps of this guideline, the operator should return immediately to this step. The purpose of this step is to assure that the core temperature remains below 1200°F. If the temperature rises above

1200°F, the operator is instructed to start an additional reactor coolant pump. If all of the available reactor coolant pumps are running and the temperature remains above 1200°F, the operator is instructed to open all pressurizer PORVs and block valves. If the temperature continues to rise, the operator is instructed to open all other RCS vent paths to the containment. One example of an additional vent path is the vessel head vent. Other vent paths would be plant specific and should be included explicitly in the plant guidelines. If at this point the core temperature continues to rise, the operator should initiate containment spray, hydrogen recombiners, and other systems associated with CLASS 9 events.

As was stated earlier, in the explanation of the first note to this step, the RCPs provide effective cooling of the reactor core. In order to illustrate this effectiveness, figure 1 shows the core exit temperature, as a function of time, for various system pressures, with the secondaries at 1106 psig and the RCS containing only steam. Thus, the pressurizer PORVs and other vent paths into the containment, should only be needed if the RCPs cannot be run.

It should be noted that opening PORVs and other vent paths will only be effective in very few cases. This futher emphasizes the need to start RCPs, whether or not the normally required systems are available.

If the operator has opened all vent paths from the RCS into the containment and has all of the available RCPs running and the core exit temperature continues to rise, the core will be damaged severely. This will result in large quantities of hydrogen being released into the containment. Thus, the operator should start his containment sprays and prepare for a CLASS-9 event.

Step 23

This step instructs the operator to depressurize the secondaries to atmospheric pressure. The operator should use condenser steam dump, if it's available. If not, he should use the secondary PORVs. The operator should dump steam at a maximum rate, until the RCS is placed on the Residual Heat Removal (RHR) system. When the RHR system is put into use, the secondary valves can be closed.

If neither condenser steam dump or secondary PORVs are available, the operator should use any plant specific means of removing water or steam from the steam generators. These could include, opening the blowdown lines or allowing the steam driven AFW pump to run at its maximum rate.

At this point the secondary should be depressurized by any means available. Since this could take a considerable amount of time, the operator should proceed with steps 24 through 31, while waiting for the secondary to depressurize.

The secondary should not be depressurized too rapidly, until the accumulators have been isolated, to prevent nitrogen injection.

Step 24

This step instructs the operator to check the steam generator levels. Since the secondary system is being used to recover the core, it is important to maximize primary to secondary heat transfer. This is done by keeping the steam generator tubes covered at all times. Therefore, the operator is instructed to maintain full AFW flow until a narrow range level indication is obtained. Then, the AFW flow should be throttled to maintain no-load steam generator level. The operator should proceed with subsequent steps while attempting to complete this step.

Step 25

This step instructs the operator to verify low-head SI flow. If low-head SI flow cannot be verified, the operator is instructed to manually start the low-head SI pumps and to align valves as appropriate to supply the RCS with water.

The low-head flow should be verified by either direct flow indication or by the low-head SI pump discharge pressure being less than the shut-off head of the low-head SI pump. Each plant should evaluate the preferred indication and define this in the guideline, along with the shut-off pressure of the low-head SI pumps.

If the RCPs are running, and the secondary hasn't been fully depressurized, the low-head SI flow will just match break flow. If the break is very small, the flow required to match break flow may be so small that the RCS pressure will approach the shut-off head of the low-head pumps. If this occurs, the low-head flow may be intermittant, however this is sufficient to verify low-head SI flow.

It is very important to verify low-head SI flow as soon as it occurs, so that the next step (accumulator isolation) can be completed. Thus, the operator should proceed to step 26 as soon as low-head SI is verified.

Step 26

This step instructs the operator to isolate all of the accumulators. The operator should attempt to close the accumulator isolation valves. If this cannot be done, the operator should then attempt to vent the accumulator nitrogen to atmospheric pressure. The operator should not proceed with subsequent steps of guideline, until the accumulators have been isolated or vented. Each plant

should determine if the accumulator pressure measurement would be available. If it isn't available, alternate means of determining accumulator vent, should be incorporated in this guideline. The operator must return to step 22 if the core exit thermocouples exceed 1200°F, while waiting for the accumulators to be vented.

The accumulators should be vented to atmospheric pressure. This is done to assure that accumulators won't inject nitrogen into the RCS. The secondaries are currently being depressurized to atmospheric pressure. Eventually the RCS will refill and reach an equilibrium pressure, where the low-head SI flow is equal to the flow through the break. However, the RCS may approach atmospheric pressure before it refills. Therefore, to limit the amount of nitrogen injected into the RCS, the accumulators must be depressurized to atmospheric pressure.

This step is of extreme importance due to the nature of this transient. For large LOCAs, the accumulators inject nitrogen into the RCS, which is then released through the break, with little consequence. In small LOCAs, the RCS pressure never drops sufficiently for the nitrogen to be injected. The preceeding steps of this guideline depressurize the RCS to the point where nitrogen could be injected. If this happens, the reactor coolant pumps must continue to run, until the nitrogen is removed. This could take a considerable amount of time. Thus, caution should be exercised to minimize the possibility of injecting nitrogen into the RCS.

Step 27

This step instructs the operator to check the hot leg temperature. This is done to assure that the core is cool and that very little superheat remains in the RCS. Thus, the operator must wait until the hot leg temperature drops below 350°F, before he can stop the RCPs (step 28).

Two RTDs are used to determine the success of the depressurization, to assure that one RTD is not giving an erroneous reading.

Step 28

This step instructs the operator to stop the RCPs. This step allows the operator to stop the pumps when they are no longer needed for cooling.

Step 29

This step instructs the operator to verify low-head SI flow. If continuous low-head SI flow cannot be verififed, the operator is instructed to go to step 22 of this guideline.

The low-head flow should be verified by either direct flow indication or by the low-head SI pump discharge pressure being less than the shut-off head of the low-head SI pump. Each plant should evaluate the preferred indication and define this in the guideline, along with the shut-off pressure of the low-head SI pumps.

Initially, the low-head SI flow should be steady; then the flow will reduce the match break flow. If the break is very small, the RCS pressure will approach the shut-off head of the low-head SI pumps. If this occurs low-head flow is verified.

Step 30

This step instructs the operator to check for adequate core cooling. If the core exit thermocouples are reading less than 400°F and the reactor vessel narrow range level indication is greater than the top of the core plus instrument inaccuracies, the operator is instructed to go to step 14 of E-1 (The Loss of Reactor Coolant Guideline) in step 31. The operator must monitor those conditions

until the criteria are met, before proceeding to step 31. If the core temperature should rise above 1200°F, while he is waiting the operator is instructed to return to step 22 of this guideline.

The vessel level indication of the top of the core plus instrument inaccuracies assures that the core is completely covered, since the core is filled with a two-phase mixture. In addition core exit thermocouples at 400°F assure that there is little superheated steam in even the hottest regions of the core.

Step 31

This step instructs the operator to go step 14 of E-1 (The Loss of Reactor Coolant Guideline). This is done, when the core has been returned to a stable and cool condition.

References

1. R. H. Mark, et. al., "Inadequate Core Cooling Studies of Scenarios With Feedwater Available, for UHI Plants, Using the NOTRUMP Computer Code", WCAP-9763, Non-Proprietary, July 1980.

2. C. M. Thompson, et. al., "Inadequate Core Cooling Studies of Scenarios With Feedwater Available, Using the NOTRUMP Computer Code", WCAP-9754, Non-Proprietary, June 1980.

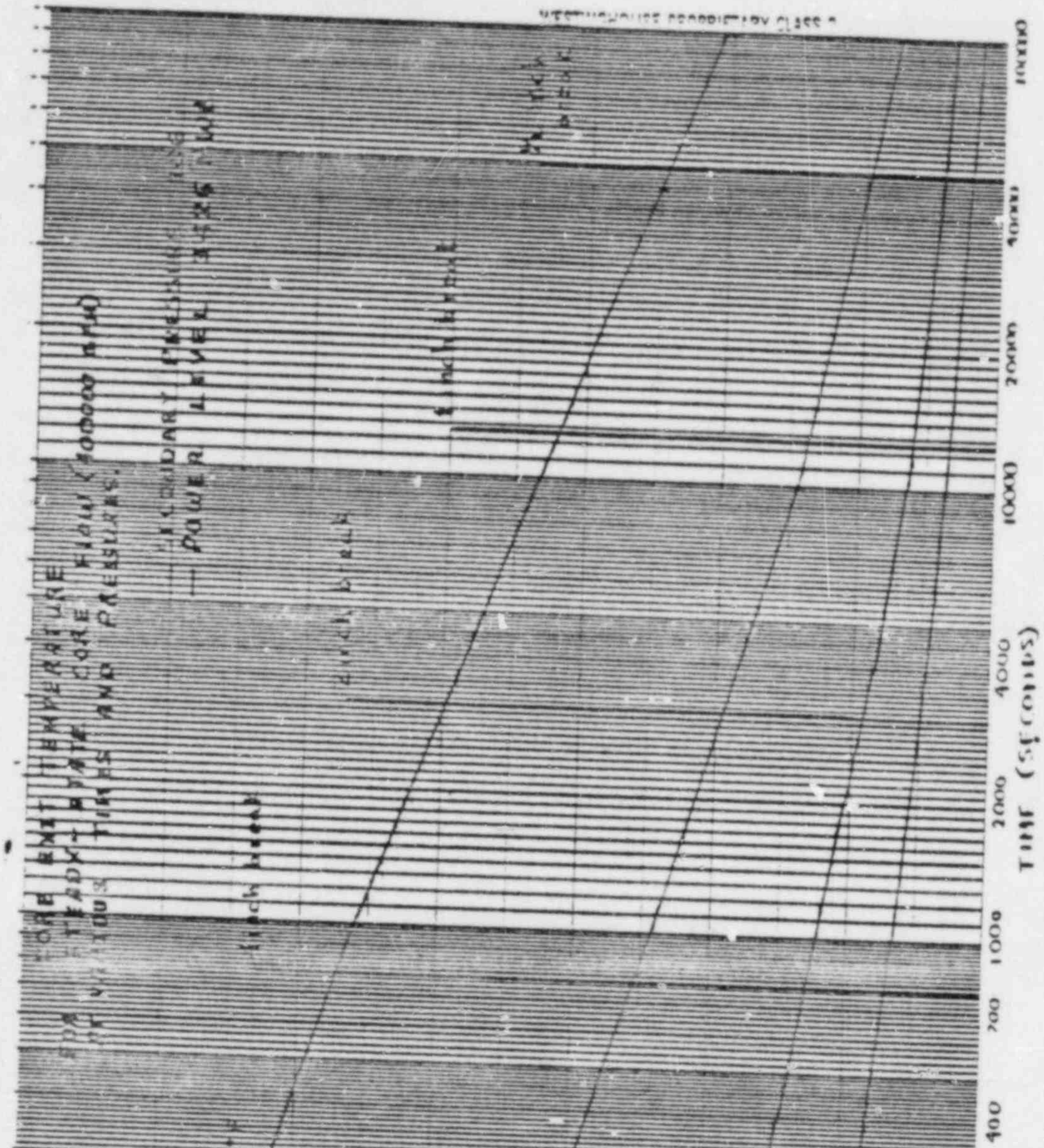
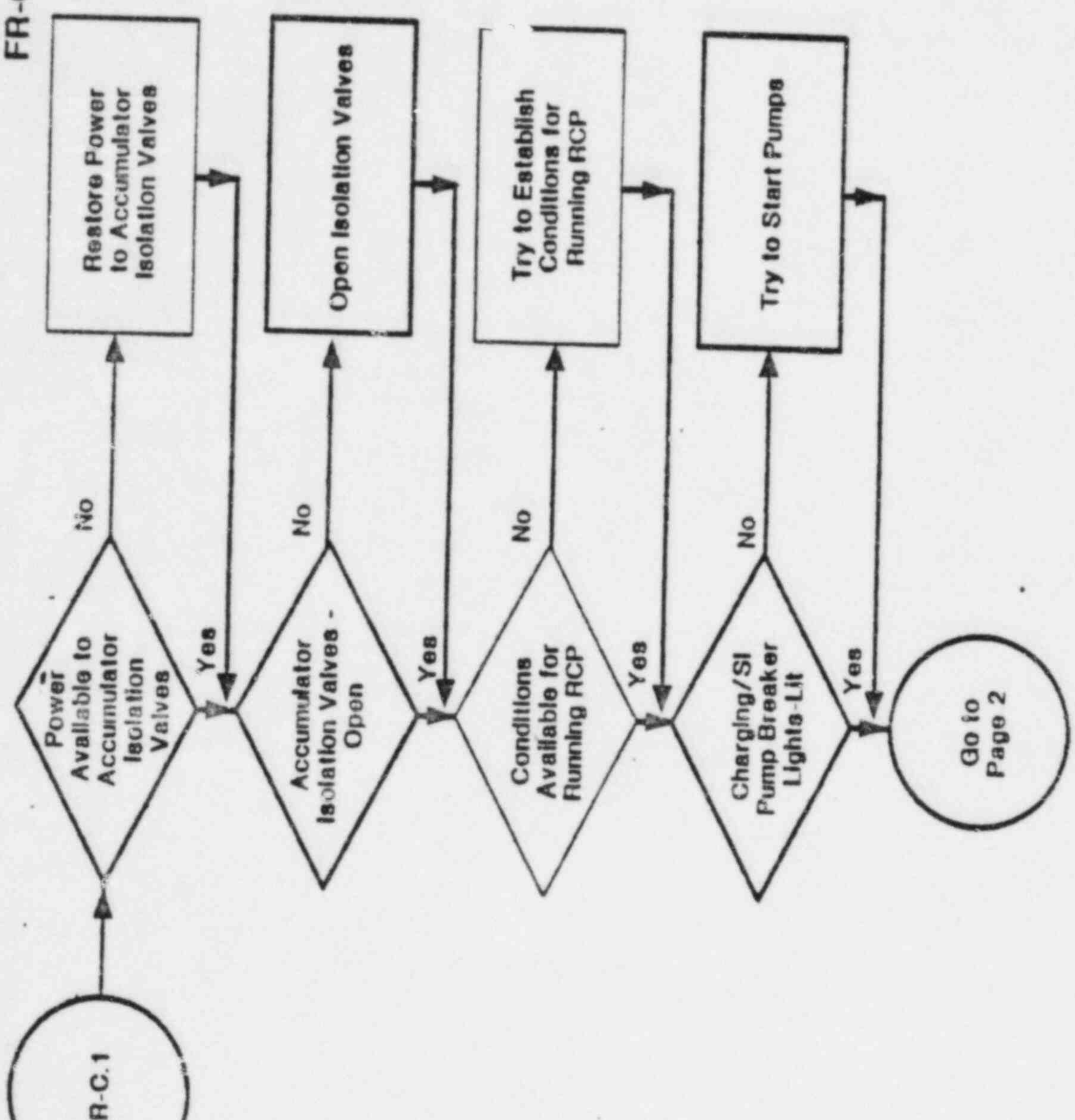


Figure 1 Core Exit Temperature as a Function of Pressure and Time

FR-C.1 PAGE 1



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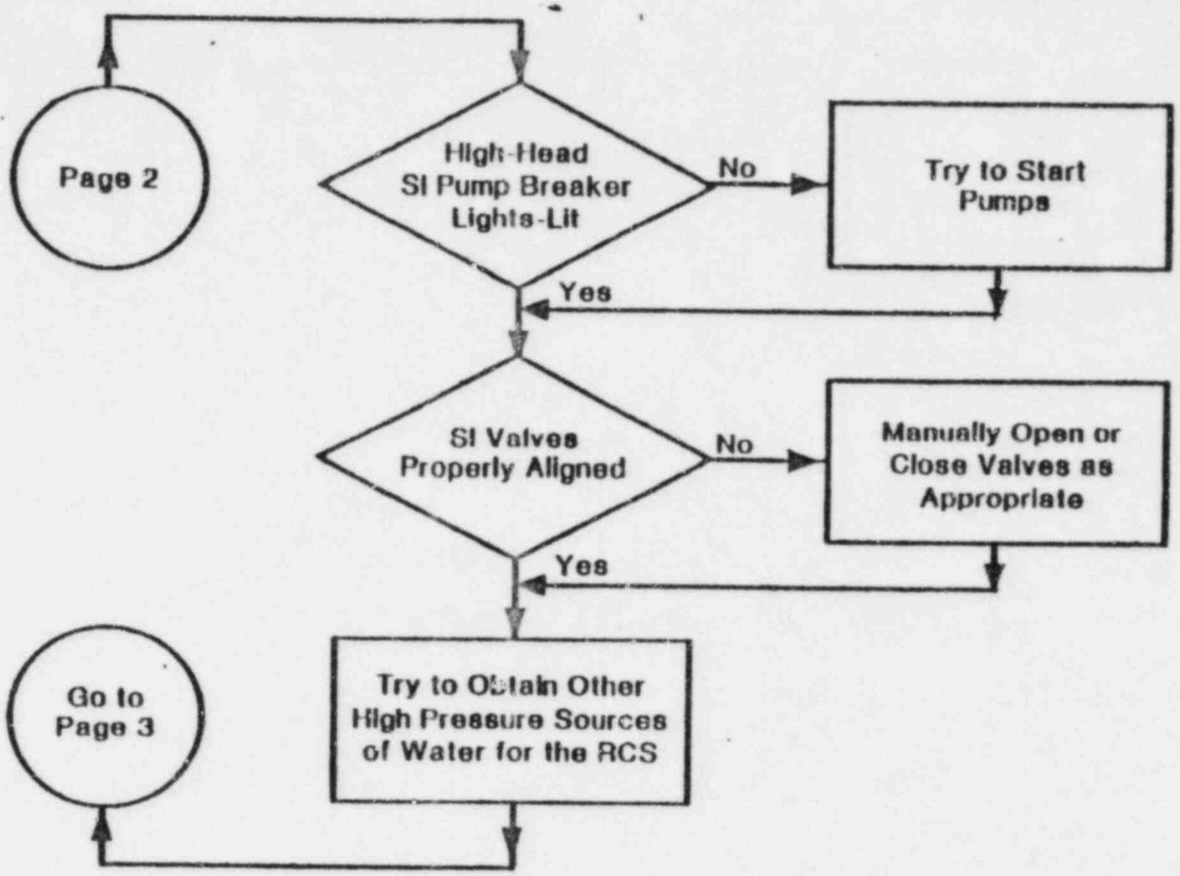
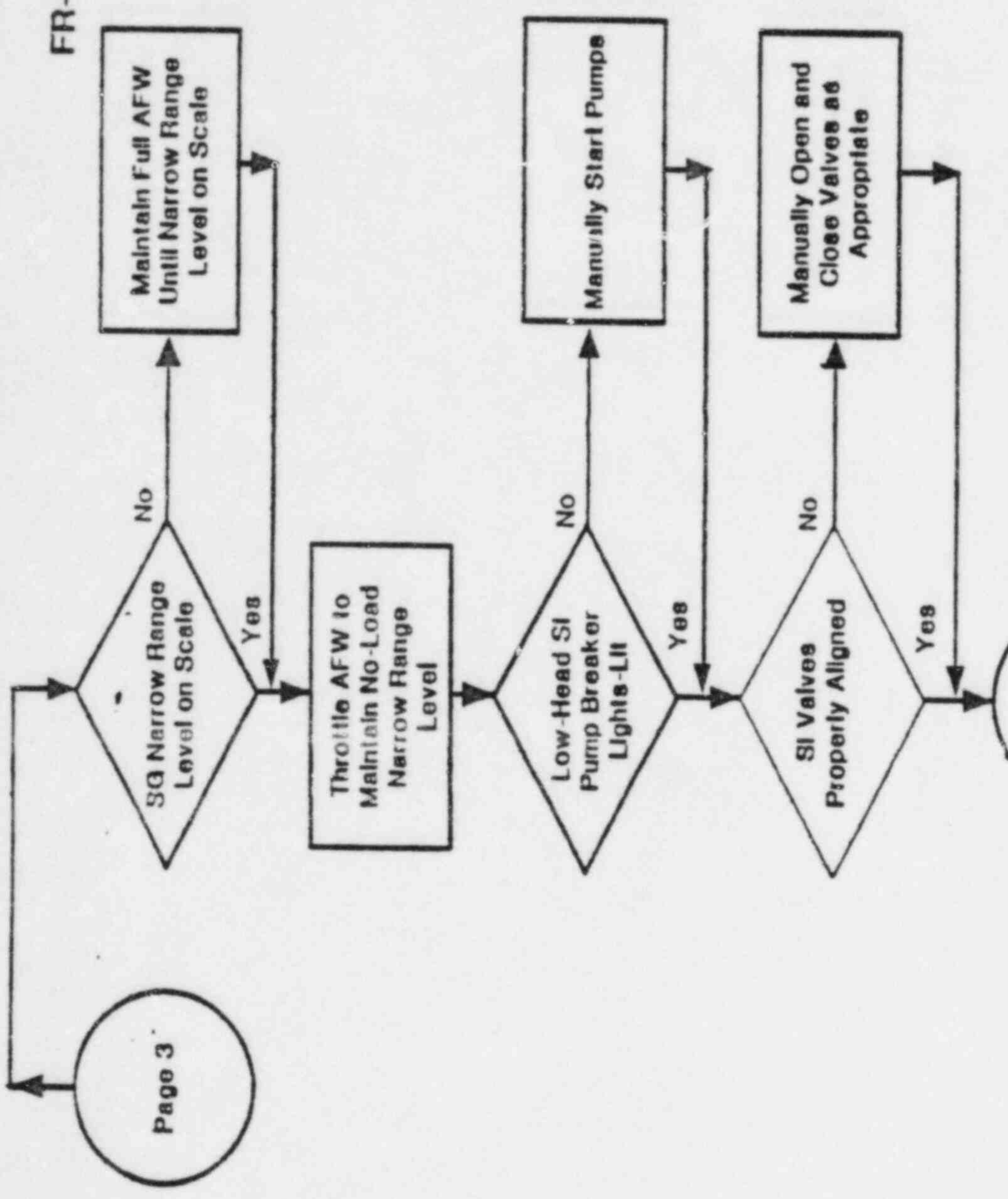
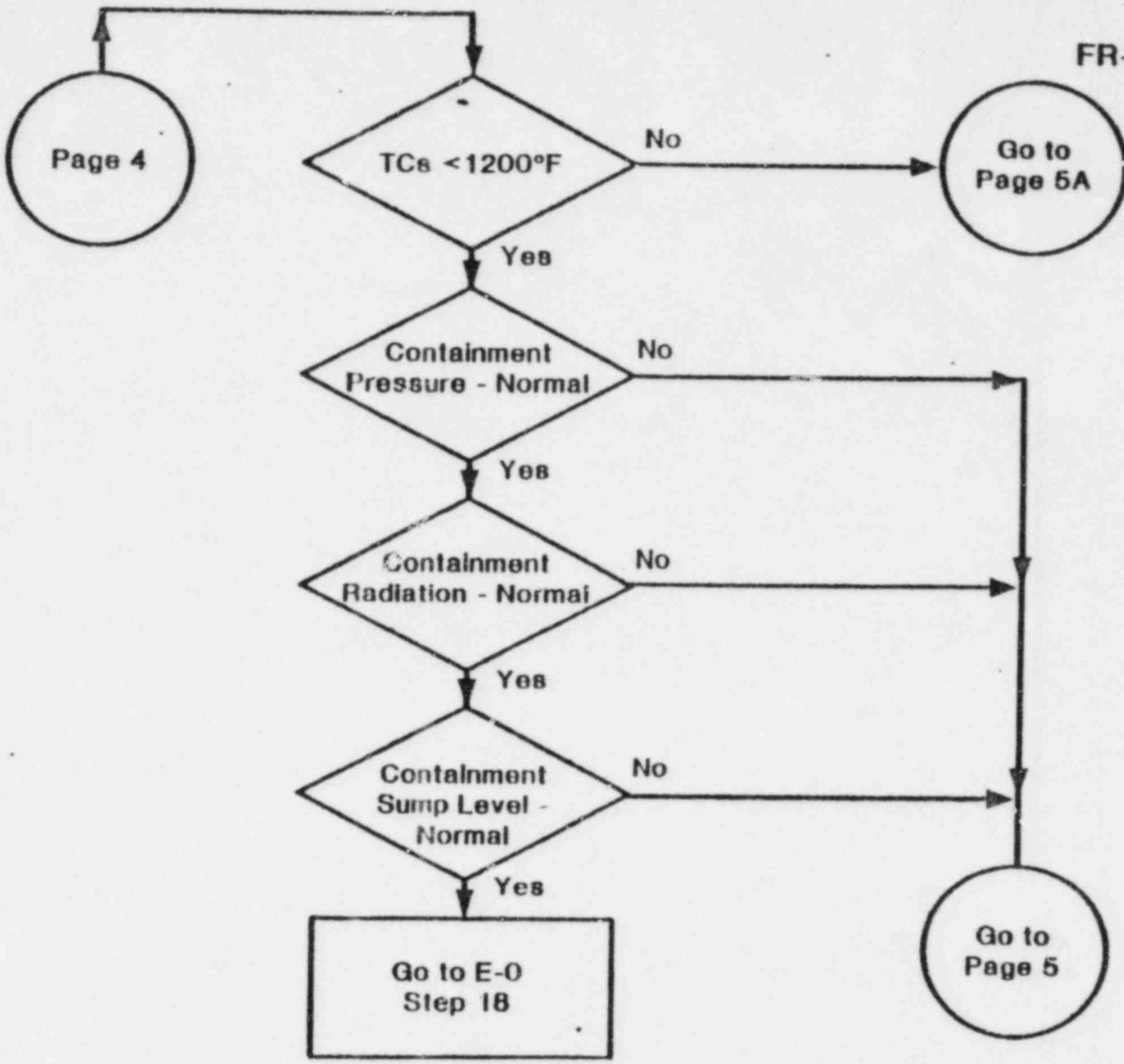
FR-C.1 PAGE 2

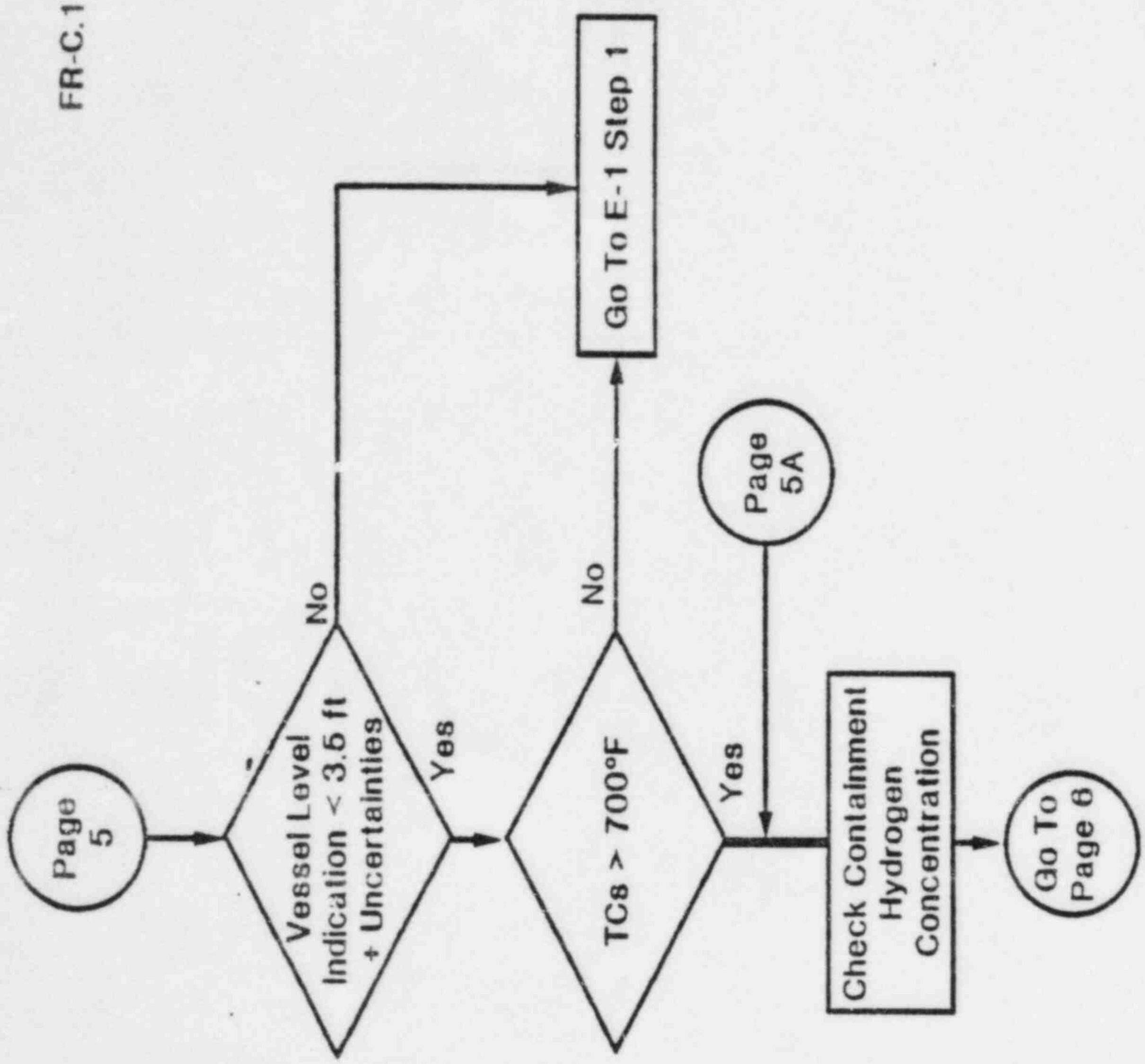

Page 2
High-Head SI Pump Breaker Lights-Lit
No
Try to Start Pumps
Yes
SI Valves Properly Aligned
No
Manually Open or Close Valves as Appropriate
Yes
Try to Obtain Other High Pressure Sources of Water for the RCS
Go to Page 3

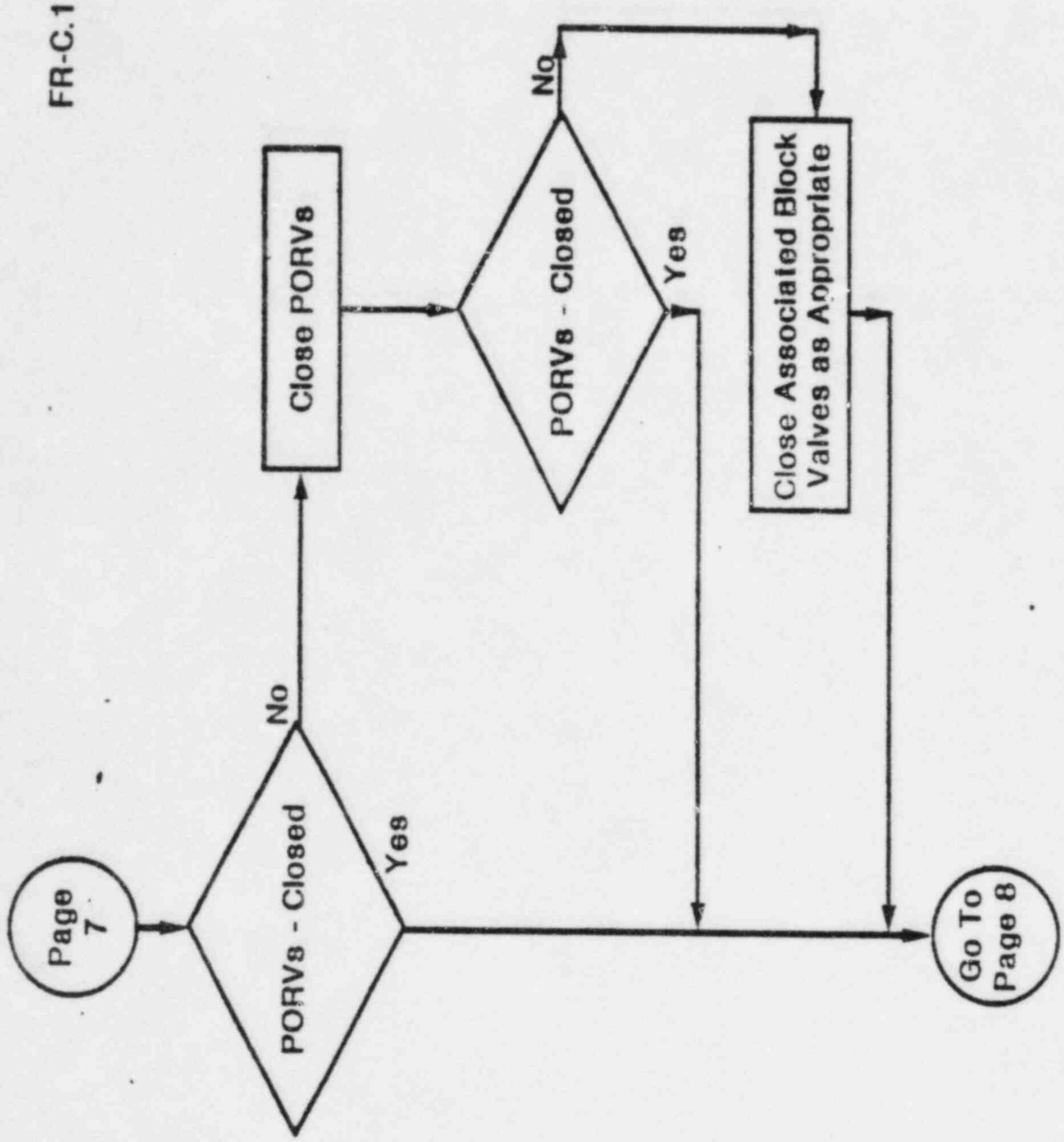


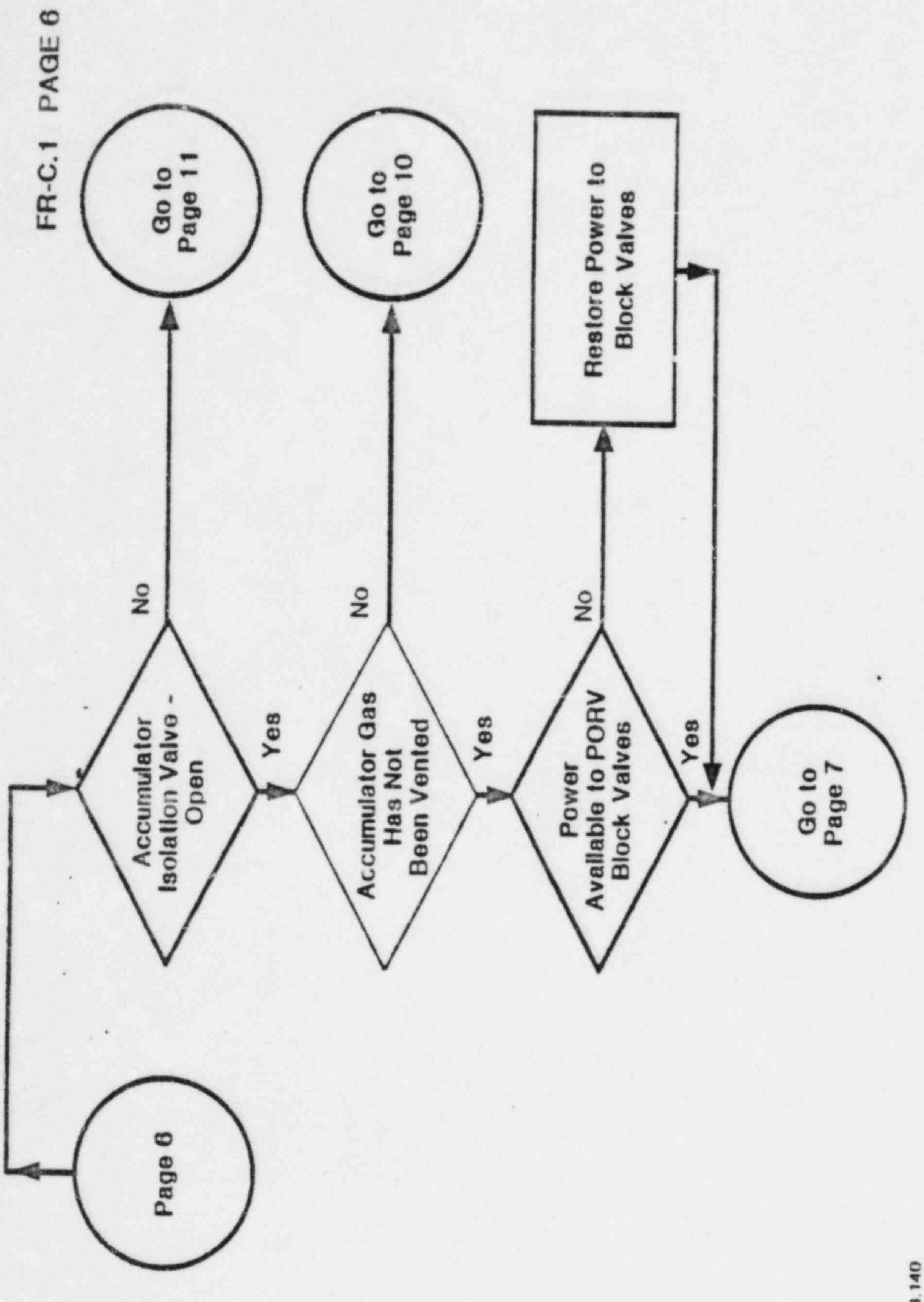
84DW02398 137

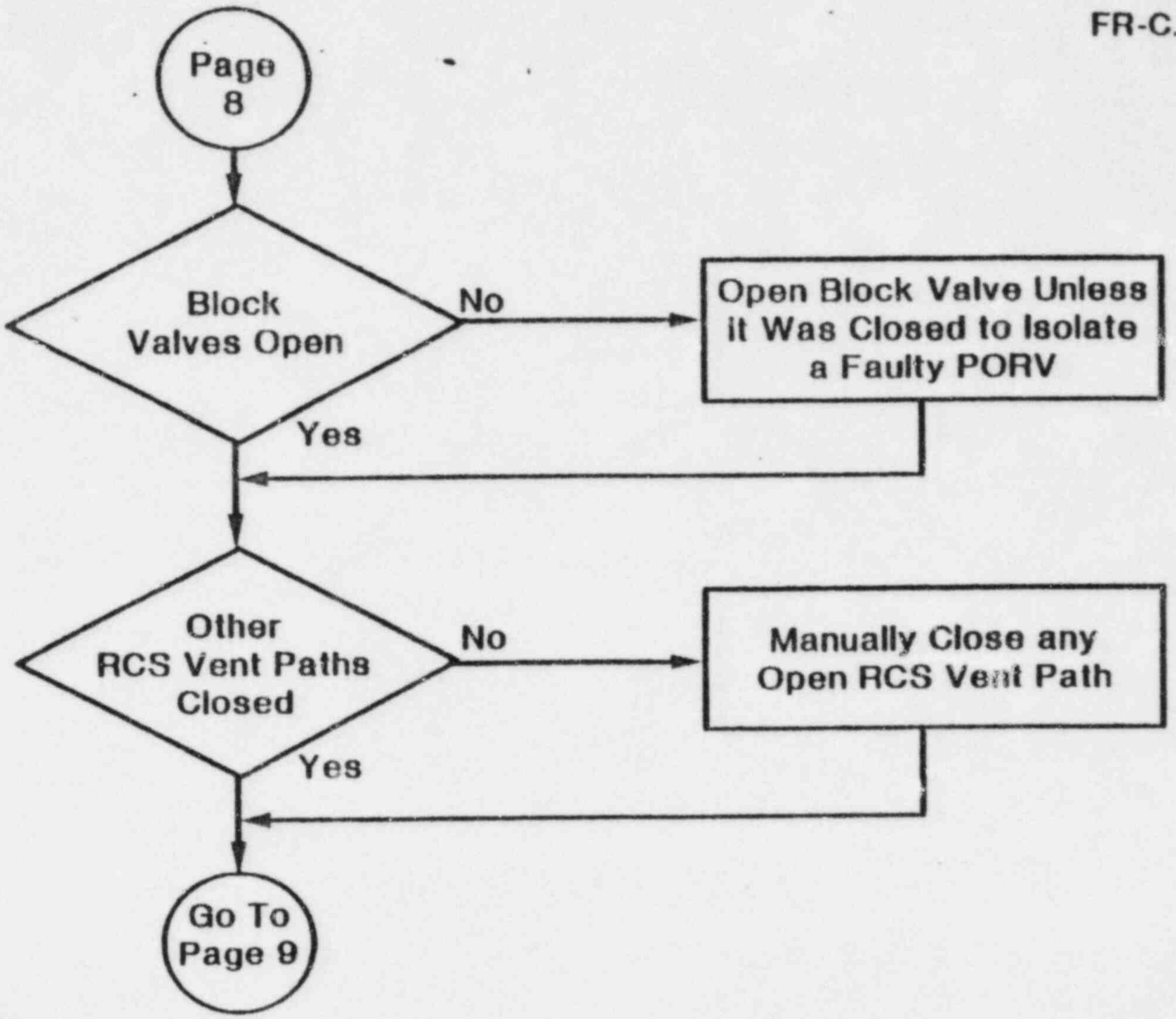

Page 4
TCs <1200°F
No
Go to
Page 5A
Yes
Containment
Pressure - Normal
No
Yes
Containment
Radiation - Normal
No
Yes
Containment
Sump Level -
Normal
No
Yes
Go to E-0
Step 18
Go to
Page 5

FR-C.1 PAGE 5

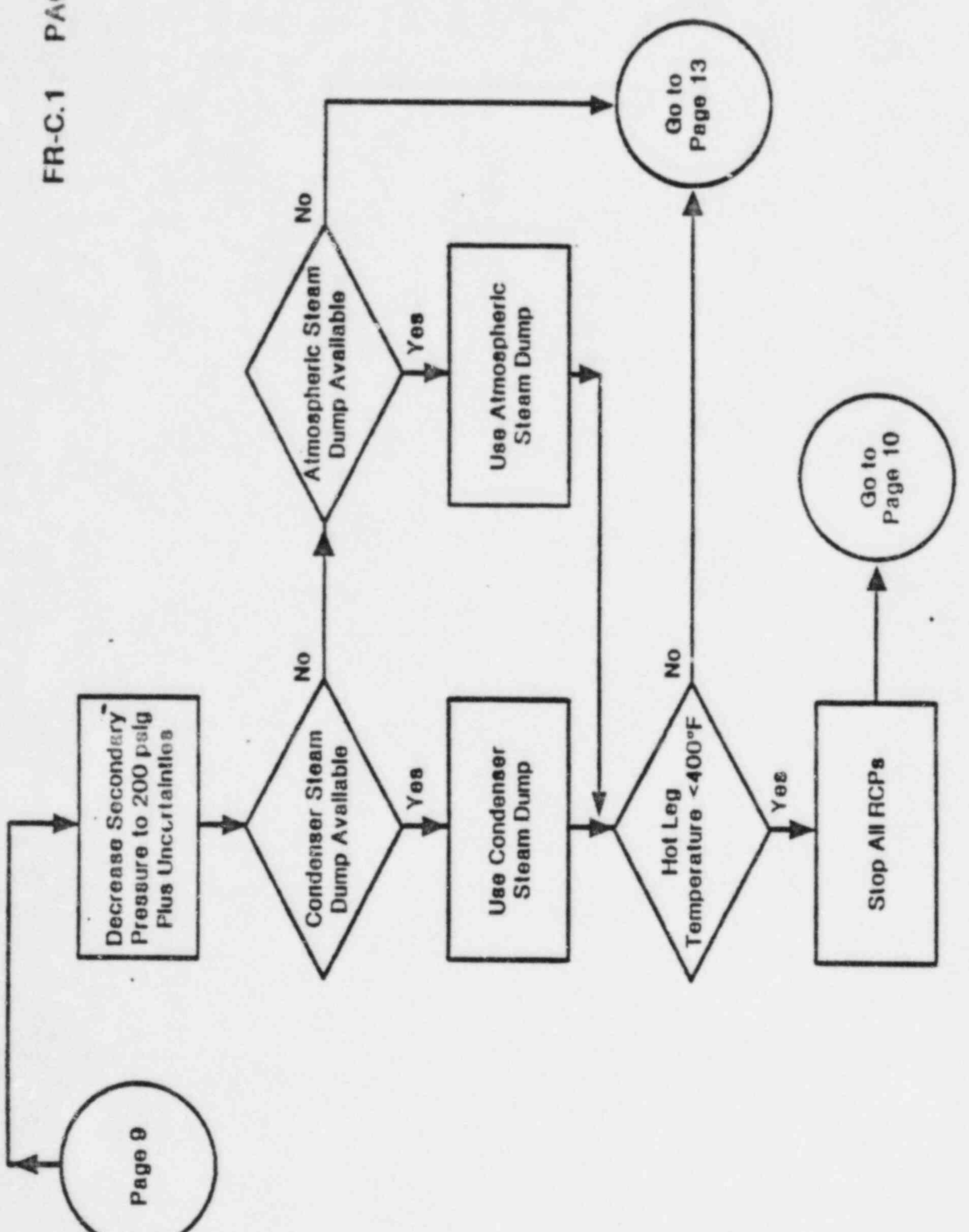

Page 5
Vessel Level Indication < 3.5 ft + Uncertainties
No
Go To E-1 Step 1
Yes
TCs > 700°F
No
Yes
Page 5A
Check Containment Hydrogen Concentration
Go To Page 6

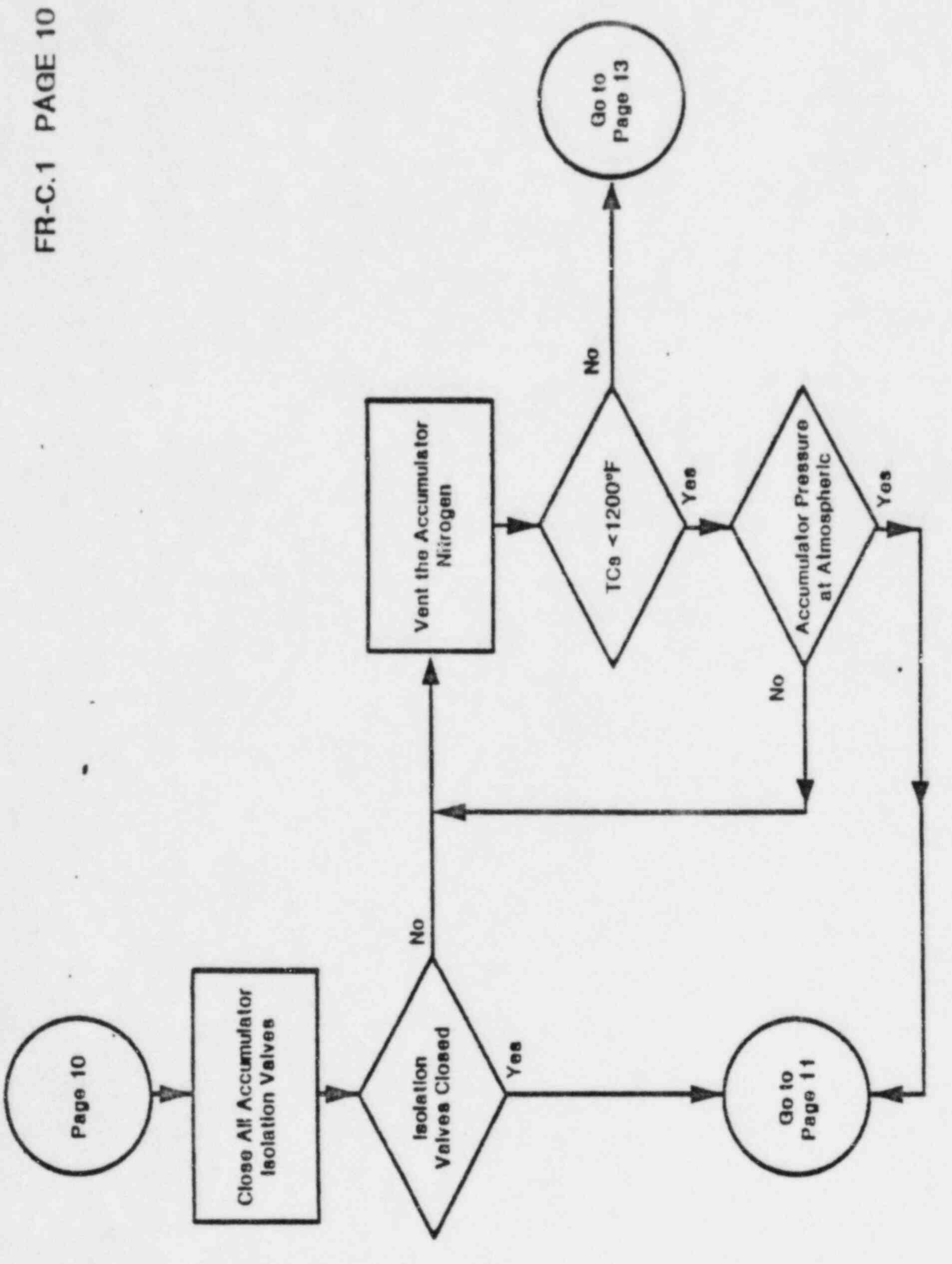

Page 7
PORVs - Closed
Yes
No
Close PORVs
PORVs - Closed
Yes
No
Close Associated Block Valves as Appropriate
Go To Page 8


FR-C.1 PAGE 6
Page 6
Accumulator Isolation Valve - Open
No
Go to Page 11
Yes
Accumulator Gas Has Not Been Vented
No
Go to Page 10
Yes
Power Available to PORV Block Valves
No
Restore Power to Block Valves
Yes
Go to Page 7
394DW02398.140

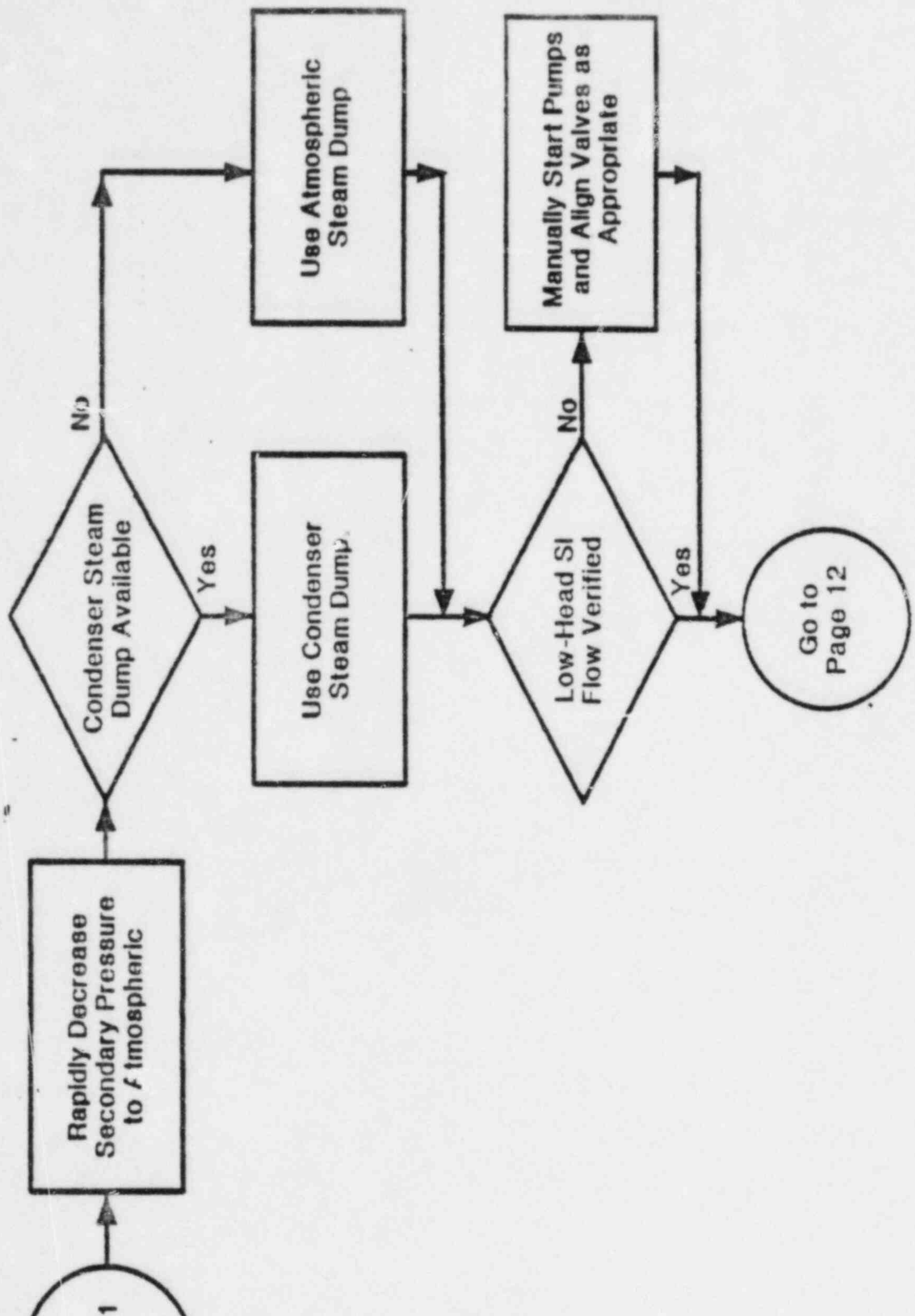

Page 8
Block Valves Open
No
Open Block Valve Unless it Was Closed to Isolate a Faulty PORV
Yes
Other RCS Vent Paths Closed
No
Manually Close any Open RCS Vent Path
Yes
Go To Page 9

FR-C.1 PAGE 9

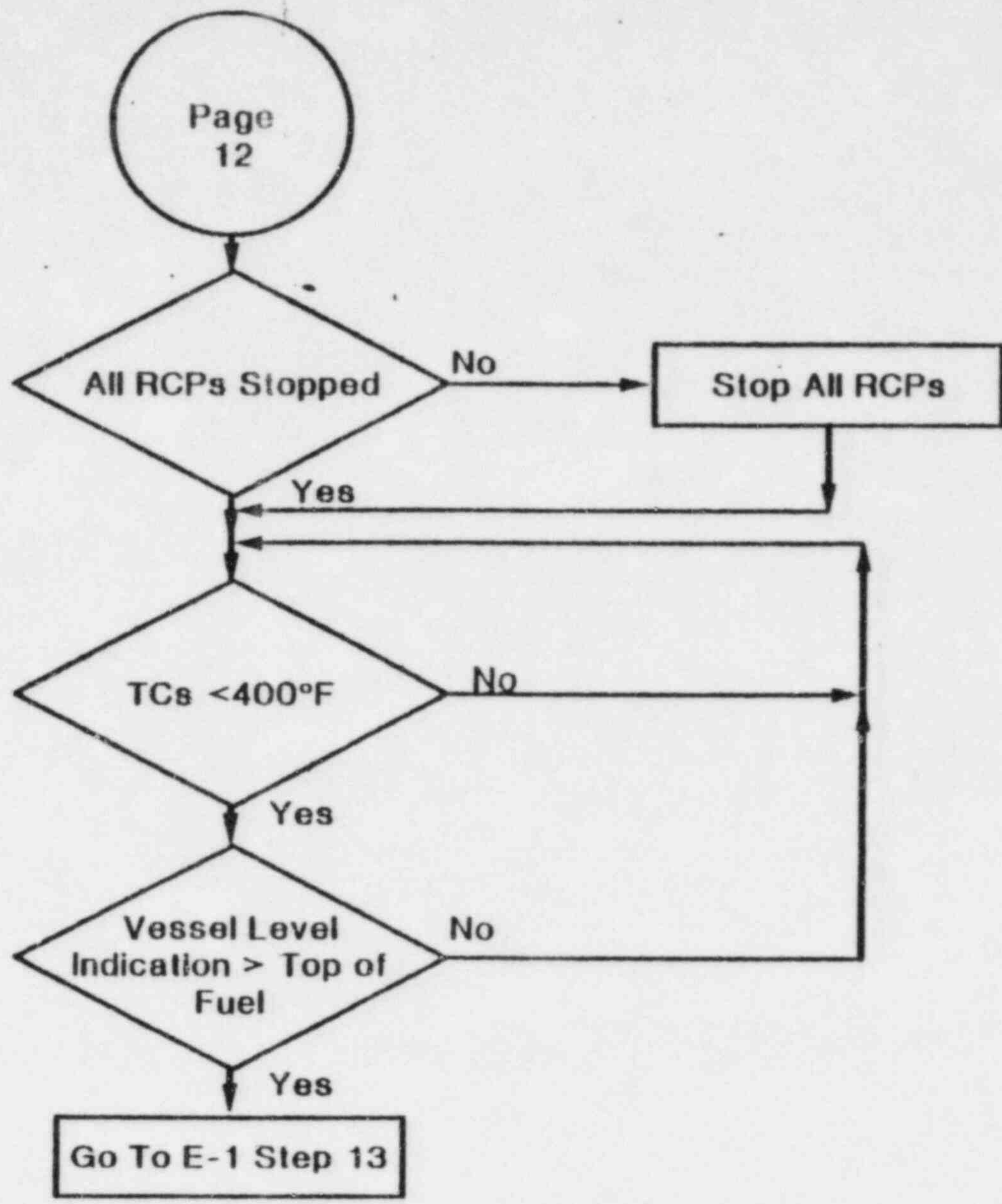

Page 9
Decrease Secondary Pressure to 200 psig Plus Uncertainties
Condenser Steam Dump Available
No
Yes
Atmospheric Steam Dump Available
No
Yes
Use Condenser Steam Dump
Use Atmospheric Steam Dump
Go to Page 13
Hot Leg Temperature <400°F
No
Yes
Stop All RCPs
Go to Page 10
394DW02398.143


FR-C.1 PAGE 10
Page 10
Close All Accumulator Isolation Valves
Isolation Valves Closed
Yes
No
Go to Page 11
Vent the Accumulator Nitrogen
TCs <1200°F
No
Yes
Go to Page 13
Accumulator Pressure at Atmospheric
No
Yes
394DW02398.144

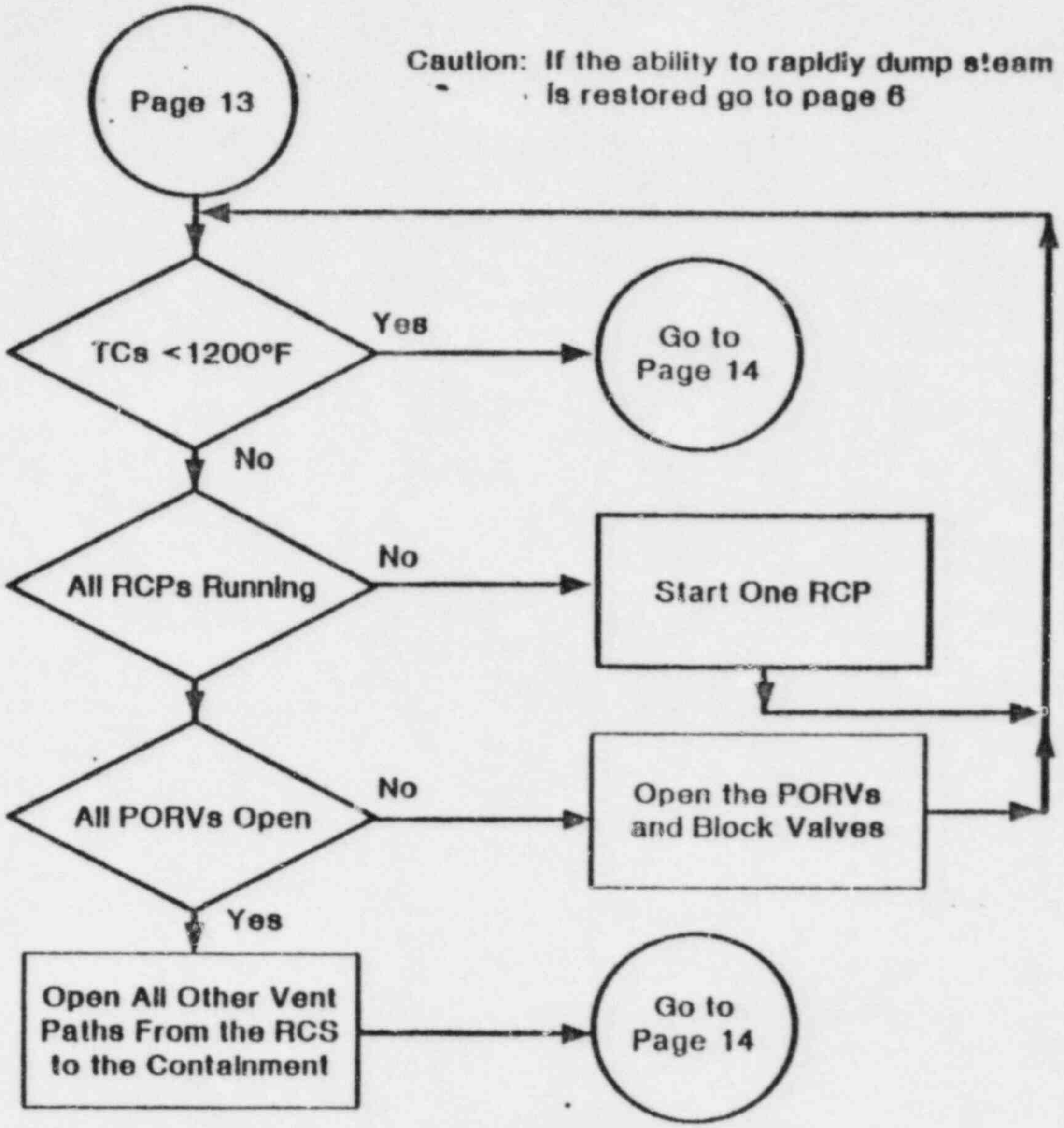
FR-C.1 PAGE 11

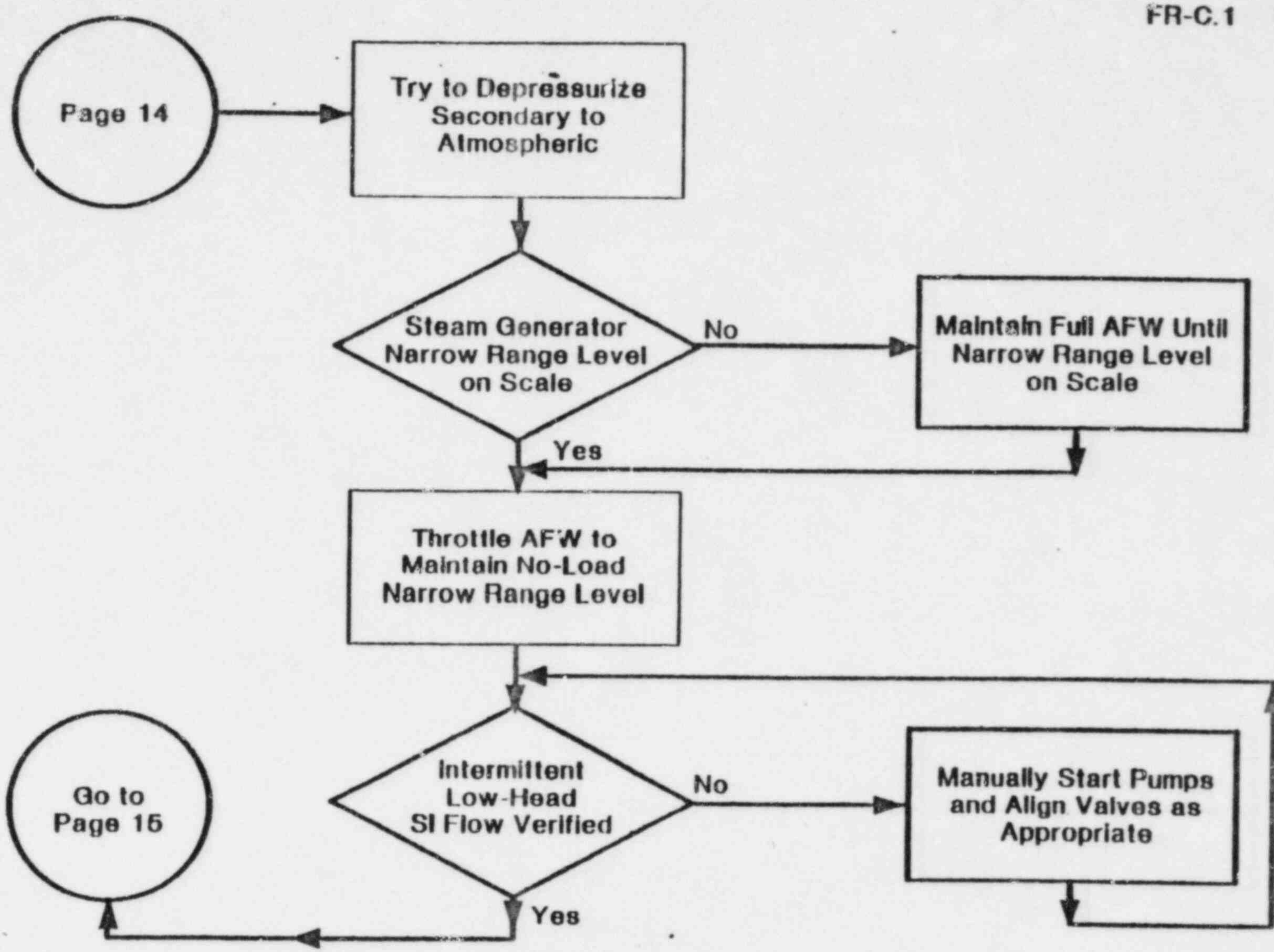


Page 11
Rapidly Decrease Secondary Pressure to Atmospheric
Condenser Steam Dump Available
Yes
No
Use Condenser Steam Dump
Use Atmospheric Steam Dump
Low-Head SI Flow Verified
Yes
No
Manually Start Pumps and Align Valves as Appropriate
Go to Page 12

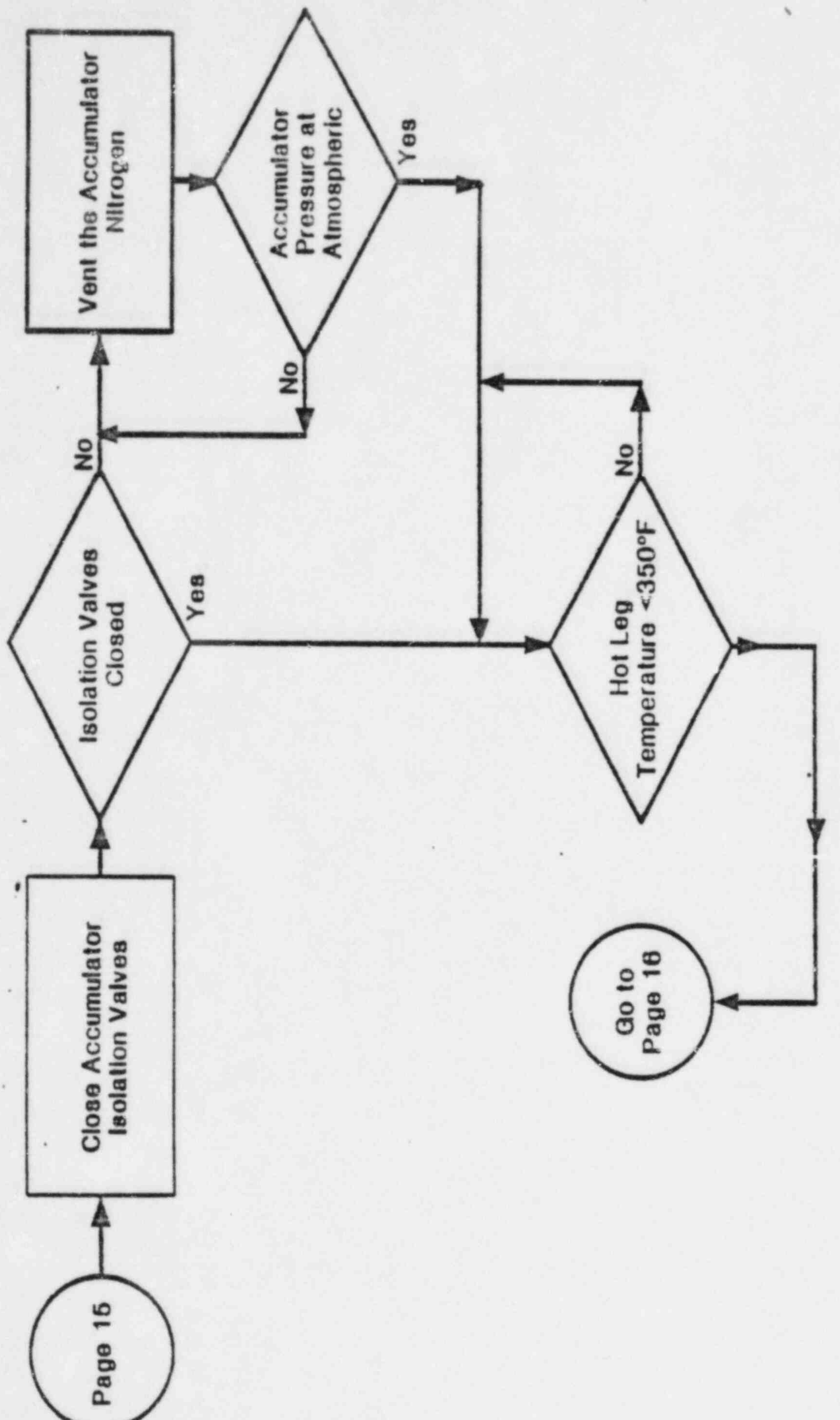

Page 12
All RCPs Stopped
No
Stop All RCPs
Yes
TCs <400°F
No
Yes
Vessel Level Indication > Top of Fuel
No
Yes
Go To E-1 Step 13

Caution: If the ability to rapidiy dump steam is restored go to page 6




Page 14
Try to Depressurize Secondary to Atmospheric
Steam Generator Narrow Range Level on Scale
No
Maintain Full AFW Until Narrow Range Level on Scale
Yes
Throttle AFW to Maintain No-Load Narrow Range Level
Intermittent Low-Head SI Flow Verified
No
Manually Start Pumps and Align Valves as Appropriate
Yes
Go to Page 15

FR-C.1 PAGE 15



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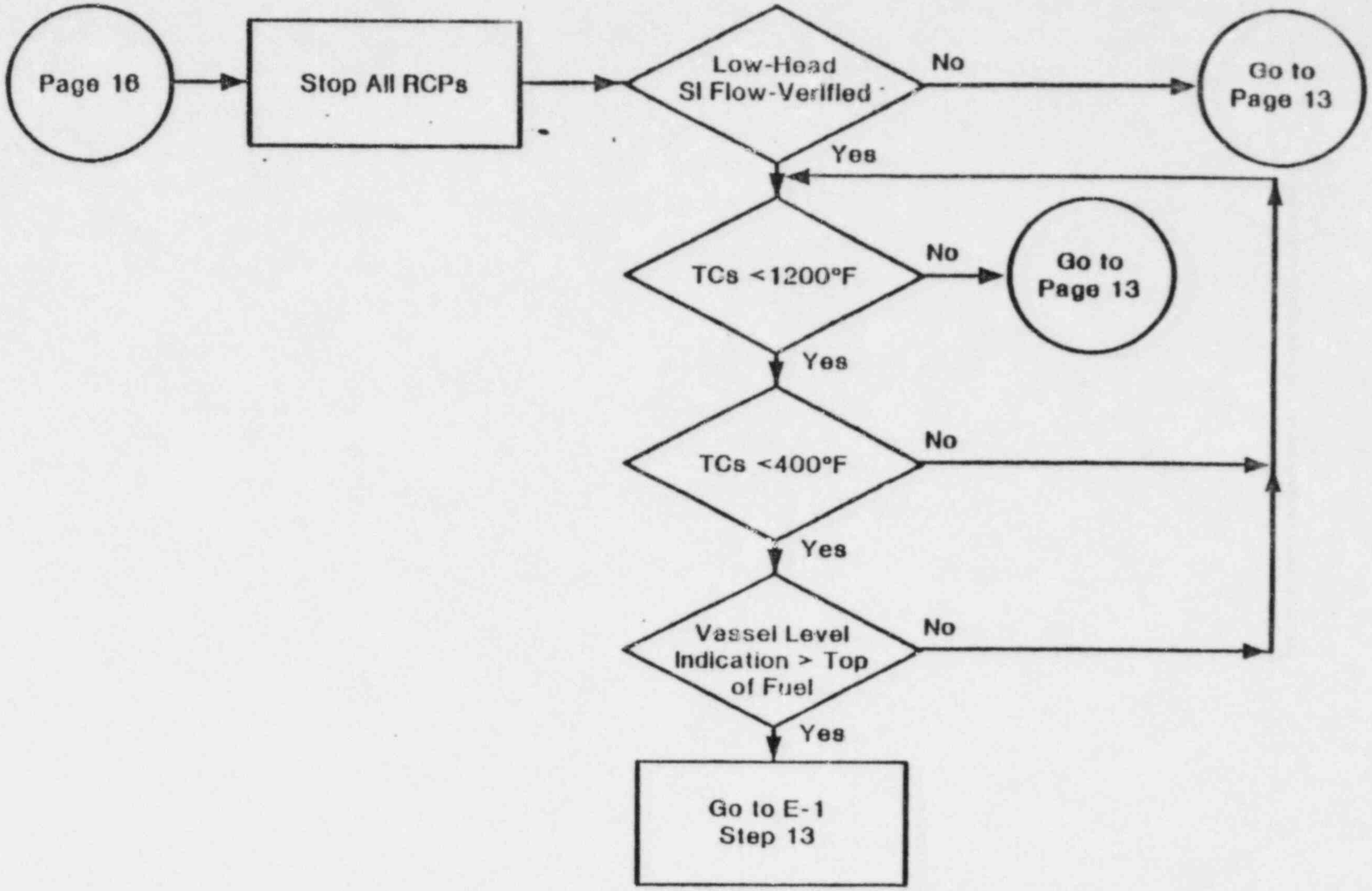
Page 16
Stop All RCPs
Low-Head SI Flow-Verified
No
Go to Page 13
Yes
TCs <1200°F
No
Go to Page 13
Yes
TCs <400°F
No
Yes
Vassel Level Indication > Top of Fuel
No
Yes
Go to E-1 Step 13

Attachment 2

Technical Bases of Feed and Bleed Core Cooling in the Millstone - 3 Probabilistic Safety Study