STEAM GENERATOR TUBE RUPTURE
RECOVERY GUIDELINE

PURPOSE

This guideline provides operator actions which must be accomplished in the event of a Steam Generator Tube Rupture (SGTR). The actions in this guideline are necessary to ensure that the plant is placed in a stable, safe condition. The goal of the guideline is to safely establish Shutdown Cooling System entry conditions while minimizing radiological releases to the environment and maintaining adequate core cooling. This guideline provides technical information to be used by utilities in developing a plant specific procedure.

ENTRY CONDITIONS

1. The Standard Post Trip Actions have been performed.

   or

   All of the following conditions exist:

   a. Event initiated from Mode 3 or Mode 4,
   b. SIAS has NOT been blocked,
   c. LTOP has NOT been initiated.

   and

2. Plant conditions indicate that a steam generator tube rupture has occurred. Any one or more of the following may be present:

   a. Condenser Vacuum Pump high activity alarm.
   b. Steam generator blowdown high activity alarm.
   c. High activity and conductivity in steam generator liquid sample.
   d. Increasing steam generator level.
   e. Main Steamline N-16 monitor alarms.
   f. Turbine Building sump activity alarms
   g. Decreasing pressurizer level
   h. Steamline area radiation monitor alarms.

EXIT CONDITIONS

1. The diagnosis of a Steam Generator Tube Rupture event is not confirmed.

   or

2. Any of the Steam Generator Tube Rupture Safety Function Status Check acceptance criteria are not satisfied.

   or

3. The Steam Generator Tube Rupture EOG has accomplished its purpose by satisfying All of the following:

   a. All Safety Function Status Check acceptance criteria are being satisfied.
   b. Shutdown Cooling System entry conditions have been established.
   c. An appropriate, approved procedure to implement exists or has been approved by the [Plant Technical Support Center or the Plant Operations Review Committee].

INSTRUCTIONS	CONTINGENCY ACTIONS
*1. Confirm diagnosis of a Steam Generator Rupture by: a. verifying Safety Function Status Check acceptance criteria are satisfied, and b. referring to the Break Identification Chart (Figure 6-2), and c. sampling both steam generators for activity.	1. Rediagnose event and exit to either appropriate Optimal Recovery Guideline or to the Functional Recovery Guideline.
*2. If pressurizer pressure decreases to or below [1825 psia], Then verify SIAS is actuated.	2. If pressurizer pressure decreases to or below [1825 psia] and a SIAS has NOT been initiated automatically, Then manually initiate a SIAS.
*3. Ensure maximum charging and safety injection flow to the RCS, unless SI termination criteria are met, by: a. start available charging pump and idle SIS pumps and verify SIS flow in accordance with Figure 6-3.	3. If charging and safety injection flow NOT maximized, Then do the following as necessary: a. ensure electrical power to valves and pumps, b. ensure correct SIS valve lineup, c. ensure operation of necessary auxiliary systems.

INSTRUCTIONS	CONTINGENCY ACTIONS
*4. If pressurizer pressure decreases to less than [1400 psia] following an SIAS, Then ensure two of four RCPs are tripped (in opposite loops).	4. Continue RCP operation.
*5. Verify RCP operating limits are satisfied.	5. Trip the RCP(s) which do not satisfy RCP operating limits.
6. Verify RCS hot leg temperature is less than [547°F] in order to minimize the possibility of lifting steam generator safeties after isolating a steam generator.	6. Cooldown the RCS to a hot leg temperature of less than [547°F] by (listed in order of preference: a. operation of the steam bypass system, or b. operation of the steam generator blowdown system to the condenser, or c. If the condenser or steam bypass system not available and the blowdown is insufficient, Then by operation of the atmospheric dump valve(s).

INSTRUCTIONS	CONTINGENCY ACTIONS
7. Maintain steam generator level(s) in the normal band using main, startup or emergency feedwater.	7.
8. Determine which steam generator has the tube rupture by performing the following: a. sample steam generators for activity, b. monitor main steam piping for activity (area monitors and/or Nitrogen-16 monitors), c. monitor steam generator levels,	8.
9. When RCS hot leg temperature is less than [547°F], Then isolate the steam generator with the higher activity, higher radiation levels, or increasing water level by performing the following:	9.
a. close the MSIV,	a. locally close MSIV,
b. verify closed, or close the MSIV bypass valve,	b. locally close MSIV bypass valve,

INSTRUCTIONS	CONTINGENCY ACTIONS
9. c. ~~raise the setpoint for the associated ADV to [1150 psia].~~ Verify the associated ADV closed.	c. ~~Maintain the affected SG pressure ≤ [1150 psia] by: i) manual operation of the associated ADV~~ ~~ii)~~ locally close ~~operation of~~ the associated ADV
d. close the main feedwater isolation valve,	d. locally close main feedwater isolation valve,
e. close the emergency feedwater isolation valve(s) including the steam driven pump steam supply valve associated with the steam generator being isolated,	e. locally close EFW isolation valve(s) and steam driven pump steam supply valve.
f. isolate steam generator blowdown	f. locally isolate steam generator blowdown
g. close vents, drains, exhausts, and bleedoffs from the steam system,	g. locally isolate vents, drains, exhausts, and bleedoffs.
h. Close turbine plant sump to radwaste	
10. Verify the most affected steam generator is isolated by checking the following: a. activity levels, b. radiation levels, c. possible steam generator level increase.	10. If the wrong steam generator was isolated, Then unisolate that steam generator and isolate the most affected steam generator per step 9.

INSTRUCTIONS	CONTINGENCY ACTIONS
*11. Decrease and control RCS pressure by using main or auxiliary spray, reactor coolant gas vent system, operation of charging and letdown, or throttling of safety injection pumps (refer to step 14), in order to control pressurizer pressure within the following criteria: a. less than [1200 psia], and b. maintain RCS pressure approximately equal to but within 50 psi above isolated SG pressure.	11.
*12. Maintain the RCS within the acceptable Post Accident Pressure-Temperature limits of Figure 6-1 by the following: a. controlling RCS heat removal via the unisolated steam generator, and b. control of RCS pressure (refer to step 11),	12. If RCS subcooling greater than P-T limits or cooldown rate greater than [100°F/Hr], Then do the following as appropriate: a. stop the cooldown. b. depressurize the plant using Reactor Coolant Gas Vent System or main or auxiliary spray or Reactor Coolant Gas Vent System to restore and maintain pressurizer pressure within the Post Accident P-T limits of Figure 6-1,

INSTRUCTIONS	CONTINGENCY ACTIONS
12.	c. attempt to maintain the plant in a stable pressure-temperature configuration or continue to cooldown within the limits of Figure 6-1, d. <u>If</u> overpressurization due to SI/charging flow, <u>Then</u> throttle or secure flow (refer to step 14) and manually control letdown to restore/maintain pressure within the P-T limits of Figure 6-1.
*13. <u>Maintain</u> the isolated steam generator level within [40% to 95%] narrow range by the following: a. periodic draining to the radioactive waste system via blowdown processing system or blowdown to the condenser b. dump steam from the affected steam generator to the condenser with approval of the [Emergency Coordinator] or Technical Support Center.	13. <u>Restore</u> the isolated steam generator level to less than [95%] narrow range by the following: a. draining to the radioactive waste system or blowdown to the condenser

INSTRUCTIONS		CONTINGENCY ACTIONS	
*14.	If SI pumps are operating, Then they may be throttled or stopped, one pump at a time, if ALL of the following are satisfied: a. RCS is subcooled based on representative CET temperature (Figure 6-1), b. pressurizer level is greater than [14.3%] and not decreasing, c. the unisolated steam generator is available for removing heat from the RCS (ability for feed and steam flow), d. the HJTC RVLMS indicates a minimum level at the top of the hot leg nozzles.	14.	Continue SI pump operation.
*15.	If criteria of step 14 cannot be maintained after SI pumps throttled or stopped, Then appropriate SI pumps must be restarted and full SI flow restored.	15.	

INSTRUCTIONS	CONTINGENCY ACTIONS
*16. Control charging and letdown, and SI (unless SI termination criteria met) to restore and maintain pressurizer level [2% to 78%].	16. If RCS subcooling can NOT be maintained, Then [78%] may be exceeded to restore RCS subcooling.
*17. If RCPs are NOT operating, Then evaluate the need and desirability of restarting RCPs. Consider the following: a. adequacy of RCS and core heat removal using natural circulation, b. existing RCS pressure and temperatures, c. the need for main pressurizer spray capability, d. the duration of CCW interruption to RCPs, e. RCP seal staging pressures and temperatures.	17. a. If RCP operation NOT desired, Then go to step 20. or b. If at least one RCP operating in each loop, Then go to step 21.

INSTRUCTIONS	CONTINGENCY ACTIONS
*18. Determine whether RCP restart criteria are met by ALL of the following: a. electrical power is available to the RCPs, b. RCP auxiliaries ([CCW]) to maintain seal, bearing, and motor cooling are operating, and there are no high temperature alarms on the selected RCPs. c. the unisolated steam generator is available for removing heat from the RCS (ability for feed and steam flow), d. pressurizer level is greater than [33%] and not decreasing, e. RCS is subcooled based on representative CET temperature (Figure 6-1),	18. Go to step 20.

INSTRUCTIONS	CONTINGENCY ACTIONS
18. f. other criteria satisfied per RCP operating instructions.	
*19. <u>If</u> RCP restart desired and restart criteria satisfied, <u>Then</u> do the following: a. start one RCP in unaffected loop, b. ensure proper RCP operation by monitoring RCP amperage and NPSH, c. operate charging (and SI) pumps to maintain pressurizer level greater then [14.3%] and until SI termination criteria met. (Refer to step 14). d. start one RCP in the affected loop.	19. <u>Go to</u> step 20.

INSTRUCTIONS		CONTINGENCY ACTIONS	
*20.	If no RCPs are operating, Then verify natural circulation flow in at least one loop by ALL of the following: a. loop $\Delta T (T_H - T_C)$ less than normal full power ΔT, b. hot and cold leg temperatures constant or decreasing, c. RCS is subcooled based on representative CET temperature, d. no abnormal difference (greater than [10°F]) between T_H RTDs and Core Exit Thermocouples.	20.	Ensure proper control of steam generator steaming and feeding (refer to steps 22 and 23), and RCS pressure and inventory (refer to steps 11 and 16).
21.	Sample the RCS periodically for radioactivity and boron concentration. Calculate and add sufficient boron to the RCS to raise the entire RCS (including the pressurizer) to the shutdown margin required by Technical Specifications.	21.	

INSTRUCTIONS	CONTINGENCY ACTIONS
22. Perform controlled plant cooldown, using forced or natural circulation, in accordance with Technical Specifications. Reduce RCS temperatures by the following: a. If the condenser is available, Then cooldown using the steam bypass system, or b. If the condenser or steam bypass system NOT available, Then cooldown using the unisolated steam generator atmospheric dump valve.	22.
*23. Maintain unisolated steam generator level in the normal band throughout the cooldown using main, startup or emergency feedwater.	23.
24. Bypass or lower the automatic initiation setpoints of MSIS and SIAS as the cooldown and depressurization proceed.	24.

INSTRUCTIONS	CONTINGENCY ACTIONS
*25. Ensure the available condensate inventory is adequate per Figures 6-4 and 6-5.	25.
26. Cool and depressurize the isolated steam generator as the cooldown proceeds by one of the following methods: a. feed and bleed using main, startup or emergency feedwater and blowdown, b. steaming the isolated steam generator to the condenser (if available) or to atmosphere, with approval of the [Emergency Coordinator] or the Technical Support Center.	26.
*27. Sample the condensate and other connecting systems, including turbine building sumps, for activity.	27.

INSTRUCTIONS	CONTINGENCY ACTIONS
*28. Monitor the turbine and radwaste building ventilation radiation monitors and any other applicable radiation monitors. a. If radiation monitor readings are excessive, Then take corrective actions in accordance with TSC recommendations.	28.
*29. When pressurizer pressure reaches [740 psia], reduce SIT pressure to [300 psi].	
*30. If pressurizer pressure decreases to [445 psia], Then isolate, vent or drain the safety injection tanks (SITs).	30.
*31. Initiate low temperature overpressurization protection (LTOP) at $T_c \leq$ [259°F].	31.

INSTRUCTIONS

*32. When the following SCS entry conditions are established:

a. pressurizer level > [14.3%] and constant or increasing,
b. RCS is subcooled
c. RCS pressure ≤ [450 psia]
d. RCS T_H ≤ [400°F],

Then exit this guideline and initiate SCS operation per operating instructions.

CONTINGENCY ACTIONS

32. If the RCS fails to depressurize, Then a void should be suspected.

a. voiding in the RCS may be indicated by any of the following indications, parameter changes, or trends:
   i) letdown flow greater than charging flow,
   ii) pressurizer level increasing significantly more than expected while operating pressurizer spray,
   iii) the HJTC RVLMS indicates that voiding is present in the reactor vessel,
   iv) HJTC RVLMS unheated thermocouple temperature indicates saturated conditions in the reactor vessel upper head,
b. If voiding inhibits RCS depressurization to SCS entry pressure, Then attempt to eliminate the voiding by:

INSTRUCTIONS	CONTINGENCY ACTIONS
32. (Continued)	i) verify letdown is isolated, and ii) stop the depressurization, and iii) pressurize and depressurize the RCS within the limits of Figure 6-1 by operating pressurizer heaters and spray or SI and charging pumps. Monitor pressurizer level and the HJTC RVLMS for trending of RCS inventory. c. If depressurization of the RCS to the SCS entry pressure is still not possible, Then attempt to eliminate the voiding by: i) operate the Reactor Coolant Gas Vent System to clear trapped non-condensible gases. and

INSTRUCTIONS

32. (Continued)

CONTINGENCY ACTIONS

ii) monitor pressurizer level and/or the HJTC RVLMS for trending of RCS inventory.

d. If depressurization of the RCS to the SCS entry pressure is still not possible, and voiding is suspected to exist in the steam generator tubes, Then attempt to eliminate the voiding by:

i) cool the suspected steam generator (by steaming and/or blowdown, and feeding) to condense the steam generator tube void,

and

ii) monitor pressurizer level for trending RCS inventory.

e. Continue attempts to establish SCS entry conditions, or exit this guideline and initiate an appropriate procedure as directed by the Technical Support Center.

The Steam Generator Tube Rupture Recovery Guideline has accomplished its purpose if the most affected steam generator has been isolated and cooled, shutdown cooling system entry conditions have been established, and all SFSC acceptance criteria are being satisfied.

END

SUPPLEMENTARY INFORMATION

This section contains items which should be considered when implementing EOGs and preparing plant specific EOPs. The items should be implemented as precautions, cautions, notes, or in the EOP training program.

1. To minimize the release of radioactivity directly to the environment, use of the atmospheric steam dump valves on the affected steam generator should be minimized.

2. To reduce the release of potentially radioactive steam from turbine driven pump exhausts, the motor driven main, startup and emergency feedwater pumps should be used. If the motor driven pumps are not available, steam from the intact steam generator should be used to drive the turbine driven emergency feed pump.

3. During all phases of the cooldown, RCS temperature and pressure should be monitored to avoid exceeding a maximum cooldown rate greater than Technical Specification Limitations.

4. Automatic feedwater modulation may mask the expected steam generator level increase due to a steam generator tube rupture.

5. If the faulted steam generator has been isolated and the cooldown is proceeding via natural circulation, an inverted ΔT (i.e., T_C greater than T_H) may be observed in the idle loop. This is due to a small amount of reverse heat transfer in the isolated steam generator and will have no effect on natural circulation flow in the intact steam generator.

6. Do not place systems in "manual" unless misoperation in "automatic" is apparent. Systems placed in "manual" must be checked frequently to ensure proper operation.

7. All available indications should be used to aid in diagnosing the event since the accident may cause irregularities in a particular instrument reading. Instrument readings must be corroborated when one or more confirmatory indications are available. (e.g., during depressurization the indicated level in the pressurizer may be higher than the actual level).

8. If the initial cooldown rate exceeds Technical Specification Limits, there may be a potential for pressurized thermal shock (PTS) of the reactor vessel. Post-Accident Pressure/Temperature Limits of Figure 6-1 should be maintained.

9. Solid water operation of the pressurizer should be avoided unless subcooling cannot be maintained in the RCS (Figure 6-1). If the RCS is solid, closely monitor any makeup or draining and any system heatup or cooldown to avoid any unfavorable rapid pressure excursions.

10. Minimize the number of cycles of pressurizer auxiliary spray whenever the temperature differential between the spray water and the pressurizer is greater than [200°F] in order to minimize the increase in the spray nozzle thermal stress accumulation factor.

11. If restarting reactor coolant pumps, consideration should be given to choosing pump combinations which will maximize pressurizer spray flow.

12. The operator should continuously monitor for the presence of RCS voiding and take steps to eliminate voiding any time voiding causes heat removal or inventory control safety functions to begin to be threatened. Void

elimination should be started soon enough to ensure heat removal and inventory control are not lost.

13. When a void exists in the reactor vessel, and RCPs are not operating, the HJTC RVLMS provides an accurate indication of reactor vessel liquid inventory. When a void exists in the reactor vessel, and RCPs are operating, it is not possible to obtain an accurate reactor vessel liquid level indication due to the effect of the RCP induced pressure head on the HJTC RVLMS. Information concerning reactor vessel liquid inventory trending may still be discerned. However, the operator is cautioned not to rely solely on the HJTC RVLMS indication when RCPs are operating.

14. It is desirable to have all electrical equipment available in order to most effectively mitigate and recover from a steam generator tube rupture event. Therefore, if any safety division AC or DC is de-energized, operators should attempt to restore power to the lost bus(es). This action is taken even though the loss of one vital AC or DC bus will not prevent the operators from performing all necessary actions in the Steam Generator Tube Rupture ORG.

15. Operators should be aware of the status of CCW supply to the RCPs and, if CCW has been isolated, should restore CCW if possible and desired.

16. The operator should take all steps possible to minimize the possibility of opening main steam safeties on the isolated SG. These steps include; ensuring RCS T_H is below [547°F], ensuring RCS pressure is below [1200 psia], and taking steps to avoid filling the isolated SG. These actions minimize the possibility of opening the main steam safety valve(s) with a resultant uncontrolled release of radioactivity to the environment.

17. When restarting RCPs, it is preferable to first start an RCP in the loop with the operating SG. Starting an RCP in the affected loop could cause a temporary reversal of T_H and T_C indications in the operating loop and minimize the rate of mixing of inventory from the isolated loop.

18. When indicated SG water level is excessively high (100% or greater) the possibility of valve damage and uncontrolled radioactive releases from direct water relief through the ADVs should be considered before steaming the affected steam generator.

19. If there is a conflict between isolating a SG and maintaining adequate heat removal, then maintain RCS heat removal via the least affected SG. At least one SG should always be available for heat removal, if at all possible.

Figure 6-1

TYPICAL POST ACCIDENT PRESSURE-TEMPERATURE LIMITS

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

Figure 6-2

BREAK IDENTIFICATION CHART

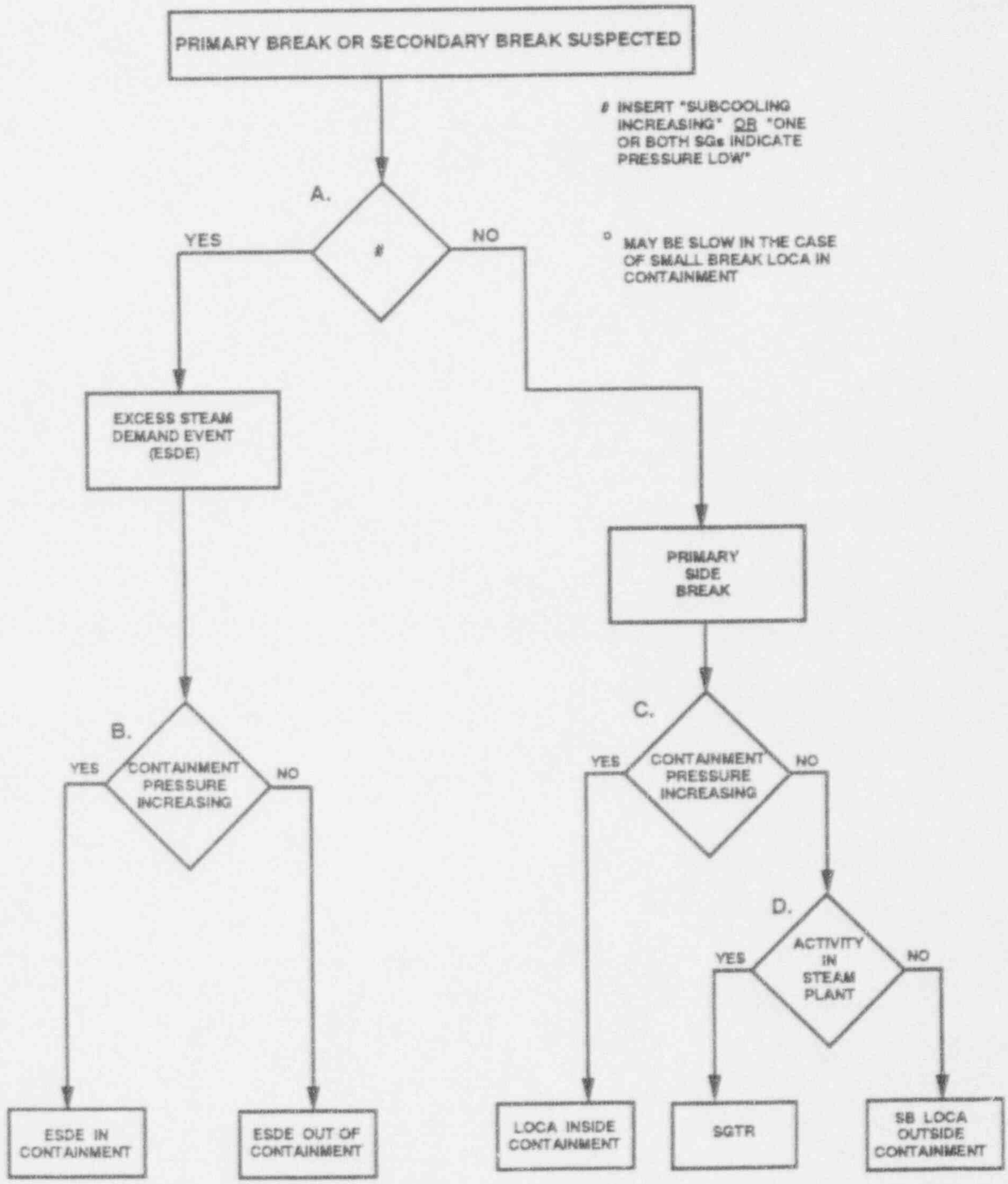
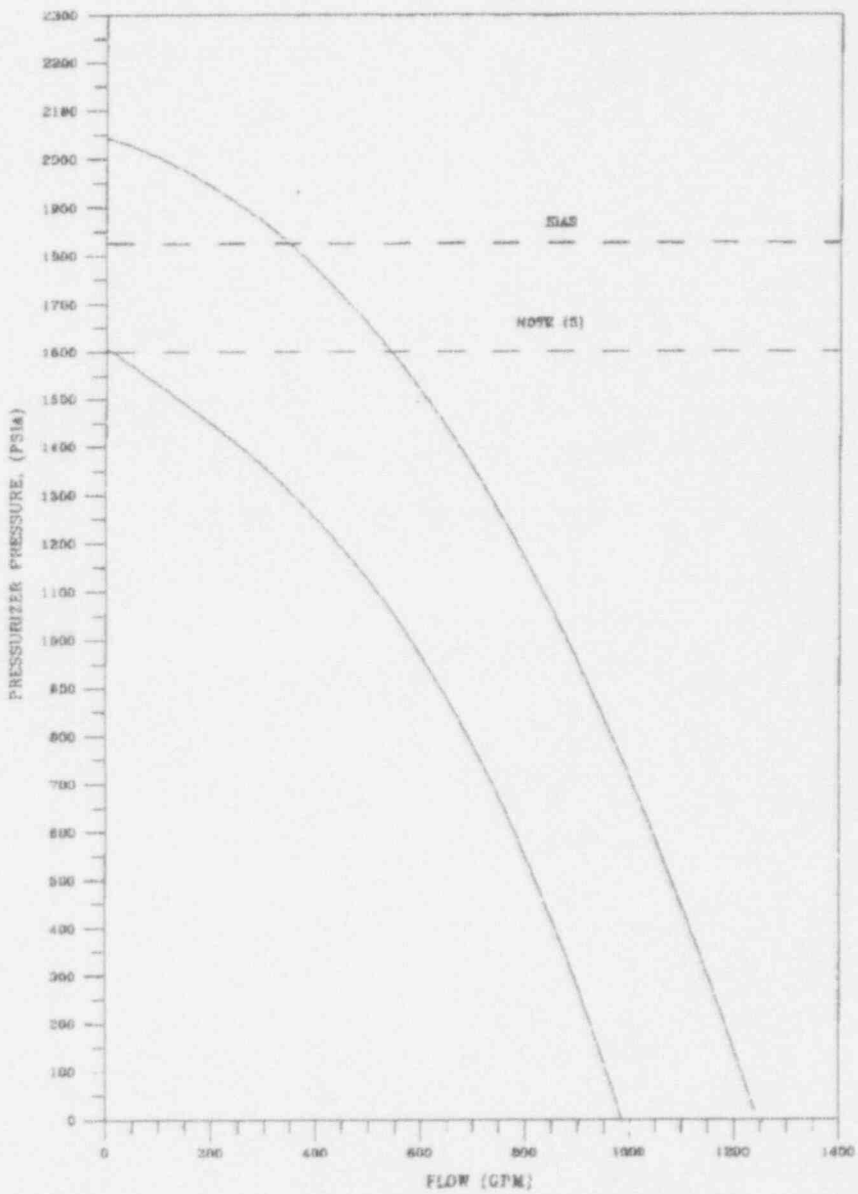


Figure 6-3

TYPICAL ACCEPTABLE SIS FLOW VS RCS PRESSURE[1]

INJECTION MODE[2]



NOTES: (1) SEE IMPLEMENTATION SECTION FOR DEVELOPMENT OF PLANT SPECIFIC CURVE.
(2) FOR HOT LEG AND DVI INJECTION, FULL FLOW FROM SIS PUMPS 1 AND 3 IS DIRECTED TO THE HOT LEGS.
(3) BELOW THE SIAS SETPOINT, THE SIS PUMPS WILL BE OPERATING, BUT THERE WILL BE NO INJECTION FLOW UNTIL SYSTEM PRESSURE FALLS BELOW THE SHUTOFF HEAD OF THE SIS PUMPS.

Figure 6-4

TYPICAL FEEDWATER CAPACITY VS TIME REMAINING UNTIL SHUTDOWN COOLING REQUIRED

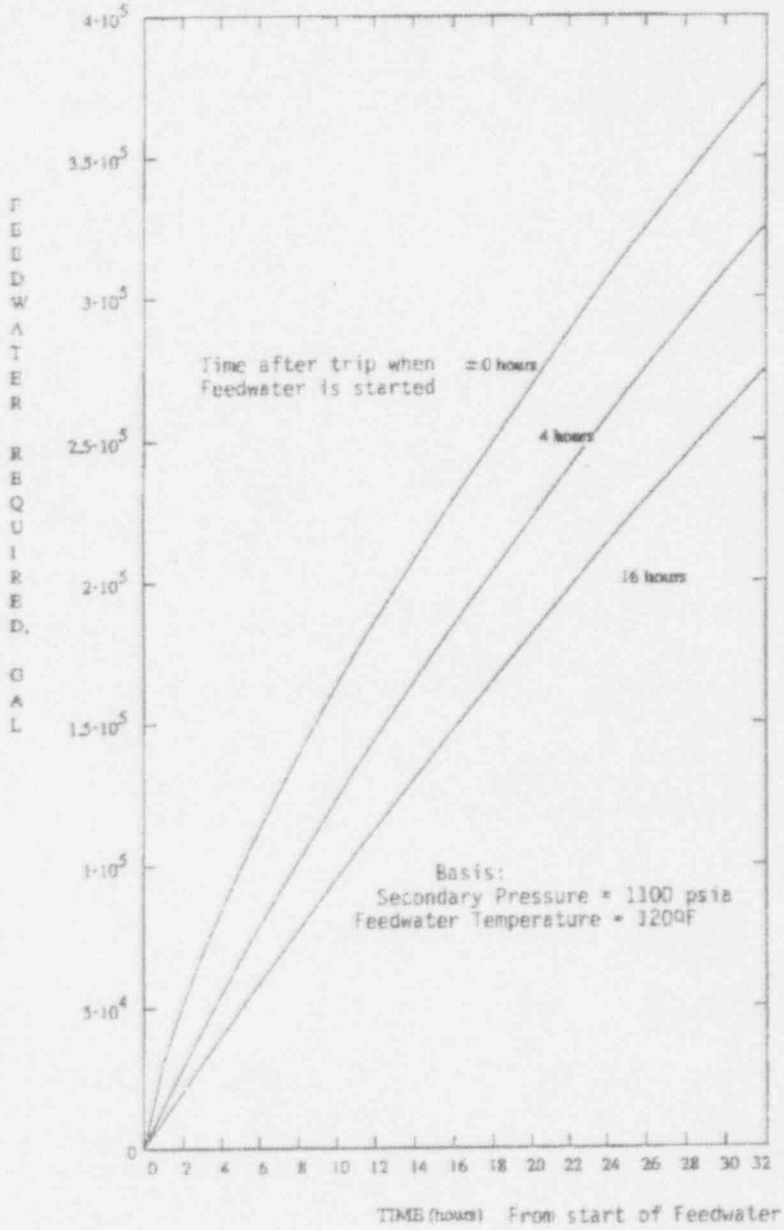


Figure 6-5

TYPICAL FEEDWATER REQUIRED FOR SENSIBLE HEAT REMOVAL

T_{cold} (Required) vs T_{cold} (Initial)

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

SAFETY FUNCTION STATUS CHECK

SAFETY FUNCTION	ACCEPTANCE CRITERIA
1. Reactivity Control	1. a. Reactor power decreasing and b. Negative Startup Rate and c. Maximum of 1 CEA not fully inserted or RCS is borated per Tech Specs.
2. Maintenance of Vital Auxiliaries (AC and DC Power)	2. a. Safety Load Division I energized ~~via Permanent Non-safety Bus X~~ or Safety Load Division II energized ~~via Permanent Non-safety Bus Y~~ and b. i) [125V] DC and [120V] AC Safety Bus A energized and [125V] DC and [120V] AC Safety Bus C energized or ii) [125V] DC and [120V] AC Safety Bus B energized and [125V] DC and [120V] AC Safety Bus D energized

SAFETY FUNCTION	ACCEPTANCE CRITERIA
3. RCS Inventory Control	3.a. If pressurizer level is [2% to 78%], Then: i) charging and letdown, and SI (unless SI termination criteria are met), are maintaining or restoring pressurizer level and ii) the RCS is subcooled and iii) the HJTC RVLMS indicates the core is covered or b. If pressurizer level is less than [2%], Then: i) available charging pump is operating and the SIS pump(s) are injecting water into the RCS per Figure 6-3, and ii) the HJTC RVLMS indicates the core is covered.

SAFETY FUNCTION	ACCEPTANCE CRITERIA
4. RCS Pressure Control	4.a. Pressurizer heaters and spray, or charging and letdown, or SI pumps (unless SI termination criteria met) are maintaining or restoring pressurizer pressure within the limits of Figure 6-1. or b. available charging pump is operating and the SI pump(s) are injecting water into the RCS per Figure 6-3 (unless SIS termination criteria are met).
5. Core Heat Removal	5. T_H RTD and representative Core Exit Thermocouple temperatures less than [626°F].
6. RCS Heat Removal	6.a. The unisolated steam generator has level: i) within the normal level band with feedwater available to maintain level or ii) being restored by feedwater flow with increasing level and

SAFETY FUNCTION	ACCEPTANCE CRITERIA
6. RCS Heat Removal (Continued)	6.b. RCS T_H is less than [547°F] *and* c. RCS temperature is controlled by turbine bypass system or ADVs.
7. Containment Isolation	7.a. Containment pressure less than [2.0 psig] *and* b. No containment area radiation monitors alarming *and* c. No abnormal increase in IRWST or containment sump levels. *and* d. No Nuclear Annex alarms
8. Containment Temperature and Pressure Control	8.a. Containment temperature less than [110°F] *and* b. Containment pressure less than [2.0 psig.]
9. Containment Combustible Gas Control	9.a. Containment temperature less than [110°F] *and* b. Containment pressure less than [2.0 psig.]

BASES

The bases section of the Steam Generator Tube Rupture (SGTR) Recovery Guideline describes the SGTR transient in relation to the actions which the operator takes during a SGTR. The purpose of the bases section is to provide the operators with information which will enable them to understand the reasons for, and the consequences of, the actions they take during a SGTR.

Characterization of a SGTR Event

The Steam Generator Tube Rupture accident is a penetration of the barrier between the reactor coolant system (RCS) and the main steam system. The penetration can range from the failure of an etch pit, a small crack in a U-tube or weld joining the U-tube to the tube sheet, to a single tube double-ended rupture, to multiple ruptures in one generator, or to simultaneous ruptures in both generators. The inside diameter of a steam generator tube is [0.67 inches]. A complete severance of a tube which allows reactor coolant to flow out both ends has an equivalent flow area of approximately [0.7 square inches]. This size may be compared to 0.072 square inches, the smallest hole which is classified as a Loss of Coolant Accident. The flowrate for a Steam Generator Tube Rupture differs from the classic Loss of Coolant Accident in that the backpressure opposing flow is the steam generator pressure instead of the containment pressure.

For the double ended rupture of one steam generator tube, without operator action, a reactor trip is expected within 15 minutes after rupture. Multiple tube failures could result in a more rapid plant response. Ruptures within charging system capacity will not result in a continuously decreasing pressurizer level and pressure, since the automatic operation of the PLCS may stop the decrease. An automatic reactor trip may not occur and a controlled reactor shutdown should be performed using the appropriate non-emergency procedures.

A steam generator tube rupture is characterized by specific parameters that are indicated in the control room. Some of these indications are:

a. Radiation monitors indicating an increase in activity levels at the vacuum pump discharge, at the steam generator blowdown lines, at the turbine or nuclear annex building ventilation monitors, at the stack monitor, in the steam generator liquid sample, and/or the steamline area and/or N-16 monitor.
b. Decreasing level in the volume control tank.
c. An unaccounted for increase in the charging and/or a decrease in the letdown system flowrates.
d. Relatively constant temperature and power indications prior to reactor trip or operator intervention.
e. Steam generator water level either remaining relatively constant (indicating a small rupture) or increasing slowly (indicating a large rupture) due to the primary to secondary leakage incurred.
f. Containment temperature and pressure remaining unchanged.

<u>Safety Functions Affected</u>

The Steam Generator Tube Rupture accident directly affects two safety functions. One is RCS inventory control. The second safety function affected is containment isolation since the reactor coolant boundary has been broken and control of the spread of contamination is provided by secondary plant alignment and isolation. All safety functions should be monitored to assure public safety.

The general goals related to controlling RCS inventory and radionuclide containment are met by controlling leakage between the primary and secondary systems and, after isolating the leaking steam generator, by avoiding opening the leaking steam generator's main steam safety valves. Primary to secondary leakage is minimized by minimizing the pressure differential between the reactor coolant system and the steam generators. The steam generator safety valves can be lifted in two ways. Adding heat to the steam generator causes steam generator pressure to increase, which in turn causes the safety valves to lift. A second way to lift steam generator safety valves is to have RCS leakage into the steam generator with the RCS pressure greater than the steam generator safety valve setpoint. This second process has a time delay built into it. The pressure drop across the steam generator tube rupture keeps the steam generator from seeing high RCS pressure until the steam generator fills sufficiently to drive steam generator pressure up. The optimum response to control RCS inventory and radionuclide containment is to minimize RCS and steam generator pressure differential as soon as possible while lowering RCS pressure below the steam generator safety valve setpoint and to control RCS temperature to preclude lifting steam generator safety valves by heat transfer to the steam generators.

RCS inventory control is affected in the following manner. The rupture size determines when an automatic reactor trip occurs. For example, the inventory loss out a double-ended tube rupture will exceed the total maximum charging flow into the RCS. Consequently, pressurizer level and pressure decrease and a reactor trip occurs. Pressure and level fall rapidly following the trip, usually emptying the pressurizer and initiating an SIAS. If the pressurizer level decreases to less than [14.3%], all heaters are deenergized due to low pressurizer level. RCS inventory loss is controlled by minimizing the differential pressure between the RCS and the steam generators. Inventory control for the SGTR is dependent on RCS and steam generator pressure control.

Containment Isolation is the second safety function challenged by the SGTR. In addition to the loss of reactor coolant caused by a Steam Generator Tube Rupture, fission products and activated corrosion products normally suspended in the reactor coolant will be transferred from the primary to the secondary plant. Steam plant vents and exhausts provide a potential path to the environment for the radioactive products. The transfer of fission and activated corrosion products from the RCS to the affected steam generator will result in increased levels of activity in the steam generator liquid sample. A high radiation alarm could occur in the steam generator blowdown monitoring system. Activated products (mostly noble gases and nitrogen-16) will be carried into the steam plant by the main steam flow. The N-16 monitors on the steamlines may alarm if the power level is above about 25%. The non-condensible gases may eventually be exhausted to the environment by way of the stack via the condenser vacuum pump exhaust and may alarm the radiation monitoring system. As a result of gases being emitted and the build-up of activity in the affected steam generator, general area radiation levels in the turbine and possibly the Nuclear Annex Building will increase and may cause area radiation monitors to alarm. Ventilation exhaust and stack monitors may also alarm. For double ended tube ruptures at powers above 25%, the expected order of alarms is: steamline monitors, vacuum pump discharge, blowdown, ventilation and stack monitors. For small tube leaks, the first indication may be a high activity level in the steam generator liquid sample.

In this SGTR recovery guideline, containment isolation is accomplished in several stages. A step is provided which cools the RCS so that once the damaged steam generator is isolated, the RCS cannot transfer enough heat into it to cause its safety valves to open. The steps to detect and isolate the damaged steam generator are provided. The actions provided to control RCS inventory and RCS pressure minimize the release of radioactivity through the steam generator safety valves.

Trending of Key Parameters

Reactor Power (Figure 6-6)

In response to a steam generator tube rupture, reactor power initially remains constant. Ruptures exceeding the capacity of the available charging pump will result in a reactor trip on DNBR in a time dependent upon the size of the rupture.

RCS Temperature (Figure 6-7)

The RCS temperatures remain relatively constant until the reactor trips. Following the reactor trip, the RCS hot and cold leg temperatures will decrease to approximately the hot standby values if reactor coolant pumps are running. If all reactor coolant pumps are stopped, RCS temperatures are expected to stabilize near hot zero power values with hot leg temperature less than fifty degrees greater than cold leg temperature in the loop or loops with natural circulation flow established.

Pressurizer Pressure (Figure 6-8)

Pressurizer pressure response is dependent on the severity of the tube rupture. For small ruptures the pressure will remain relatively constant due to the ability of the PPCS to respond. For more extensive ruptures, a continual and sometimes rapid decrease in pressure will be seen, and without operator action a DNBR reactor trip will occur. If pressure continues to fall and goes below the SIAS setpoint and subsequently below the SI pump shut-off head, the SIS is expected to restore RCS pressure and inventory control.

Pressurizer Level (Figure 6-9)

Pressurizer level will remain relatively constant for small ruptures due to the ability of the PLCS to make up for inventory losses. For larger tube ruptures, a slowly decreasing level will be seen. If the ruptures are large enough to cause the level to fall below the heater cutout setpoint, the subsequent pressure decrease will cause an SIAS and inventory control is expected to be restored.

Reactor Vessel Level (Figure 6-10)

For tube ruptures which are small enough so that the PPCS and PLCS can make up the pressure and inventory decreases, no RVUH voiding is expected. The loss of primary coolant for a double-ended rupture of one tube will result in constantly decreasing pressure and level. Voids will form in the RVUH if the RCS pressure reaches the saturation pressure of the hottest RCS temperature. The void is not expected to drop below the RCS hot leg however, due to inventory replacement via the SIS.

Steam Generator Pressure (Figure 6-11)

Steam generator pressure remains relatively constant until reactor trip. The reactor trip causes a turbine trip, and the reactor trip initially causes a slight dip in S/G pressure, followed by a rapid rise in steam generator pressure due to the reduced steam demand. The steam bypass system automatically actuates to control main steam pressure. The pressure is eventually reduced to the hot standby value (which is higher than operating steam generator pressure at full power).

Steam Generator Level (Figure 6-12)

Following the reactor trip, the level in both steam generators will shrink to the usual post trip level. Steam generator water level will be relatively unaffected for small ruptures. Large ruptures usually cause a slow increase in level in the affected steam generator if level control is in the manual mode. Otherwise S/G level will remain relatively unchanged. In general, level experiences a sharp decrease following the reactor trip and turbine trip, followed by a steady increase due to the rupture and feedwater control system until the hot zero power level is reached. If the rupture is large enough, especially after the affected steam generator has been isolated, level may increase enough in the affected steam generator to fill the steam generator unless appropriate actions are taken.

Figure 6-6

REPRESENTATIVE SGTR EVENT CHARACTERISTICS

REACTOR POWER

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

Figure 6-7

REPRESENTATIVE SGTR EVENT CHARACTERISTICS

RCS NARROW RANGE TEMPERATURES

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

Figure 6-8

REPRESENTATIVE SGTR EVENT CHARACTERISTICS

PRESSURIZER WIDE RANGE PRESSURE

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

Figure 6-9

REPRESENTATIVE SGTR EVENT CHARACTERISTICS

PRESSURIZER LEVEL

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

Figure 6-10

REPRESENTATIVE SGTR EVENT CHARACTERISTICS

COLLAPSED LEVEL ABOVE FUEL ALIGNMENT PLATE

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

Figure 6-11

REPRESENTATIVE SGTR EVENT CHARACTERISTICS

AFFECTED STEAM GENERATOR PRESSURE

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

Figure 6-12

REPRESENTATIVE SGTR EVENT CHARACTERISTICS

AFFECTED STEAM GENERATOR WIDE RANGE LEVEL

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

Guideline Strategy and Information Flow

Figure 6-13 provides the reader with a summary description of the SGTR Recovery Guideline strategy and information flow.

If a SGTR is initiated from MODE 1 or MODE 2, the operator performs the Standard Post Trip Actions and diagnoses the event prior to entering the SGTR Recovery Guideline. However, if the event is initiated from MODE 3 or MODE 4, the operator is not directed to the Standard Post Trip Actions since they may not apply. Instead, the operator ensures that the SGTR is properly diagnosed and that the specified entry conditions are met prior to entering the SGTR Recovery Guideline.

The first steps of this guideline require a verification that these actions have been performed and require the operator to use the SGTR Safety Function Status Check to confirm that the plant is recovering. The next steps can be broken into four major recovery actions. The four major recovery actions carry the plant to Shutdown Cooling System (SCS) entry conditions. The first major action consists of cooling the RCS using both SGs until the RCS T_H is lower than [547°F]. This initial cooldown is done prior to isolating the affected SG. This action reduces the risk of challenging the steam generator safety valves of the affected SG after it is isolated. The second major action consists of detecting and isolating the affected SG. This terminates further uncontrolled radioactive releases from the affected SG. In the third major action, the RCS pressure is reduced and then maintained approximately equal to or within ~~100~~ 50 psi above the isolated SG pressure. This action allows the operator more control of leak flow from the RCS to the SG through the break. The fourth major action consists of cooling the plant, using either forced circulation or natural circulation in the RCS, to SCS entry conditions. This cooldown is performed using the unisolated SG. The isolated SG should also be cooled and depressurized along with the RCS.

A more detailed flow chart illustrates the SGTR Recovery Guideline strategy and lists all guideline steps. Refer to Figure 6-19.

Figure 6-13a

STEAM GENERATOR TUBE RUPTURE

GUIDELINE FLOWCHART

(FLOW AND STRATEGY CHARTS WILL REFLECT THE DETAILED STEPS IN THE GUIDELINE.)

Figure 6-13b

STEAM GENERATOR TUBE RUPTURE

GUIDELINE FLOWCHART

(FLOW AND STRATEGY CHARTS WILL REFLECT THE DETAILED STEPS IN THE GUIDELINE.)

BASES FOR SGTR OPERATOR ACTIONS

The operator actions are directed at recovering the plant from the SGTR, and placing it in a safe, stable condition. Actions are taken to ensure that a proper heat sink for the reactor is being maintained, and that radiation releases are minimized.

*1. The diagnosis of a Steam Generator Tube Rupture should be confirmed using the Break Identification Chart (Figure 6-2) and by comparing control board parameters to the acceptance criteria in the Safety Function Status Check to ensure that all safety functions are being satisfied. In particular, the operator should note the status of RCS subcooling and containment and steam plant activity. These parameters provide a means of discriminating between SGTRs and LOCAs/ESDEs. For a SGTR, steam plant activity monitors may be alarming but containment activity monitors should not be alarming. For LOCAs, the RCS reaches saturation conditions and containment activity monitors may be alarming, but steam plant activity monitors should not be alarming. For ESDEs, neither steam plant nor containment activity monitors should be alarming. ESDEs which occur in plants which exhibit SG tube leakage may result in increases in steam plant or containment activity. Sampling both steam generators for activity will assist in confirming the diagnosis of a SGTR. These actions ensure that the proper guideline is being used to mitigate the effects of a SGTR.

If the initial diagnosis of a SGTR is confirmed, then the operator should continue with the actions of this guideline. However, if the initial diagnosis of a SGTR is not confirmed, and the operator determines that an ESDE or LOCA has occurred, then the SGTR ORG should be exited and the proper procedure should be implemented. This step allows the operator to switch to the proper procedure for those events which may have occurred having similar symptoms to a SGTR (LOCA, ESDE). If a diagnosis of one event cannot be made, then the Functional Recovery

Figure 6-14a

RCP TRIP STRATEGY FOR SGTR

(FLOW AND STRATEGY CHARTS WILL REFLECT THE DETAILED STEPS IN THE GUIDELINE.)

Figure 6-14b

RCP TRIP STRATEGY FOR SGTR

(FLOW AND STRATEGY CHARTS WILL REFLECT THE DETAILED STEPS IN THE GUIDELINE.)

Guideline (FRG) should be implemented. The FRG is safety function based and will ensure that all safety functions are addressed regardless of what event(s) is occurring.

*2. If the Steam Generator Tube Rupture is large enough to decrease pressurizer pressure to or below the SIAS setpoint of [1825 psia], then SIAS should be initiated automatically. If this does not occur, then the operator should manually initiate SIAS.

*3. A SGTR may result in actuation of the safety injection system. If SIAS is actuated, then the available charging pump and SIS pumps should be operating and injecting water into the RCS. The SIS flowrate will vary according to pressurizer pressure. The SIS and charging flowrates should be checked and maximized (Figure 6-3 provides information which can be utilized to verify adequate SIS flow is occurring) for RCS inventory replenishment and/or core heat removal. The charging pump may have to be manually restarted if an interruption of electrical power to the charging pump bus(es) has occurred. The following guidance will assist in ensuring maximum injection of water into the RCS:

a. idle SIS pumps should be started and system flow should be verified to be within the limits of Figure 6-3, unless SI termination criteria have been met,
b. idle charging pump should be started.

If any SIS pump that should be operating won't start, no charging pump will start, or SIS flow is not in accordance with Figure 6-3, then the following guidance is provided:

a. the operator should verify that electrical power is available to valves and pumps necessary for inventory control,
b. the SIS valve lineup should be verified correct from control board indications,

c. auxiliary systems necessary for SIS or charging operation should be checked.

It must be noted, however, that the maximization of charging and safety injection can result in excess RCS inventory, possible filling of the pressurizer to a solid condition, and a PTS concern upon RCS heat up, fluid expansion, and subsequent RCS pressure excursion. Operators must be aware of these concerns and terminate or throttle SIS pumps when the criteria are met.

*4. Steps 4 and 5 contain guidance regarding the RCP operating strategy for a SGTR (Figure 6-14). A generic RCP trip strategy has been developed which results in the tripping of all four RCPs for depressurization events where RCS is not subcooled, but allows the continued operation of two RCPs (in opposite loops) for depressurization events where RCS is subcooled. For undiagnosed events, where the Functional Recovery Guideline is implemented, the RCP trip strategy is identical to that followed in the LOCA guideline. Steps 4 and 5 detail the two significant operational aspects regarding the RCP trip strategy for a SGTR.

The first operational strategy results in the operator tripping two RCPs (in opposite loops) if pressurizer pressure decreases to less than [1400 psia] following a SIAS and RCS is subcooled. This action may occur in the Standard Post Trip Actions and, in this case, the operator would simply verify that two RCPs (in opposite loops) have been tripped. The operator trips all four RCPs if pressurizer pressure decreases to less than [1400 psia] following a SIAS and RCS is not subcooled. If the operator cannot confirm that a SGTR has occurred, and the Functional Recovery Guideline is implemented, the RCP trip strategy is identical to that followed in the LOCA guideline. If the depressurization event can be diagnosed and is determined to be other than a LOCA (i.e., ESDE or SGTR), then only two RCPs (in opposite loops) are tripped. The other two RCPs remain operational until one or more of the RCP operating requirements (e.g., NPSH, temperatures, seal flow, oil pressures, motor amperage, vibration) are not longer satisfied, then, any pump which does not satisfy these requirements should be tripped. This gives the operator maximum flexibility in plant control because a normal plant cooldown can be performed while still ensuring a conservative approach to event recovery.

*5. The second aspect of the RCP operating strategy concerns the verification that RCP operating limits are satisfied. The RCPs will be operating in a pressure-reduced RCS and may not satisfy NPSH requirements. The operator must continuously monitor RCP operating limits (e.g., temperatures, seal flow, oil pressures, NPSH, motor amperage, vibration) and trip any RCPs which do not satisfy RCP operating limits. Plant specific RCP operating limits appear in the operating instructions.

6. The goal of this step is to verify that the RCS hot leg temperature has been decreased to less than [547°F] prior to isolating the affected SG in order to prevent lifting main steam safety valves in the affected SG. Under natural circulation flow conditions, T_H will increase approximately [15°F] as the core ΔT increases as a result of the change from two loop to one loop heat removal. The temperature in the isolated SG will be essentially T_H since it is no longer being used as a heat sink. The first bank MSSVs open at [1200 psia] which corresponds to a saturation temperature of [567°F]. Allowing a [5°F] margin and accounting for a [15°F] rise in T_H results in a value of [547°F] for isolating the affected SG. For forced flow conditions, the increase in T_H at the time the SG is isolated is negligible (1°F). Thus, this strategy will cover both forced and natural circulation conditions. If RCS hot leg temperature is not less than [547°F] the operator will manually cooldown the RCS. This action should be performed

preferentially by feeding the steam generators with main, startup or emergency feedwater and dumping steam to the condenser via manual control of the turbine bypass system. If the condenser or turbine bypass system is not available, the next order of priority for discharging steam would be to use the steam generator blowdown system with discharge to the condenser, followed by use of the atmospheric dump valves. It is less desirable to use the atmospheric dump valves to cooldown the RCS because of the release of activity to the environment.

This step is presented before the leaking steam generator has been identified and isolated. This step is most easily accomplished when RCPs are operating and when one or more steam generators are providing cooling. If all RCPs have been tripped and natural circulation is the heat removal process, then it is necessary to cooldown both steam generators to provide uniform RCS cooling. Therefore, if forced circulation is available, this step can be done in parallel with steps 8 and 9, detecting and isolating the affected steam generator. If forced circulation is not available, this step should be done in parallel with step 8, but completed before going on to step 9.

Natural circulation cooldown of the RCS is not an effective method for cooling the RV head region. If natural circulation cooling provides the reduction of T_H to less than [547°F], heat transfer to the steam generator from the RCS loops will not cause lifting of the secondary safety valves. However, the energy stored in the RV head region and pressurizer has to be dealt with to bring RCS pressure close to steam generator pressure to minimize leakage into the steam generator and to preclude steam generator safety valve opening due to filling the steam generator with high RCS pressure. Controlling RCS pressure with the pressurizer and with an uncooled RV head region is addressed in a later step.

7. Steam generator levels are to be maintained in the normal band using main, startup or emergency feedwater. This ensures that an adequate heat sink for removing heat from the RCS is available while steaming both SGs.

8. The steam generator with the tube rupture should be determined by performing the following steps. These steps include:

   a. Sampling the steam generators for activity,
   b. Monitoring the main steam piping for activity using the steam pipe area monitors and the steam pipe nitrogen-16 monitors,
   c. Monitoring steam generator levels,

9. The steam generator with higher activity, higher radiation levels, or increasing water level should be isolated. Reducing RCS temperature to below the saturation temperature associated with the lowest pressure setpoint of the steam generator safety valves is one of the actions necessary to prevent opening a direct path to the environment for radionuclides after steam generator isolation. Steam generator isolation is an attempt to re-establish the containment isolation safety function. To maintain SG pressure below the MSSV setpoint, manual operation of the ADV is used. Should the pressure in an isolated steam generator approach the lift setpoint for the associated MSSVs, it is desirable from the perspective of positive operator control that the ADV open first. This is accomplished by manually opening the ADV at [1150 psia] increasing, or locally opening the ADV at [1150 psia]. The value of [1150 psia] was chosen based on the MSSV setpoint of [1200 psia] minus an operating margin of [50 psi]. To minimize the unmonitored release of radioactivity, use of the atmospheric steam dump valves on the affected steam generator should be minimized. If both steam generators have tube ruptures, then the operators must determine which generator is most affected and isolate that generator.

The most affected steam generator is isolated as follows:

a. The main steam isolation valve is closed.

b. The main steam isolation valve bypass valve is verified closed, or closed.

c. The atmospheric steam dump valve is verified closed or closed.

d. The main feedwater isolation valve is closed.

e. The emergency feedwater isolation valves are closed, including the steam driven pump steam supply valve associated with the steam generator being isolated.

f. Steam generator blowdown is isolated.

g. Vents, drains, exhausts, and bleedoffs from the steam system are isolated. The crosstie to the auxiliary steam header is isolated. This completes the isolation of the radionuclides still in the secondary system to prevent further releases to the environment.

10. Once the steam generator has been isolated, isolation of the correct (most affected) steam generator should be verified by checking radiation indications, sampling for activity, and noting any possible increase in the isolated steam generator level. This provides feedback that the correct steam generator has been isolated. If the wrong steam generator has been isolated then it should be unisolated and the most affected steam generator should be isolated per step 9.

*11. The general goals associated with RCS pressure control are: providing subcooling to support the core heat removal process, avoiding overpressure situations for PTS and RTNDT considerations, minimizing the pressure differential between the steam generator and the RCS to minimize the leakage, and controlling RCS pressure so that it is below the steam generator safety valve setpoints. This step addresses steam generator to RCS pressure differential and RCS depressurization to below the SG safety valve setpoint.

Maintaining the RCS pressure approximately equal to but above the isolated steam generator pressure (-0, +50 psi) and below the steam generator safety valve setpoint, [1200 psia], will minimize the loss of primary fluid to the secondary side and the possibility of overfilling the isolated SG. This is accomplished by either using main spray (the preferred method), auxiliary spray, operation of reactor coolant gas vent system (RCGVS) on the pressurizer, operation of charging and letdown, or throttling of the SI pumps. This action will minimize the potential for release of radiation to the environment by minimizing RCS to steam generator leakage.

Maintaining RCS pressure approximately equal to SG pressure (-0, +50 psi) prevents backflow from the secondary system to the primary system while minimizing primary to secondary leakage.

A key point in the strategy for the SGTR event involves maintaining or restoring forced circulation. However, maintaining subcooling and adequate NPSH for RCP operation may cause the operator to hold RCS pressure above secondary pressure by the amount needed to provide adequate subcooling. This requirement takes precedence over the procedural strategy of bringing primary pressure to the point where it will be approximately equal to secondary pressure.

During the forced circulation cooldown process the lower region of the isolated steam generator may cool faster than the upper region (see Figure 6-15). The cooling of the isolated SG steam space will significantly lag in the cooldown and cause the fluid in the lower regions to be subcooled. If the tube rupture is located in this subcooled region, then the primary fluid can be at the same pressure as the secondary fluid and still be subcooled. However the continued depressurization of the primary during the cooldown will now be limited by the ability to depressurize the isolated SG (Step 26 provides guidance on isolated SG depressurization).

During natural circulation cooldown conditions the isolated steam generator will take considerably longer to cool unless there is a transfer of mass in the isolated SG. This complicates RCS pressure control during the cooldown. It is desirable to cool the RCS such that the tube bundle region of the affected SG remains subcooled. Voiding in the tube bundle region can be expected and may result in the region becoming a pressurizing source for the RCS (Step 32 provides guidance on void detection and elimination). Maintaining the presence of subcooled liquid in the affected loop will be a complicated process under natural circulation conditions. Forced circulation conditions are much more desirable and if possible should be maintained or restored. During natural circulation conditions the cooldown and depressurization of the RCS will be limited to the operator's ability to control the conditions of the isolated steam generator.

*12. Maintaining RCS pressure within the acceptable limits of Figure 6-1 helps to ensure the core is covered by subcooled fluid and minimizes the concern for pressurized thermal shock by keeping plant pressure below the [200°F] subcooling limit. This is accomplished by controlling RCS heat removal via the unisolated steam generator, and controlling RCS pressure as discussed in Step 11.

If subcooling or the cooldown limits of Figure 6-1 are being violated, then the operators should take actions to restore the RCS to within the P-T limits. Depending on the situation, the operator should perform the following actions as appropriate:

a. Stop the cooldown.
b. Operate RCGVS or main or auxiliary spray as necessary to restore pressurizer pressure to within the P-T limits of Figure 6-1.
c. Attempt to maintain the plant in a stable pressure-temperature configuration. The cooldown may be continued, if desired, within the limits of Figure 6-1,

d. If an overpressure situation exists and is caused by SI and/or charging flow, then throttle or stop SI (refer to step 14) or charging pumps and manually control letdown to restore and maintain pressure within the Post Accident P-T limits of Figure 6-1.

*13. The potential exists for filling of the isolated steam generator steam space and the main steam piping up to the MSIV. This action could result in the inadvertent opening of the MSSVs and an undesirable spread of contamination and the potential for main steam piping support snubber damage.

Draining to the radioactive liquid waste system or blowdown to the condenser will reduce level and minimize the spread of contamination and the possibility of piping support snubber damage although the piping up to the MSIVs is designed for static liquid water. If the generator draining is not feasible or is insufficient, then steaming the generator to the condenser will reduce level and minimize radioactivity release. Water hammer damage should be avoided by not reopening the affected MSIV while a significant amount of water is in the main steam piping. Draining to the radioactive waste system or blowing down to the condenser or reducing RCS pressure below the isolated steam generator pressure can lower steam generator level. The off-site dose coordinator should assess the radioactive releases to the environment. The value of [95%] was chosen to prevent overfilling the steam generator by ensuring the level remains in the indicated range. The value of [40%] was chosen to ensure all tubes remain covered, which minimizes the potential of radioactive fission products reaching the steam generator steam space.

Figure 6-15

ISOLATED STEAM GENERATOR WITH TUBE RUPTURE

(ILLUSTRATIONS WILL REFLECT THE PROCESSES DESCRIBED IN THE GUIDELINE)

*14. If the SI pumps are operating, then they must continue to operate at full capacity until SI termination criteria are met. Termination of SI should be sequenced by stopping one pump at a time while observing the termination criteria. Throttling of SI flow is also permissible if all of the following SI termination criteria are satisfied:

a. RCS is subcooled based on representative CET temperature (Figure 6-1). Establishing subcooling ensures the fluid surrounding the core is subcooled, and provides sufficient margin for re-establishing flow should the subcooling deteriorate when SI flow is secured. Voids may exist in some parts of the RCS (e.g., reactor vessel head, as determined by the HJTC RVLMS), but these are permissible as long as core heat removal is maintained.

b. Pressurizer level is greater than 14.3% and not decreasing. A pressurizer level greater than 14.3% and not decreasing, in conjunction with criterion a) above, is an indication that RCS inventory control has been established. This level also ensures the heaters are covered.

c. The unisolated steam generator is available for removing heat from the RCS. A steam generator having the ability for feed flow and steam flow is available for removing heat from the RCS.

d. The HJTC RVLMS indicates a minimum level at the top of the hot leg nozzles. This provides an extra margin of core coverage and, taken in conjunction with the above, serves as an additional indication that adequate RCS inventory control has been established.

If all of the SI termination criteria are met, then the operator may either stop or throttle the SI pumps. The operator may decide to throttle, rather than terminate the flow, if the SI is to be used to control pressurizer level or plant pressure. A general assessment of the SI performance can be made from the control room. The operator should confirm that at least one train and preferably both trains of SI are operating and that system delivery rate is consistent with RCS pressure as shown in Figures 6-17 and 6-18. Injection flow rates to each Direct Vessel Injection (DVI) nozzle should be approximately equal. Departures from this would indicate a closed or misaligned flow path or some system leakage in addition to the SGTR.

*15. If the criteria of steps 14 cannot be maintained after SI pumps are throttled or stopped, then the appropriate SIS pumps should be restarted (if necessary) and full SI flow restored.

*16. Pressurizer level should be restored and maintained at [2% to 78%] by control of charging and letdown (preferentially) as necessary, and SI pumps. If SI termination criteria are met, then SI pumps may be throttled or stopped. When pressurizer level is being controlled at [2%] or greater, then the charging pump may be operated as necessary. A pressurizer level of [2% to 78%] should be restored and maintained to avoid losing pressure control with a saturated bubble in the pressurizer. The top of the pressurizer heaters is at [14.3%]. If pressurizer level drops below the heaters, pressurizer heater operation will be interlocked off for heater protection. It may be necessary to exceed [78%] pressurizer level if the operator is attempting to restore RCS subcooling since pressurizer heaters may be unavailable and solid water operation may be necessary to restore subcooling. The value of [2%] was chosen based on preventing the operator from draining the pressurizer. The value of [78%] is based on the operator maintaining an operable bubble in the pressurizer.

*17. Plant conditions should be carefully assessed before any RCPs are restarted. The need for forced circulation operation should be balanced against the risk of damage to the RCP seals.

The need for operation of the RCPs should be evaluated based on:

1. the adequacy of the RCS and core heat removal under the existing natural circulation conditions,
2. the existing RCS pressure and temperatures,
3. the need for main pressurizer spray capability.

If the existing natural circulation is providing satisfactory RCS and core heat removal, a transfer to forced circulation operation may not be necessary. This would be particularly true if the RCS had already been cooled and depressurized to SCS entry conditions. If the RCS pressure and temperatures are closer to hot standby conditions, it may be desirable to restart the RCPs in order to allow a normal forced circulation cooldown. Consideration should also be given to the necessity of having main pressurizer spray capability if auxiliary spray is not providing the desired depressurization rate.

The potential for RCP seal degradation should be evaluated based on:

1. how long CCW to the RCPs was interrupted,
2. RCP seal staging pressures and temperatures.

The possibility for seal degradation increases if the CCW has been interrupted. The seal staging pressures provide an indication of degraded seal stages (a low pressure drop across a stage indicates a problem). Restart of an RCP with one or more degraded seal stages should be avoided if possible.

*18. If all RCPs have been stopped, then operation of two RCPs (in opposite loops) should be attempted if RCP restart criteria are met. This will ensure continued forced circulation of coolant through the core, cooling of the RV head region, provide the capability for the normal mode of pressurizer spray, condense RCS steam voids, and remove non-condensible gases from the SG tube bundle. Furthermore, this action enhances the strategy to obtain an uncomplicated cooldown, since a forced circulation cooldown is preferred to a natural circulation cooldown whenever possible during recovery from a SGTR. Only one reactor coolant pump in each loop should be operated to minimize heat input to the RCS.

Determine whether RCP restart criteria are met by the following:

a. Electrical power available to the RCP.

b. RCP auxiliaries ([in particular, Component Cooling Water]) to maintain seal cooling bearing and motor cooling should be operating in order to prevent damage to the pump and/or motor. Note: [Following automatic or operator initiated containment isolation, reinstatement of one of the following means of RCS seal cooling ([CCW], [CVCS seal injection (SI)], [Dedicated Seal Injection System (DSIS)], should be considered to ensure adequate RCP cooling]. There should be no high temperature alarms on the RCPs to be operated.

c. The unisolated steam generator is available for removing heat from the RCS. A steam generator having the ability for feed flow and steam flow is available for removing heat from the RCS.

d. Pressurizer level is greater than [33%] and not decreasing. With pressurizer level above [33%] the possibility of draining the pressurizer due to loop shrinkage and/or steam void condensation is minimized and there is a greater likelihood of keeping the pressurizer heaters covered. This will assist in maintaining positive RCS pressure control. The criterion of pressurizer level not decreasing implies that RCS inventory control has been established. The value of [33%] was determined by assuming a void in the RCS equal to one-half the volume of the reactor vessel head and determining the volume required in the pressurizer to compensate for that void collapse with draining the pressurizer (i.e., level > [2%]).

e. RCS is subcooled based on representative CET temperature. A subcooled condition in RCS taken in conjunction with d) above indicates that adequate inventory control has been established.

f. All plant specific RCP operating criteria are satisfied before the RCPs are restarted to prevent damage to RCPs resulting from abnormal operating conditions.

*19. Upon restarting two RCPs in opposite loops, pressurizer level and pressure may decrease due to loop shrinkage and/or steam void condensation. It is possible that this action will drain the pressurizer. Steam voids present in the reactor vessel will condense upon restarting RCPs. The HJTC RVLMS should be monitored for the trending of reactor vessel liquid level. This trending information may be correlated to pressurizer level decrease. RCP operation with a drained pressurizer may continue provided certain actions are taken and certain criteria are satisfied.

The following constitute the actions to be taken and the criteria to be satisfied when restarting RCPs:

a. Start one RCP in the unaffected loop.
b. Ensure proper RCP operation by monitoring RCP amperage and pump NPSH. NPSH is determined by pressurizer pressure and corresponding Tc on Figure 6-1
c. Operate charging (and SI) pumps to maintain pressurizer level greater than [14.3%] and until SI termination criteria are met (refer to step 14). The value [14.3%] ensures the heaters remain covered.
d. Start one RCP in the affected loop.

*20. If all RCP operation is terminated and inventory and pressure are controlled, then natural circulation is monitored by heat removal via at least one steam generator. Natural circulation flow should occur within 5-15 minutes after the RCPs are tripped. Natural circulation heat removal is illustrated in Figure 6-16.

Natural circulation is governed by decay heat, component elevations, primary to secondary heat transfer, loop flow resistance, and voiding. Component elevations are such that satisfactory natural circulation decay heat removal is obtained by fluid density differences between the core region and the steam generator tubes.

The operator has adequate instrumentation to monitor natural circulation for the single phase liquid natural circulation process. The RCS temperature instrumentation, namely loop ΔT, can be used along with other information to confirm that the single phase natural circulation process is effective. The natural circulation process involving two phase cooling is complex and varied enough so that RCS loop ΔT may not be a meaningful indication of adequate natural circulation cooling. The guidelines are written to alert the operator to use explicit acceptance criteria for natural circulation only when RCS inventory and pressure are controlled.

The RCS temperature response during natural circulation will usually be slow 5-15 minutes as compared to a normal forced flow system response time of 6-12 seconds, since the coolant loop cycle time will be significantly longer.

When single phase circulation is established in at least one loop, the RCS indicates all of the following conditions:

a. Loop ΔT (T_H - T_c) less than normal full power ΔT,
b. Hot and cold leg temperatures constant or decreasing,
c. RCS is subcooled based on representative CET temperature,
d. No abnormal differences between T_H RTDs and core exit thermocouples. Hot leg RTD temperature should be consistent with the core exit thermocouples. Adequate natural circulation flow ensures that core exit thermocouple temperatures will be

approximately equal to the hot leg RTD temperatures within the bounds of the instrument's inaccuracies. An abnormal difference between T_H and the CETs could be any difference greater than [10°F].

If the criteria listed in step 20 are not satisfied, then the contingency actions must be addressed. Single phase natural circulation in the RCS is not effectively transferring heat from the core to the steam generators. Both RCS Heat Removal and Core Heat Removal Safety Functions may become jeopardized if the natural circulation flow criteria continue to be violated. Operators should ensure that RCS pressure and inventory, and SG steaming and feeding, are being controlled properly in order to prevent violation of a safety function.

21. The RCS is sampled for activity and boron concentration and is borated to achieve the required shutdown margin (including the mass in the pressurizer) per Technical Specifications. The sample identifies whether reactor coolant dilution has occurred and provides the necessary information for borating to the required concentration. Activity samples will be used for dose assessments and to satisfy reporting requirements.

22. An orderly cooldown to an RCS hot leg temperature of ≤ ~~350~~ 400°F is performed, using forced or natural circulation, in accordance with Technical Specifications. One of the following methods should be utilized to reduce RCS temperature:

    a. The preferred method for cooling the RCS is by discharging steam using the turbine bypass system. This method can only be implemented if the condenser is available.

<u>or</u>

b. If the condenser or turbine bypass system is not available, an RCS cooldown should be performed by dumping steam using the atmospheric steam dump valve of the unisolated steam generator.

The turbine bypass system is preferred due to the unmonitored release of radioactivity to the environment through the atmospheric dump valve.

*23. The unisolated steam generator's level is to be maintained in the normal band using startup, main or emergency feedwater. This ensures that a heat sink is available for removing heat from the RCS.

24. During a controlled cooldown and depressurization, the automatic operation of certain safeguard systems is undesirable. Therefore, the setpoints of MSIS and SIAS must be manually reset (lowered) as the cooldown progresses to ensure that automatic engineered safeguards protection remains available until the RCS is cooled down and depressurized.

*25. The available condensate inventory should be continually monitored, and replenished from available sources as necessary to provide a source for a secondary heat sink. Examples of alternate sources of condensate are nonseismic tanks, fire mains, lake water supplies, potable tanks, etc. Plant specific alternate sources of feedwater should be identified and cited in the procedure. The amount of condensate required to either maintain the plant at hot standby conditions or during a cooldown may be determined from Figures 6-4 and 6-5.

Figure 6-16

STEAM GENERATOR TUBE RUPTURE

(NATURAL CIRCULATION HEAT REMOVAL)

(ILLUSTRATIONS WILL REFLECT THE PROCESSES DESCRIBED IN THE GUIDELINE)

26. It is important to understand why the isolated SG needs to be cooled. Although the unaffected (or least affected) SG is being used to remove heat from the RCS, the isolated SG can still cause problems which will affect RCS depressurization during the cooldown because it will remain at a high temperature and pressure.

The pressure in an isolated SG will remain high during the cooldown due to thermal stratification of the secondary water because without boiling and recirculation flows, the secondary side fluid is not well mixed. This pressure is a concern as the SGTR strategy maintains RCS pressure approximately equal to the isolated SG's pressure to minimize the tube leak flow. Therefore, the isolated SG must be depressurized to further depressurize the RCS to SCS entry conditions.

The following methods are available for cooling and depressurizing the isolated steam generator.

a. Feed and bleed using startup, main or emergency feedwater and the blowdown system. This is a slow method which transfers feedwater through the downcomer region and out the blowdown line. Heat is transferred to the feedwater across the SG shroud from the tube bundle region. The feed rate that can be maintained will determine the effectiveness of this method. The feed rate, however, will be limited by tube leak rate in order to prevent overfilling the SG. If the tube rupture results in a leak rate comparable to or greater than the blowdown system's flow capacity, then this method would not be effective.

b. Short duration steaming of the isolated steam generator will rapidly depressurize the steam generator. Less steaming will be required if the evaporator region has been cooled by the operation of the RCPs. Steaming will result in radiological release to the atmosphere if the ADVs are used. The activity released can be minimized by steaming to the condenser, while maintaining SG water level above the top of the U-tubes. However, both methods require the approval of the [Emergency Coordinator] or the TSC since both methods may increase offsite dose.

In addition to the isolated steam generator depressurization methods listed above, there are two methods available which do not require operator action. One of these methods is simple ambient cooling which will take approximately 10 to 15 hours or longer. If steam generator level control can be maintained during this period, this may be the optimum method since no radiological releases occur after the steam generator is isolated. The other method takes into account existing small steam leaks (such as leakage past the MSIVs) which may depressurize the isolated steam generator. Even the low "normal" leakage may be sufficient to cool and depressurize the isolated steam generator. However, the operator should be aware that this may increase offsite doses.

*27. The condensate and all other connecting systems, including the turbine building sumps, should be sampled for activity that may have been transferred from the affected steam generator(s). These samples aid in determining the extent of contamination throughout the plant systems.

*28. The turbine and radwaste building ventilation systems' radiation monitors, and any other applicable radiation monitors, should be continually observed. Corrective actions, if necessary, should be taken in accordance with plant Technical Specification Limitations.

Figure 6-17

TYPICAL SAFETY INJECTION DELIVERY CURVES

NO FAILURES

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

Figure 6-18

TYPICAL SAFETY INJECTION DELIVERY CURVES

FAILURE CONDITION - LOSS OF ONE EMERGENCY GENERATOR

(TO BE DEVELOPED DURING DETAILED ENGINEERING)

*29. If pressurizer pressure reaches [740 psia], the safety injection tanks (SITs) must be vented, drained, or their discharge valves shut to prevent the nitrogen cover gas from being discharged into the RCS when RCS pressure is reduced below the SIT's pressure during a controlled cooldown. The max SIT pressure is [640 psia] and the value of [740 psia] is ~~simply~~ 100 psi greater than the maximum SIT pressure.

*30. If the pressurizer pressure reaches [445 psia], the isolation valves on the SITs may be closed to prevent unnecessary SIT discharge. Automatic override of an SIT isolation valve closure signal occurs above [475 psia] to assure the SITs are available when needed. The value of [445 psia] was chosen to ensure some margin below the automatic override setpoint.

*31. Low temperature overpressurization protection (LTOP) is instituted at $T_c \leq$ [259°F] to protect against subjecting the RCS pressure boundary to low temperature brittle fracture.

*32. The cooldown and depressurization should continue until shutdown cooling system entry conditions are established.

a. pressurizer level control should be established and verified by a level greater than [14.3%] and constant or increasing,
b. RCS should be ~~of~~ subcooled,
c. RCS pressure should be at or below the shutdown cooling system entry pressure of [~~400~~ 450 psia],
d. RCS hot leg temperature should be at or below the shutdown cooling system entry temperature of [~~250~~ 400°F],

When these criteria are established, the SGTR ORG should be exited and SCS operation initiated per operating instructions.

If the RCS cannot be depressurized, then a void should be suspected. Any time it is found that voiding inhibits RCS depressurization to SCS entry pressure, when SCS operation is desired, then an attempt at elimination of the voiding should be made.

a. The operator should monitor for the presence of voids. Voiding in the RCS may be indicated by any of the following indications, parameter changes, or trends:

   i. letdown flow greater than charging flow,
   ii. pressurizer level increasing significantly greater than expected while operating pressurizer spray,
   iii. the HJTC RVLMS indicates that voiding is present in the reactor vessel,
   iv. RVLMS HJTC unheated thermocouple temperature indicates saturated conditions in the reactor vessel upper head,

b. If voiding should be eliminated, then proceed as follows:

   i. Letdown is isolated or verified to be isolated to minimize further inventory loss,
   ii. The depressurization is stopped to prevent further growth of the void,
   iii. Pressurizing and depressurizing the RCS within the limits of Figure 6-1 may condense the void. Pressurizing has the effect of filling the voided portion of the RCS with cooler fluid which will remove heat from the region. Subsequent depressurization and a repeating of this process several times will cool and condense the steam void. In this case of a void in the reactor vessel, the pressurization/depressurization cycle will preclude a fill and drain of the reactor vessel.

The pressurization/depressurization cycle may be accomplished using pressurizer heaters and spray (preferred method) or the SIS/charging system (alternative method). Monitor pressurizer level and the RVLMS for trending of RCS inventory. This will assist the operator in assessing the effectiveness of void elimination.

c. If indications of unacceptable RCS voiding continue, then voiding may be caused by non-condensible gases. Operate the Reactor Coolant Vent Gas System to clear trapped non-condensible gases. Monitor pressurizer level and/or the HJTC RVLMS for trending of RCS inventory. This will assist the operator in assessing the effectiveness of void elimination.

d. If indications of unacceptable RCS voiding continue, and voiding is suspected to exist in the (isolated) steam generator tubes, then cool the (isolated) steam generator (by steaming or blowdown, and/or feeding) to condense the tube bundle void. This will be effective for condensing steam voids but will not have an effect on non-condensible gases trapped in the tube bundle. A buildup of non-condensible gases in the tube bundles will not hinder natural circulation even with a large number of the tubes blocked. This is due to the small amount of heat transfer area required for the removal of decay heat. Monitor pressurizer level for trending of RCS inventory. This will assist the operator in assessing the effectiveness of void elimination.

When SCS entry conditions are established, the SGTR guideline should be exited and shutdown cooling initiated per plant specific operating instructions. Consideration should be given to the processing and handling of the contaminated steam generator(s) secondary side fluid. If significant voiding is present in the isolated loop, the SCS should be aligned to the subcooled loop. This activity places the plant in an operational mode where a complete cooldown and depressurization of the plant can take place.

Safety Function Status Check

The Safety Function Status Check (SFSC) is used to continually verify the status of safety functions. The safety function acceptance criteria are selected from best estimate analysis to reflect the range for each parameter which would be expected following a Steam Generator Tube Rupture Event. If all SFSC acceptance criteria are being satisfied, then the adequacy of this guideline for mitigating the event in progress is confirmed and the health and safety of the public is ensured.

The safety functions and their respective acceptance criteria listed below are those used to confirm the adequacy of the SGTR Guideline in mitigating the event.

SAFETY FUNCTION	ACCEPTANCE CRITERIA	BASES
1. Reactivity Control	a. Reactor Power Decreasing and b. Negative Startup Rate and c. Maximum of 1 CEA not fully inserted or RCS is borated per Tech Specs.	For all emergency events, the reactor must be shutdown. Reactor power decreasing, in conjunction with negative startup rate, is a positive indication that reactivity control is established. The criterion that no more than one CEA not be fully inserted or the RCS borated observes typical Technical Specification requirements.

SAFETY FUNCTION	ACCEPTANCE CRITERIA	BASES
2. Maintenance of Vital Auxiliaries (AC and DC power)	a. Safety Load Division I energized ~~via Permanent-Non-Safety Bus X~~ or Safety Load Division II energized ~~via Permanent Non-Safety Bus Y~~ and b.i) [125V] DC and [120V] AC Safety Bus A energized and [125V] DC and [120V] AC Safety Bus C energized or ii) [125V] DC and [120V] AC Safety Bus B energized and [125V] DC and [120V] AC Safety Bus D energized	One Safety Division is required to power equipment necessary to maintain control of all other safety functions. One DC Division is required as a minimum to provide monitoring and limited control of the other safety functions.

SAFETY FUNCTION	ACCEPTANCE CRITERIA	BASES
3. RCS Inventory Control	a. If pressurizer level is [2% to 78%], Then: i) charging and letdown, and SI pumps (unless SI termination criteria are met), are maintaining or restoring pressurizer level <u>and</u> ii) the RCS is subcooled <u>and</u> iii) the HJTC RVLMS indicates the core is covered <u>or</u>	A value of [2%] of range, was chosen as the lower limit to ensure that at least some water is in the pressurizer. The value of [78%] range, is the upper limit for pressurizer level to en-sure that there is an operable steam space in the pressurizer. This level can be exceeded if solid operation is re-quired to restore sub-cooling.
	b. pressurizer level is < [2%], Then: i) available charging pump is operating and the SI pump(s) are injecting water into the RCS per Figure 6-3 <u>and</u>	Subcooling coexisting with a pressurizer level of at least [2%] indi-cates adequate RCS in-ventory control via either solid plant oper-ation or a saturated bubble in the pres-surizer. Representative CET temperature is utilized during natural

SAFETY FUNCTION	ACCEPTANCE CRITERIA	BASES
3. RCS Inventory Control (Cont'd)	ii) the HJTC RVLMS indicates the core is covered.	circulation flow conditions and T_H RTDs are utilized for forced circulation flow conditions. An HJTC RVLMS indication that the core is covered, taken in conjunction with RCS subcooling, is an additional indication that RCS inventory control has been established. For cases where RCS inventory is degraded, charging pump and SI operation provides implicit assurance that inventory control is being regained.

SAFETY FUNCTION	ACCEPTANCE CRITERIA	BASES
4. RCS Pressure Control	a. Pressurizer heaters and spray, or charging and letdown, or SI pumps are maintaining or restoring pressurizer pressure within the limits of Figure 6-1. or b. available charging pump is operating and the SI pump(s) are injecting water into the RCS per Figure 6-3 (unless SI termination criteria are met).	For the SGTR event, when pressurizer level has been restored, operation of the pressurizer heaters and sprays (automatic or manual control), or solid plant control using charging and letdown, or SI pumps should be sufficient to control RCS pressure. For cases where RCS pressure control is degraded, charging pump and SIS operation provides implicit assurance that inventory control is being regained.

SAFETY FUNCTION	ACCEPTANCE CRITERIA	BASES
5. Core Heat Removal	a. T_H RTDs and representative Core Exit Thermocouple temperatures less than [626°F].	The basis for the temperature limit during the use of optimal recovery procedures other than LOCA is the indication that the event specific recovery strategy is not effective in core heat removal. For the optimal recovery guidelines other than LOCA, heat is normally removed from the RCS by the steam generators. The value of the CET temperature will be governed by steam generator conditions (i.e., pressure and temperature). In general, $T_c \cong T_{SG}$ and CET temperature will be T_c + core ΔT. For forced RCS flow conditions $T_{SG} \cong T_c \cong T_H \cong$ CET temperature.

SAFETY FUNCTION	ACCEPTANCE CRITERIA	BASES
5. Core Heat Removal (Continued)		T_o is based on the secondary system design of [1200 psia] which has a corresponding T_{sat} = 567°F. The core ΔT during natural circulation is [59°F]. Therefore T_{sat} + ΔT = [626°F].
6. RCS Heat Removal	a. The unisolated steam generator has level: i) within the normal level band with feedwater available to maintain level or ii) being restored by feedwater flow with increasing level and b. RCS T_H is less than [547°F]. and c. RCS temperature is controlled by steam bypass system (preferred) or ADVs.	Adequate RCS heat removal will be maintained if at least one steam generator is available for removing heat (capable of steam flow and feed flow). The increasing level indicates sufficient feed flow to remove decay heat from the core. Decay heat levels may not be high enough to require full feed flow. In this case, feedwater levels in the normal band with feed flow capability satisfies the RCS heat removal safety function.

SAFETY FUNCTION	ACCEPTANCE CRITERIA	BASES
6. RCS Heat Removal (Continued)		[547°F] is based on maintaining RCS temperature below the saturation temperature corresponding to the SG safety valve setpoint. The lowest lifting MSSV setpoint is [1200 psia]. The corresponding saturation temperature is [567°F]. When one steam generator is isolated, the hot leg temperature will rise in the operating loop approximately [15°F]. An additional [5°F] is added to this to account for process uncertainties. Therefore, the maximum hot leg temperature must be [567°F] minus [20°F]. RCS temperatures should be controlled by operation of the steam bypass system or ADVs. The steam bypass system is preferred because of the unmonitored release of radioactivity to the

SAFETY FUNCTION	ACCEPTANCE CRITERIA	BASES
6. RCS Heat Removal (Continued)		environment via the ADVs. Controlled temperature response is specified to distinguish between an uncontrolled cooldown with a stuck open MSSV.
7. Containment Isolation	a. Containment Pressure < [2.0 psig] and b. No containment area radiation monitors alarming and	[2.0 psig] is based on the containment pressure alarm. It is not expected for the SGTR event that containment pressure will increase to the alarm setpoint.
	c. No abnormal increase in containment sump levels.	No radiation is anticipated in the containment for a SGTR.
	d. No Nuclear Annex alarms	During a SGTR event no increase in IRWST or reactor cavity sump levels is anticipated. During a SGTR event, no Nuclear Annex alarms are anticipated.

8. Containment Temperature and Pressure Control	a. Containment temperature less than [110°F]. and b. Containment pressure less than [2.0 psig].	[110°F] is the containment temperature Technical Specification limit. Containment temperature is not expected to increase to [110°F] for the SGTR event. [2.0 psig] is based on the containment pressure alarm. It is not expected that the pressure will reach this value during the SGTR event.
9. Containment Combustible Gas Control	a. Containment temperature less than [110°F] and b. Containment pressure less than [2.0 psig].	Maintaining these containment conditions provides an indirect indication that the conditions required for H_2 generation do not exist.

Event Strategy

This section contains the SGTR operator actions strategy flow chart (Figure 6-19). The flow chart depicts the strategy around which the SGTR guideline is built. It is intended to assist the procedure writer in understanding the intent of the guideline and for use in training. Operators should understand what the major objectives of the guideline are in order to facilitate their progress toward those goals.

The strategy chart shows the recovery guideline strategy in detail and lists the guideline steps which correspond to each strategy objective. Some steps in the guideline may be performed at any time during the course of an event. These steps are indicated by an asterisk next to the step number.

Figure 6-19a

STRATEGY CHART FOR STEAM GENERATOR TUBE RUPTURE

(FLOW AND STRATEGY CHARTS WILL REFLECT THE DETAILED STEPS IN THE GUIDELINE.)

Figure 6-19b

STRATEGY CHART FOR STEAM GENERATOR TUBE RUPTURE

(FLOW AND STRATEGY CHARTS WILL REFLECT THE DETAILED STEPS IN THE GUIDELINE.)

Figure 6-19c

STRATEGY CHART FOR STEAM GENERATOR TUBE RUPTURE

(FLOW AND STRATEGY CHARTS WILL REFLECT THE DETAILED STEPS IN THE GUIDELINE.)

Figure 6-19d

STRATEGY CHART FOR STEAM GENERATOR TUBE RUPTURE

(FLOW AND STRATEGY CHARTS WILL REFLECT THE DETAILED STEPS IN THE GUIDELINE.)