REACTOR VESSEL

HEAD VENT OPERATION

REVISION 0

FEBRUARY, 1981

REACTOR VESSEL HEAD VENT OPERATION

A. PURPOSE

The objective of these instructions is to specify required operator actions and precautions necessary to remove gases from the reactor vessel head by operation of the Reactor Vessel Head Vent.

CAUTION: This venting guideline should not be used as the primary means to mitigate an Inadequate Core Cooling event. Refer to Inadequate Core Cooling Guidelines for appropriate operator actions and precautions.

CAUTION: This venting guideline assumes that the reactor containment conditions are near normal conditions and that any venting operation is performed prior to throttling safety injection flow during a POST-LOCA cooldown and depressurization operation.

B. SYMPTOMS

For plants with a RV level indication

1. Reactor vessel level is less than (insert plant specific value which includes an allowance for normal channel accuracy) percent of span.

For plants with/without a RV level indication

2. Abnormal reactor coolant system conditions such as large variations in pressurizer level during normal charging or spraying operations have occurred.

3. If available, reactor vessel head temperatures equal to or greater than saturation temperature.

4. Plant events have occurred (such as accumulator tank discharge, rapid RCS cooldown, or core uncovery events) that may result in the presence of a gaseous void in the vessel head.

C. IMMEDIATE ACTIONS

None

D. SUBSEQUENT ACTIONS

CAUTION: Do not trip any running or start any non-operating reactor coolant pumps during the performance of the following actions.

NOTE: If the safety injection system is in operation, then the actions of steps marked by an asterisk will not be applicable.

1. Terminate any changes to the reactor coolant system that may be in progress and bring the RCS to as close to a steady-state condition as possible.

*2. Attempt to recombine any condensible gases by increasing RCS pressure through the use of the pressurizer backup heaters and increased charging flow. If this step is successful in condensing the gas volume in the vessel head (as indicated by a return to normal readings in those parameters used to determine the presence of the gases) then return to the appropriate operating instruction.

CAUTION: Increased charging flow with condensible gases in the RCS may result in a decreasing pressurizer level. If pressurizer level decreases to less than 20% of span, then attempt to restore level by continuing the charging flow or manually starting safety injection pumps. If level cannot be restored, then manually initiate safety injection and proceed to EOI-0, Immediate Actions and Diagnostics.

3. In preparation for venting, isolate the containment purge and exhaust system and the pressure vacuum relief line and start all available containment air circulation equipment.

4. Increase the RCS sub-cooling to (insert plant specific value which is 50°F above the value which is the sum of the errors for the temperature measurement system used, and for the pressure measurement system translated into temperature using the saturation tables) by either initiating an RCS pressurization or by dumping steam from the non-faulted steam generators.

5. If required, perform the actions of Appendix B to determine the maximum allowable time period for venting (only for plants which vent directly to containment).

*6. Isolate letdown and initiate an RCS makeup by the chemical volume and control system to increase pressurizer level to greater than 50% of span.

*7. If not already performed, manually block the low pressure SI initiation if the permissive is energized.

CAUTION: The venting operation may result in pressure decreasing below the SI setpoint. Action should be taken to manually block the automatic SI signal when the permissive is energized.

*8. Increase charging flow to maximum to limit the pressurizer pressure and level decrease during the venting period.

NOTE: Observe the pressurizer level trend during the venting and, from the following conditions, determine the probable status of the reactor coolant system.

a) Increasing pressurizer level - Gaseous voids exist in the RCS other than the reactor vessel head or pressurizer.

b) Constant pressurizer level - No significant gaseous voids exist in the reactor coolant system.

c) Decreasing pressurizer level - Gaseous void exists in the reactor vessel head.

9. Open the vent isolation valves in one head vent flow path.

NOTE: If one or both valves fail to open, close both valves and open the isolation valves in the parallel flow path.

10. Close both vent isolation valves when:

a) Reactor vessel level indication stabilizes,
OR
b) The time period determined in Step 5 is met,
OR
c) Pressurizer pressure decreases by 200 psi,
OR
d) Pressurizer level decreases below 20 percent of span
OR
e) Reactor coolant sub-cooling decreases below (insert plant specific value which is the sum of the errors for the temperature measurement system used, and for the pressure measurement system translated into temperature using the saturation tables).
OR
f) The reactor vessel head is refilled as indicated by a decrease in the rate of a depressurization or a change in the rate of the pressurizer level trend.

CAUTION: If during the venting period, a loss of reactor coolant pump operation occurs, continue the venting and allow natural circulation to establish itself.

*11. Re-establish normal charging and letdown to maintain the pressurizer water level in the operating range.

*12. Evaluate the response of the pressurizer level trend to determine if a gas bubble existed in the vessel head. If a gas bubble existed and the venting was terminated prior to the vessel head being completely refilled, then return to Step 4.

NOTE: If multiple venting operations are required and the containment hydrogen concentration is equal to or greater than 3 volume percent, then provisions must be made to remove or reduce the volume of hydrogen from the containment prior to re-opening the reactor vessel head vent.

13. Return to the appropriate operating instruction following the successful completion of the venting of the reactor vessel head.

APPENDIX "A"

RV HEAD VENT GUIDELINE

RCS GASEOUS VOID
DETECTION AND SIZING

1. Achieve a constant pressurizer level and pressure condition.

2. Place the RCS wide range or pressurizer pressure and the pressurizer level on trend recorders. The scale should be 150 psig pressure and 10% of span for level.

3. Record the following parameters.

RCS Pressure	= _____	PSI
PZR Level	= _____	%
Charging Rate	= _____	GPM
Seal Injection Flow	= _____	GPM
Seal Leakoff Low	= _____	GPM
Time	= _____	

4. Isolate the RCS letdown flow, turn off all pressurizer heaters, and terminate the pressurizer spray by placing the spray control in manual and zeroing the demand signal.

5. Allow the RCS charging flow to either increase RCS pressure 100 psi or increase pressurizer level 5% of span.

6. Record the RCS pressure, pressurizer level and time.

RCS Pressure	= _____	PSI
PZR Level	= _____	%
Time	= _____	

7. Reinitiate RCS letdown flow and restore normal pressurizer pressure and level control.

8. Calculate the initial and final pressurizer vapor space volumes.

Initial Vapor Volume = (1-PZR Level % X Total Cylindrical PZR Volume FT^3) + (Upper Spherical Volume FT^3)

= _____ FT^3

Final Vapor Volume = (Initial Volume) - (Δ PZR Level X Total Cylindrical Volume)

= _____ FT^3

9. Determine the total charged volume into the RCS.

Charged Volume = (Charging + Seal Injection - Seal Leakoff GPM) X

(Time) X $\left(\frac{1}{7.45 \frac{GPM}{FT^3}}\right)$

= _____ FT^3

10. Determine the expected pressurizer level change.

Expected Δ level = (Charging Volume FT^3) X $\left(\frac{100\%}{\text{Total PZR Volume } FT^3}\right)$

= _____ %

11. If the actual pressurizer level change is less than the xpected level change then a gaseous void exists in the reactor coolant system. Perform the following step to determine the volume of the RCS void.

12. The initial and final RCS gaseous void volumes can be calculated from the following equations.

$$\text{Initial RCS Void} = \frac{(\text{Initial Vapor Volume}) - (\text{Final Vapor Volume}) - (\text{Charged Volume}}{\left(1 - \frac{\text{Initial Pressure}}{\text{Final Pressure}}\right)}$$

$$= \_\_\_\_\_ FT^3$$

$$\text{Final RCS Void} = \frac{(\text{Initial RCS Void}) \times (\text{Initial Pressure})}{(\text{Final Pressure})}$$

$$= \_\_\_\_\_ FT^3$$

APPENDIX "B"

RV HEAD VENT GUIDELINE

VENTING TIME PERIOD

1. Convert the containment free-volume to containment volume at standard temperature and pressure conditions.

$$\text{Cont. Volume (STP)} = (\text{Cont. Volume } FT^3) \times \left(\frac{\text{Cont. Pressure}^{**}}{14.7 \text{ PSIA}}\right) \times \left(\frac{492^\circ R}{\text{Cont. Temp.}^{*}}\right)$$

$$= \_\_\_\_\_ FT^3$$

* Temperature in degrees Rankine (°F + 460)

**If containment pressure has increased above 14.7 psia then use 14.7 psig as pressure for conservatism.

2. Determine the containment hydrogen concentration in volume percent units.

NOTE: The containment hydrogen concentration will be insigificant if there has been no leakage from the RCS to the containment.

3. Calculate the maximum hydrogen volume that can be vented to the containment which will result in a containment hydrogen concentration of less than or equal to 3 volume percent.

$$\text{Maximum } H_2 \text{ Volume to be Vented} = \frac{(3.0\% - \text{Cont. } H_2 \text{ Concentration } \%) \times (\text{Cont. Volume [STP]})}{100\%}$$

$$= \_\_\_\_\_ \%$$

4. From Curve #1 (RCS Pressure vs. H_2 Flow Rate) determine the allowable venting period which will limit the containment hydrogen concentration to 3 volume percent.

$$\text{Venting Period} = \frac{\text{Max. } H_2 \text{ Vented (From Step 3)}}{H_2 \text{ Flow Rate}}$$

$$= \_\_\_\_\_ \text{ Mins.}$$

CURVE #1

APPENDIX B