OPERATING MANUAL

PROCEDURE Q

RESPONSE TO VOID IN REACTOR VESSEL

Q. Response to Void in Reactor Vessel

This procedure describes response to a detected, or suspected void, (condensible, or non condensible) in the Reactor Vessel. The specific accident which caused the void to be formed will not be discussed, instead, it will be assumed that a void exists regardless of the specific accident scenario.

Symptoms

1. Variations from the normal pressurizer pressure and level response due to normal charging and spraying operations. The pressurizer level may decrease during a RCS pressurization from charging due to RCS void contraction, and level may rise rapidly during spray operations due to RCS void expansion.

2. Reactor Core Cooling Monitor [SCM-RC-100] or the Margin to Saturation Meter [SCI-RC-100] indicate departure from subcooled conditions.

3. A plant evolution that may result in the introduction of significant amounts of non condensible gases to the RCS, such as accumulator tank discharge has occured.

Automatic Actions - None Required.

Immediate Manual Action - None Required.

Follow Up Actions

A. If the symptoms of a Reactor Coolant System Void Exist, attempt to determine the void size as follows:

   1. Achieve a constant pressurizer level and pressure condition.

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

   3. Record the following parameters.

      a. RCS Pressure ____________ PSI
      b. PZR Level ____________ %
      c. Charging Rate ____________ GPM
      d. Total Seal Injection Flow ____________ GPM
      e. Total Seal Leak Off Flow ____________ GPM
      f. Time Readings Taken ____________

4. Isolate the RCS letdown flow, turn off all pressurizer heaters, and terminate the pressurizer spray.

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 at the completion of the charging transient.

   a. RCS Pressure ________ PSI

   b. PZR Level ________ %

   c. Time Readings Taken ________

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

8. Calculate the initial and final pressurizer vapor space volumes as follows:

   Initial Pressurizer Vapor Volume = (1-PZR. Level % x 528 FT^3*)+200 FT^3**

   = ________ FT^3

   Final Pressurizer Vapor Volume = (Initial Volume)-(Change in PZR Level x 528 FT^3*) +200 FT^3**

   = ________ FT^3

9. Determine the total volume of water charged to the RCS as follows:

   Charged Volume=

   (Charging Flow Rate [Step 3.c.] + Seal Injection Flow Rate [Step 3.d.] - Seal Leak Off Flow Rate [Step 3.e])

   X Elapsed Time [Diff. Step 6.c. and 3.f.] X $\frac{1}{7.45 \frac{GAL.}{FT^3}}$

   = ________ FT^3

10. Calculate the expected change in pressurizer level from the volume charged as deteremined in Step 9.

   Expected Pressurizer Level Change = (Charged Vol. FT^3) [Step 9.] X ($\frac{100\%}{528\ FT^3**}$) = ________ %

* Volume of pressurizer spanned by level instruments

** Volume of pressurizer above spanned level

11. If the actual pressurizer level change is less than the expected level change then a gaseous void exists in the RCS. Perform step 12 to determine the volume of the RCS void.

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

$$\text{Initial RCS Void} = \underset{\text{[Step 9]}}{\text{(Charged Vol.)}} - \frac{\underset{\text{[Step 8]}}{\text{Initial Vapor Volume}} - \underset{\text{[Step 8]}}{\text{Final Vapor Volume}}}{\left(1 - \frac{\text{Initial Pressure [Step3]}}{\text{Final Pressure [Step 6]}}\right)}$$

= ______________ FT^3

$$\text{Final RCS Void} = \frac{\underset{\text{[Determined Above]}}{\text{(Initial RCS Void)}} \times \underset{\text{[Step 3]}}{\text{(Initial Pressure)}}}{\underset{\text{[Step 6.a.]}}{\text{(Final Pressure)}}}$$

B. If a gaseous void is indicated by performance of Step A, attempt to condense the void as described below. This attempt will ultimately succeed if the RCS void is steam.

CAUTION: Do not stop any running RCPs or start any stopped RCPs until completion of this procedure.

1. Record RCS pressure as indicated by trend recorder.
   RCS Pressure ______________ PSI

2. Verify that the RCS is in a stable condition by ensuring that:

   a. Pressurizer level is between 40% and 60%
   b. RCS pressure is stable
   c. RCS hot leg temperature is stable

   These stable RCS conditions must be achieved prior to proceeding with this procedure.

3. Turn on all pressurizer heaters and increase RCS pressure 50 psi while maintaining a balanced charging and letdown flow and while maintaining pressurizer level greater than 20%.

NOTE: If pressurizer level drops below 20% of span, turn off the pressurizer heaters and return the RCS to the stable condition described in Step 2.

4. After raising RCS pressure 50 psi, perform step A to determine if the attempt to condense the steam bubble has been effective.

   a. If no further indication of an RCS void exists, this procedure is complete.

   b. If a RCS void is still indicated it must be assumed the void consists of non condensible gas, and an RCS vent is required.

C. Preparation of Containment for Vessel Head Vent.

   1. Verify the Containment Purge and Exhaust system is not in operation, and is isolated.

   2. Start all available containment air circulation equipment.

   3. Monitor containment hydrogen concentration and if required place the hydrogen recombiners in operation per BVPS O.M. Chapter 46 Sect. 4 Procedure A, B and C.

D. Determine Maximum Allowable Venting Period as follows:

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

$$\text{Cont. Volume (STP)} = [1{,}890{,}000\ FT^3 *] \times \left[\frac{\text{Cont. Pressure**}}{14.7\ PSIA}\right] \times \left[\frac{492\ °R}{\text{Cont. Temp.***}}\right]$$

= ____________________ FT^3

   2. Record the containment hydrogen concentration.

H2A-HY-101A ______________% H2A-HY-101B ______________%

   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 percent volume.

$$\text{Max. } H_2 \text{ Vol.} = \frac{(3.0\% - \overset{\text{Cont. } H_2 \text{ Conc\%}}{[\text{Highest Reading from Step 2.}]}) \times (\overset{\text{Cont. Vol.}}{[\text{Step 1.}]})}{100\ \%}$$

= ______________________ FT^3

   4. From Curve #1 (RCS Pressure vs. H2 Flow Rate) determine the allowable venting period which will limit the containment hydrogen concentration to 3% volume.

$$\text{Venting Period} = \frac{\text{Max. } H_2 \text{ Vented [Step 3]}}{H_2 \text{ Flow Rate [Curve \#1]}}$$ = __________ Mins.

* Containment Volume = 1,890,000 FT^3

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

*** Temperature in degrees Rankine (°F + 460)

E. Vent Termination Criterion.

1. If any vent termination criterion listed below is reached or exceeded while venting, immediately stop venting.

a. Containment hydrogen concentration greater than 3% as observed on Containment Hydrogen Analyzers [H2A-HY-101A or 101B].

b. Reactor Coolant Sub-cooling decreases below 50° as determined from Figure 53-1 or 53-1A.

c. Pressurizer level decreases below 20% of span.

d. Maximum vent duration determined in step D.4. is reached.

e. Expected vent duration determined by Curve 1 and the RCS void volume calculated in Step A.12.

f. RCS pressure decreases by 200 psi.

NOTE: Venting of hydrogen to containment through the direct path or through a ruptured PRT rupture disc will cause an increase of containment hydrogen concentration. If large quantities of hydrogen must be vented, the recombiners must be in operation and even then hydrogen concentration may approach combustible levels. If the concentration approaches combustible levels, the decision will have to be made to continue venting, or to secure venting until containment hydrogen levels decrease. The decision to continue venting should be based on full consideration of all plant conditions including the status of core cooling and containment hydrogen level.

Venting the reactor vessel should take priority over containment hydrogen limits due to the potential for interruption of core cooling with hydrogen in the vessel.

Venting the pressurizer should not take priority over containment hydrogen limits unless the pressurizer bubble is interferring with the ability to maintain pressure control.

F. Determine the optimum vent path using the following guidelines.

a. With only one power source available, vent through the powered solenoid valves to containment.

b. With power available to both valves and the PRT rupture disc blown, vent to the PRT <u>if</u> there <u>is</u> water in the tank to take advantage of the cooling provided by this water.

c. <u>If</u> there is <u>no</u> water in the PRT, vent to atmosphere. The location of the atmospheric vent will provide more complete mixing with the containment atmosphere and quicker access to the hydrogen recombiners.

d. With power available to both paths and the PRT rupture disc intact, small quantities of gas may be vented to the PRT and thus not enter the containment atmosphere.

e. Large quantities of gas should be vented directly to containment.

G. Vent the reactor vessel as follows:

1. Increase the RCS subcooling to 50° as determined from Figure 53-1 or 53-1A by either initiating an RCS pressurization or by dumping steam from the non-faulted steam generators.

2. Isolate letdown and manually control charging to raise pressurizer level to greater than 50% and less than 90% of span.

CAUTION: The venting operation may result in pressure dropping below the SI setpoint.

3. Manually block the low pressure SI circuit if RCS pressurizer is less than 2000 psig, and the "PZR SI BLOCKED" status light is illuminated.

CAUTION: The circuit will be automatically unblocked if the RCS pressure increases above 2000 psig. If this occurs, the blocking will have to be repeated when pressure is again reduced below 2000 psig.

4. Immediately before initiating vessel vent, manually raise charging flow to maximum. This limits the pressurizer pressure and level decrease during the vent.

5. Vent the reactor vessel to containment or the PRT by opening:

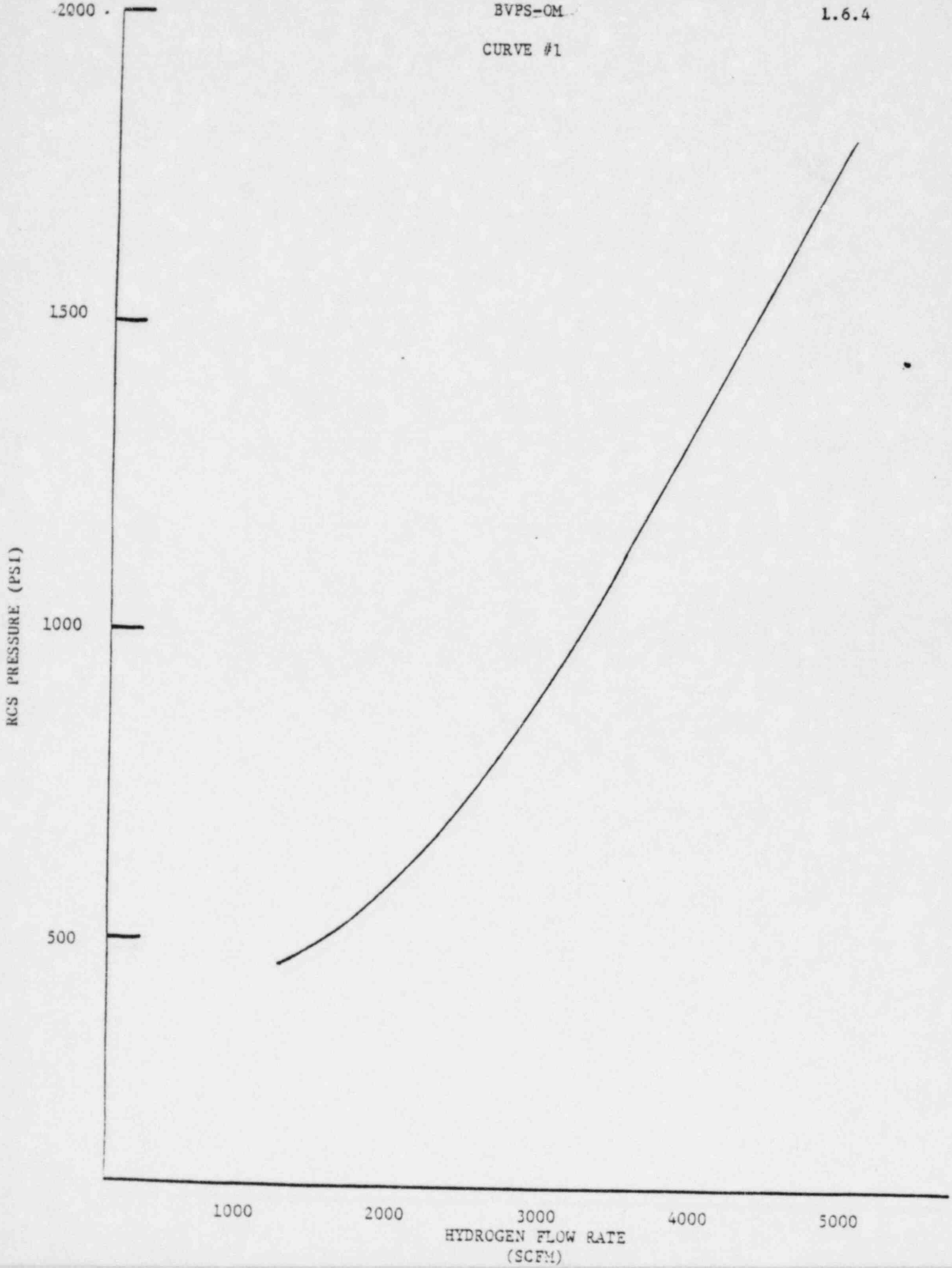
a. [SOV-RC-102A or 102B] Reactor Vessel Vent Valves <u>and</u> [SOV-RC-104] Vent to PRT Isolation Valve <u>or</u> [SOV-RC-105] Vent to Containment Isolation Valve.

6. Stop venting by shutting valves opened in previous step when one of the vent termination criterion is met.

7. Return RCS pressure control and PZR level control to normal. Verify RCS is stable.

8. When vent is complete and RCS is stable perform step A.1-12. to determine the effectiveness of the vent on void removal. If RCS void is still indicated repeat steps D, E, F and G until no further voiding is indicated.

CURVE #1


2000
1500
1000
500
RCS PRESSURE (PSI)
1000
2000
3000
4000
5000
HYDROGEN FLOW RATE
(SCFM)