PROCEDURAL GUIDELINES

FOR

REACTOR COOLANT GAS VENT SYSTEM

FOR

SOUTHERN CALIFORNIA EDISON

SAN ONOFRE 2 & 3

1370-PE-PR07, Rev. 00

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Introduction

Procedural guidelines for use of the reactor coolant gas vent system are provided in this section. The procedures have been divided into three basic sections: system status and surveillance, normal operations, and emergency operation. In addition to presentation of the operational guidelines, the emergency operation includes a discussion of the plant response to the use of the RCGVS using the layout of the RCGVS (Figure 1) and basic RCGVS parameters.

2.0 System Status and Surveillance

2.1 RCGVS Standby Mode

1. Description of Operation

   During normal plant operations, the Reactor Coolant Gas Vent System is in a standby mode. All solenoid isolation valves (RV-101, 102, 103, 104, 105, 106) are key-locked closed with appropriate administrative controls in force to prevent inadvertent system operation.

2. Initial Conditions

   1) RCS fluid boundaries are intact with RCGVS refueling spool-piece in place.
   2) The plant is in any mode of operation except refueling.
   3) The following interfacing systems are available for use with the RCGVS should the system be required.

      Electrical Power for the Valves

      Quench Tank (QT)

      Containment Recombiners and H_2 Analyzers
   4) The RCGVS pressure instrument (P-138) is operational.
   5) All RCGVS solenoid valves are key-locked closed with administrative controls imposed. Power may be removed from the valves.
   6) The pressurizer vent manual valve (010-A-305) is opened. (Reference: Bechtel RCS P&ID 40111)
   7) Manual Drain Valve (RV-200) is locked closed.

Operational Requirements:

1. The leak tightness of the RCGVS isolation valves is verified by periodically monitoring the RCGVS pressure indicator (P-138).
2. The standby status of the system is verified by assuring that the administrative controls remain in force.

3.0 Normal Plant Operations

3.1 RCGVS Response to Valve Leakage During Normal Operations

1. Description of Operation

   While in standby, P-138 indicates that leakage has occurred past one of the 4 solenoid valves. Operator response to the leakage includes verification that leakage is occurring, quantification of the leak rate, and eventual repair of the leaking valve. A flow chart to summarize operator response is provided as Figure 2.

2. Initial Conditions

   1. Same as Status and Surveillance
   2. P-138 indicates valve leakage by a pressure increase (and eventual alarm).

3. Operational Requirements

   1. Conduct a RCS leak rate determination in accordance with established plant procedures and compare with a leak rate determination made prior to the pressure increase. No difference indicates that either the pressure indicator is faulty or that the leakage has been contained by the second isolation valve. An increase in the leak rate indicates that not only is leakage occurring, but it is also leaking past the second isolation valve.

2. If there is no change in the RCS leak rate and P-138 indicates roughly the same pressure as the RCS, then the most likely situation is that a first isolation valve leaks, but the leakage has been contained by the second valve. In this event, no action is necessary other than to repair the leaking valve when the plant conditions permit.

3. If there is no change in RCS leak rate, but P-138 does not indicate RCS pressure, then instrument malfunction is possible. No action is necessary other than to repair the instrument when plant conditions permit. Alternatively, the pressure increase may be due to expansion of fluid between the solenoid valves due to containment ambient temperature rise. This is unlikely as the line is not normally solid, but can be inferred if the pressure change correlates with containment ambient temperature fluxuation. In this event, the downstream valve (RV-105) should be temporarily opened to relieve the pressure and the line drained when plant conditions permit.

4. If there is a change in RCS leak rate then both isolation valves are leaking. If the leak rate is less than technical specification limits, then operation can continue, but the RCS leak rate determination should be monitored to assure that the rate does not increase. Containment activity and QT parameters should be monitored to determine if the leakage is being directed to containment or to the QT. The leaking valves should be repaired at the earliest opportunity and if leakage reaches technical specification limits, the plant must be shut down to repair the valves.

2 RCGVS Use in RCS Venting Prior to Refueling

1. Description of Operation

The RCGVS may be used to vent the RCS when the RCS is being pumped down to remove the reactor vessel head for refueling. This is done by aligning first the pressurizer vent and later the reactor vessel vent to the QT or containment while the RCS fluid is being pumped out of the system.

2. Initial Conditions

Same as Status and Surveillance except the reactor is in cold shutdown in preparation for head removal.

3. Operational Requirements

1) Obtain administrative approval to operate the RCGVS valves.
2) Initiate RCS draining and line up the pressurizer vent to either the QT or containment. If the QT is used, assure sufficient N_2 is supplied to the tank.
3) When the pressurizer empties, open the reactor vessel vent to allow removal of fluid from the reactor vessel head.
4) After drain-down is complete, close RCGVS valves and remove the refueling spool-piece from the system.

3.3 RCGVS Use in RCS Venting Post-Refueling

1. Description of Operation

The RCGVS may be used to vent the RCS when the RCS is being refilled following refueling. This is done by aligning the RCGVS to vent first the reactor vessel head and then the pressurizer to the QT if the pressure in the QT can be kept lower than the rupture disc pressure by removal of the gas to the Gaseous Waste Vent System. Otherwise, vent to the containment.

2. Initial Conditions

Same as Status and Surveillance except the RCS is partially drained from refueling, with the system ready to be refilled. Administrative controls of the solenoid valves may not be in force.

3) Operational Requirements

1. Obtain administrative approval (if required) to operate the RCGVS valves and repower the valves.
2. Align the system to vent the reactor vessel head to the QT and commence system fill.
3. When QT level indicates liquid flow (or, alternately, a vent system drain may be monitored for flow) close the reactor vessel isolation valves and open the pressurizer isolation valves.
4. When the pressurizer is full, close all RCGVS solenoids and establish administrative controls in preparation for startup.
5. The RCGVS should be put in the standby mode (para. 2.1)

0 Emergency Plant Operations

This section describes the operation of the RCGVS in response to a plant accident which has created a non-condensible gas bubble in the reactor coolant system. The specific accident which caused the bubble to be formed will not be discussed; instead it will be assumed that a bubble exists regardless of the specific accident scenario. It is also assumed that means to detect the presence of the bubble exists.

4.1 Determination of Venting Path and Duration

1. Description of Operation

   The first step in the use of the RCGVS under post-accident conditions is the establishment of the need to vent, the determination of the venting duration, and the choice of the venting path. Detection of the gas bubble establishes the need to vent, and the venting duration and path are determined based upon the bubble size and RCS parameters.

2. Initial Conditions
   1) Same as Status and Surveillance except an accident has occurred which could lead to bubble formation.
   2) The RCS fluid boundary may not be intact.
3. Operational Requirements
   1. Establishing the need to vent:
      a. For the reactor vessel, if a gas bubble, no matter how small, is detected in the reactor vessel by ΔP, heated-junction thermocouple, or some other suitable means, then there is a need to vent the reactor vessel.
      b. The presence of a non-condensible gas in the pressurizer steam bubble can be indirectly ascertained by a departure from saturation conditions. For a given pressurizer temperature, the pressure will be higher than saturation by an amount dependent upon the steam/bubble volume and amount of gas present in the steam space. The effect is illustrated in Figure 3.

This method, however, is only useful for large gas volumes and provides an indirect indication of the volume of gas and how long the pressurizer should be vented to remove the gas. Further, since gas is present in the space even during normal plant operations, the objective of venting the pressurizer is not to remove all gas as is the case for the reactor vessel, but to remove enough of the gas so that the pressurizer can continue to function efficiently to maintain and control plant pressure. The procedural guidelines to accomplish this objective are as follows:

1. If a bubble is detected in the reactor vessel, it will be assumed that some hydrogen has collected in the pressurizer as well even if the gas volume cannot be definitely measured in the pressurizer.
2. In this case, or if hydrogen is identified in the pressurizer independent of its presence in the reactor vessel by departing from saturation, sluggish pressure control, or sampling; then there is a need to vent the pressurizer.

2. Determination of Venting Duration

a) For the reactor vessel, the vent duration is selected to be long enough to remove the entire gas bubble from the vessel head. The bubble size is determined by reactor vessel level indication, and with this information and the RCS temperature and pressure conditions, the venting duration is determined by referring to Figures 4 through 6 as appropriate. The venting times are based upon system vent flow rates illustrated in Figures 7 and 8.

b) For the pressurizer, the vent duration is selected as long enough to remove a sufficient amount of the gas from the pressurizer steam bubble to prevent the gas from interferring with RCS pressure control. This is done by venting the pressurizer long enough to remove the mass equivalent of the steam bubble. Steam bubble size is given by pressurizer level instrumentation and with this and the pressurizer temperature and pressure, the venting duration is determined by referring to Figure 9. This vent duration is also sufficient to remove an equivalent volume of hydrogen, should the bubble be pure hydrogen. The venting times are based upon system vent flow rates illustrated in Figures 10 and 11.

c) The venting process will result in a pressure decrease within the RCS, the extent of which is influenced by the venting location, charging pump availability, and the initial pressure and temperature conditions. Figures 12 through 17 present the impact of a timed vent upon system pressure and pressurizer level for the venting process. Dependent upon initial conditions and the duration of venting required, it may be necessary to temporarily secure the venting process before the selected venting duration has elapsed to restore pressurizer level and plant pressure.

3. Selection of Venting Path

The RCGVS removes gas from the RCS by venting the RCS either to containment or to the QT. The choice of which path to use is based upon the following guidelines:

1) With only one power source available, vent through the powered solenoid valves.

2) With power available to both valves and the QT rupture disc blown, vent to the QT if there is water in the tank to take advantage of the cooling provided by this water. If there is no water in the QT, vent to atmosphere as this location should provide more complete mixing with the containment atmosphere and quicker access to the hydrogen recombiners.

3) With power available to both valves and the QT rupture disc intact, small quantities of gas may be vented to the QT and thus not enter the containment atmosphere. Larger quantities of gas are vented directly to containment.

4. Venting of hydrogen to containment, either through the direct path or through a ruptured QT rupture disc, will cause an increase of containment hydrogen concentration. Figure 18 illustrates the impact of the venting with and without hydrogen recombiners in operation. It is obvious that if large quantities of hydrogen must be vented, the recombiners must be in operation and even then hydrogen may approach combustible levels. If the concentration approaches combustible levels, the operator will have to make a decision to continue venting or to secure venting until containment hydrogen levels decrease. The decision should be based upon the following:

   1. 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.

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

4.2 Venting the Reactor Vessel to the Containment

This section and the following sections describe operator actions to vent the RCS via the various vent paths in the event of an accident. A summary flow path for the venting process is provided in Figure 19.

1. Description of Operation

   The RCGVS is initially in standby and the need to operate the system to remove a gas bubble from the reactor vessel has been identified. After obtaining administrative approval to operate the system, the reactor vessel is vented to containment for a time period determined by system pressure, temperatures, and bubble size.

2. Initial Conditions

   Same as Status and Surveillance except
   - the RCS fluid boundary may not be intact
   - an accident has occurred which has created a bubble in the reactor vessel

- the bubble size has been determined and the containment vent path chosen
- verify that containment isolation has occurred before venting operations begin.

3. Operational Requirements

   1. Permission to use the RCGVS is obtained, and power restored to the system (if applicable).
   2. Using the bubble size and RCS temperature and pressure, determine the vent duration to remove the bubble.
   3. Assure that there is sufficient water in the pressurizer to conduct the vent without uncovering pressurizer heaters. It may be necessary to raise pressurizer level prior to venting or to secure venting temporarily and reestablish level if large bubbles are to be removed. Charging should be in operation during the vent to minimize pressurizer level changes. Pressure will also drop during the venting process. The effect of the vent on pressurizer pressure and level is illustrated in Figures 14 and 17. Pressurizer heaters should be energized during the vent to minimize the pressure drop.
   4. Place the hydrogen recombiner(s) in operation and monitor containment H_2 concentrations if not already accomplished.
   5. Vent to containment by opening the containment isolation valve and then one of the two reactor vessel isolation valves.
   6. Secure venting after the predetermined time has elapsed by closing the reactor vessel isolation valve and then the containment isolation valve.
   7. Evaluate the effectiveness of the vent on bubble removal and repeat if necessary after returning RCS pressure and pressurizer level to desired levels.

4.3 Venting the Reactor Vessel to the Quench Tank (QT)

1. Description of Operation

   This operation is identical to the previous section except the vented gas is directed to the QT . This path is used primarily if the containment path is unavailable or the rupture disc has already been ruptured. It may also be used for small bubble volumes.

2. Initial Conditions

Same as vent to containment except for the vent path

3. Operational Requirements

1. Same as the vent to containment except for the vent path.
2. During venting to the QT, monitor vent tank instrumentation and (assuming the containment vent path is available and with the rupture disc already ruptured) terminate venting to the QT by redirecting vent flow to containment if tank water level decreases to the point where it is no longer providing cooling for the vented gas.

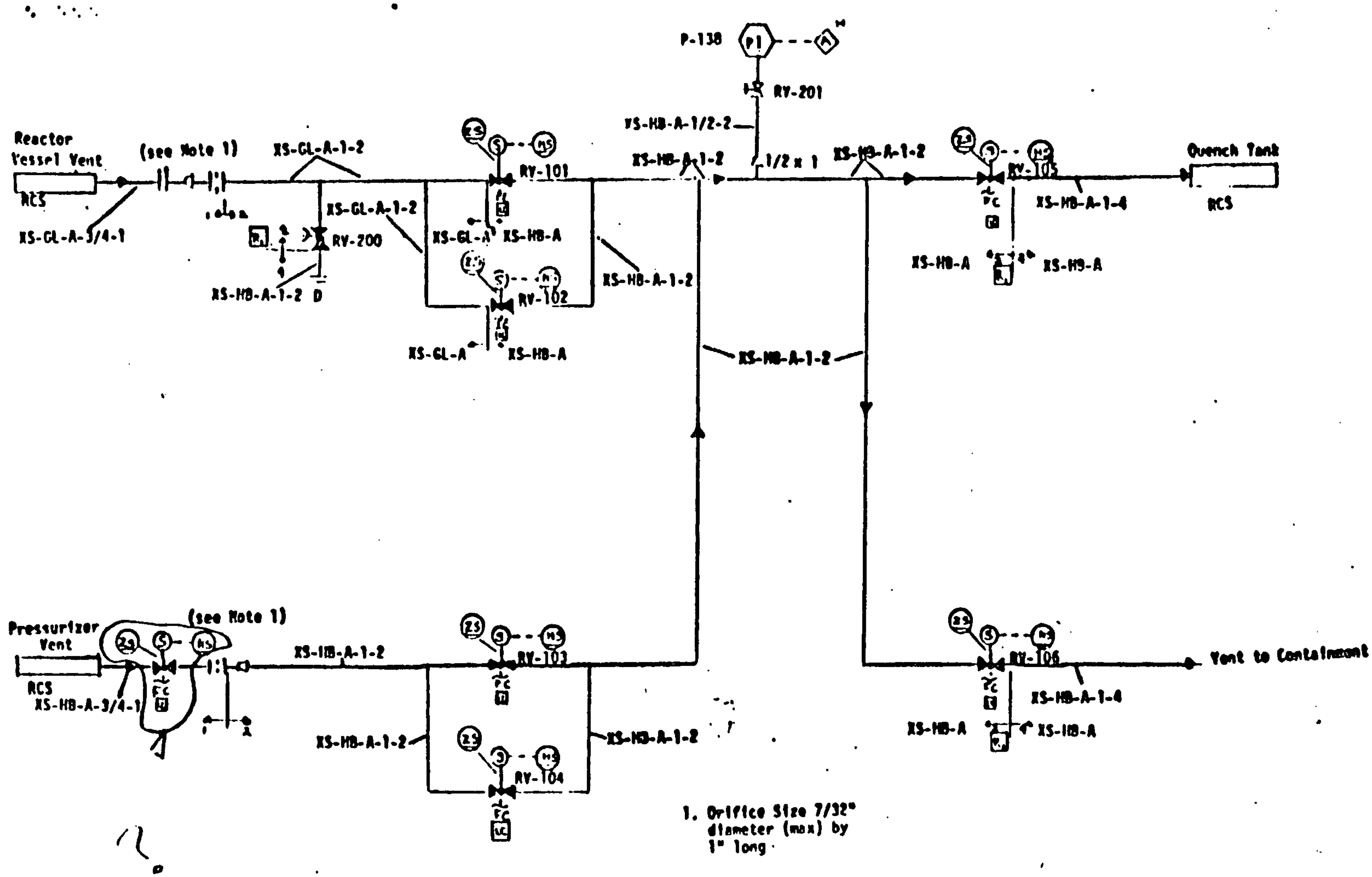
4.4 Venting the Pressurizer to the Containment or Quench Tank

Description of Operation

This operation is identical to the previous operations except that the pressurizer is the source of vented gas. The effect of the vent on the pressurizer pressure is illustrated in Figures 12-13 and 15-16.

FIGURE 1

REACTOR COOLANT GAS VENT SYSTEM



1. Orifice Size 7/32" diameter (max) by 1" long

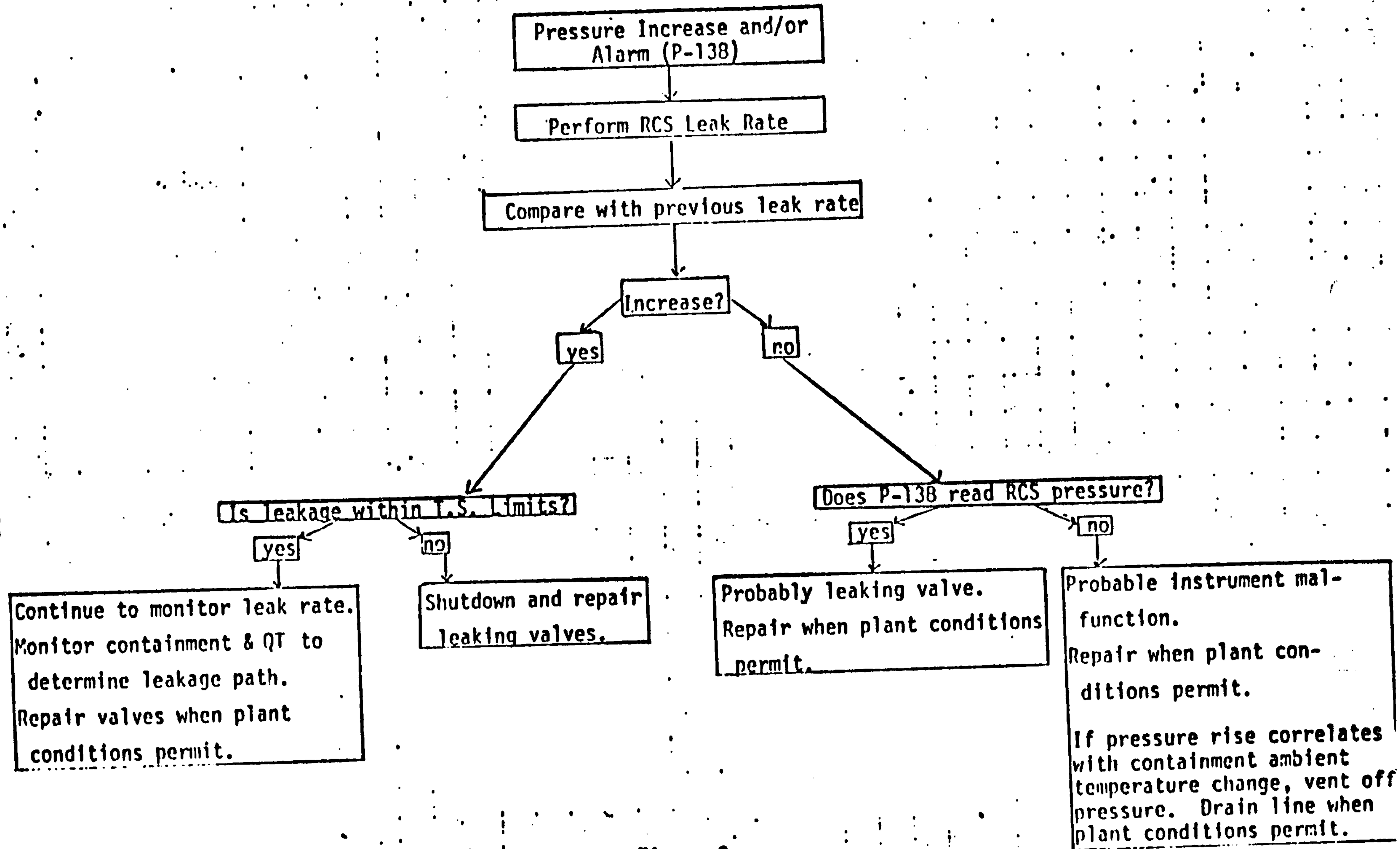


Figure 2

Response to System Valve Leakage

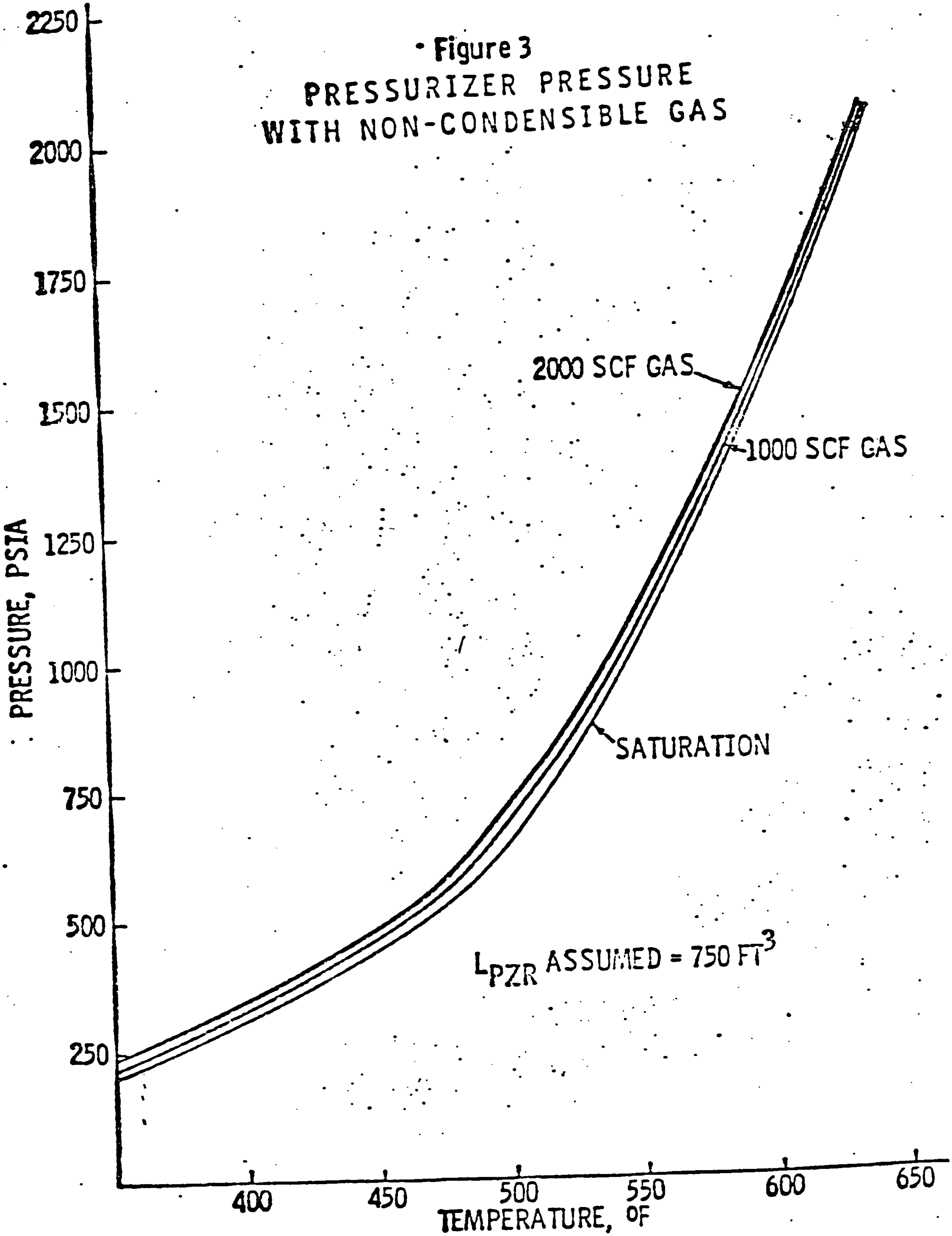


Figure 3
PRESSURIZER PRESSURE
WITH NON-CONDENSIBLE GAS
2000 SCF GAS
1000 SCF GAS
SATURATION
L_{PZR} ASSUMED = 750 FT^3
PRESSURE, PSIA
2250
2000
1750
1500
1250
1000
750
500
250
400
450
500
550
600
650
TEMPERATURE, °F

FIGURE 4

VENT DURATION OF HYDROGEN vs RV TEMP.
AT P = 2250 PSIA

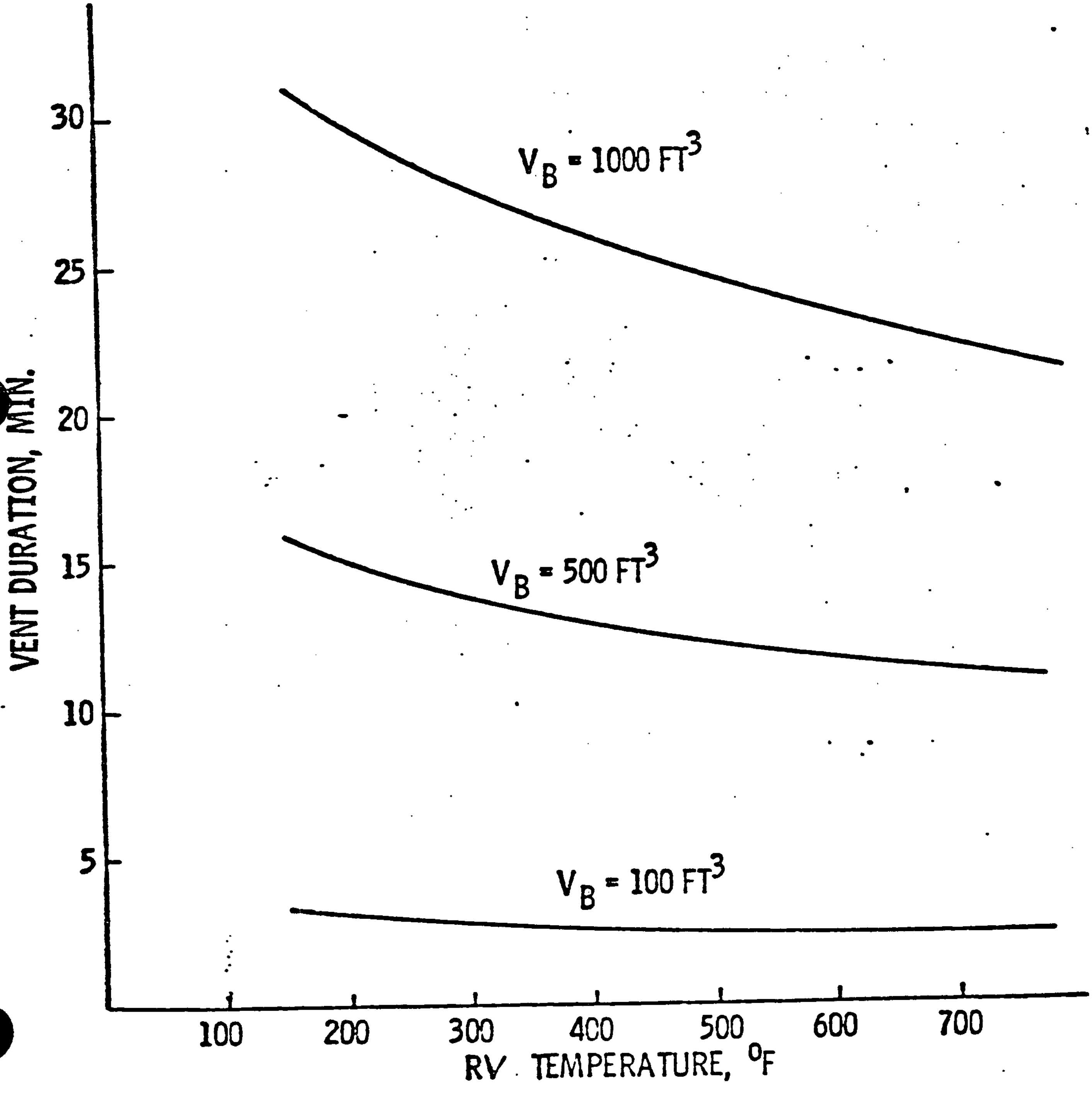


FIGURE 5
VENT DURATION OF HYDROGEN vs RV TEMP.
AT P = 1000 PSIA

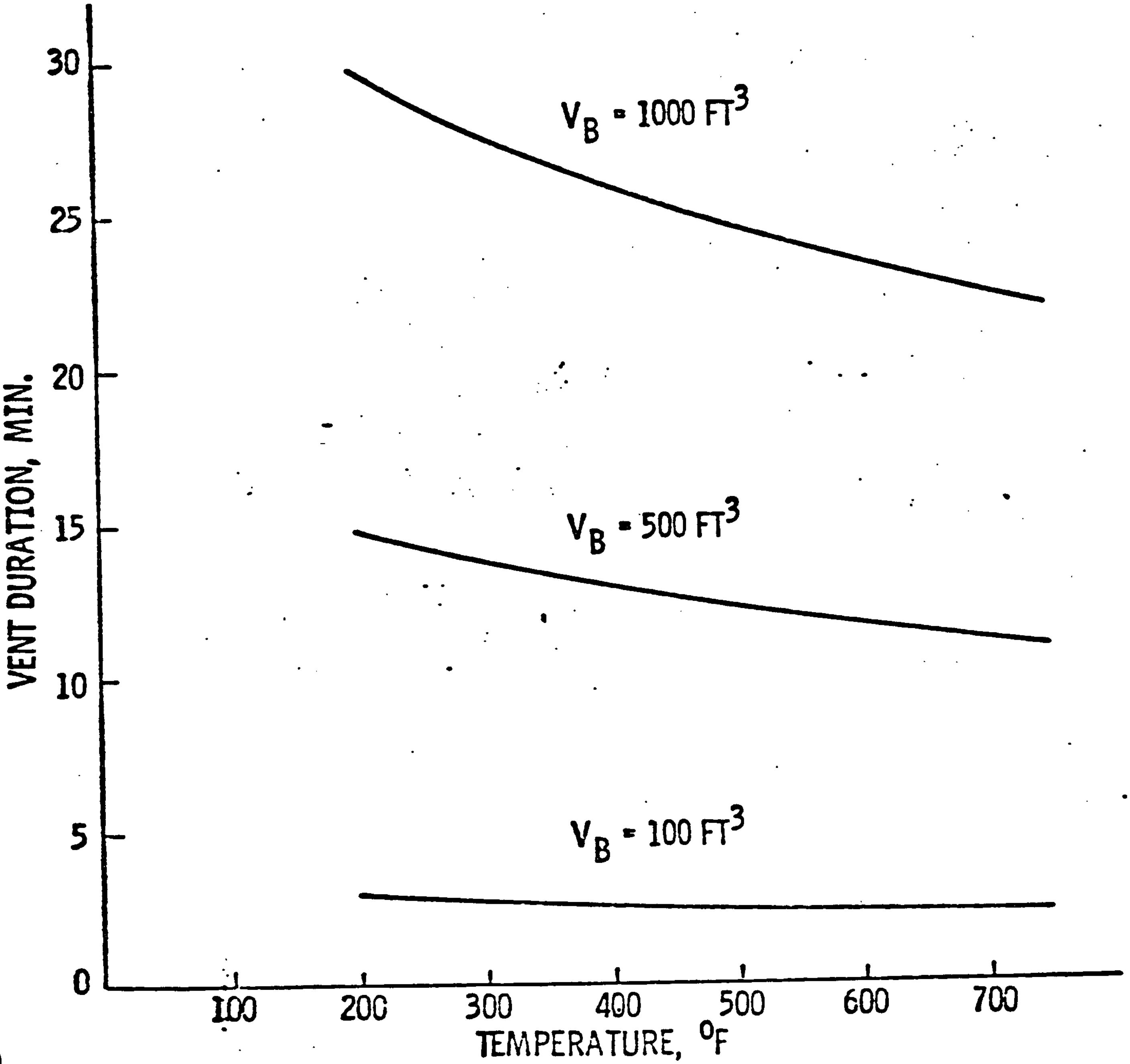


FIGURE 6
VENT DURATION OF HYDROGEN vs RV , TEMP.
AT P = 250 PSIA

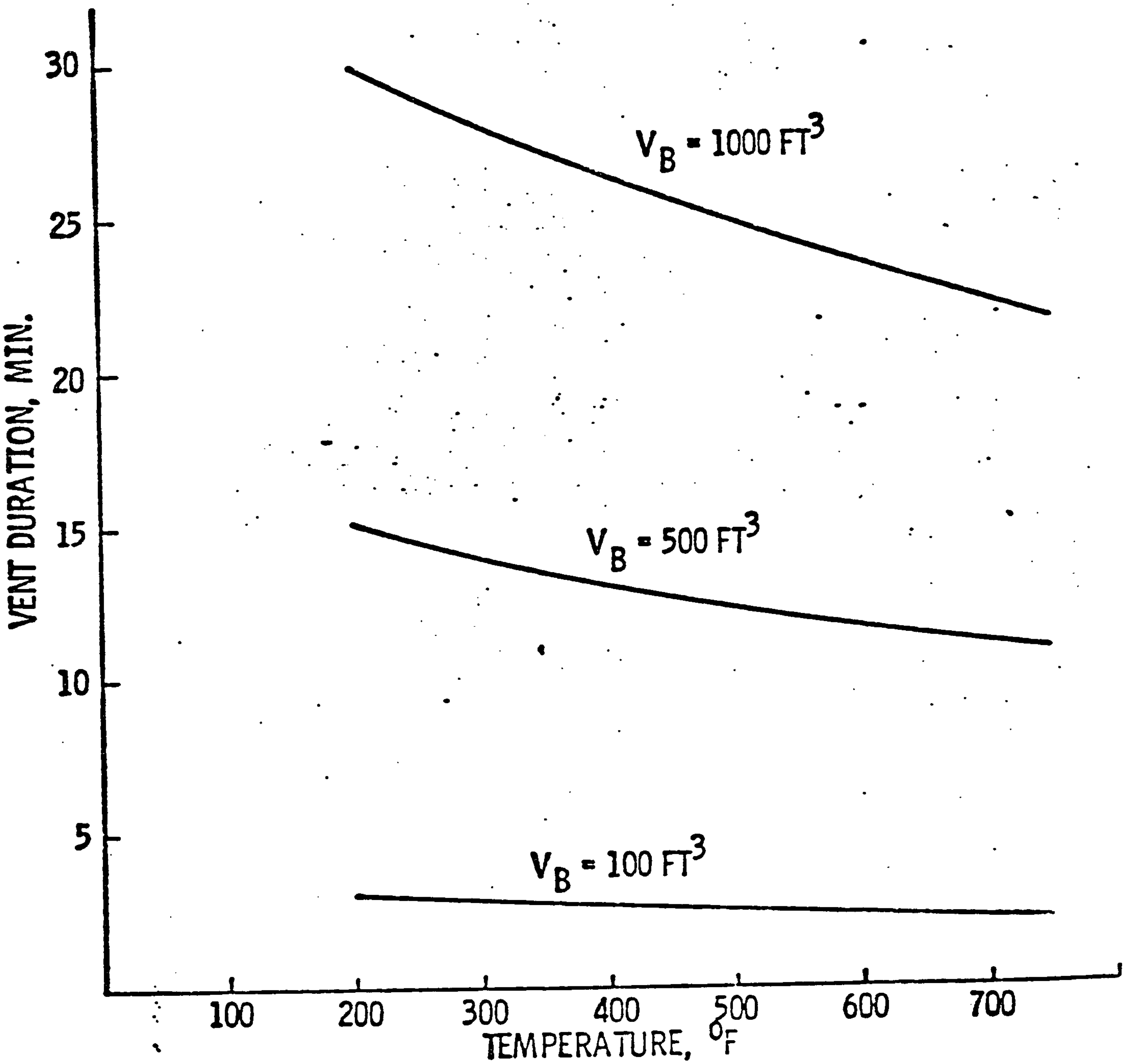


FIGURE 7
STEAM (REACTOR)

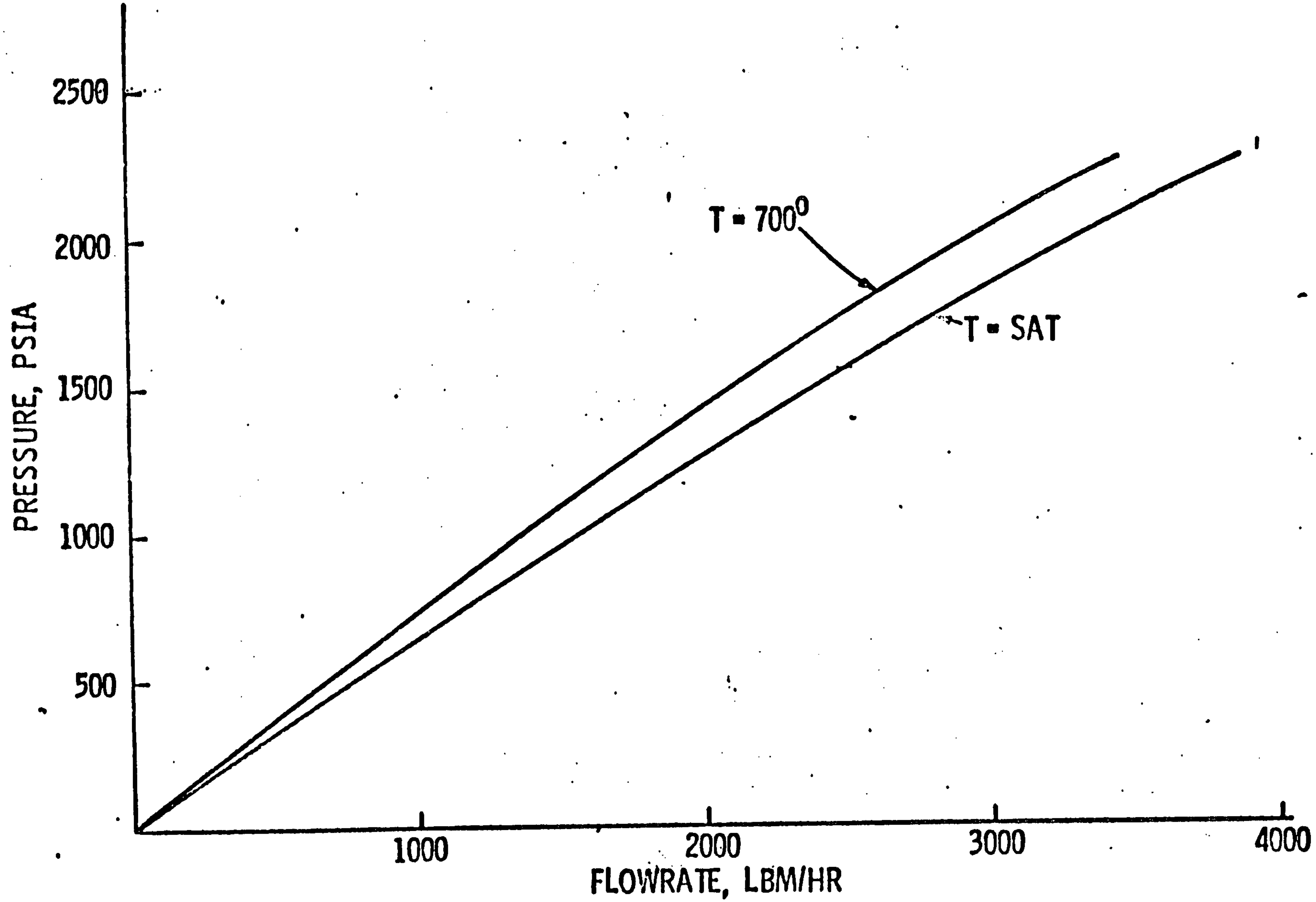


FIGURE 8

HYDROGEN (REACTOR)

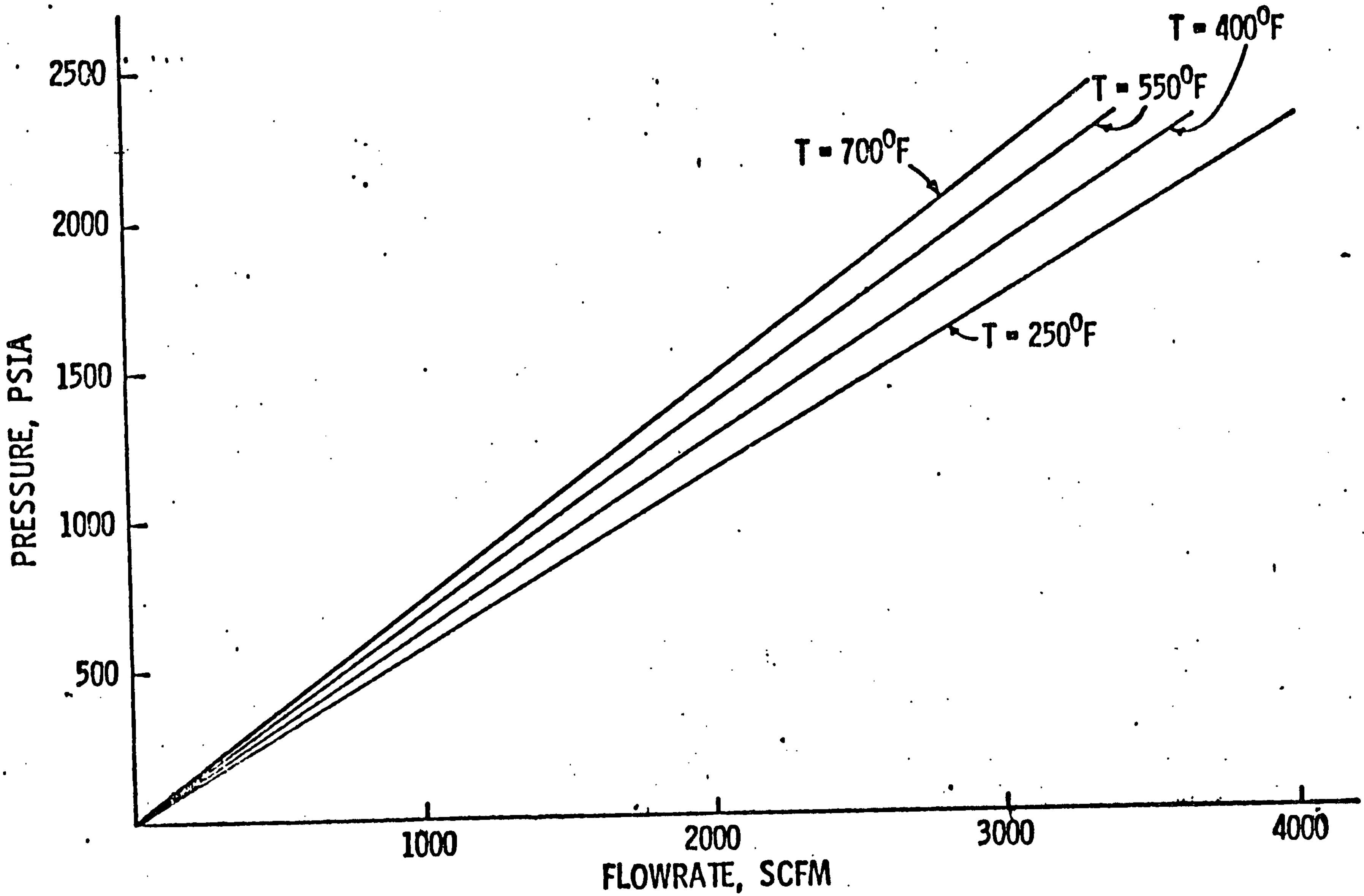


FIGURE 9
VENTING DURATION FROM PZR AT P = P_{SAT}

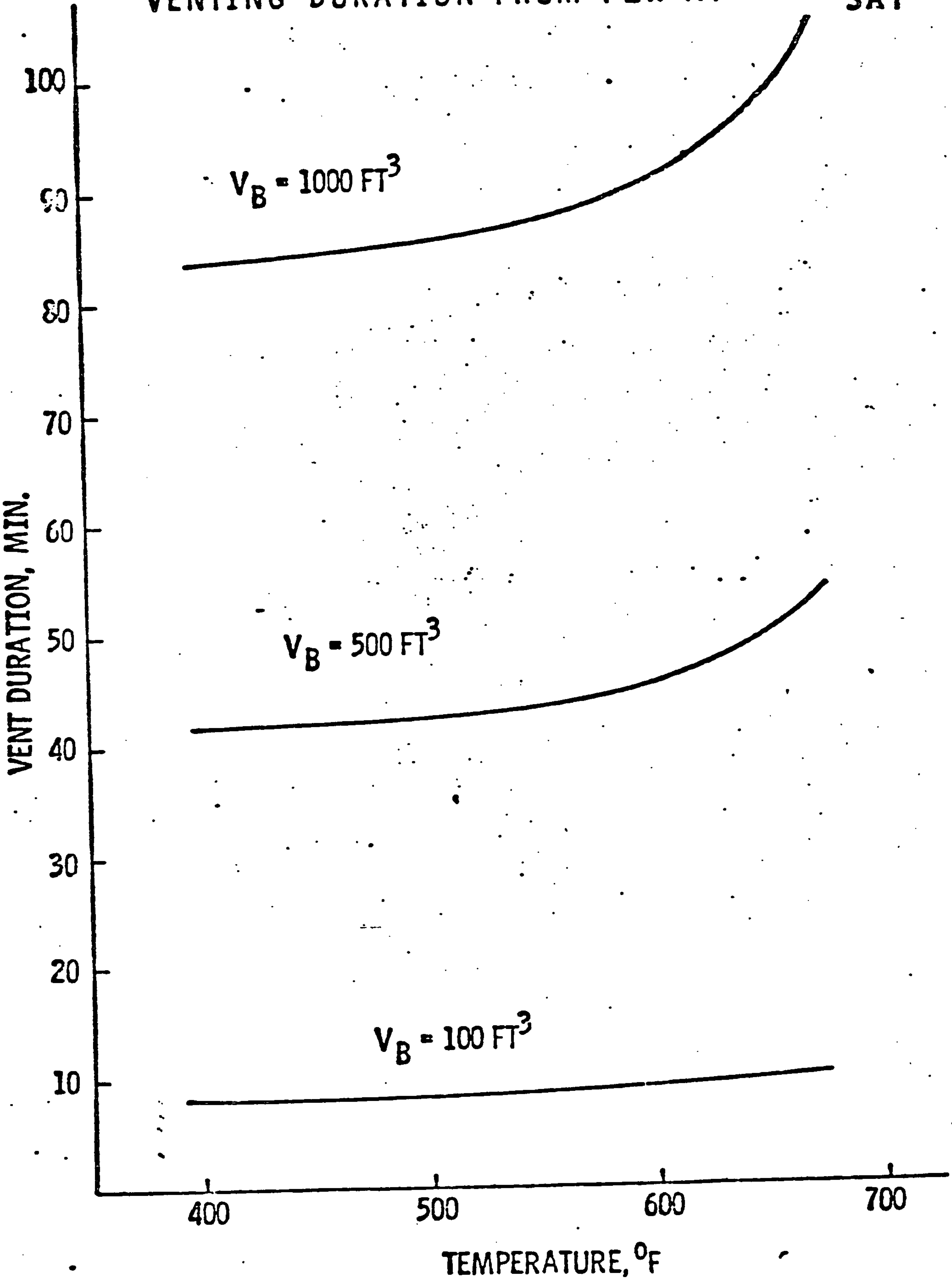


FIGURE 10
STEAM (PZR)

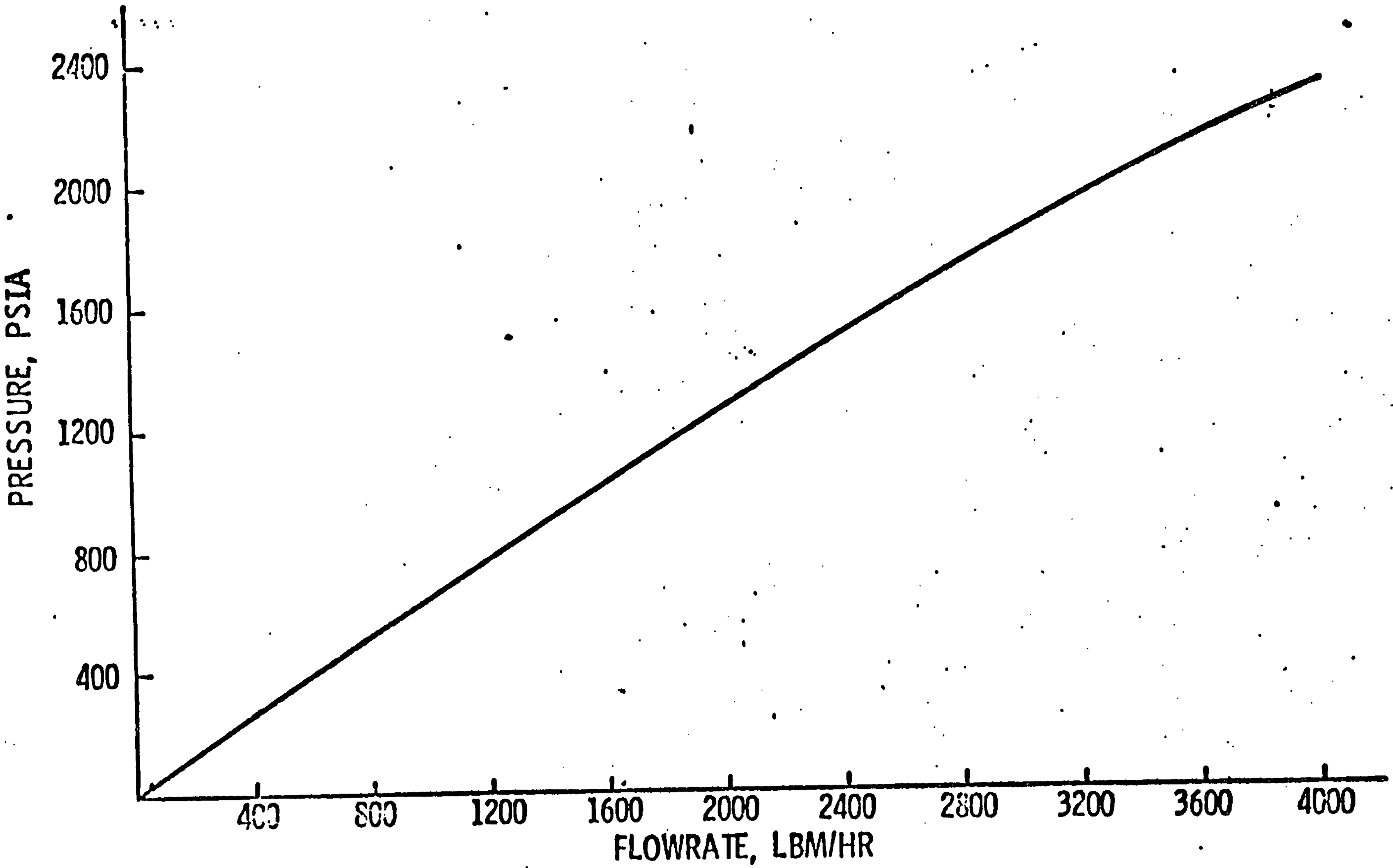


FIGURE 11

HYDROGEN (PRESSURIZER)

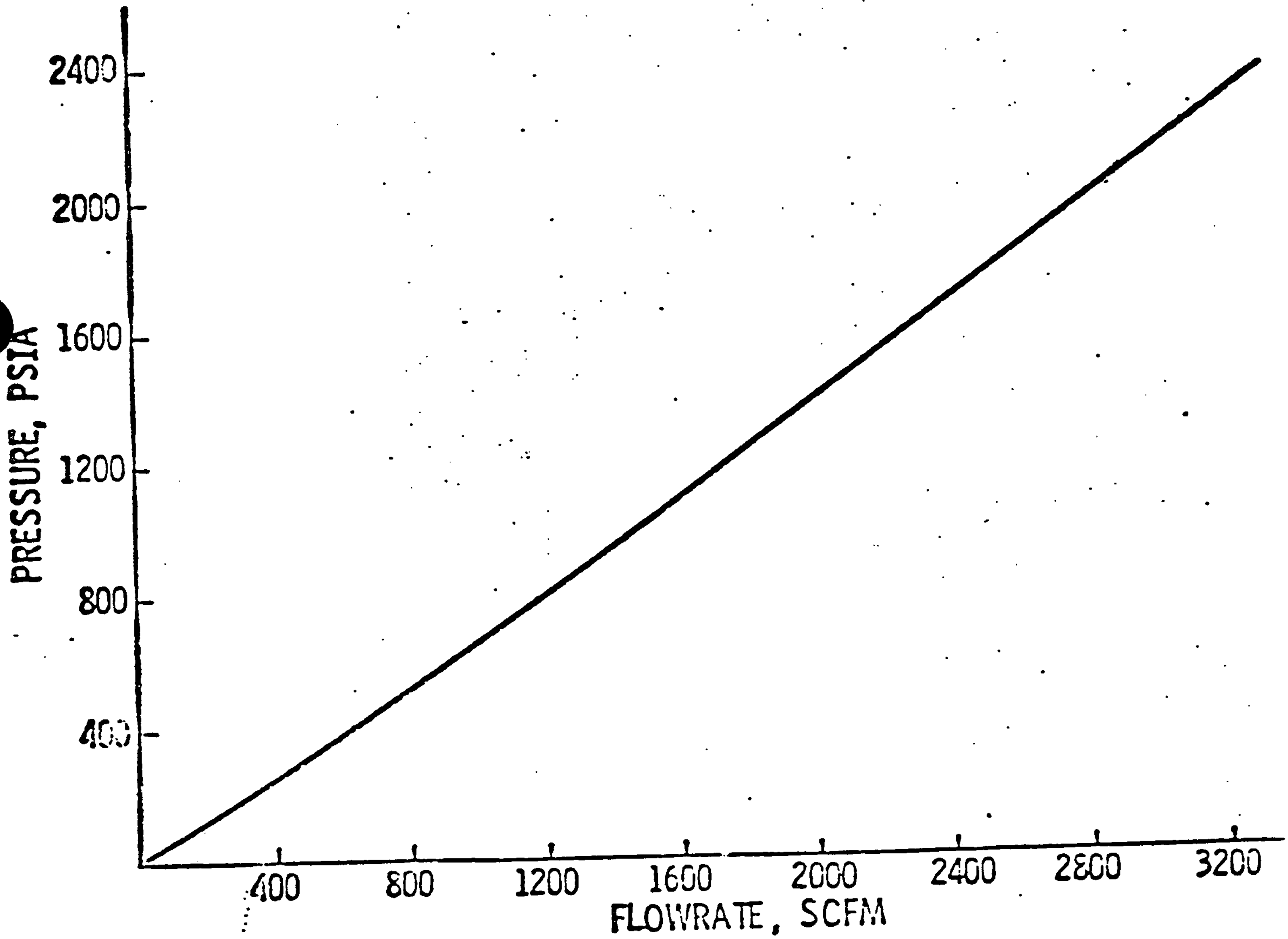


FIGURE 12

PRESSURIZER VENT - ΔP vs VENT TIME

CHARGING PUMP ON - STEAM

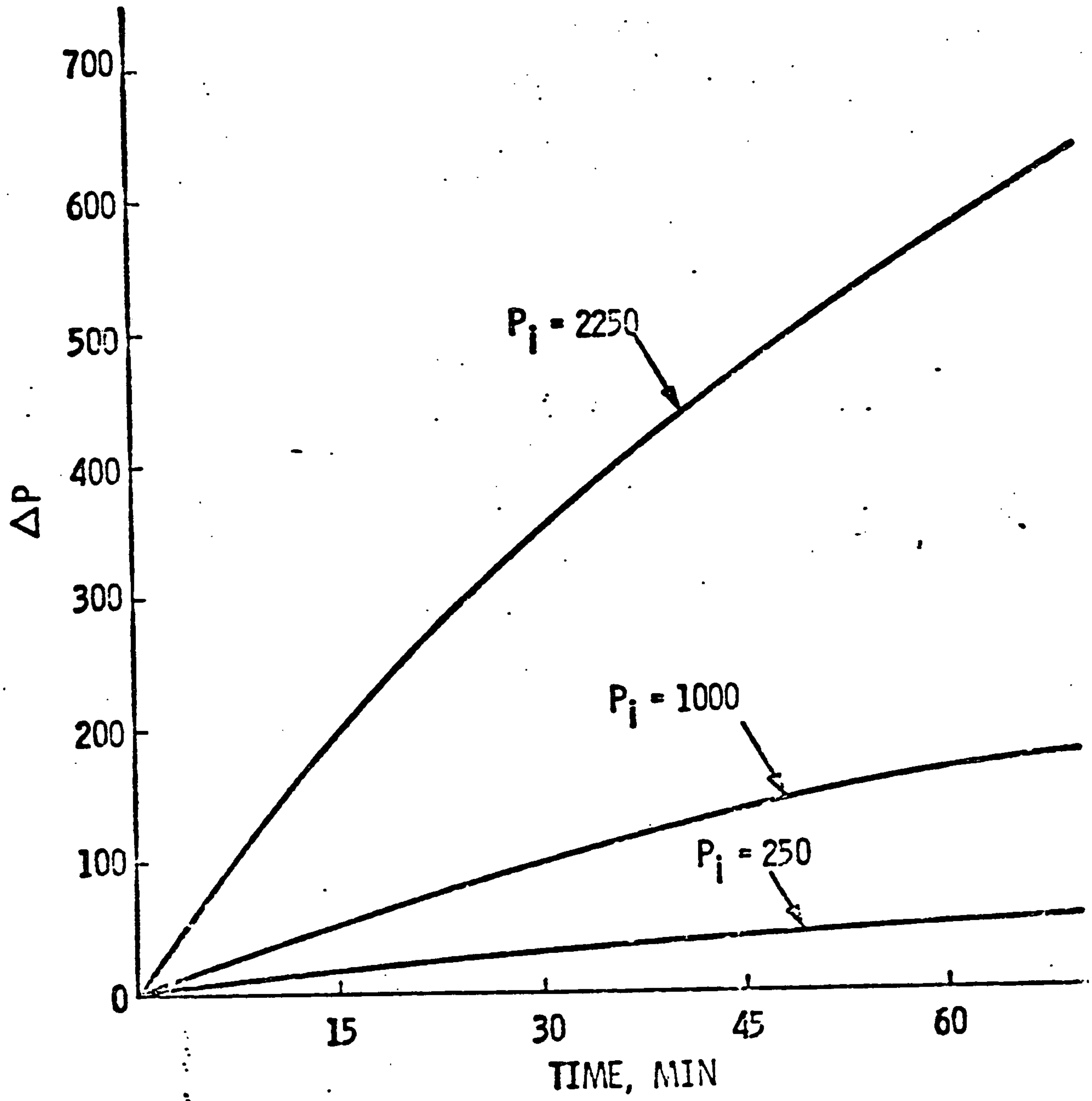


FIGURE 13

PRESSURIZER VENT - ΔP vs VENT TIME

CHARGING PUMP OFF - STEAM

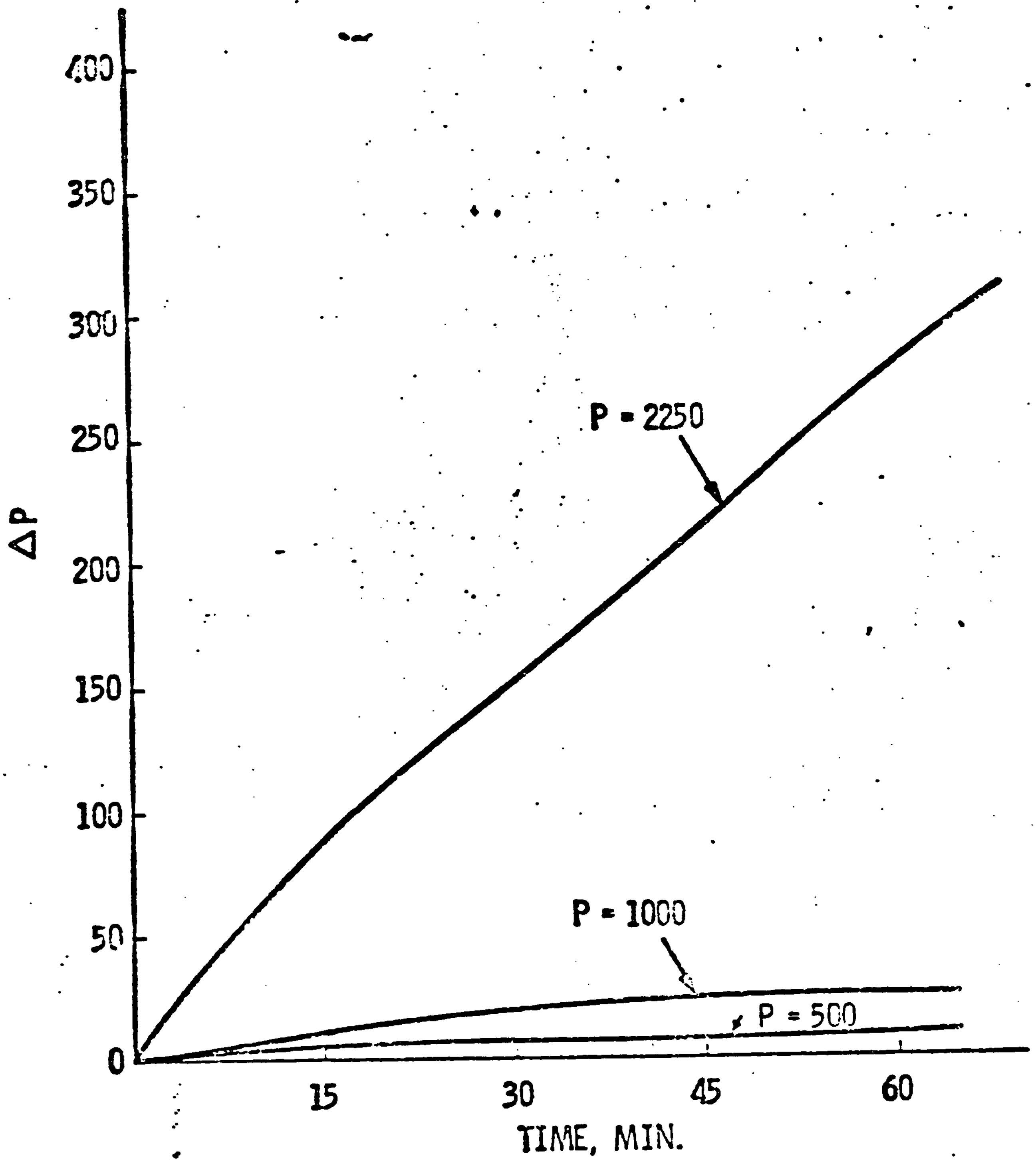


FIGURE 14

REACTOR VESSEL VENT - ΔP vs VENT TIME

CHARGING PUMP ON - HYDROGEN

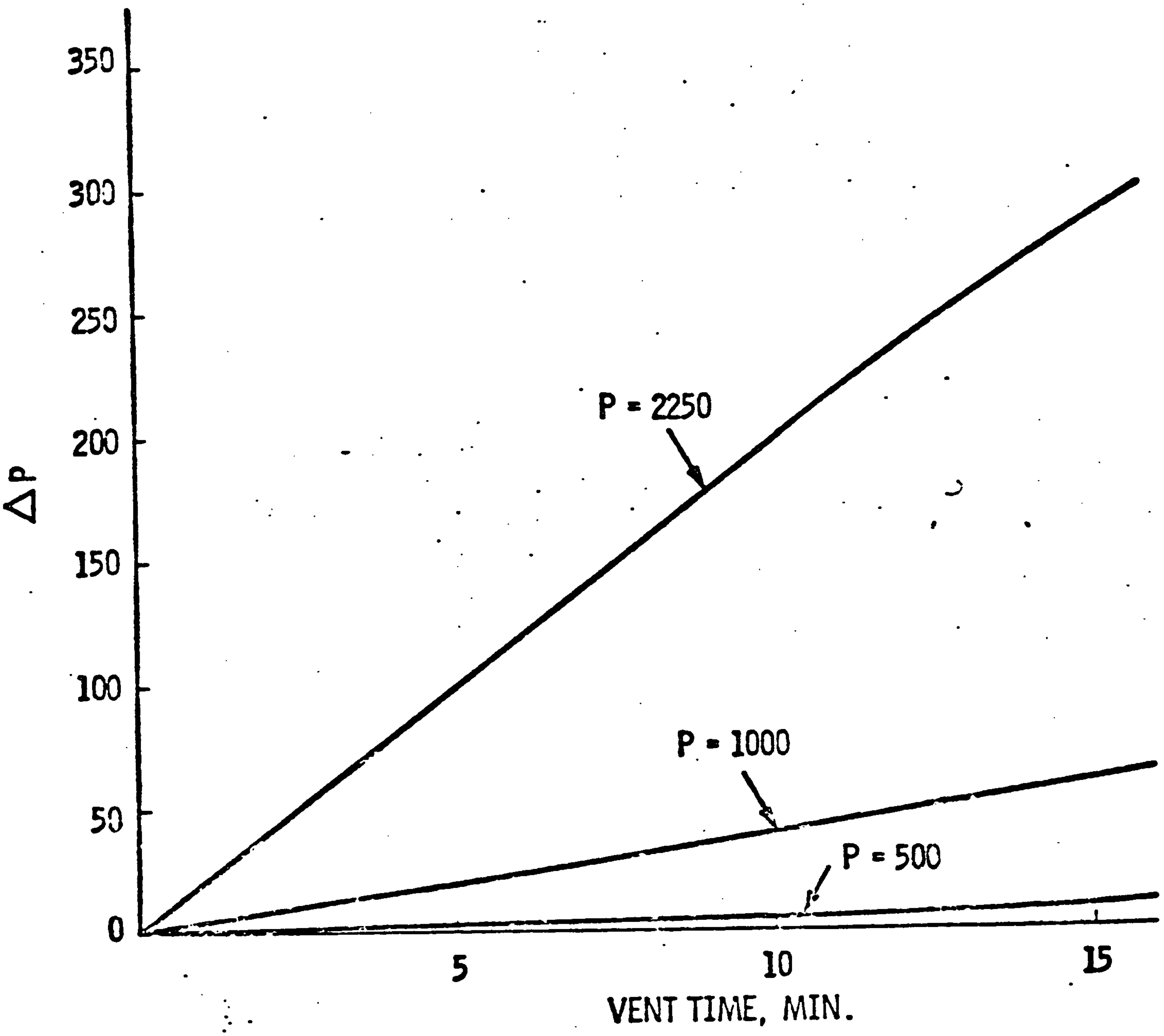


FIGURE 15

VENTING FROM PRESSURIZER WITH CHARGING PUMPS ON

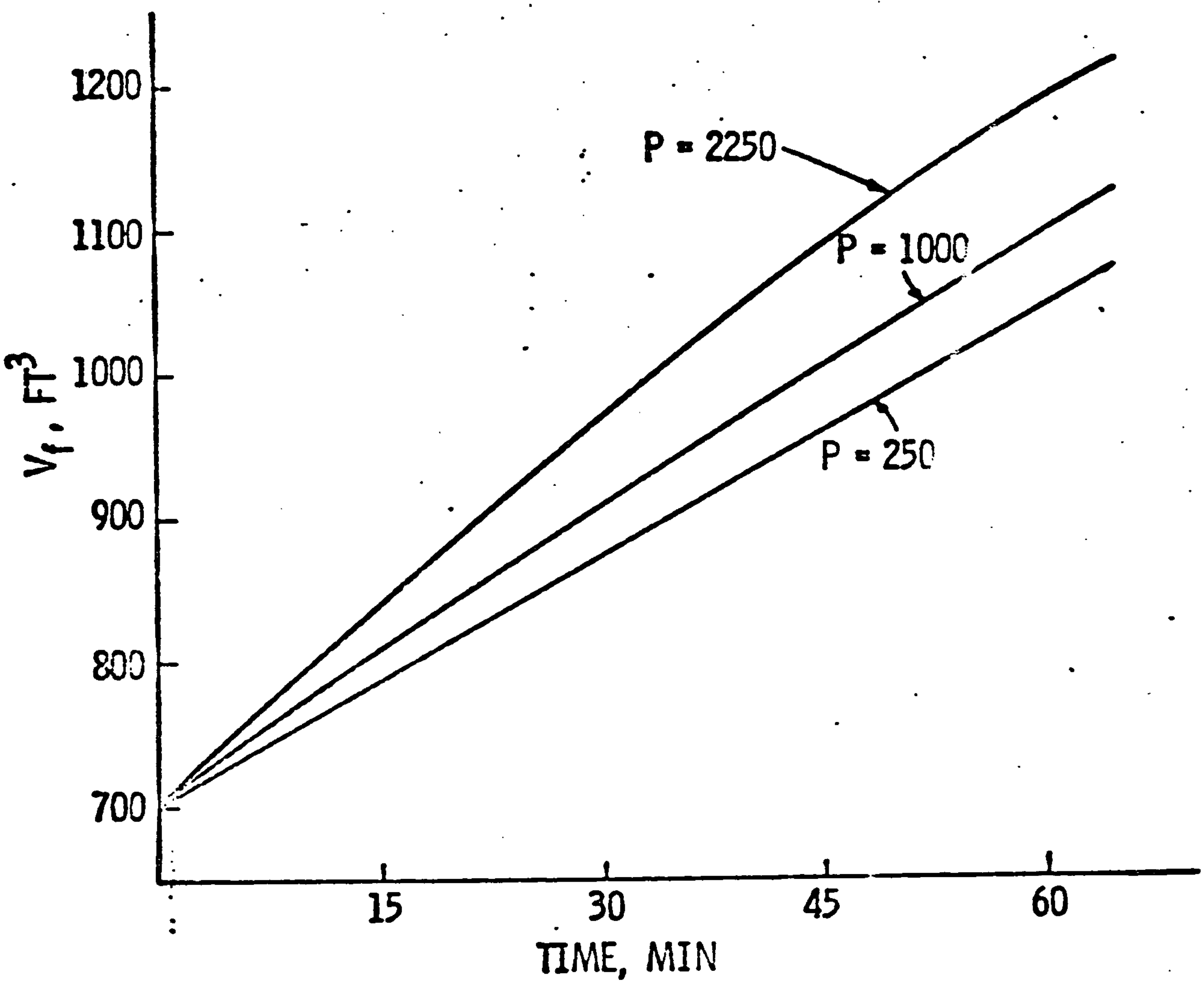


FIGURE 16

PRESSURIZER LEVEL vs TIME - PRESSURIZER VENT

CHARGING PUMP OFF - STEAM

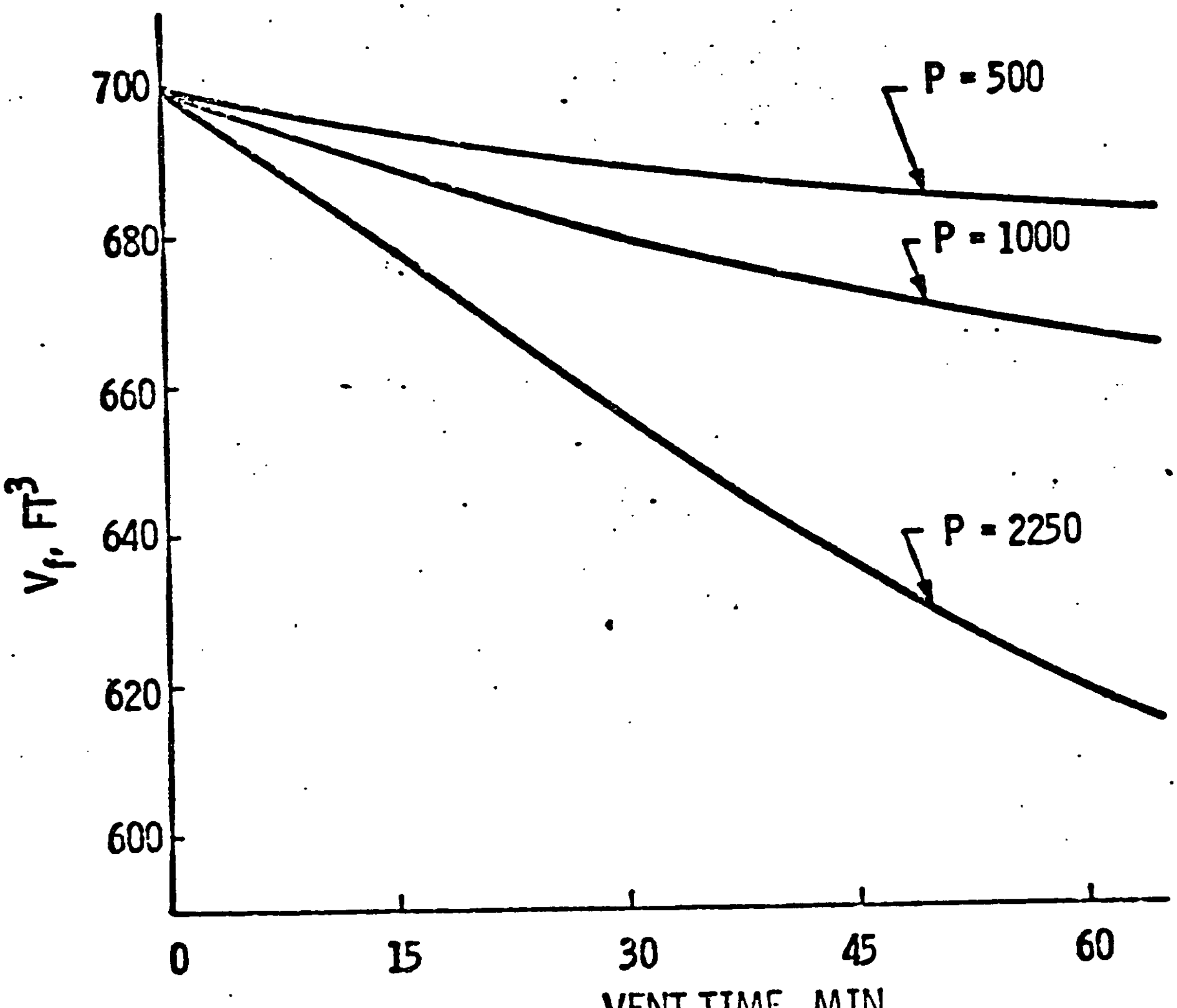


FIGURE 17

V_f VS TIME IN PZR WHEN VENT HYDROGEN IN RV

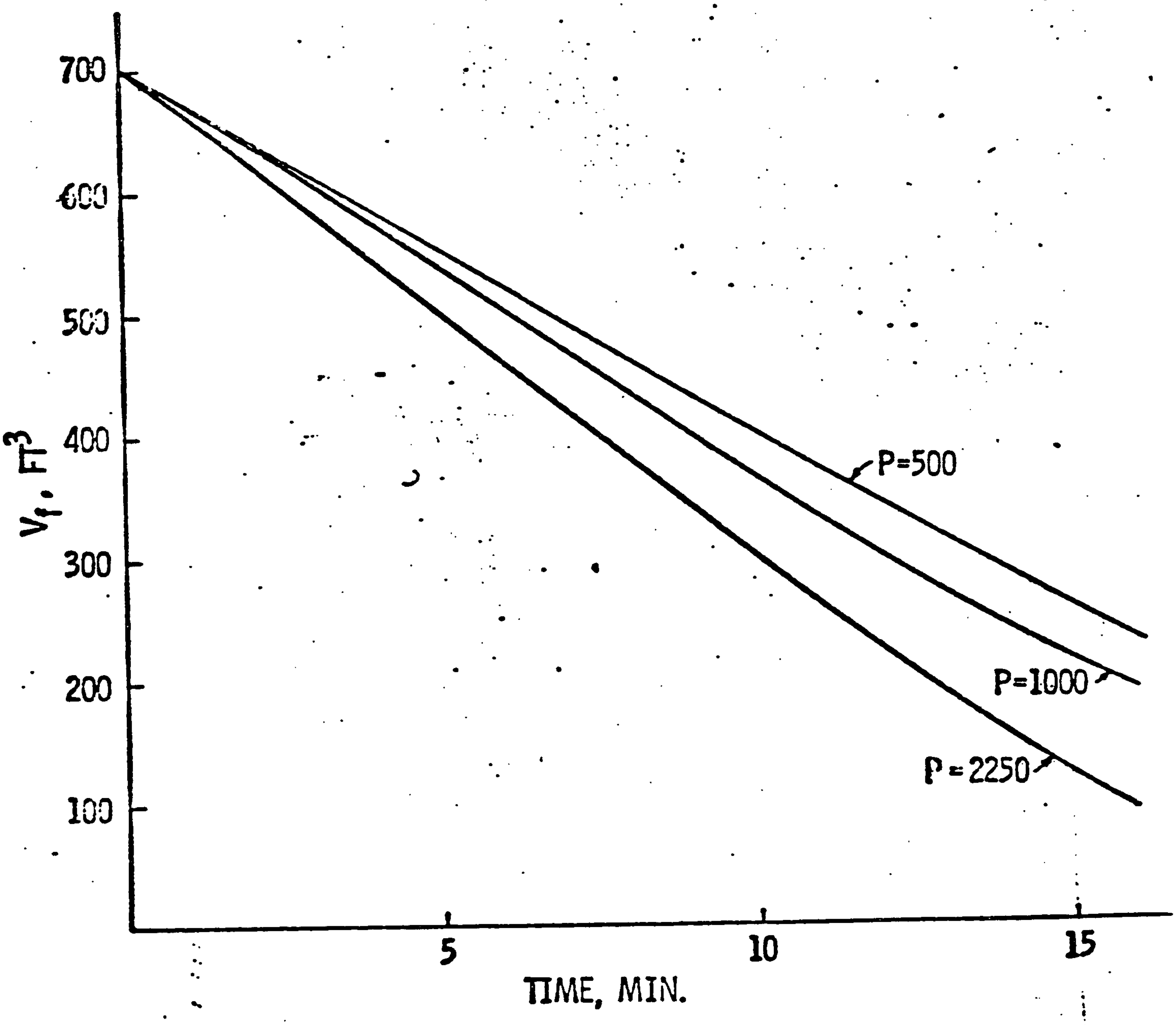


FIGURE 18

CONTAINMENT HYDROGEN CONCENTRATION

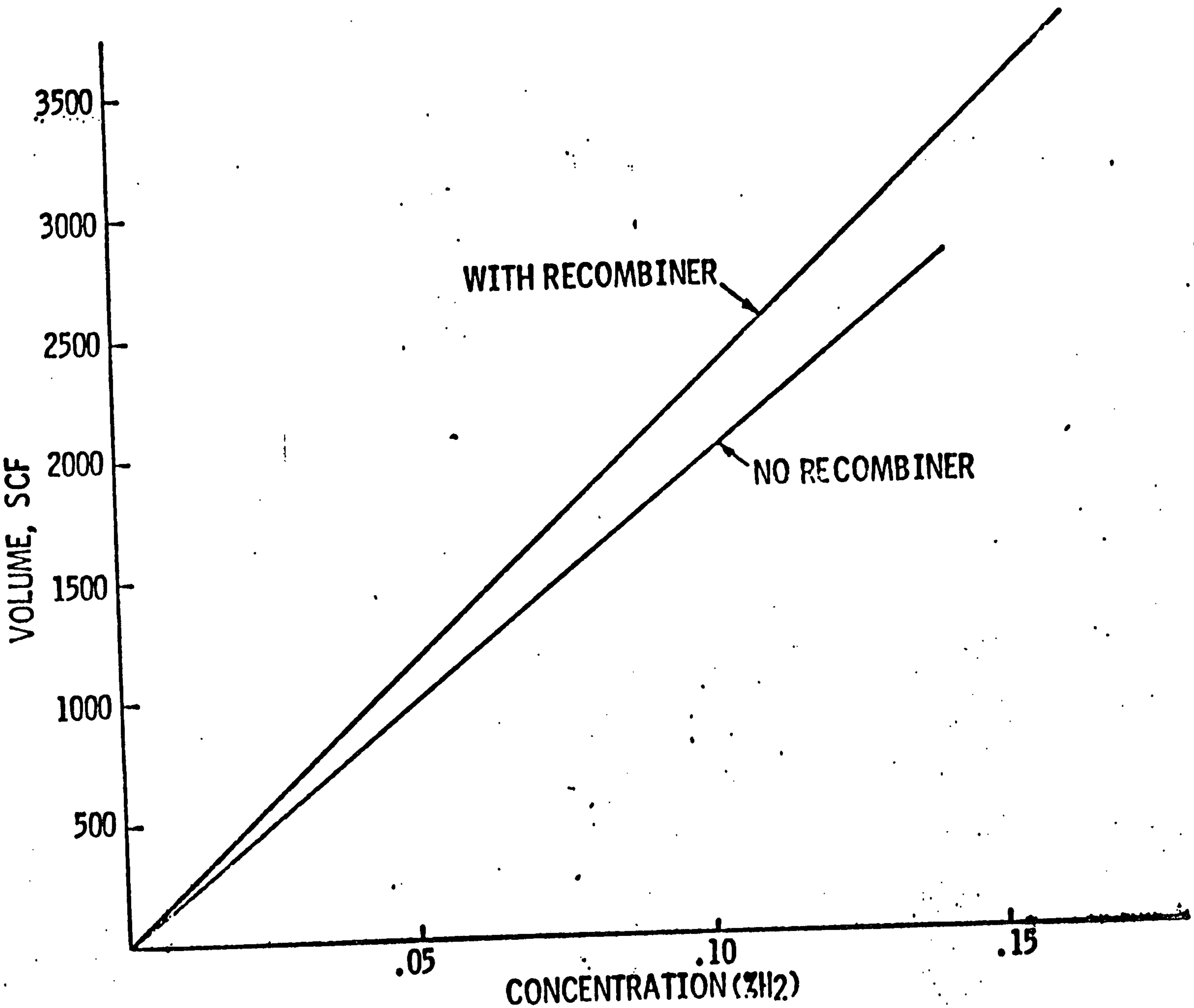
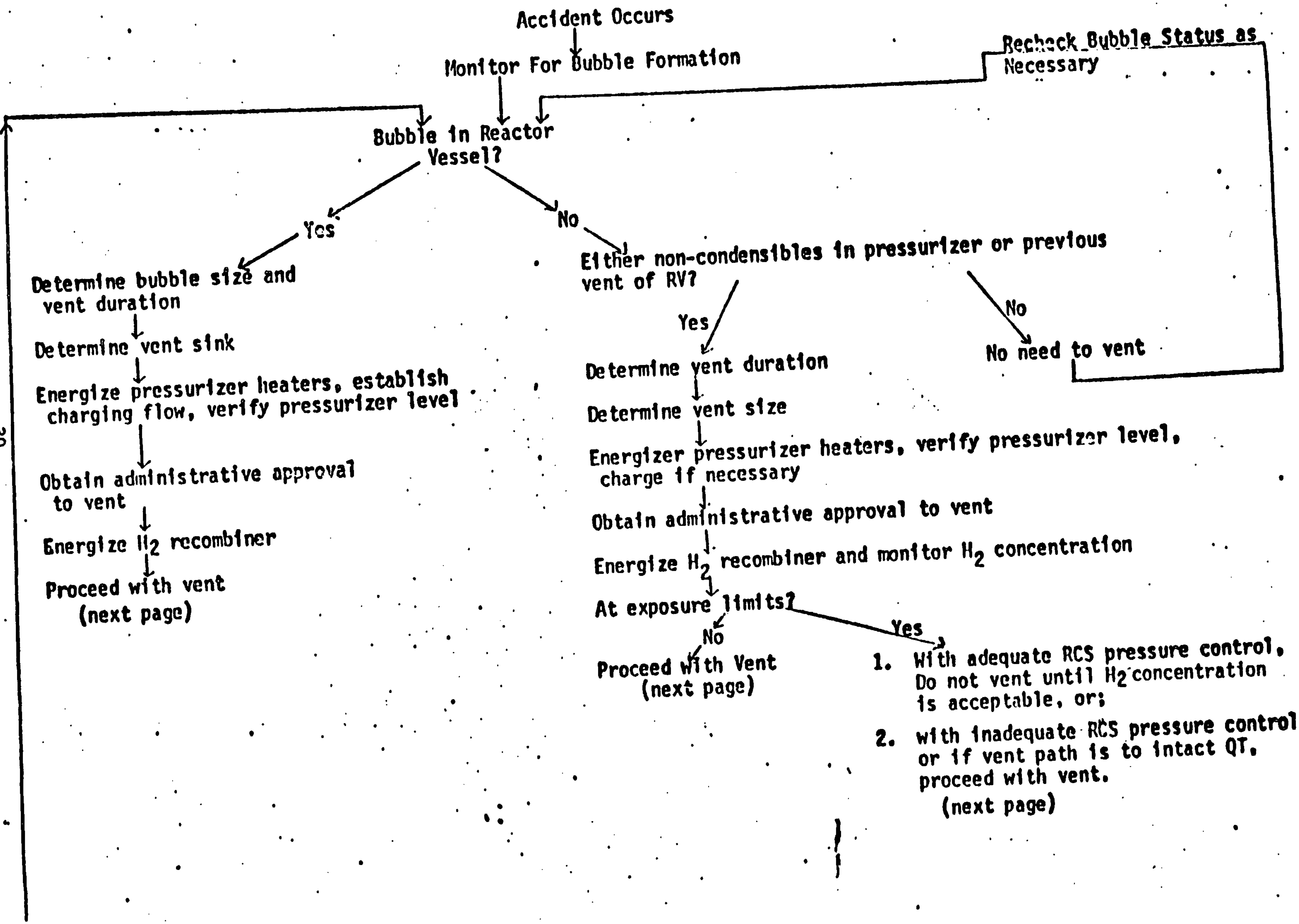
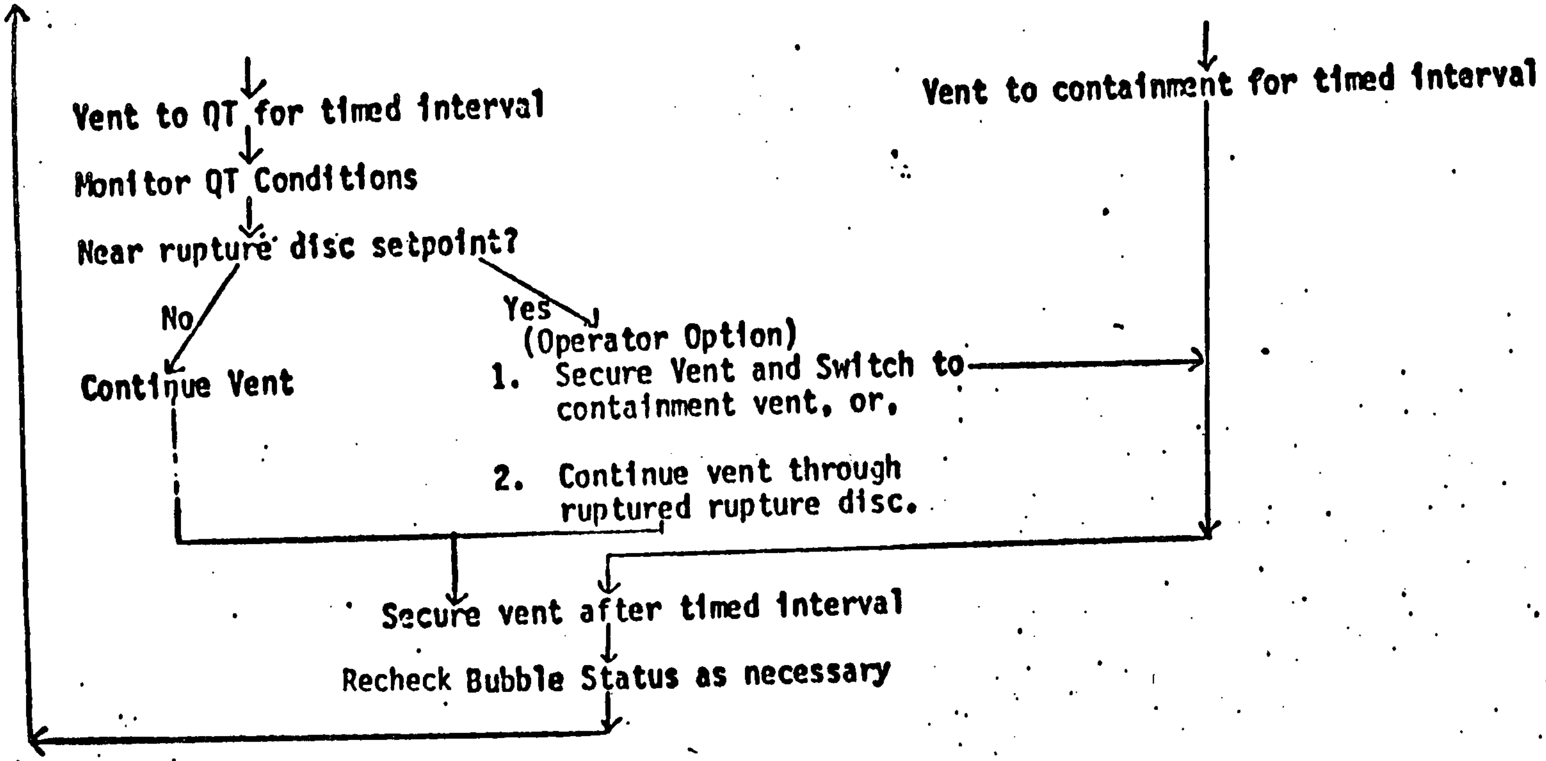


Figure 19 - RCGVS Accident Response




Vent to QT for timed interval
Monitor QT Conditions
Near rupture disc setpoint?
No
Continue Vent
Yes
(Operator Option)
1. Secure Vent and Switch to containment vent, or,
2. Continue vent through ruptured rupture disc.
Vent to containment for timed interval
Secure vent after timed interval
Recheck Bubble Status as necessary