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July 1, 1981

Director of Nuclear Reactor Regulation
United States Nuclear Regulatory Commission
Attn: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing
Washington, DC 20555

Reference: Beaver Valley Power Station, Unit No. 1
Docket No. 50-334
NUREG-0737

Gentlemen:

In accordance with the requirements of NUREG-0737 we are providing information for the following action items.

II.B.1 Reactor Coolant System Vents

The attached information provides the design description for the Reactor Vessel Vent System including pertinent drawings. Also included are the procedural guidelines provided by the vendor for use of the vent system. These guidelines will be used to develop plant specific procedures.

II.D.I Relief and Safety Valve Test Requirements

We have been in continuous contact with EPRI and understand that the Safety and Relief Valve Testing Report has been forwarded to the NRC for review. We expect to receive the report shortly, at which time we will perform the preliminary assessment required by the NUREG. We will transmit our assessment to you within a few days after completing our review.

II.E.4.2.7 Radiation Signal on Purge Valves

The requirement for purge and vent valves to close on a high radiation signal is not applicable to Beaver Valley Power Station due to the subatmospheric containment design. The requirement has been reviewed and approved in a letter from the NRC to Duquesne Light Company dated April 29, 1981.

Drawings to: BC
Aperture Card
Dist

A046
S/1

II.F.2 Instrumentation For Detection of Inadequate Core Cooling

In our letter of December 30, 1980, we committed to provide you with our evaluation of the Beaver Valley Power Station Core exit thermocouples to the criteria in II.F.2 Attachment 1. The present design does not meet the criteria specified in Attachment 1. We are investigating the measures which we can take to upgrade the incore thermocouple system so that we can more closely meet the requirements of Attachment 1.

II.K.3.1 Auto PORV Isolation

This item is dependent on NRC staff review of studies performed under TMI action item II.K.3.2 and determination that the modification is required as a result of the staff review. No activity is currently underway on this item pending further guidance from the NRC.

II.K.3.5 Auto Trip of Reactor Coolant Pump

The Westinghouse Owners Group, of which Duquesne Light Company is a participant, has forwarded the required analyses for NRC staff review and approval. The current status of this action item was summarized in a letter from Robert Jurgensen, Chairman of the owners group, to the NRC dated June 15, 1981. Further action in the area is dependent on NRC staff review and approval of the owners group submittals.

Very truly yours,

J J Carey

J. J. Carey
Vice President, Nuclear

cc: Mr. D. A. Beckman, Resident Inspector
U.S. Nuclear Regulatory Commission
Beaver Valley Power Station
Shippingport, PA 15077

SYSTEM DESCRIPTION

FOR

REACTOR COOLANT GAS VENT SYSTEM

FOR

BEAVER VALLEY

Beaver Valley Power Station, Unit No. 1
System Description For Reactor Coolant Gas Vent System

1.0 PURPOSE

The purpose of this document is to provide a general description of the Reactor Coolant Gas Vent System (RCGVS), including system function, major parameters and operation.

2.0 SYSTEM FUNCTIONS

2.1 Remotely Vent Gases From Reactor Vessel Head and Pressurizer Steam Space

The Reactor Coolant Gas Vent System is designed to be used to remotely vent non-condensible gases from the reactor vessel head and pressurizer steam space during post-accident situations when large quantities of non-condensible gases may collect in these high points. The purpose of venting is to prevent possible interference with core cooling. Small amounts of gas can be vented to the pressurizer relief tank (PRT) and thus not enter the containment atmosphere. Larger volumes will require venting directly to the containment in the pressurizer cubicle where the hydrogen concentration will be controlled by the containment hydrogen recombiners. Pressure instrumentation is included in the design to monitor system leakage during normal plant operation.

2.2 Aid in RCS Venting Procedures Following a Maintenance Outage.

Although designed for accident conditions, the system may be used to aid in the pre- or post-refueling venting of the reactor coolant system. Venting of the individual Reactor Coolant Pumps (RCPs) will still be necessary, however, pressurizer and reactor vessel venting can be accomplished with the system if desired. Vent flow would be directed to the PRT or waste gas system for this operation to prevent inadvertent release of radioactive fluid to the containment.

3.0 SUMMARY DESCRIPTION

3.1 System Parameters

Flow less than 100 scfm H2, dependent upon RCS pressure and temperature

Design Temperature	700F
Design Pressure	2500 psia
Line Size	1"

3.2 Description Summary

The system is designed to permit the operator to vent the reactor vessel head through a part length control rod drive mechanism housing or pressurizer steam space through existing sample lines from the control room under post-accident conditions and is operable following all design basis events except those requiring evacuation of the control room. The vent path from either the pressurizer or reactor vessel head is single active failure proof with active components powered from emergency power sources. The system meets the seismic requirements for Beaver Valley Power Station. Parallel valves powered off alternate power sources are provided at both vent sources to assure a vent path exists in the event of a single failure of either a valve or the power source. The system provides a redundant vent path either to the containment directly or to the PRT. Venting to the PRT allows removal of the gas from the RCS without the need to release the highly radioactive fluid into containment. Use of the PRT provides a discharge location which can be used to store small quantities of gas without influencing containment hydrogen concentration levels. However, venting large quantities of gas to the PRT will result in rupture of the PRT rupture disc providing a second path to containment for vented gas.

Cooling of gas vented to the PRT is provided by introducing the gas below the PRT volume. The direct vent path in the pressurizer cubicle is located to take advantage of mixing and cooling in the containment.

Non-condensible gases are removed from either the pressurizer or reactor vessel through the flow restricting orifice and one of the parallel isolation valves and delivered to the PRT or containment via their isolation valves. Venting under accident conditions would be accomplished using only one source (reactor vessel or pressurizer) and one sink (PRT or containment) at a given time.

4.0 COMPONENT DESCRIPTION

4.1 Piping and Valves

All piping and valves used in the RCGVS are either Type 304 or Type 316, austenitic stainless steel or equivalent. Socket welded connections are used throughout except where disassembly for maintenance, particularly refueling operations, is required. The system is designed for 2500 psia and 700F and compatible

4.1 Piping and Valves (continued)

with superheated steam, steam/water mixtures, fission gas, helium, nitrogen and hydrogen. A 7/32 x 1" stainless steel flow restriction orifice is provided in each vent path to limit reactor coolant leakage to less than the capacity of one charging pump in the event of a line break or inadvertent operation. A listing of the major system valves is provided in Table 1.

4.2 Instrumentation

4.1 Pressure indication in the vent line downstream of the reactor vessel head and pressurizer isolation valves is provided to detect leakage past any of these valves during normal power operations and alarm to alert the operator of the leakage. This instrument is not required to function during post-accident conditions and is therefore not provided with emergency power.

4.2 Open/close position indication for all remotely operated solenoid valves is provided in the control room.

5.0 OPERATION

5.1 The RCGVS is not used during normal power operations. All remotely operated valves are administratively controlled in the control room to assure the system is used only when necessary under accident conditions. Pressure instrumentation is provided to detect leakage pass the first isolation valves.

5.2 Post-Accident System Operation

In the unlikely event that an accident results in the generation of significant quantities of non-condensible gases within the RCS, the RCGVS is used to remove the gases from the RCS. Prior to operation of the system, the quantity of non-condensible gases that may be present in the RCS must be estimated. This is accomplished through reactor vessel level indication for the case of gas bubbles in reactor vessel and by the response of system pressure control methods or departure from saturation conditions in the pressurizer for the case of gas in the pressurizer. Plant operating guidelines will provide detailed instructions concerning the detection of the presence of non-condensible gas and the approximate volume of the gas.

5.2 Post-Accident System Operation (continued)

If it is determined that a gas bubble exists in either the reactor vessel or the pressurizer and administrative approvals to operate the RCGVS are obtained, the system is placed in operation as follows:

A. Administrative controls are removed from control room panels.

B. The Vent flow rate will be dependent upon reactor coolant system temperature and pressure. Flow rates for non-condensible gas (hydrogen) from the reactor vessel are provided in Figure 1. With the bubble size estimates and the flow rate, a venting duration can be determined. Figure 2 provides vent durations for various initial conditions. Plant operating guidelines will contain detailed instructions concerning the determination of the duration of venting.

C. The vent system is aligned to vent from the pressurizer or reactor vessel to the containment or pressurizer relief tank. Small quantities of gas may be vented to the PRT without rupture of the PRT rupture disc. Larger quantities of gas are vented directly to containment; containment H2 concentration will be monitored and controlled with hydrogen recombiners. Valve position indication is provided to monitor valve operation.

D. Venting is terminated after the previously determined time interval. If necessary, the bubble size is re-estimated and the venting re-established as often as necessary.

After system operation has been completed, administrative controls are again implemented to preclude operation.

5.3 System Maintenance and Inspection

5.3.1 Routine maintenance is limited to inservice inspection of the Class 2 solenoid valves required by Section XI of the ASME Code. Drains have been provided for this purpose.

5.3.2 The system will have to be partially disassembled each refueling to allow head removal. A removable spool-piece has been included in the design for this purpose.

6.0 SAFETY EVALUATION

6.1 Performance

The RCGVS may be required to operate during post-accident situations to remove non-condensible gases from the RCS. To assure operability under those conditions, the components of the system required to perform venting operations have been designed to operate under post-accident environmental conditions. They are provided with emergency power sources. The system is Safety Class 2, Seismic 1. Parallel valves assure a vent flow path to containment in the event of single active failure.

The RCGVS is not required to operate during normal power operation. To preclude inadvertent operation of the system, valves are subject to administrative controls prior to placing the system in operation. Should inadvertent operation occur, a flow limiting orifice is provided to limit mass loss from the RCS to less than a single charging pump.

6.2 Failure Modes and Effects

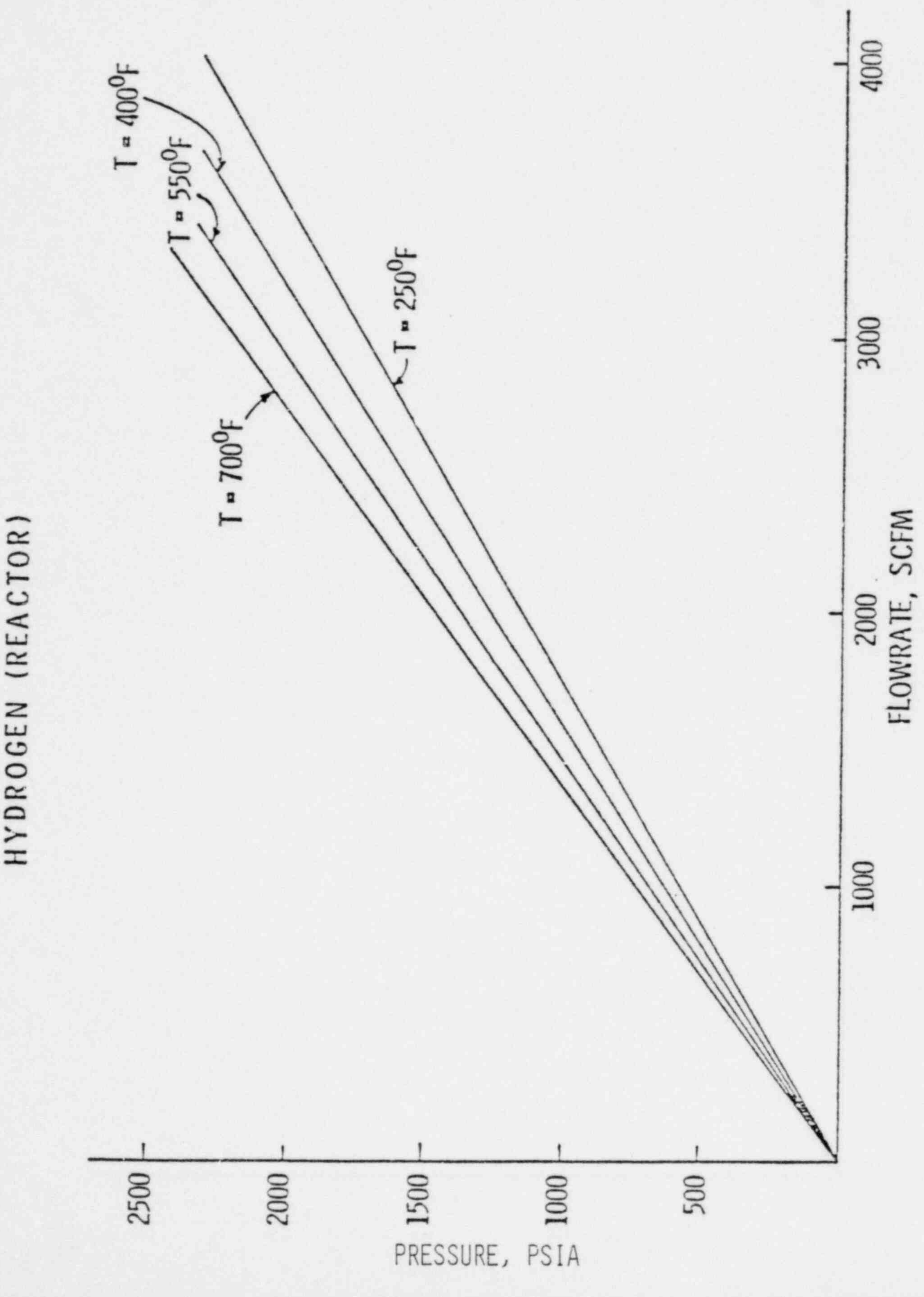
Appendix B provides the failure modes and effects of those failures upon the RCGVS.

TABLE 1

Major System Valves

Valve Number	RV-101, 102, 103, 104, 105, 106
Valve Type	Globe
Operator	Solenoid
Design Pressure	2485 psig
Design Temperature	700F
Operating Environmental	Containment: Normal, LOCA, Main Steamline Break
Seismic Class	1
Safety Class	2
Design Code	ASME Code Section III, Class 2
Electrical Class	1E
Active (yes/no)	Yes
Fail Position	Closed
Limit Switch Position Indication	Yes (open, close)
Body Material	Stainless Steel
Leakoff	Packless

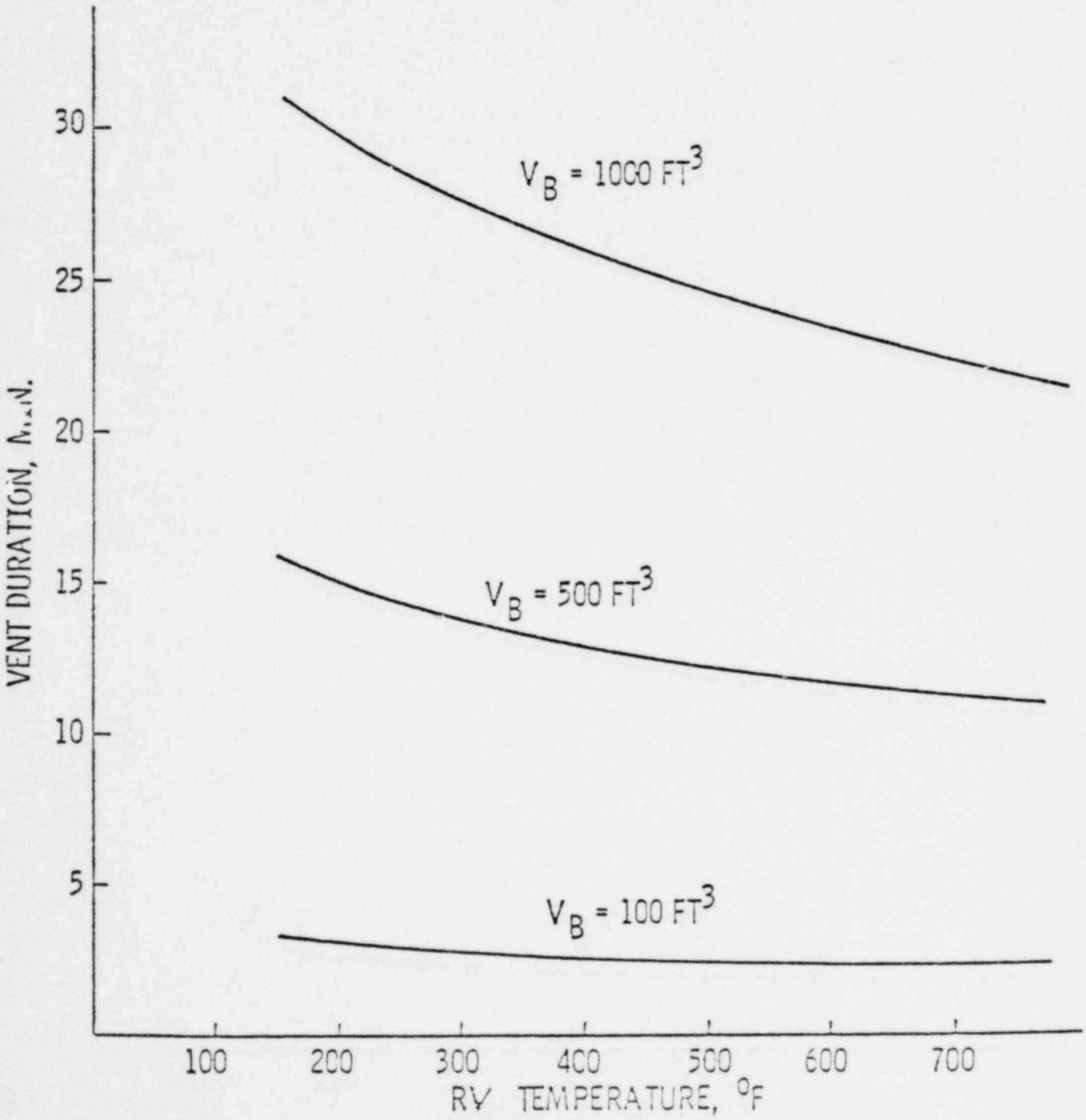
FIGURE 1



HYDROGEN (REACTOR)
T = 400°F
T = 550°F
T = 700°F
T = 250°F
2500
2000
1500
1000
500
PRESSURE, PSIA
1000
2000
3000
4000
FLOWRATE, SCFM

FIGURE 2

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



Appendix A

Summary of Definitions and
Summary of Definitions and Abbreviations

1.0 DEFINITIONS

COMPONENT CLASSIFICATIONS

Safety Class: As defined in ANSI N18.2 (Safety Class 4, defined as Quality Group D in Reg. Guide 1.26).

Mechanical Code Class: ASME pressure vessel code or other

Seismic Category: As defined in NRC Reg. Guide 1.29

Active/Non-Active Component: As defined in Reg. Guide 1.48. Class I Electrical: As defined in IEEE 308

2.0 ABBREVIATIONS

1.	SYSTEMS:	RCS	- Reactor Coolant System
		RCGVS	- Reactor Coolant Gas Vent System
2.	EQUIPMENT:	CRDM	- Control Rod Drive Mechanism
		RCP	- Reactor Coolant Pump
		PRT	- Pressurizer Relief Tank

Appendix B

RCGVS Failure Modes Effects Analysis

Failure Modes Effects Analysis for the Reactor Coolant Gas Vent System

No.	Name	Failure Mode	Cause	Symptoms and Local Effects Including Dependent Failures	Method of Detection	Inherent Compensating Provision	Remark and oth. Effects
1	Pressure Indicator P-138	a. spurious high pressure indication/alarm	Electro-mechanical failure, setpoint drift	No impact on normal operation. Loss of ability to detect leakage into the vent system piping.	Valve position indication in the control room.	None	
		b. spurious low pressure indication	Electro-mechanical failure, setpoint drift	No impact on normal operation. Loss of ability to detect leakage into the vent system piping.	Valve position indication in the control room.	None	
2	Pressurizer Relief Tank (PRT) Isolation Valve RV-105	a. Fails Open	Mechanical Binding, Seat Leakage	Inability to isolate the pressurizer relief from the reactor coolant gas vent system.	Valve position indication in the control room.	Redundant isolation manual valve RV-209	Redundant isolation valves to the reactor vessel and pressurizer preclude uncontrolled venting to the PRT.
		b. Fails Closed	Mechanical Failure, Loss of Power	No impact on normal operation. Inability to vent pressurizer or reactor to PRT.	Valve position indication in the control room. Operator.	None	Venting to the containment is possible, if necessary.
3	Pressurizer Relief Tank Isolation Valve RV-209	a. Fails Open	Mechanical Binding, Seat Leakage	None	Operator	Redudant Valves	
		b. Fails Closed	Mechanical Failure	No impact on normal operations. Inability to vent pressurizer or reactor to PRT.	Operator	None	Unlikely event since valve is normally open and has only manual operator. Venting to the containment is possible, if
4	Pressure Instrument Isolation Valves RV-201, 202	a. Fails Open	Mechanical Binding, Seat Leakage	None	Operator	Redundant Valves	
		b. Fails Closed	Mechanical Failure	Loss of ability to detect seat leakage from the pressurizer and reactor isolation valves into the reactor coolant gas vent system piping.	Operator	None	Unlikely event since valve is normally open and has only a manual operator.

Failure Modes Effects Analysis for the Reactor Coolant Gas Vent System

No.	Name	Failure Mode	Cause	Symptoms and Local Effects Including Dependent Failures	Method of Detection	Inherent Compensating Provision	Remark and other Effects
5	Containment Isolation Valve RV-106	a. Fails Open	Mechanical Binding, Seat Leakage	Inability to isolate reactor coolant vent system from containment.	High containment pressure and humidity if venting is in progress. Valve position indication in the control room.	None	
		b. Fails Closed	Mechanical Failure, Loss of Power to the Valve	No impact on normal operation. Inability to vent pressurizer or reactor to containment.	Valve position indication in the control room. Operator.	None	Venting to the PRT is possible if necessary.
6	Pressurizer Vent Isolation Valve RV-103, 104	a. Fails Open	Mechanical Binding, Seat Leakage	No impact on normal operation. Inability to vent the reactor vessel without also venting pressurizer.	Valve position indication in control room. P-138 high pressure indication.	Redundant Isolation manual valves RV-207, 208	Redundant isolation values to containment (RV-106), and PRT (RV-105) precludes uncontrolled venting of the pressurizer.
		b. Fails Closed	Mechanical Failure, Loss of Power	Inability to vent the pressurizer.	Valve position in the control room. Isolation valve. Operator.	Parallel redundant isolation valve.	Parallel isolation valve allows venting of the pressurizer.
7	Pressurizer Vent Isolation Valve RV-207, 208	a. Fails Open	Mechanical Binding, Seat Leakage	None	Operator	Redundant isolation valves RV-103, 104	
		b. Fails Closed	Mechanical Failure	Inability to vent the pressurizer	Operator	Parallel redundant isolation valve.	Parallel isolation valves allows venting of the pressurizer. Unlikely event since valve is normally open and has only a manual operator

Failure Modes Effects Analysis for the Reactor Coolant Gas Vent System

No.	Name	Failure Mode	Cause	Symptoms and Local Effects Including Dependent Failures	Method of Detection	Inherent Compensating Provision	Remarks and other Effects
8	Reactor Vessel Vent Isolation Valve RV-101, 102	a. Fails Open	Mechanical Binding, Seat Leakage	No impact on normal operation. Unable to vent pressurizer without also venting the Reactor Vessel.	Valve position indication in the control room. P-138 high pressure indication.	Redundant isolation manual valves RV-205, 206	Redundant isolation valves to containment (RV-106) and (RV-105) precludes uncontrolled venting of the reactor vessel.
		b. Fails Closed	Mechanical Failure, Loss of Power	Inability to vent the reactor vessel.	Valve position in the control room. Operator.	Parallel redundant isolation valve.	Parallel isolation valve allows venting of the reactor vessel.
9	Reactor Vessel vent Isolation Valve RV-205, 206	a. Fails Open	Mechanical Binding, Seat Leakage	None	Operator	Redundant isolation valve RV-101, 102	
		b. Fails Closed	Mechanical Failure	Inability to vent the Reactor Vessel	Operator	Parallel redundant isolation valve	Parallel Isolation valve allows venting of the reactor vessel. Unlikely event since valve is normally open and has only a manual operator

Failure Modes Effects Analysis for the Reactor Coolant Gas Vent System

No.	Name	Failure Mode	Cause	Symptoms and Local Effects Including Dependent Failures	Method of Detection	Inherent Compensating Provision	Remark and other Effects
10	Position Indicator for RV-101, 102	False indication of valve position	Electro-mechanical failure.	Loss of ability to detect valve position in reactor vessel vent line.	Pressure gauge (P-138) indication shows valve is opened.	None	
11	Position Indicator for RV-103, 104	False indication of valve position	Electro-mechanical failure.	Loss of ability to detect valve position in pressurizer vent line.	Pressure gauge (P-138), indication shows valve is opened.	None	
12	Position Indicator for RV-105	False indication of valve position	Electro-mechanical failure	Loss of ability to detect valve position in pressurizer relief tank vent line.	PRT temperature and pressure verify value position. Pressure gauge (P-138).	None	
13	Position Indicator for RV-106	False indication of valve position	Electro-mechanical failure	Loss of ability to detect valve position in containment vent line.	Containment pressure/humidity/radiation levels verify containment valve position. Pressure gauge (P-138).	None	
14	Drain Valves RV-200, 203, 204	a. Seat Leakage	Contamination, Mechanical damage	No impact on system operation.	None	Drain lines are blind flanged.	
		b. Fails Closed	Mechanical Binding	No impact on normal operations. Inability to drain affected line section or test isolation valves IAW ASME XI.	Operator	None	

PROCEDURAL GUIDELINES

FOR

REACTOR COOLANT GAS VENT SYSTEM

FOR

BEAVER VALLEY

1.0 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 are closed and the manual isolation valves (RV-205, 206, 207, 208, 209) are opened 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
   - Pressurizer Relief Tank (PRT)
   - Containment Recombiners and H_2 Analyzers
4) The RCGVS pressure instrument (P-138) is operational.
5) All RCGVS solenoid valves should be key-locked closed with administrative controls imposed. Power may be removed from the valves as a secondary precaution.
6) The RCGVS manual valves (RV-205,206,207,208,209,201,202) are open
7) The reactor vessel vent manual valve and the pressurizer vent manual valve (3/4" T58) are opened.
8) Manual Drain Valves (RV-200, RV-203, RV-204) are 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 determinat on 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 flui. 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 PRT parameters should be monitored to determine if the leakage is being directed to containment or to the PRT. The leaking valves should be repaired at the earliest opportunity and if leakage reaches technical specification limits, the plant must be shutdown to repair the valves.

3.2 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 PRT 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 PRT or containment. If the PRT 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 PRT if the pressure in the PRT 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) <u>Operational Requirements</u>

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 PRT and commence system fill.
3. When PRT 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)

4.0 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 PRT. 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 PRT rupture disc blown, vent to the PRT if there is water in the tank to take advantage of the cooling provided by this water. If there is no water in the PRT, 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 PRT rupture disc intact, small quantities of gas may be vented to the PRT 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 PRT 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

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 Pressurizer Relief Tank (PRT)

1. Description of Operation

   This operation is identical to the previous section except the vented gas is directed to the PRT. 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 PRT, monitor vent tank instrumentation and (assuming the containment vent path is available and with the rupture disc already ruptured) terminate venting to the PRT 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.

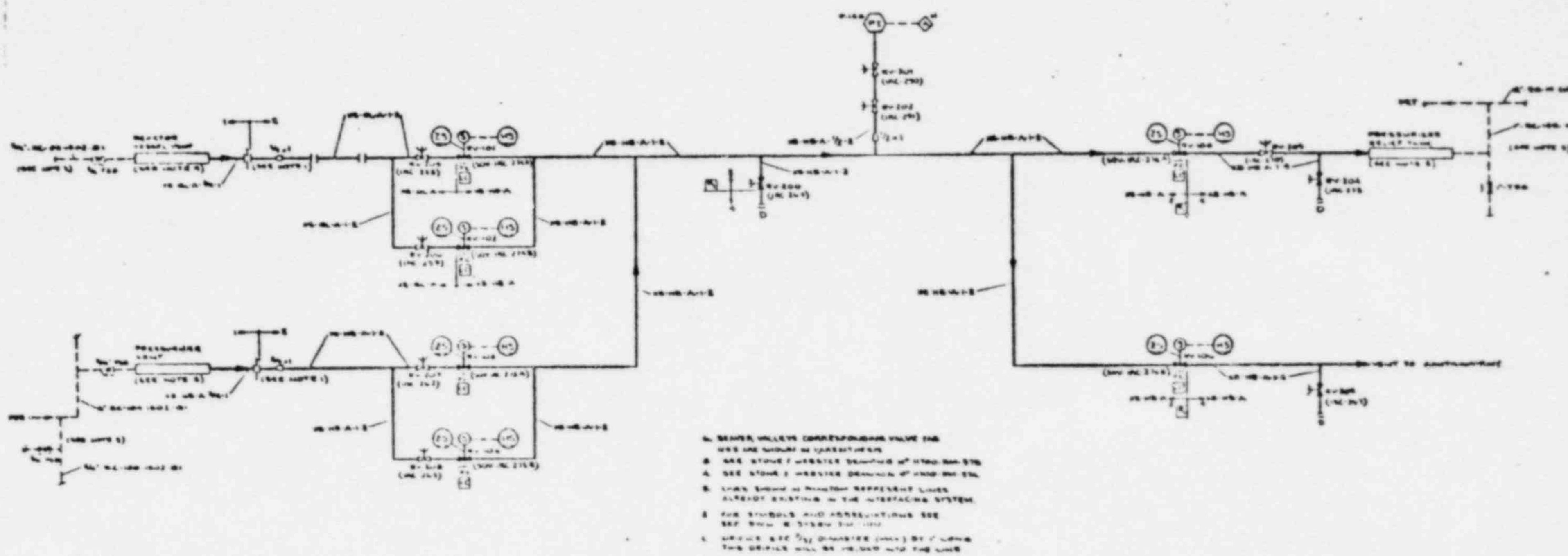
4.4 Venting the Pressurizer to the Containment or Pressurizer Relief Tank

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



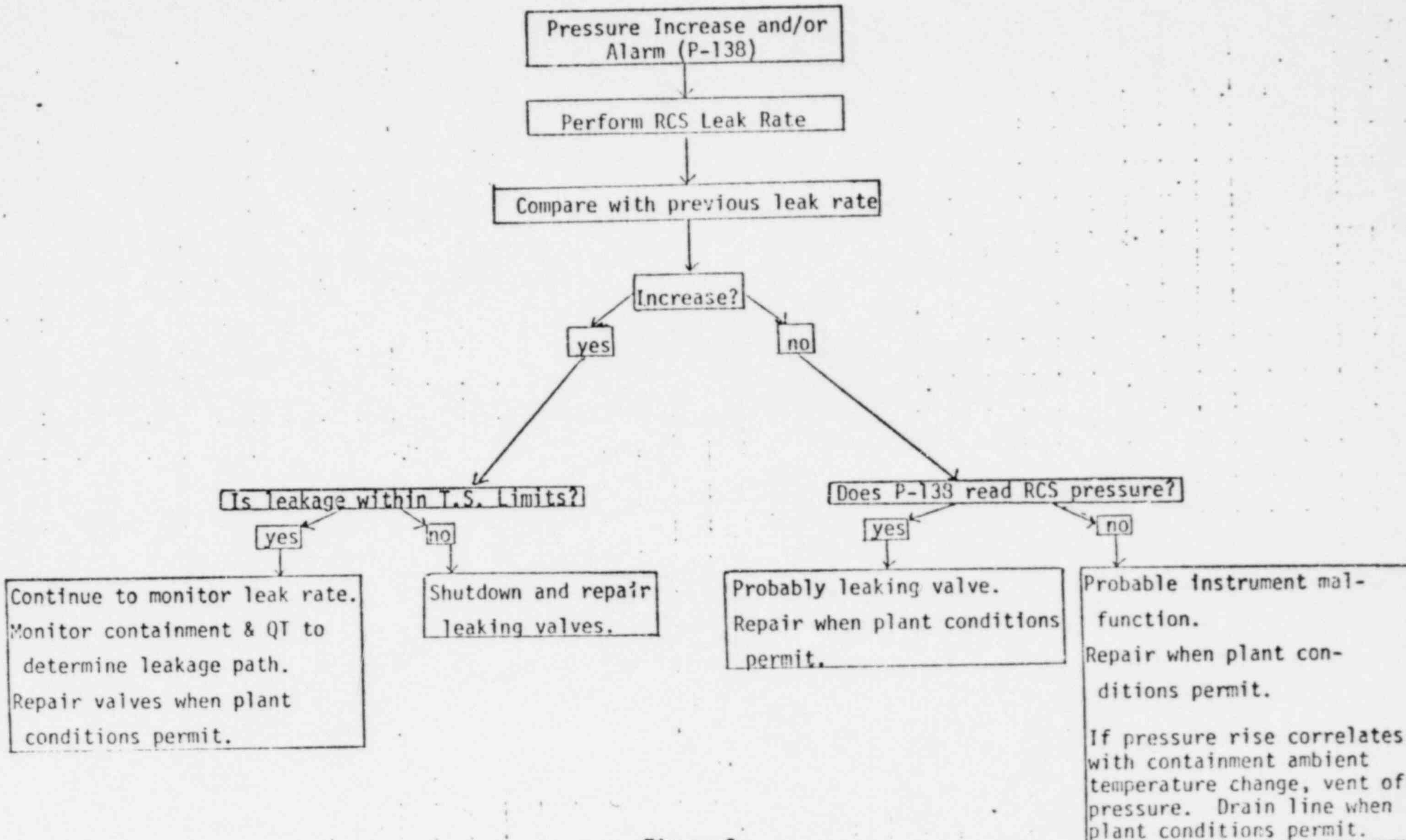


Figure 2

Response to System Valve Leakage

Figure 3
PRESSURIZER PRESSURE
WITH NON-CONDENSIBLE GAS

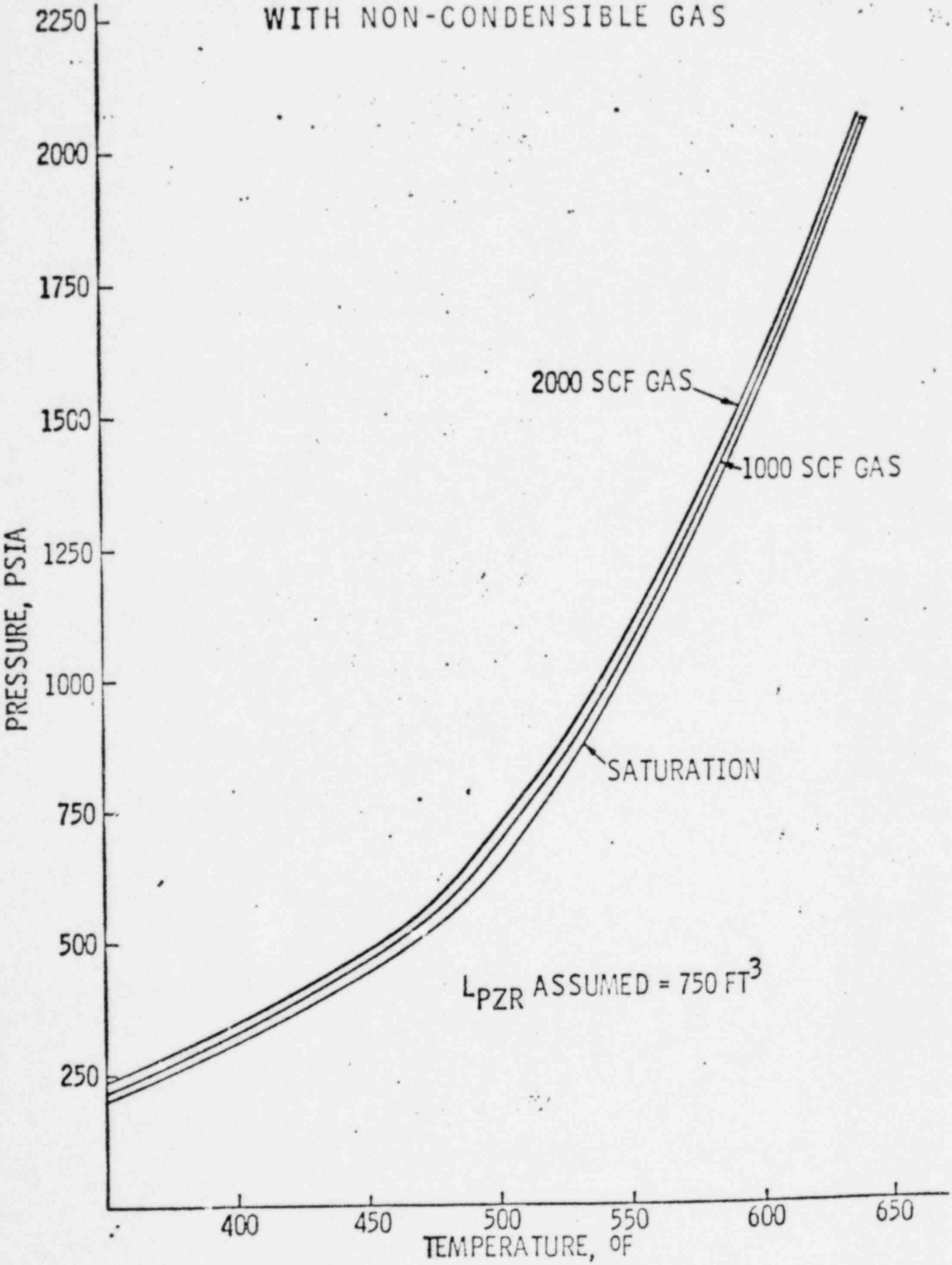


FIGURE 4

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

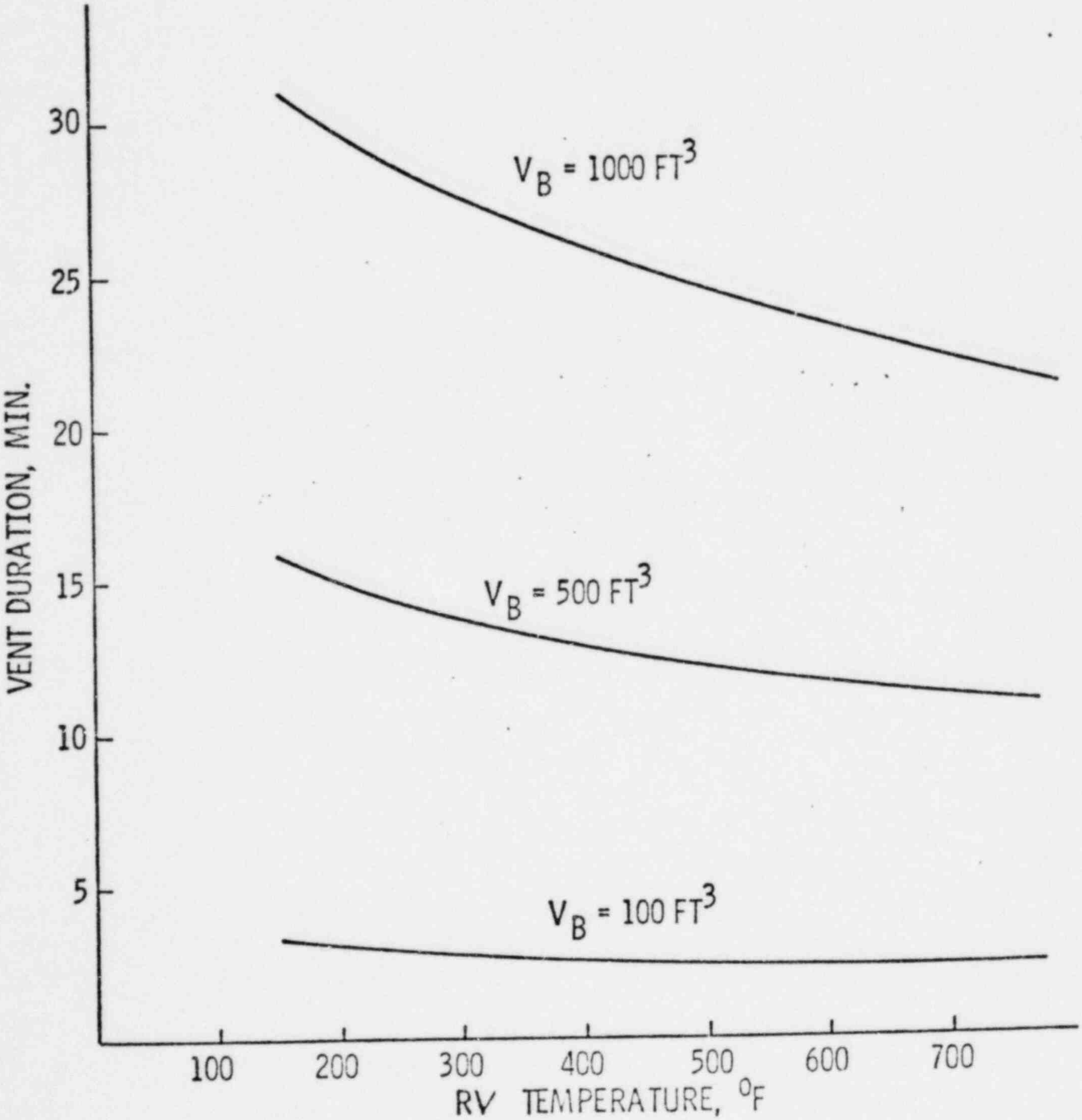


FIGURE 5
VENT DURATION OF HYDROGEN vs RV. TEMP.
AT P = 1000 PSIA

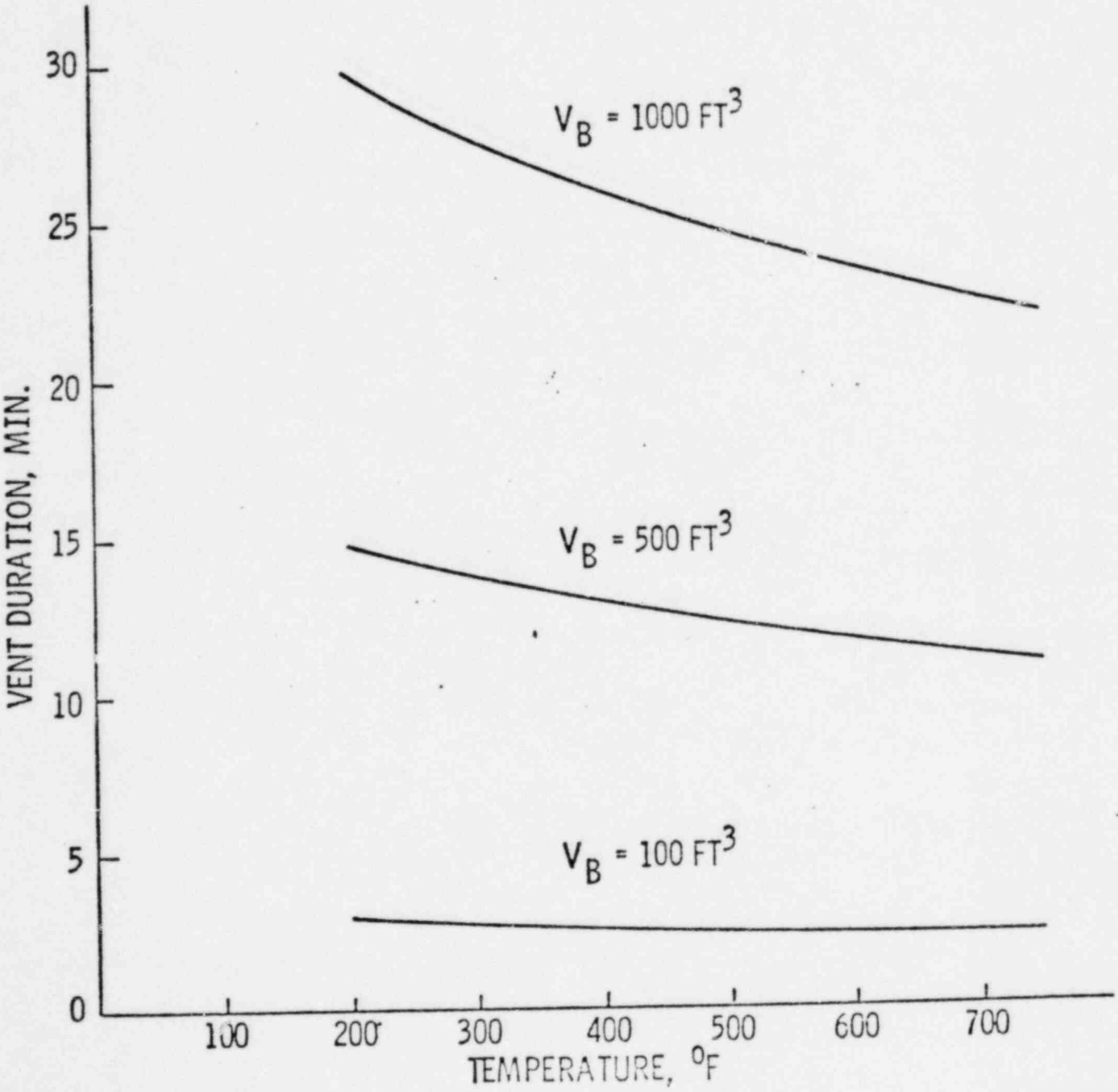


FIGURE 6

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

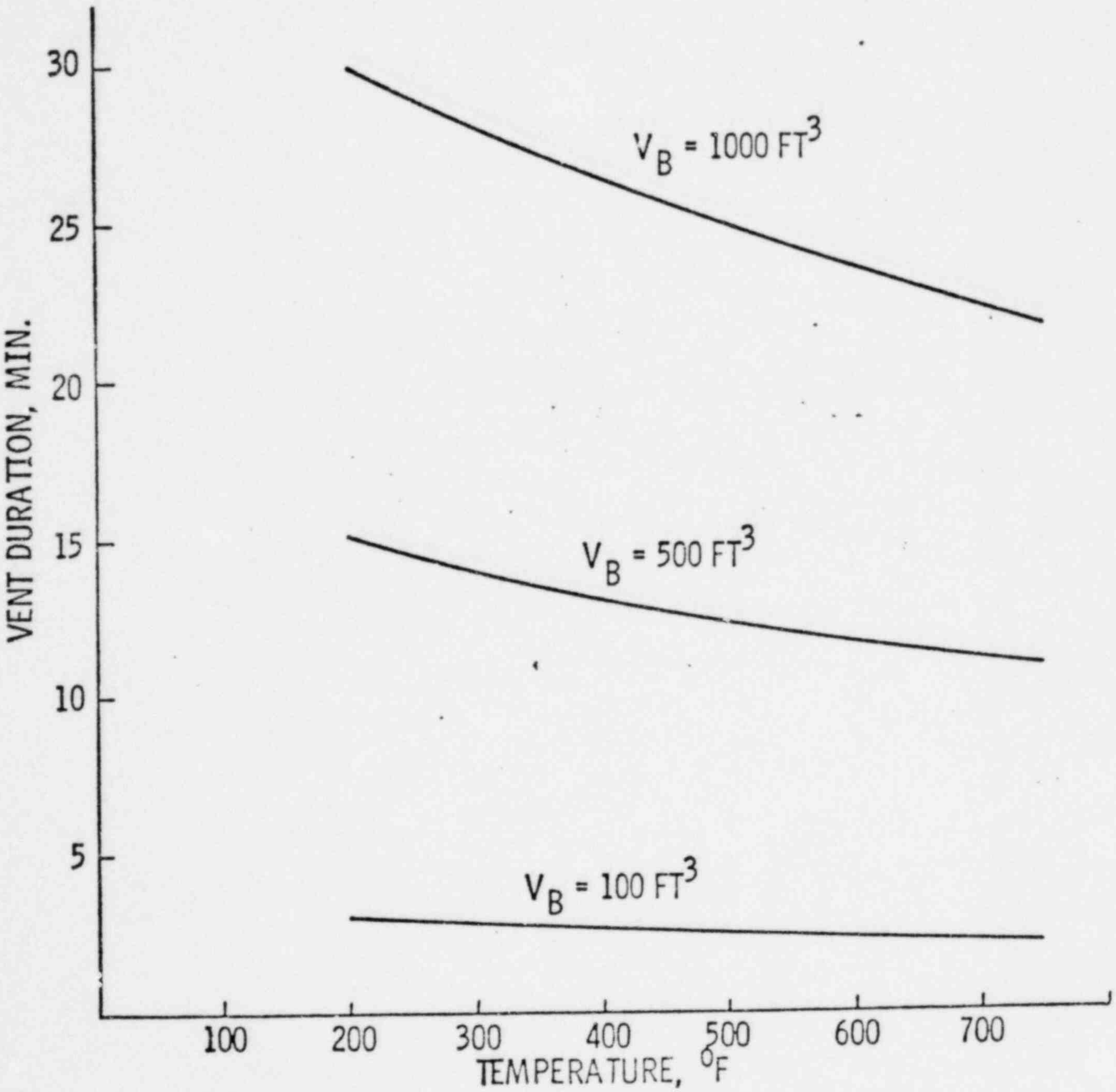


FIGURE 7

STEAM (REACTOR)

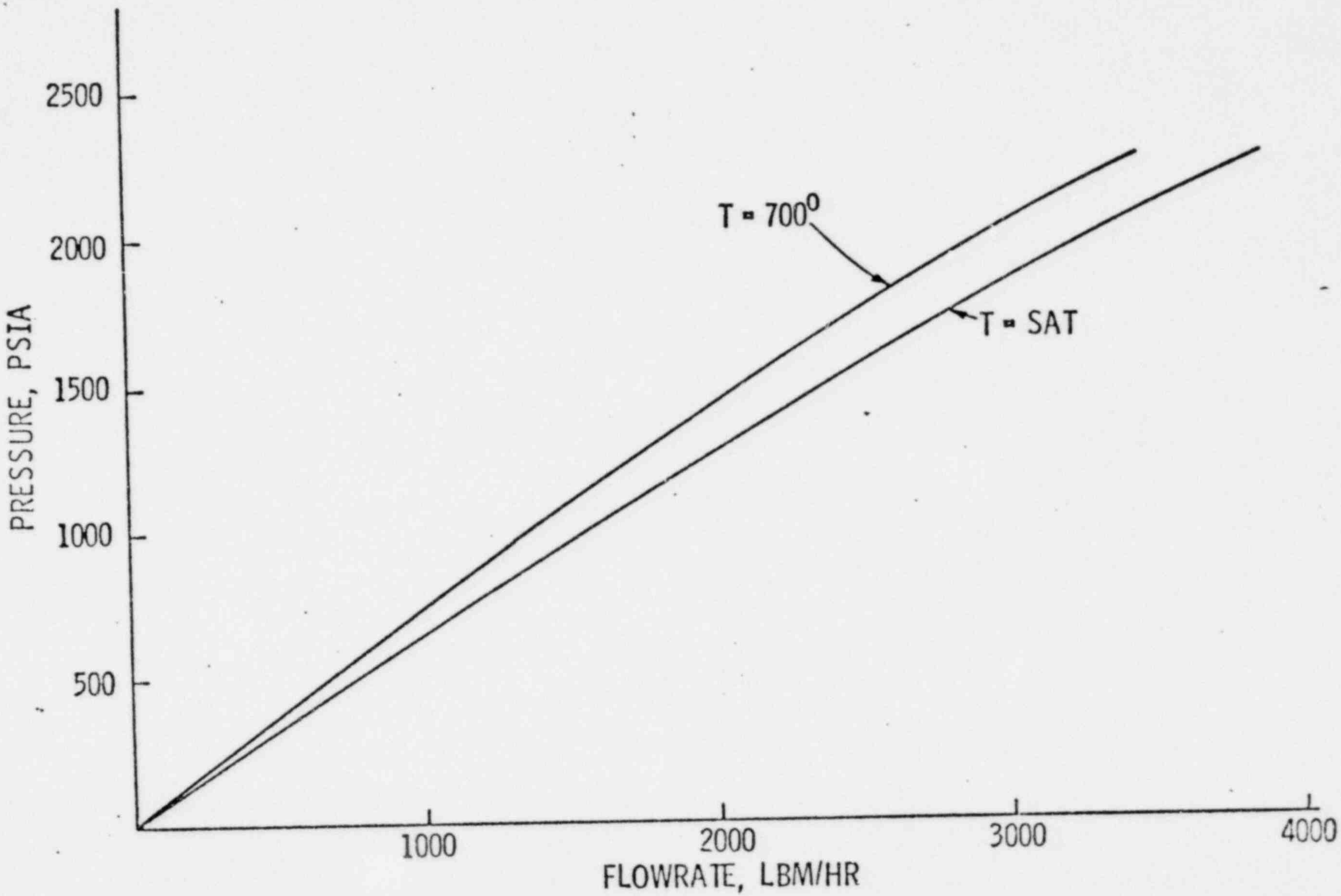


FIGURE 8

HYDROGEN (REACTOR)

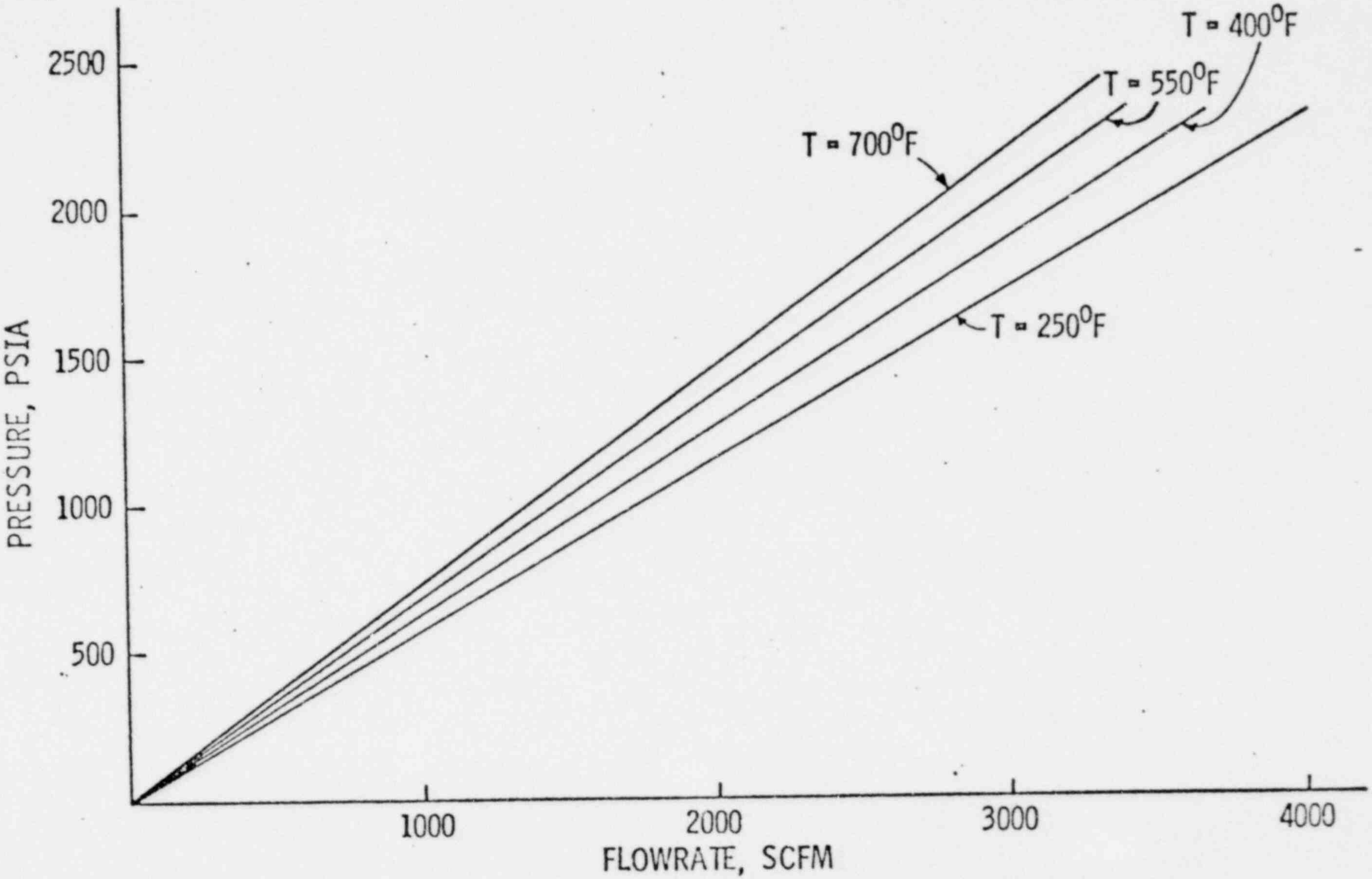


FIGURE 9

VENTING DURATION FROM PZR AT P = P_{SAT}

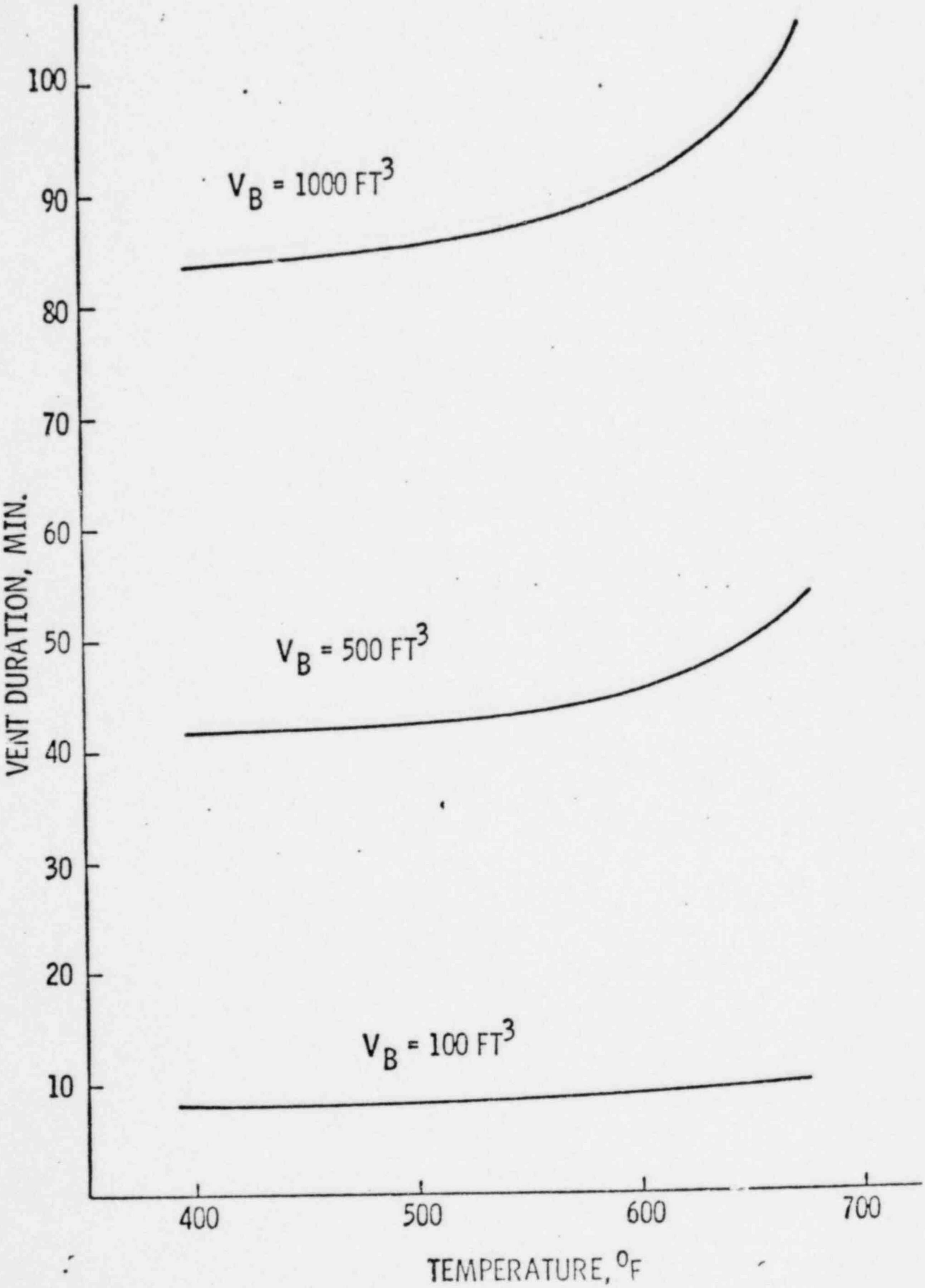


FIGURE 10
STEAM (PZR)

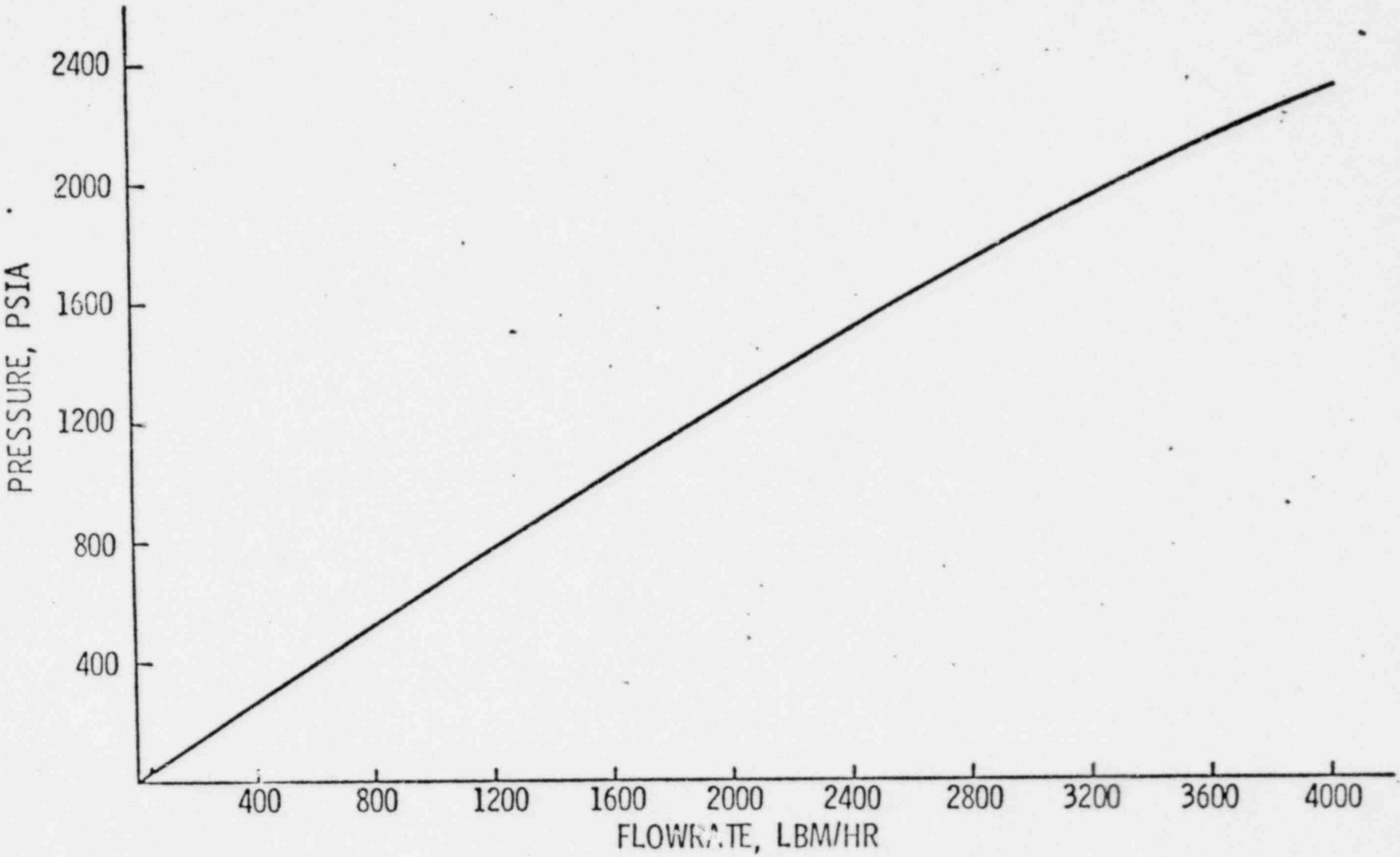


FIGURE 11

HYDROGEN (PRESSURIZER)

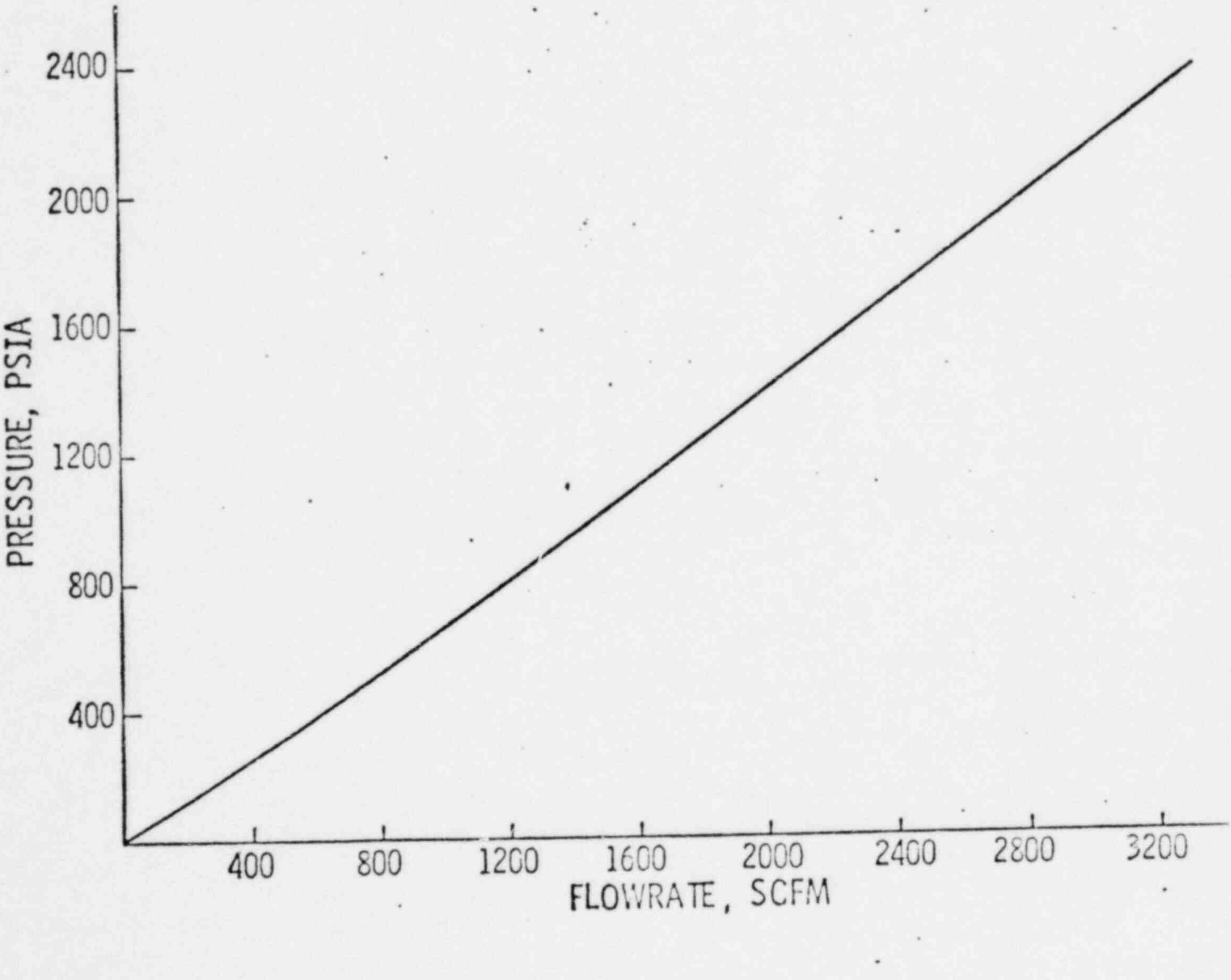


Figure 12
PRESSURIZER VENT - ΔP vs VENT TIME
(CCP ON - STEAM)

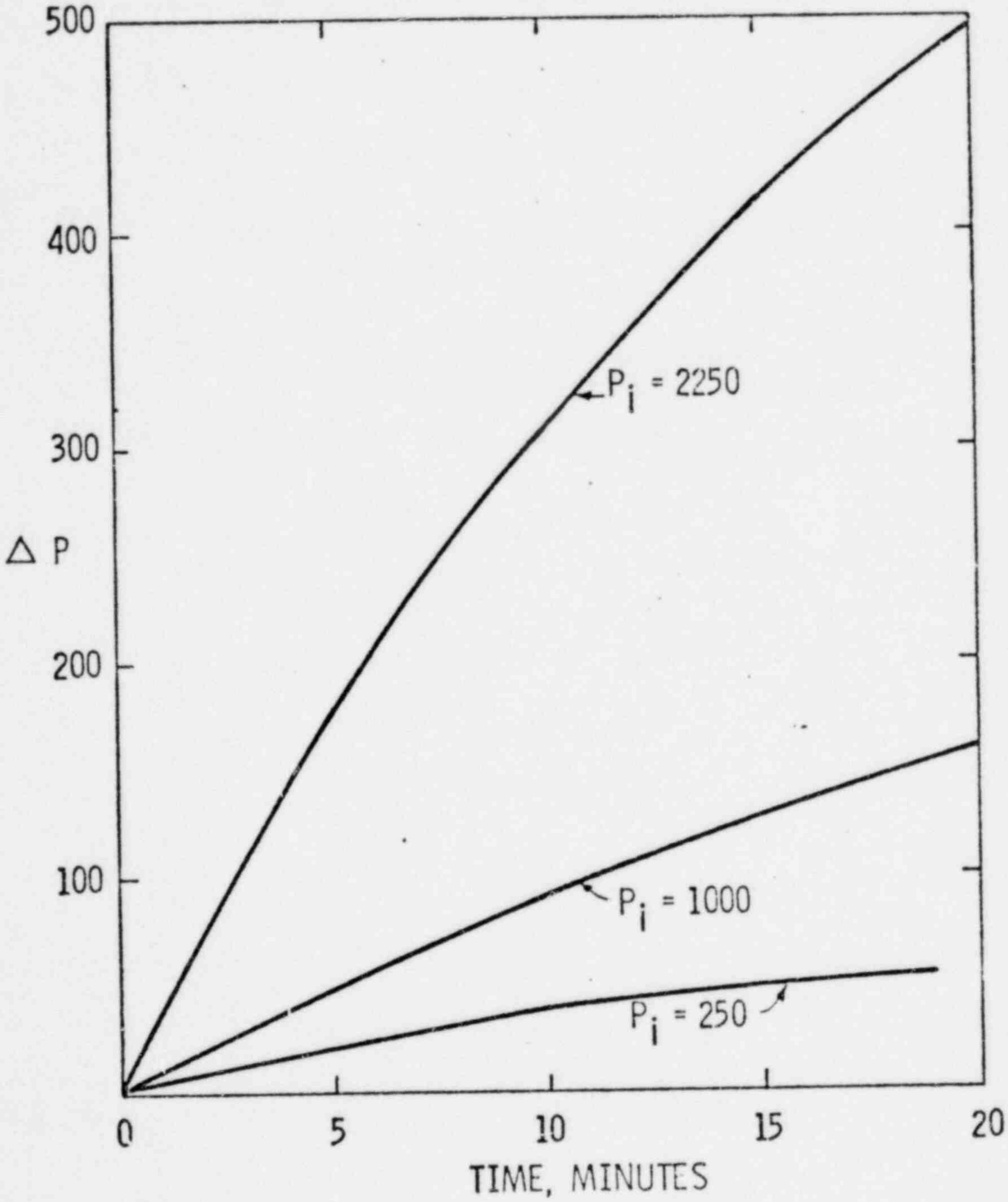


FIGURE 13

PRESSURIZER VENT - ΔP vs VENT TIME

(CCP OFF - STEAM)

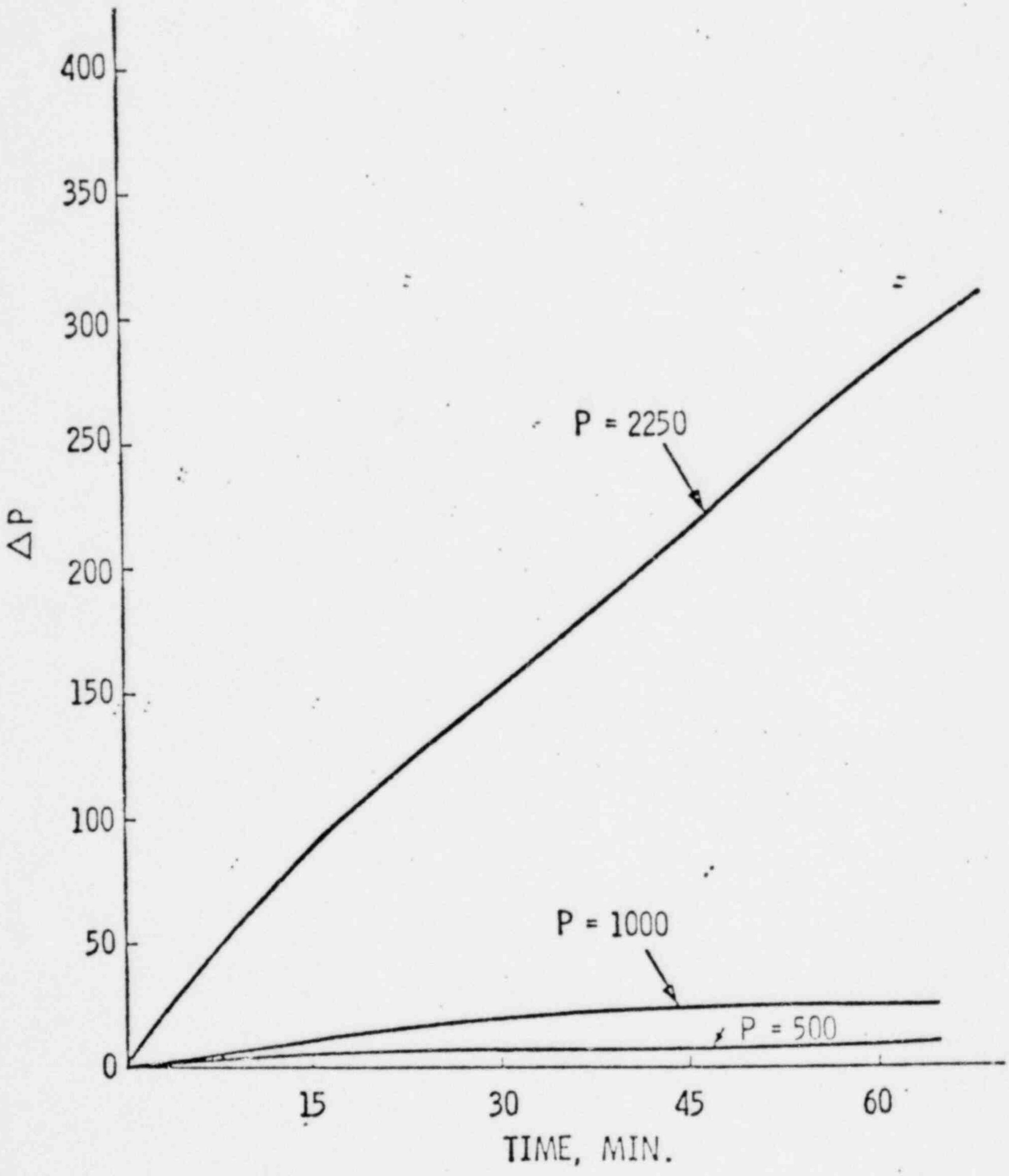


Figure 14
REACTOR VESSEL VENT - ΔP vs VENT TIME
(CCP ON - HYDROGEN)

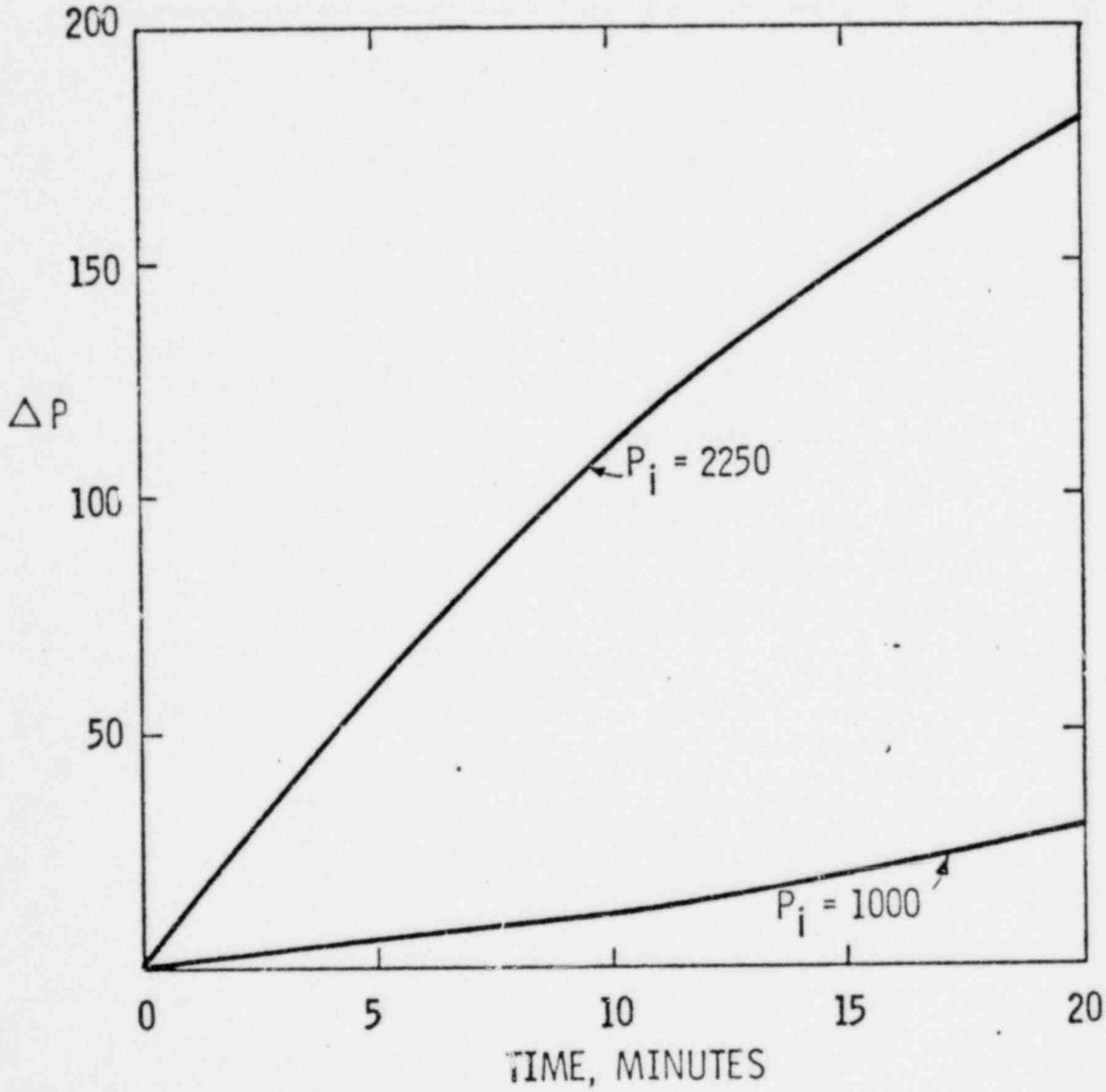


Figure 15

VENTING FROM PRESSURIZER WITH CHARGING PUMPS ON

(STEAM)

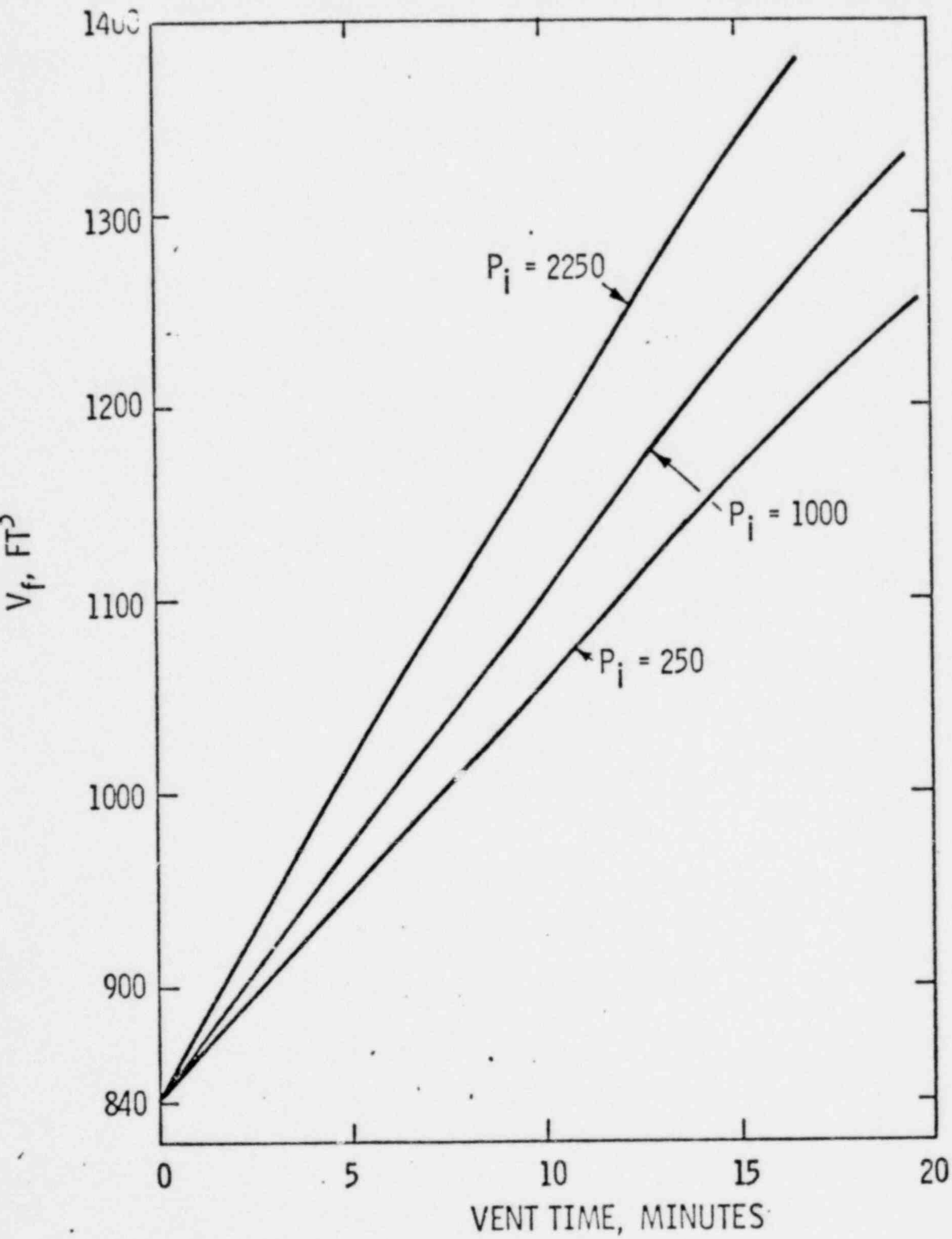


Figure 16
PRESSURIZER LEVEL vs TIME - PRESSURIZER VENT
(CCP OFF - STEAM)

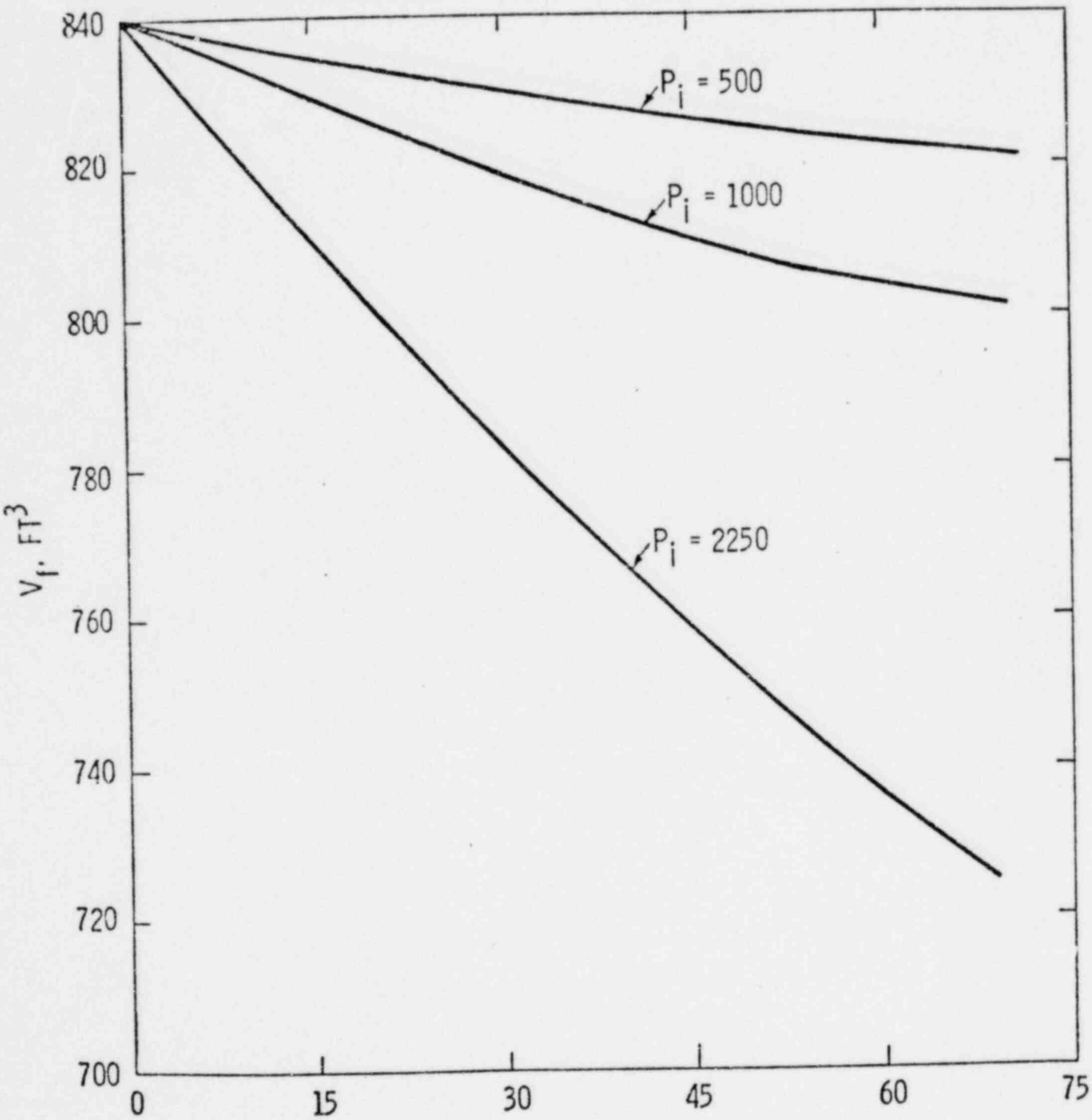


Figure 17
REACTOR VESSEL VENT - V_f vs VENT TIME
(CCP ON - HYDROGEN)

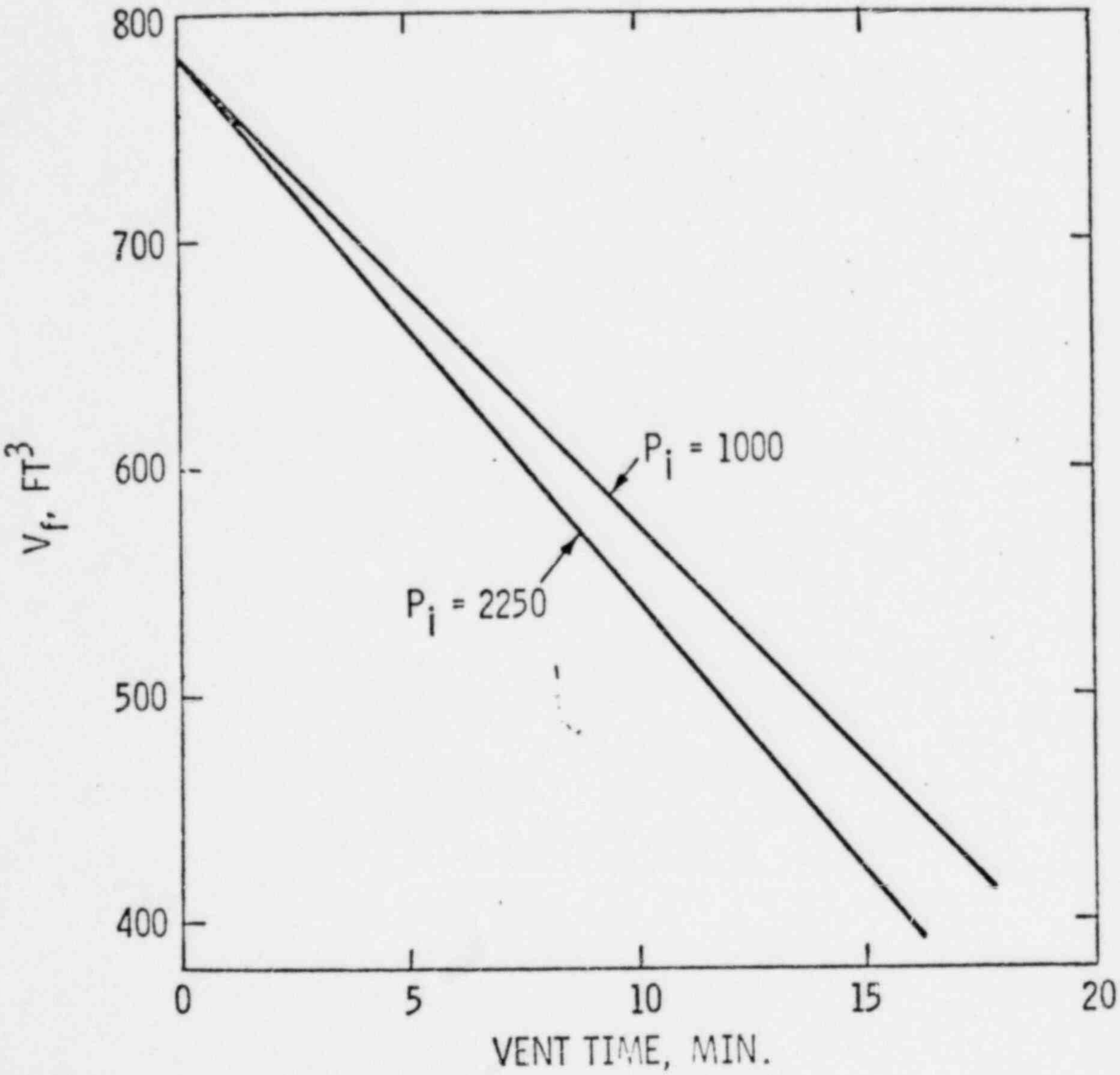


FIGURE 18

CONTAINMENT HYDROGEN CONCENTRATION

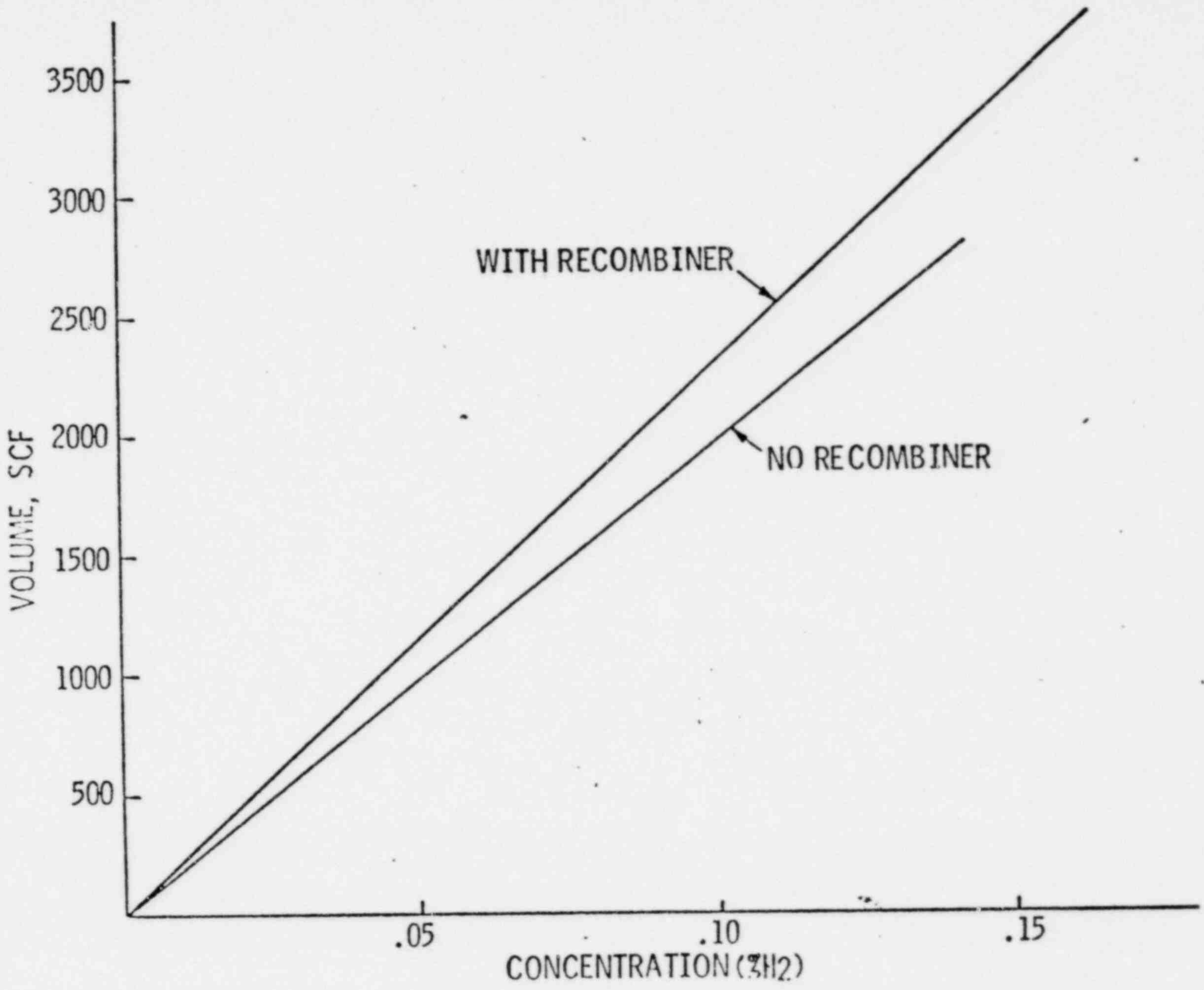


Figure 19 - R.G.V.S. Accident Response

Accident Occurs

Monitor For Bubble Formation

Recheck Bubble Status as Necessary

Bubble in Reactor Vessel?

Yes

Determine bubble size and vent duration

Determine vent sink

Energize pressurizer heaters, establish charging flow, verify pressurizer level

Obtain administrative approval to vent

Energize H_2 recombiner

Proceed with vent (next page)

No

Either non-condensibles in pressurizer or previous vent of RV?

Yes

Determine vent duration

Determine vent size

Energizer pressurizer heaters, verify pressurizer level, charge if necessary

Obtain administrative approval to vent

Energize H_2 recombiner and monitor H_2 concentration

At exposure limits?

No

Proceed With Vent (next page)

Yes

1. With adequate RCS pressure control, Do not vent until H_2 cpmcemtratopm is acceptable, or;
2. with inadequate RCS pressure control, or if vent path is to intact QT, proceed with vent. (next page)

No

No need to vent

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

Bubble Status as necessary