DOCKET 50-320

ORIGINATING OFFICE NRR

AUTHOR

DATE: (or time period covered) 3/31 - 4/4/79

DESCRIPTION OF DOCUMENT CONTENTS: MISCELLANEOUS DATA AND HANDWRITTEN NOTES RE LONG-TERM COOLING PROGRAM

OTHER IDENTIFYING PARTICULARS:

7905190141

133 324

RM

0115, 4-1-79

1. Question: Several people think 180°F better than 280°F (above boron precip).

mull it over

2. Loss of block valve
is it on vital bus?
what if can't work on LOOP? can it be jury rigged

3. What if: More RHR capacity
filters stuff in drain lines -
need stby RHR capacity

NOW

4 O_2 on makeup coolant
air bring in more -
can N_2 blanket

5. INFO: Chemists - GPU office catalysts to inhibit radio-
chemical scrubber of H_2
directly with W, CE @
GPU office. what of nuclear.

133 325

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6. TWX put N_2

make ammonia

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7. In Core analysis

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8. Change temp / pressure — no vessel prob.
to 2000psi ~~better solubility~~

---

9 Start another pump?

---

10 Inst Anal (Bernero)
/ weak link! (potential)

Capacitor in pump/starter
radiation-sensitive
B.: working problem

Outside: eqpt seeing hot stuff
no potential problem

if on RHR: $4 \cdot 10^3$ R/hr most
of eqpt in RHR - don't worry

155 326

Emmerson Qual of RHR
Shelf
3 yrs

11. Bubble size - Vollmer
flammability
very sensitive to bubble size

pin down what NRC really thinks

* 12 CCW to all pumps ? keep them going

* 13 What if: Core melt seq - more water in Cont: Consider more water in Cont now
(Only 3 or 4 ft now)

14. Unit I - in mode 5 - 133 327
consider head off -

C

remote control pumps
+ TV camera on level

- empty fuel pool & put
water for storage.

What if: Y-12 robot
umbilical + TV
camera.

put in TV anyway

put in U-2

last op crew to leave
functional position

control robot aux bldg
Unit 1

Last Wh + If: dig hole by Unit 2

find penetration above
water line pipe
to bottom of hole
fill hole w/ water
Open co + vent to
hole save bottom melt
more pc ; w/recirc water
refill reservoir etc.

135 328
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Three Modes of Core Cooling

I. High Pressure RCS Mode

- Maintain present cooling but w/bubble control

  - turn on containment sprays

a - RCP off
b - open PORV
c - open P Spray line
d - blowdown to P_{xzc} (HPSI) [No core uncovery]
e - repressurize by SI to 2000 psi and recover level in pressurizer
f - turn on RCP
g - reduce present to ~/orr

all depend on open PORV

cooling w/SG

II. ECCS Injection Mode

Same as above to "d"

Version 1 - Initiate SI
solid pressure
ECC overflow

Version 2 - ECC boiloff removes decay heat (boron precip?)

III. RHR Mode

Same as I to "d"

(a) Repressurize in ECC injection to ~200 psi
(f) recover level in pressurizer
(g) turn on RHR

T. ...
3/31/79
~10:00 pm

133 329

Don Roy info transmitted to GPU's Gary Miller in control room

get borated storage tank level up

preferred option

Get system degasified
line from MU tank to containment
in combo. w/sprays
maintain system & pressure

Second option

controlled depress to RHR
did not account for gas bubble
working on the complication
of the gas

how much gas 1500
don't want to expand it

3rd option
open block valve

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__4th option__

fast blown ~~[illegible]~~ thru LPIs

blow pump seals

open EOM

~~[illegible]~~

~ 10 to 30% MWR to yield 1500 ft^3

~~radiolysis~~ ~~2 V% in containment~~

~~[illegible]~~ ~~40,000 ft^3~~

~~20,000 ft^3~~

~~[illegible]~~ radiolysis ~~[illegible] ft^3~~

60 ft^3/day at 1000 psi

133 331 C

I. PRE-REQUISITES TO ESTABLISHING ULTIMATE REACTOR COOLANT SYSTEM CONDITIONS FOR LONG TERM RECOVERY

1. Degas the reactor. This must be done while we still have reactor coolant pumps.

   Do this by increasing pressurizer level to at least 300" and maintain the small bleed on the top of the pressurizer open to continue degassing.

   Also, continue to degas through the make-up tank.

2. When sample sink is available, verify total gas in Reactor Coolant System by normal analysis.

3. The reactor shall at all times be in condition to go immediately to natural circulation assuming failure of the A1 Reactor Coolant Pump and inability to start any other Reactor Coolant Pump.

   This means:

   A. Steam Generator water level in A & B generators must be at 95% of operate range.

   B. Auxiliary Feed nozzle on both generators must be capable of being fed.

   C. Sufficient aux. feed water must be available via the emergency feed nozzles to raise steam generator secondary water to within 10' of the bottom of the upper tube sheet to promote natural circulation start.

133 332

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II. GROUND RULES FOR FINAL CONDITION OF TMI-2 REACTOR

1. Because of high activity levels in the Reactor Coolant, the decay heat system must not, repeat, must not be used in the recirculating mode.

2. The reactor must be brought to a condition which has minimum reliance on mechanical equipment and instrumentation inside the reactor building. The reason for this is that radiation damage is occurring to reactor coolant pumps and instrumentation which may ultimately make them inoperable.

3. The final condition of the reactor must be capable of being sustained for hundreds of days while Reactor Building clean-up proceeds with the objective of ultimately gaining access to the reactor coolant system.

4. The ultimate condition of the reactor must be achievable from its present condition through an orderly and deliberate series of maneuvers involving the least complicated sequence possible.

III. ULTIMATE CONDITION OF REACTOR
GROUND RULES

1. Reactor Coolant Pumps assumed inoperable.
2. All Reactor Building instrumentation assumed inoperative through progressive failures due to radiation degradation.
3. Make-up to RC System by a centrifugal pump cabable of about 500 PSI head through continuous operation to maintain pressure on the system via existing make-up or other lines. This may be a new pump (with back-up) installed for this purpose.
4. Reactor Pressure read or inferred from discharge pressure of the above described pump.
5. Rate of make-up determined by flow meter in discharge of above pump down stream of a recirc line. Recirc line needed to allow dead head operation.

   Steam Generators are solid with continuous recirculation from auxiliary feed system from coldest source of acceptable waters on the site. (put ice in condensate storage tank?)
6. Temperatures in Steam Generator determined by overflow water in secondary system.
7. Core temperature monitored by present incore detectors which are assumed to survive.
8. HPI pumps assumed available to take water from BWST and cool reactor through electromagnetic relief valve if core temperatures increase to unacceptable levels.
9. It is assumed under the above conditions that natural circulation is taking place.

IV. ULTIMATE BUILDING CLEAN-UP TO GAIN ACCESS TO REACTOR FOR RECOVERY

1. This is assuming natural circulating as described in Ultimate Condition of Reactor.

2. Modification will be made to the recirculating line from the Reactor Building sump to extract in a controlled manner the 268,000 gallons of highly contaminated water now in the Reactor Building.
   It is assumed that portable materials will have to be brought to the site to process this highly contaminated water, and ship it for storage or burial.

3. The Reactor Building spray system should be considered for water washing the building to further decrease contamination while the activity described in (2) above for processing water is going on.

4. Use existing piping, make modifications as necessary to extract water from the Reactor Coolant System for disposal or purification to reduce coolant activity and building radiation levels.

5. Further actions as they are found to be necessary.

File
long term cooling

The following presents some specific proposals for contingency systems for implementation within the next few days, and certainly before switch to RHR operations. Included are 1) a method for filtered venting of the containment, 2) a nitrogen supply system to the containment, and 3) a last ditch remotely operated water supply into containment.

The possible applications for filtered vent capability include the following:

(1) Wish to purge large fraction of gas in containment because of large buildup of hydrogen.

(2) Wish to provide low oxygen atmosphere in containment.

(3) Concern about containment pressure, leading to a need to control or reduce it, rapidly or slowly, starting from substantial pressure in containment.

(4) Wish to provide filtered leak path from a pressurized containment because an uncontrolled leak develops in containment.

The possible applications of nitrogen addition system include:

(1) To provide low oxygen atmosphere.

(2) ~~The~~ to control hydrogen concentration.

133 336 C

(3) To clean out radioactivity in containment atmosphere.

The possible applications of remote water makeup to containment include:

(1) Provide heat dissipation source if all other heat removal capability from containment is lost. Would use filtered venting system to permit release of steam.

(2) To raise water level in containment to reach or cover vessel.

(3) To provide water if fuel debris gets to the concrete.

(4) To clean up containment atmosphere (with spray, if so connected).

Based on preliminary ideas from NRC, GPU has made the following specific proporsals:

Filtered, Venting System

Employs Irradiated Fuel Storage Cavity (filled with water). Discharges gases and steam from containment well below surface. Noble gases would pass out through normal gas control system on fuel storage building.

Two options are proposed by GPU.

(1) At penetration R552, which is connected to the construction air compressor house, a spoo. piece in 6" line could be ~~routed~~ removed and six inch piping run to fuel storage fuel (about 150 ft. of pipe which would traverse several bays in auxiliary room). To actuate venting, one would now open a manual and an air actuated valve already in existence. Consideration might be given to a second valve and to reliability and other remote actuation of air operated valve. Piping would end with crude sparger below water surface, probably at bottom of pool, particularly assuming an air compressor is placed in line to provide 40 ft. of head. (A several hundred SCFM capacity compressor is planned, preferably electric motor driven. If not, a regular, diesel driven construction air compressor is planned). Estimate is two days for installation, working round the clock.

(2) Second option would be similar but would require removing one hydrogen recombiner and connecting a 10" pipe at penetration 551, breaking it at flanged line. This line already has remotely operated valves.

Nitrogen addition system

This is readily accomplished using existing leak rate test system at penetration R552. Would tie into construction air compressor house in unit 1 area of plant (northeast corner, outside fence near the switchyard). Would tie in with liquid nitrogen trucks. Would need header to enable tying into more than one truck simultaneously. Estimated nitrogen delivery rate is about 50 SCFM per truck.

Might add isolation valve to system if same penetration is used for exit from containment for filtered, vented release.

Remote Water Makeup

Two options are proposed. Both might be employed, if further checks show auxiliary building accessibility is acceptable for both:

(1) Go into the containment building spray system. Connect with fire hose to existing fire water headers or to river. Would need pump for river, might need pump if fire water headers are used.

(2) Tie into 10" lines leading to containment sump (see Burns & Roe Dwg. 2026). Would close valves 102 A and B, open 6A and B to operate. Would cut water into sump.

Branch Elam and Dave Slear of GPU are lead individuals who prepared specific proposals. They are continuing details plans for implementation.

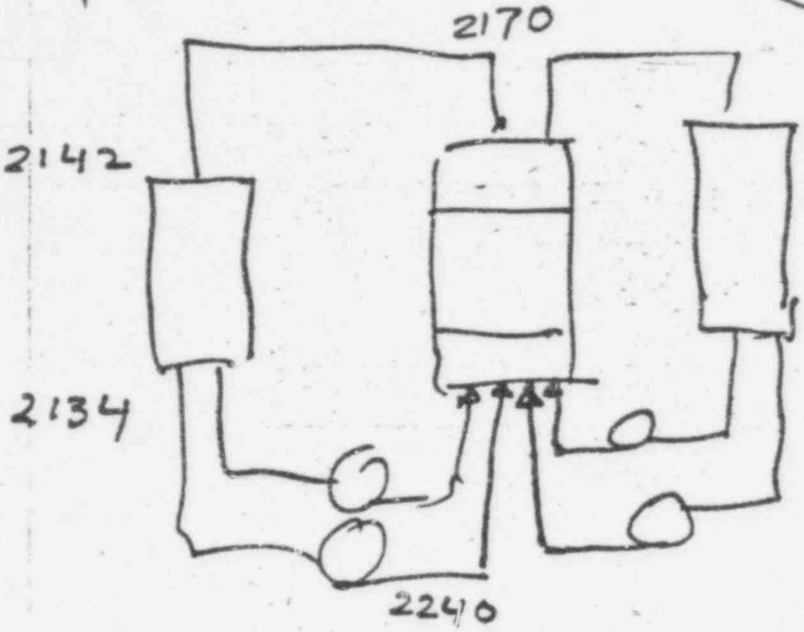
Recommend quick review, modification as appropriate, and rapid implementation.

Loss of Offsite Power

Consideration of additional onsite power sources (D-G, gas turbines) to provide the capability to sustain a loss of offsite power. The equipment would need to be compatible with existing plant equipment and technicians familiar with power sources would be required.

Thadani

Save



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long term cooling

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133 341

Thoughts

NEEDS

Natural Circulation
Forced Circulation with one pump
Forced Circulation with 2 pumps in one loop.

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133 342

$$\Delta V = \frac{\partial V}{\partial P} \Delta P + \frac{\partial V}{\partial T} \Delta T + \frac{\partial V}{\partial M} \Delta M.$$

$$\Delta M = M_1 - M_0$$

$$\frac{\partial V}{\partial P} = \frac{1}{M} \frac{\partial \rho}{\partial P} + \frac{\partial V_{H_2\,Rel.}}{\partial P}$$

$$\frac{\partial V}{\partial T} = \frac{1}{M} \frac{\partial \rho}{\partial T} +$$

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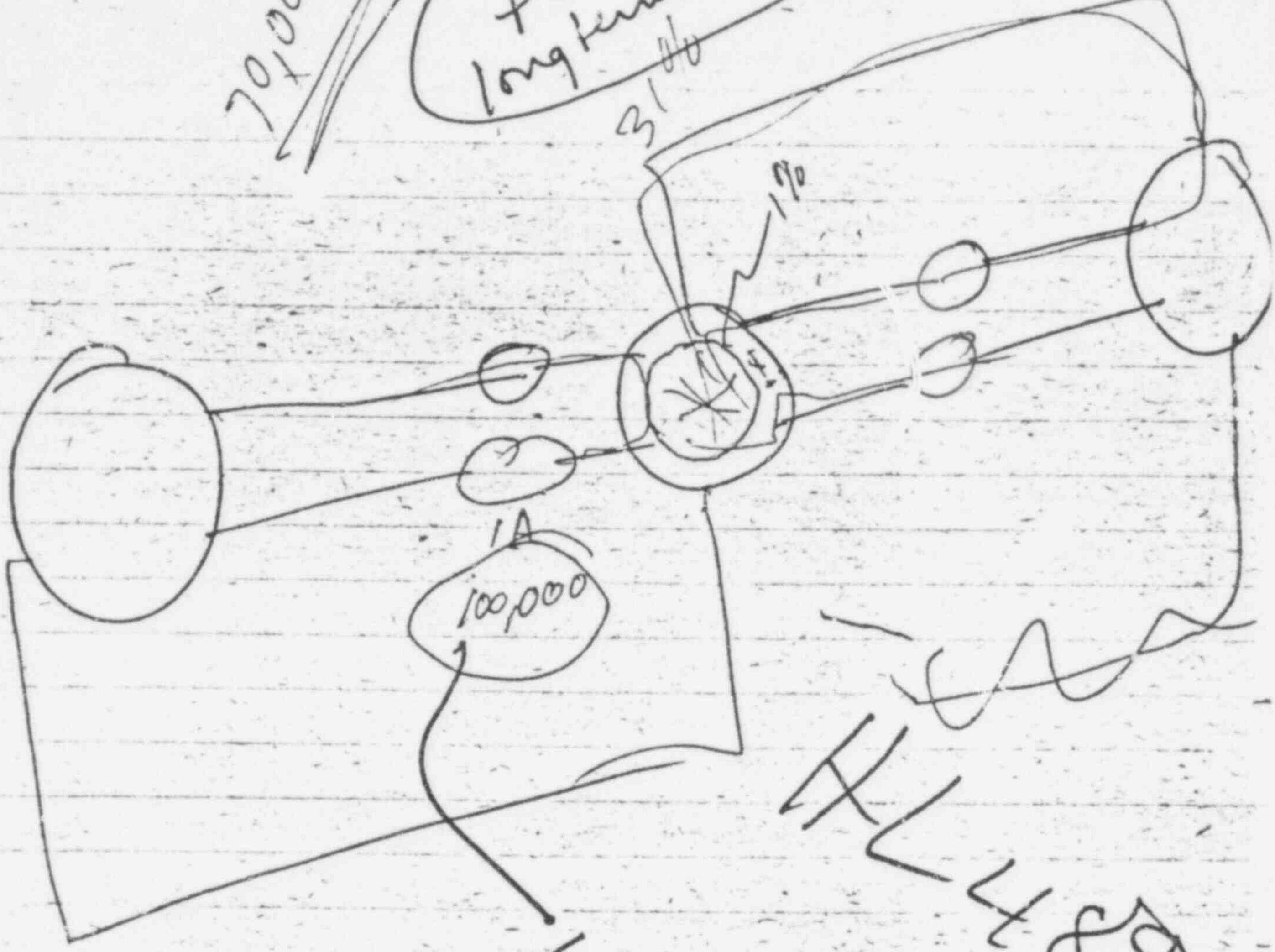
133 343

70,000 gpm

File
long term cooling



HL 482°

45.10 lb/hr

29.5 ll/core

bypass

131.106 lb/hr

C

100 cfm × 60 × 24

$6 \times 10^3 \times 24$

$144 \times 10^3 = 1.44 \times 10^5 \text{ ft}^3$

5 days = $.720 \times 10^6$

2% 60 .30 ft^3/day

2.6×10^6 3 ft^3/~~day~~ min.

2% 180 ft^3/Hr.

5.2×10^4 ft^3

170 ft^3/Hr

24
200

4.8×10^3/day 4800

133 345

9.6%

~~1%~~

1%

$\frac{1.5 \times 10^5 \text{ lb}}{2 \times 10^6}$

20 gpm ×60

.7 × 10^-1

7%

24

12 × 10²

48

24

2.88 × 10⁴ gal/day

1.6 × 10⁵

900cc/kg

1.2 × 10⁶ gal ×8

.03 ft³

2

48 × 10⁶ kg × ~~900cc~~

1.5 × 10⁵ ft³

155 346

File — Long term Cooling

TO:

De L J YBARRONDO

OR

N C KAUFMAN

OF

EG&G, Idaho, Inc

AT:

HARRISBURG COMMAND CENTER
TELECOPY NUMBER 717 941 4756

DATA FROM VENTING TEST AT BILLINGS ENERGY CORP, PROVO UT 4-5-79

FROM J L LIEBENTHAL AT BEC
PHONE 801 375 0000

PLEASE DELIVER IMMEDIATELY

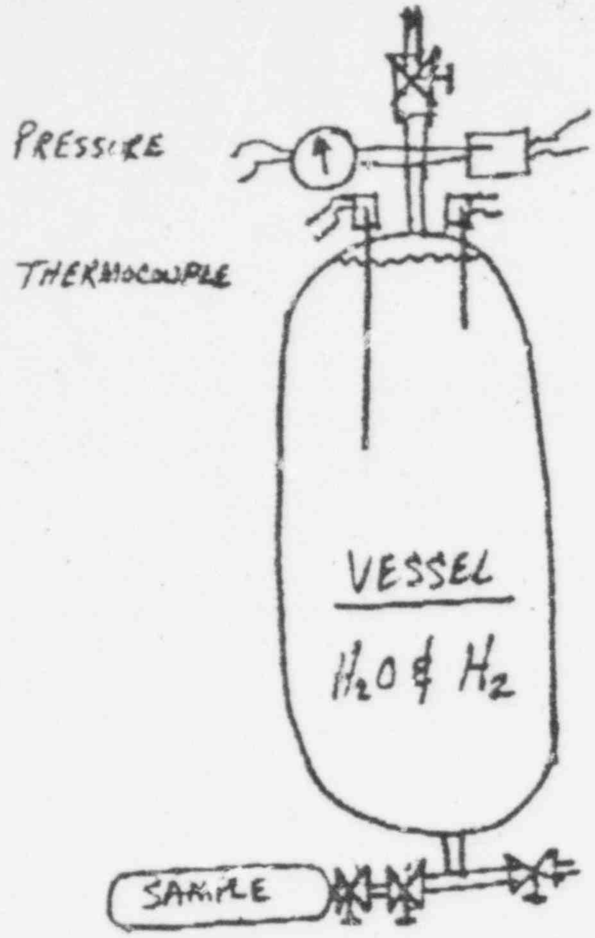
CORRECTED PLOT — BETTER V.P. SCALE

133 347

C

PRESSURE DROP TEST

4/4/79



TEST PROCEDURE

(1) FILL VESSEL WITH DEIONIZED, BOILED WATER.

(2) HEAT TO 280°F

(3) PRESSURIZE WITH H_2 FROM BELOW TO 1070PS

(4) FLOW H_2 INTO BOTTOM OF VESSEL AT BLEED RATE AND BLEED FROM TOP. MAINTAIN PRESSURE.

(5) PERIODICALLY STOP FLOW SEE IF PRESSURE MAINTAINS. REPEAT UNTIL OBTAIN SATURATION.

(6) DISCONNECT H_2 LINE. CONNECT FLASK WITH WATER PRESSURIZED AND SATURATED WITH H_2.

(7) FORCE WATER INTO BOTTOM WHILE BLEEDING TRAPPED GAS FROM TOP. CONTINUE UNTIL FILLED WITH WATER.

(8) BEGIN PRESSURE DROP TEST

(9) CONNECT SAMPLE FLASK AS SHOWN.

(10) OPEN VALUE OF SAMPLE FLASK.

(11) CRACK UPSTREAM VALUE AND OBSERVE PRESSURE DROP TO PREDEFINED LEVEL.

(12) CLOSE BOTH VALUES

(13) COOL CONNECTING LINE

(14) DISCONNECT, SAMPLE FLASK, WEIGH AND RECONNECT.

(15) CONTINUE WITHDRAWAL OF SAMPLES DOWN TO 300 psig.

OBSERVATIONS: (A) PRESSURE FALLS RAPIDLY WHILE WATER IS VENTING.

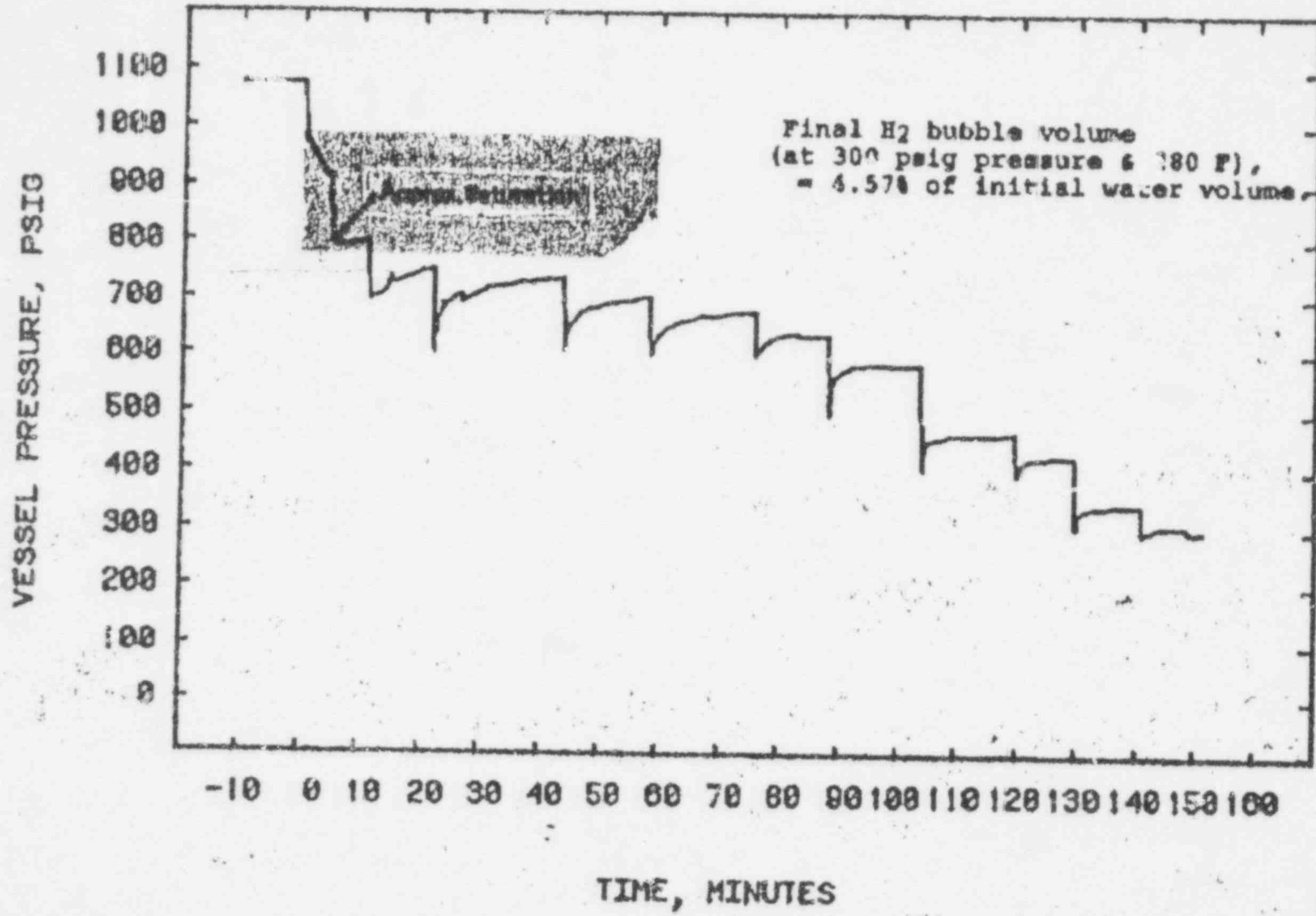
(B) PRESSURE RECOVERS AFTER THE SYSTEM IS AGAIN CLOSED TO A LEVEL ~~LOWER THAN THE STARTING~~ PRESSURE BUT WELL ABOVE THE TARGET PRESSURE. SEE ACCOMPANYING FIGURE.

(C) PRESSURE RECOVERS AS HYDROGEN COMES OUT OF SOLUTION

(D) SIZE OF HYDROGEN BUBBLE EQUALS VOLUME OF WATER RELEASED FROM SYSTEM.

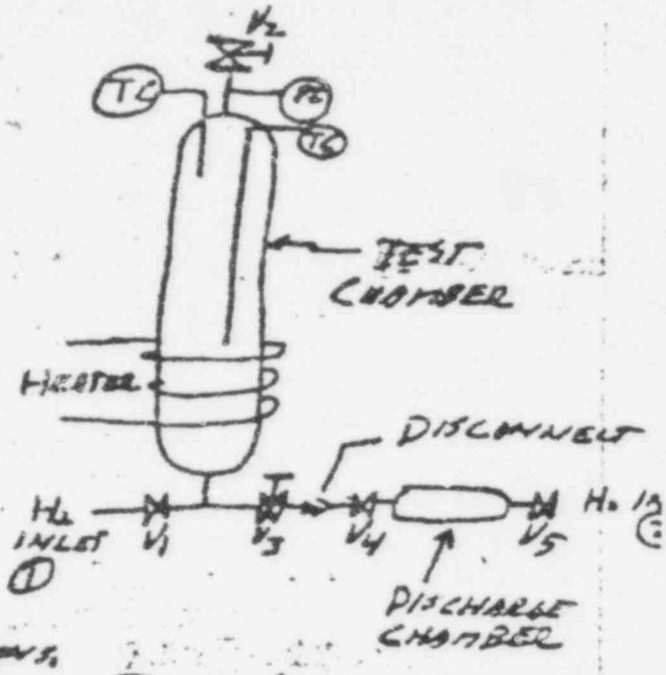
FINAL BUBBLE VOLUME != 4.57% OF INITIAL WATER VO

PRESSURE DROP TEST (WATER SATURATED WITH H2 @ 1070 PSIG, 200 F)



PROCEDURE:

FILL & SATURATE WITH H_2.



TEST APPARATUS

1. FILL TEST CHAMBER WITH WATER THRU VALVE V1.

2. ROCK CHAMBER UNTIL WATER FILLS ALL SPACES. TILT CHAMBER FROM SIDE TO SIDE & UPSIDE DOWN.

3. REPEAT STEPS 1 & 2 UNTIL ONLY WATER COMES OUT OF CHAMBER. THEN HEAT CHAMBER TO TEST CONDITIONS.

4. BUBBLE H_2 THRU CHAMBER AND CONTROL PRESSURE THRU V2. ROCK CHAMBER AS REQUIRED. SATURATE TEST CHAMBER WATER. INCREASE PRESSURE UNTIL ABOVE REQUIRED TEST PRESSURE.

5. FILL DISCHARGE CHAMBER WITH WATER AND CONNECT VERTICALLY AT DISCONNECT.

6. PUSH WATER INTO TEST CHAMBER WITH H_2 AT H_2 INL ② CONTROLLING PRESSURE WITH VALVE V2. CONTINUE UNTIL WATER DISCHARGE THRU V_2.

7. CLOSE VALVE V2, V_3, V_4 & V_5. DISCONNECT DISCHARGE CHAMBER AND EMPTY WATER FROM IT. WEIGH DISCHARGE CHAMBER.

8. RECONNECT DISCHARGE CHAMBER HORIZONTALLY TO TEST CHAMBER AT DISCONNECT. CLOSE V-5

9. REDUCE TEST CHAMBER PRESSURE TO NEW VALUE BY OPENING VALVE V4 & CONTROLLING PRESSURE THROUGH V-3. CLOSE V3 - COOL DISCONNECT TO PREVENT WATER FLASHING TO STEAM. CLOSE VALVE 4. REMOVE DISCHARGE CHAMBER & WEIGH. MEASURE TEST CHAMBER PRESSURE VS TIME.

10. RECONNECT DISCHARGE CHAMBER & REPEAT STEP 9 UNTIL 300 PSI ACHIEVED.

153 351

11. MEASURE VOLUME OF WATER IN DISCHARGE CHAMBER

THIS TEST REPRESENTS THE REACTOR DEPRESSURIZATION PROCEDURE, IN THAT A LIQUID FULL SYSTEM IS DEPRESSURIZED BY VENTING WATER. IN THE EXPERIMENT THE WATER WAS APPARENTLY NOT INITIALLY H_2 SATURATED; ONCE SATURATION WAS REACHED, A LARGE PRESSURE RECOVERY TOOK PLACE AFTER VENTING. 10 TO 20 MINUTES WAS REQUIRED FOR THE PRESSURE RECOVERY TO LINE OUT. THIS PRESSURE RECOVERY COULD BE USED AT TMI AS AN INDICATION OF SATURATION.

4 ATTEMPTS TO REACH 600 PSI, DEPRESSURIZING FROM ~750 PSI, BROUGHT THE PRESSURE TO ~630 PSI AFTER ABOUT AN HOUR. THIS SLOW RESPONSE INDICATES THAT ATTEMPTS TO REDUCE PRESSURE AND INFER REACTOR LEVEL A

ALL GAS VOLUMES ARE FT^3 BASED ON 12000 FT^3 OF LIQUID VOLUME IN 3M.I. PRIMARY SYSTEM

GAS TEMP °F	PRESSURE PSIA	VOLUME OF DISSOLVED GAS AT STP	VOLUME OF GAS EVOLVED AT STP ΔV PER STEP	VOLUM OF GAS EVOLV AT LOW PRESSU AND 2 ΔV PER STEP	Δ FR 10
	1000	1.97 E4		—	8
			2.00 E3	51.7	[illegible]
	900	1.77E4			5
			2.00 E3	58.0	[illegible]
	800	1.57 E4			11[illegible]
			1.90 E3	62.9	
	700	1.38 E4			19
			2.00 E3	76.9	
	600	1.18E4			3[illegible]
			1.96E3	90.0	
	500	9.84 E3			43
			1.97 E3	112.3	
	400	7.87 E3			6
			1.97 E3	148.0	
	300	5.90 E3			1[illegible]

REFERENCE - WAPD TM 633

133 358

AL Bussen