September 27, 1979

MEMORANDUM FOR: B. D. Elam
GPU Engineering

FROM: J. T. Collins, Deputy Director
TMI Support

SUBJECT: TMI-2 MODIFICATION DESIGN CRITERIA OF REACTOR COOLANT PRESSURE CONTROL SYSTEM

We have reviewed Rev. 4 of Reactor Coolant Pressure Control System Design Criteria - Makeup Position", dated 8/30/79 attached to your memo to R. Lane dated August 30, 1979, and we have no substantive comments to offer at this time.

J. T. Collins, Deputy Director
TMI Support

cc:
R. Vollmer
J. Herbein
R. Conte
M. Greenberg

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OFFICE	TMI Support				
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DATE	9/27/79				

Inter-Office Memorandum

GPU Service

Date August 30, 1979
TSG-405

Subject TMI-2 Modification Design Criteria of Reactor Coolant Pressure Control System

To H. R. Lane - Site Manager B&R

Location TMI

Attached is Rev. 6 of "Reactor Coolant Pressure Control System Design Criteria - Makeup Portion", dated 8/30/79. This document supersedes the one previously transmitted to you with our memorandum dated 5/11/79.

The major design criteria changes made by this revision are summarized as follows:

1. The normal system operating pressure is less than or equal to 600 psig.

2. The system shall have a design pressure of 600 psig or higher as required by interconnections with existing systems.

3. During a transient, the nitrogen regulator(s) must be capable of maintaining a minimum nitrogen gas pressure of 250 psig in the surge tank while supplying a 150 gpm injection rate to the reactor coolant system.

4. Attachment "A" is updated to reflect the revised injection rate and data from "Technical Report on RC Letdown System", Rev. 0.

It is our understanding that the system design which has been developed remains in fundamental agreement with this revised criteria.

B. D. Elam

BDE/jb
Attachment

cc: R. C. Arnold	W/att.	L. Rogers B&W	w/att.
J. G. Herbein	"	GPU Control Room Watch	"
R. F. Wilson	"	TMI-2 Control Room	"
J. L. C. Bachofer, Jr.	"	Data Reduction File	"
D. K. Croneberger	"		
W. H. Zewe	"		
J. R. Floyd	"		
F. G. Maus	"		
[redacted] - NRC	"		

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THREE MILE ISLAND - UNIT NO. 2

REACTOR COOLANT PRESSURE CONTROL SYSTEM

DESIGN CRITERIA - MAKEUP PORTION

TASK 6B

Revision	Date	Prepared By	Approved By
Rev. 3	4/23/79	L. Zanis/T. Lu T. Lu	D. Croneberger/G. Capodanno D Croneberg
Rev. 4	4/28/79	T. Lu T. Lu	D. Croneberger/G. Capodanno G. Capodanno
Rev. 5	5/11/79	T. Lu T. Lu	D. Croneberger/G. Capodanno G. Capodanno
Rev. 6	8/30/79	T. Lu T. Lu	B. D. Elam BD Elam

REACTOR COOLANT PRESSURE CONTROL SYSTEM DESIGN CRITERIA

1. Scope:

To establish the design criteria for a reactor coolant (RC) pressure control system to be used while the reactor is continuously cooled for 2 years. The system shall maintain a minimum RC pressure with the pressurizer filled solid with water and without pressurizer heaters. It shall be capable of making up reactor coolant as temperature changes cause water contraction and/or certain volume losses causing decrease in primary system pressure.

The reactor coolant pressure control system consists of passive pressure control components as well as active pressure control components. The passive pressure control portion of the system relies on manual operations only for initial fill. The active pressure control portion would allow for remote operation of motor-driven fill (chemical or makeup) pumps. The passive pressure control system will be designed so that it can be an integral part of the active pressure control system.

The passive pressure control system is defined as a series of surge tanks supplied with a nitrogen overpressure from an automatically regulated bank of nitrogen cylinders.

The active pressure control system is defined as the passive pressure control system coupled with charging pumps and associated degassed borated water supply.

Phase I of the reactor coolant pressure control system will involve the installation of a manual system controlled by a locally stationed operator. Phase II will involve additional instrumentation and control equipment required to automate the makeup portion of the system and allow control and monitoring of the system from the TMI Unit 2 control room.

2. Introduction:

The Reactor Building is presently radioactively contaminated to the degree where it is anticipated to render much of the electrical equipment and instrumentation inoperative, such as pressurizer heaters. There is also water leakage from the RC System into the Reactor Building which is and may continue to cause flooding of and failure of instrumentation at the lower levels. The lower level instrumentation include pressurizer level, steam generator level, and others. The loss in instrumentation will not allow the pressurizer to be reliably used for RC System pressure control, and will require that the pressurizer be kept in a solid water status for continued reactor core cooling operation.

The long term cooling mode for the RC System will rely upon operating the steam generators A & B as water to water heat exchangers and establishing primary coolant flow via natural circulation. The primary objective of the pressure control system shall be to: (1) maintain the RC System in a solid water condition for natural circulation core cooling operations; (2) provide adequate NPSH to the RC pumps should it prove necessary to use one; (3) absorb volumetric reductions in the coolant system to maintain system pressure within control limits, and (4) control the chemistry of the fill fluid. R3

In developing the system requirements for the third objective, the following transients were considered for the long term steady-state operation (for design data see Attachment A):

a. Loss of natural circulation in one loop while the other loop is still running.

b. Introduction of 5000 gpm of 50°F (feedwater) to a OTSG.

c. Stopping one RC pump.

d. Starting either the skid mounted ADHR or the originally installed Decay Heat Removal System. R3

The starting of a reactor coolant pump following "natural circulation abort" must be covered by the combination of this system and the "makeup" pump (MU-P1A,MU-P1B, or MU-P1C)or other active injection pumps.

Inadvertent and sustained feed of cold water to the RC System following high (> 250°F) temperature RC System operation requires that this system be supplemented by injection from the "makeup" pumps (MU-P1A,B,C) or other active injection pumps.

In lieu of this provision, administrative controls consisting of "locked out" breakers or locked closed valves shall be adhered to to preclude rapid cooling of the RC System.

3.0 Functional and Design Requirements

3.1 Passive Pressure Control System

3.1.1 Functional requirements for the system shall be as follows:

3.1.1.a The normal system operating pressure is less than or equal to 600 psig. During steady state operation (no seal injection, no RC pumps running), the system shall be capable of maintaining the RC System at a controlled pressure with an accuracy of ±10% over the range of 50 psig to 600 psig, accounting for gage error. (The selected operating pressure for an RC System temperature T_{RC} shall be determined by utilizing a pressure greater than that shown in Table A, but less than that shown in Table B. Table A provides the allowable pressure operating curve as a function of measured temperature and dissolved gas concentration and Table B provides the allowable pressure operating curve as a function of RC System temperature recognizing NDT limits). R6 R R5

3.1.1.b The system shall be designed to have the provisions for supplying degassed borated water to the RC System.

3.1.1.c The surge capacity of the system shall be sufficient to meet the makeup requirement of 4 gpm to the RC System for 8 hours at a system pressure from 50 to 600 psig or the design transients in Paragraph 2. R6

3.1.1.d The system shall be designed to operate continuously for a minimum of 2 years.

3.1.1.e System shall have a design pressure of 600 psig or higher as required by interconnections with existing systems. R6

3.1.1.f During the transient, the nitrogen regulator(s) must be capable of maintaining a minimum nitrogen gas pressure of 250 psig in the surge tank while supplying a 150 gpm injection rate to the reactor coolant system. R6

3.1.2 Design requirements for the system shall be as follows:

3.1.2.a The system shall not rely on any instrumentation or active valving within the Reactor Building except for RCS temperature and pressure instrumentation which may be utilized while available. The system shall minimize the use of active components outside the Reactor Building. R3

3.1.2.b The system shall be designed to limit in accordance with Paragraph 3.9 the entry of non-condensibles, such as N_2 and O_2, into the RC System.

3.1.2.c At least one surge tank shall be provided with pressurized N_2 blanket to maintain the desired system set pressure.

3.1.2.d Control and monitoring of the system shall be done locally during Phase I and from the TMI Unit 2 control room during Phase II. R3

3.1.2.e The surge line shall be sized to accommodate the 150 gpm surge flow rate from 3.1.1.f. R6

3.1.2.f Liquid lines and components should be designed to handle fluids with particles 0.1 inches in diameter.

3.1.2.g Provision shall be made to refill the surge tanks with degassed borated water while maintaining RC System pressure.

3.1.2.h System components should preferably be designed to ASME B & PV Code, Section III requirements. If they are not available, components designed to the following codes are acceptable:

Piping - ANSI B 31.1 R3
Tanks - ASME B & PV Code, Section VIII or API
Valves - ANSI B 16.5 and B 16.34
Supports and Hangers - ANSI B 31.1
N_2 Supply System - CGA Standards R4

3.1.2.i System shall be provided with vents for filling and drains for draining. These shall have provisions to be piped to the radwaste system.

3.1.2.j Provisions shall be made to accommodate the addition of LiOH, NaOH, boric acid, H_2, demineralized water and hydrazine.

3.1.2.k System design loads should include system pressure, pump vibrations, component and fluid weight, and pressure surges. There is no seismic requirement.

3.1.2.l Welded construction should be used as much as possible.

3.1.2.m The system shall be designed such that in the event of inadvertent depressurization of the reactor coolant system, the surge tanks shall be automatically isolated from the new charging pumps and the reactor coolant system after discharging 1900 gallons of water. The isolation shall be based on low level in the surge tank closest to the reactor coolant system. This isolation shall prevent insertion of N_2 into the reactor coolant system while maintaining the water injection function of the new charging pumps. When this isolation valve is not fully open, an alarm shall be provided to alert the operators of an abnormal valve position. The alarm shall have both local and control room annunciation. R3

3.1.2.n The pressure control system piping from the HPI makeup line back through the second isolation check valve may have a design pressure of 1500 psig provided this piping is isolated directly from the makeup pump discharge. R5

3.2 Active Pressure Control System

(See Phase II definition on Page 1) R3

Functional and design requirements for the active pressure control system are the same as those for the passive pressure control system with the following additions:

3.2.1 The system shall be provided with redundant standby pumps which will (1) fill the surge tank in response to tank level reduction, and (2) permit gradual addition of water to the RC System.

3.2.2 Motor-operated valves where provided shall have an auxiliary handwheel shielded and accessible, if required.

3.2.3 Alarm shall be provided to indicate a differential pressure greater than 50 psi between the reactor coolant system (if available) and surge tanks. R3

3.2.4 A variable capacity (0-10 gpm) pump shall be provided in parallel with the redundant pumps provided. Provisions shall be made for addition of a chemical addition flask on the discharge of the variable capacity pump.

3.3 Functional Limitations

3.3.1 The system will not be designed to maintain pressure during either HPI or LPI system operation.

3.3.2. The system will not provide seal injection water to RC pumps. It is assumed that the seal water, if required, is supplied by one of the three makeup pumps. The system shall be able to accommodate the static system pressure condition required to run one reactor coolant pump. R6

3.4 Interfaces

3.4.1 This system shall not defeat or degrade the functional capabilities of other existing systems.

3.4.2 This system shall be independent of other TMI-2 plant systems except for electrical service, sources of clean, reactor grade, demineralized water, and the use of existing piping from outside the reactor building to the RC System.

3.4.3 The system shall be designed to preclude the possibility of actions in other systems from inadvertently causing a loss of system surge capability.

3.5 Reliability

The system design objective shall be to provide redundant active components and instrumentation to increase system reliability. R6

3.6 Maintainability

The system components shall be located to limit radiation levels to 100 mr/hour in areas where maintenance or operation is required. Further, the system design shall preclude backflow of reactor coolant (radioactive fluid) into the system.

3.7 Electrical Requirements

All electrical equipment and instrumentation required to operate the system shall have an emergency alternate power supply that does not rely on off-site power.

3.7.1 The charging pumps shall be capable of being started and operated from an on-site diesel generator set in the event of a loss of off-site power. The charging pumps shall be sequenced on to the diesel generator set manually. Criteria shall be established for the maximum allowable time to restore voltage after a loss of off-site power.

3.7.2 Electrical classification of the system is non-class 1E.

3.7.3 Motor feeders shall be protected consistent with original plant design and normal trips for overload, etc., shall be used. R3

3.7.4 The preferred power sources are as follows:

a) Charging water storage tank heater - 100 kw - bus 2-45
b) Charging pump A- 100 hp - Mcc bus 2-32A
c) Charging pump B - 100 hp - Mcc bus 2-42A
d) Charging pump packing cooling pumps - 1/5 hp - as convenient
e) Variable capacity pump - - as convenient
f) Borated water transfer pump - - as convenient
g) Borated water batching tank heater - - as convenient

3.7.5 "Criteria for General Modification to the BOP Electrical System" are applicable. Also refer to "Criteria for Loss of Off-Site BOP Electrical Power."

3.8 Instrumentation

Instrument power shall be obtained from the regulated voltage power supply panels 2-12R and 2-22R. R3

The system shall be designed to be able to monitor the following parameters:

3.8.1 Surge tank level (all tanks)

3.8.2 Charging water storage tank level and temperature R3

3.8.3 Surge tank discharge pressure

3.8.4 Reactor coolant system pressure and temperature (from existing instrumentation if available).

3.8.5 Charging pump suction and discharge pressure and pump flow. R3

3.8.6 Nitrogen supply pressure

3.9 Chemistry

3.9.1 The system shall be capable of adjusting the RC fill system water chemistry to the following:

pH 7.5-10.5; Dissolved gas 5-15 Std. cc/kg H_2* R4

Boron 2200-4000 ppm; F^- , $Cl^- \leq 1$ ppm (one ppm) R3

3.9.2 The RC design gross activity shall be assumed to be 0.5 Curies/ml.

3.9.3 For Phase I the makeup water shall be degassed to a level of not greater than 15 Std. cc/kg. For Phase II, the makeup water degassification objective shall be 5 Std. cc/kg or less.

3.10 Materials

All maerials having contact with makeup water shall be compatible with water at 200°F and 4000 ppm boron as boric acid. The materials shall be stainless steel or carbon steel with stainless steel cladding. Carbon steel and copper alloys may be used in nitorgen supply system. R3

3.11 Environmental Conditions

Design ambient temperature: 40 - 120°F
Design ambient relative humidity: 100%

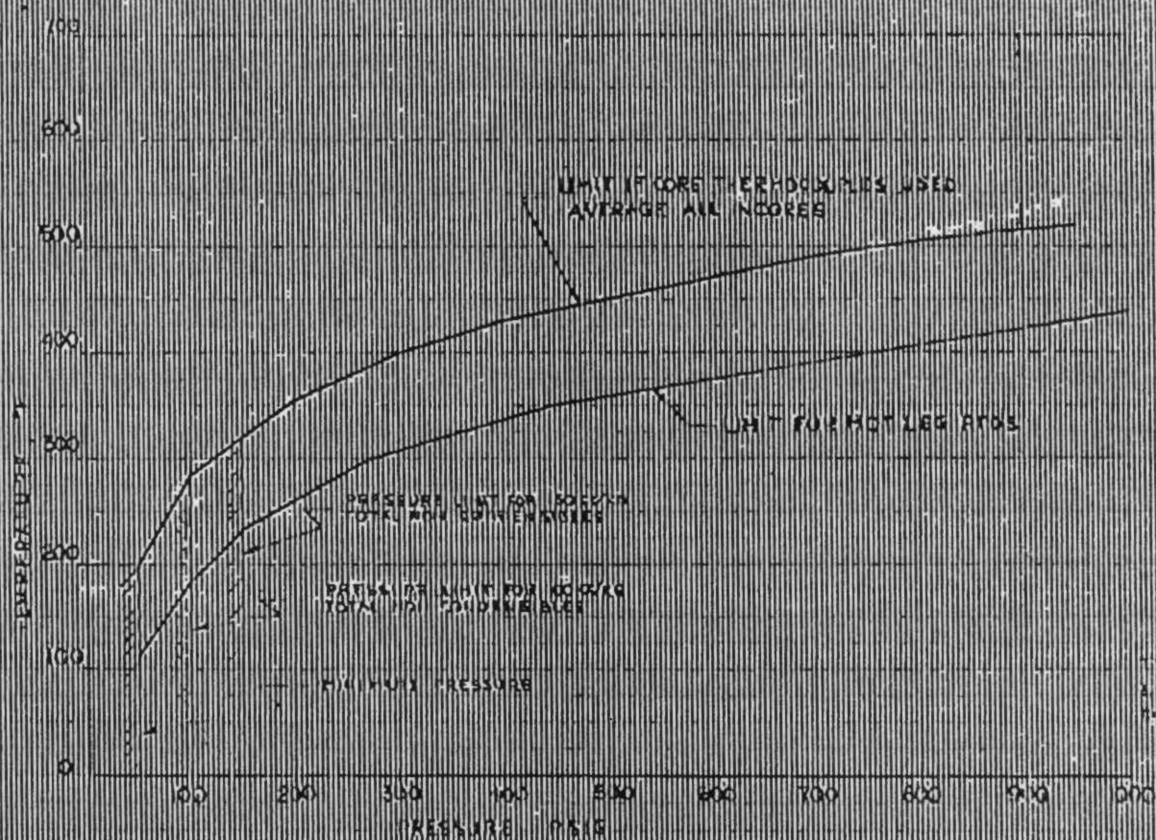
3.12 Testing

The system shall be tested, hydrostatically and preoperationally, before being placed into operation.

*Residual hydrazine may be provided in lieu of H_2. Hydrazine in this application must be maintained at 300% of the stoichiometric O_2 in the water.

ATTACHMENT A - DESIGN DATA FOR TRANSIENT

Initial System Operating Mode	Basis of Analysis	Required Maximum Inflow (I)/Outflow(0) To/From RC System Envelope	Required Time to Steady State	Total Volume Change (RCS)
R6a. No natural or forced circulation cooling due to loss of all secondary side cooling water Ref: Pages 1 & 2 of Calculation File	One closed loop cooling system restored after average hot-leg temperature rises 50°F above initial temperature at time of loss of RCS cooling. Secondary side cooling water assumed at 50°F	150 gpm(I)	2 hrs.	1900 gal(I)
b. One closed loop cooling system in operation with one RC pump running Ref: Pages 23-27 of Calculation File	Stop RC pump	9 gpm(0)	30 mins.	150 gal(0)
c. Reactor coolant system in natural circulation with two secondary cooling loops operating Ref: Pages 16-22 of Calculation File	Loss of one secondary cooling loop	6 gpm(0)	2 hrs.	720 gal(0)
6d. RC System solid, 200°F average temperature Skid mounted ADHR or original DH Removal System started Ref: See Calculations for Task 6C	RCS and DHR/ADHR Systems instantaneously reach thermal equilibrium	54 gpm (I)	5 Min.	270 gal (I)
e. RC System Solid, 200°F; Feed 3000 gpm @ 50°F directly into RC System See Calculations for Task 6C	Assume no heat transfer out of RCS	116.2 gpm(0)	5 min.	581 gal(0)



NOTES

1. [illegible] THERMOCOUPLES HAVE ±10°F AND ±50 PSI ERRORS APPLIED
2. RTD'S HOT LEG HAVE 100°F SUBCOOLING MARGIN AND 50 PSI [illegible] ERROR
3. [illegible]

TABLE A

THERMAL AND [illegible] LIMITS FOR LONG TERM COOLING [illegible]

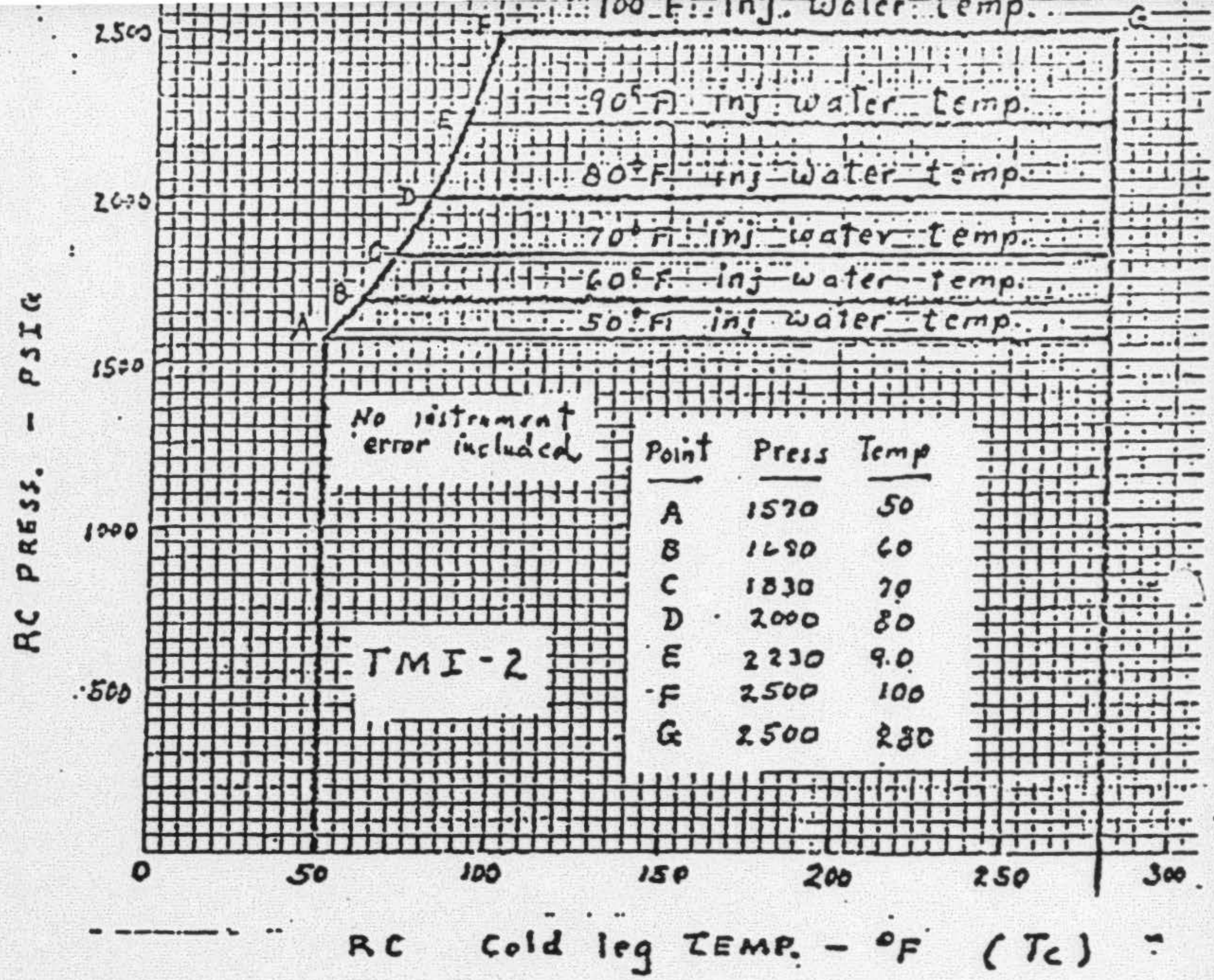


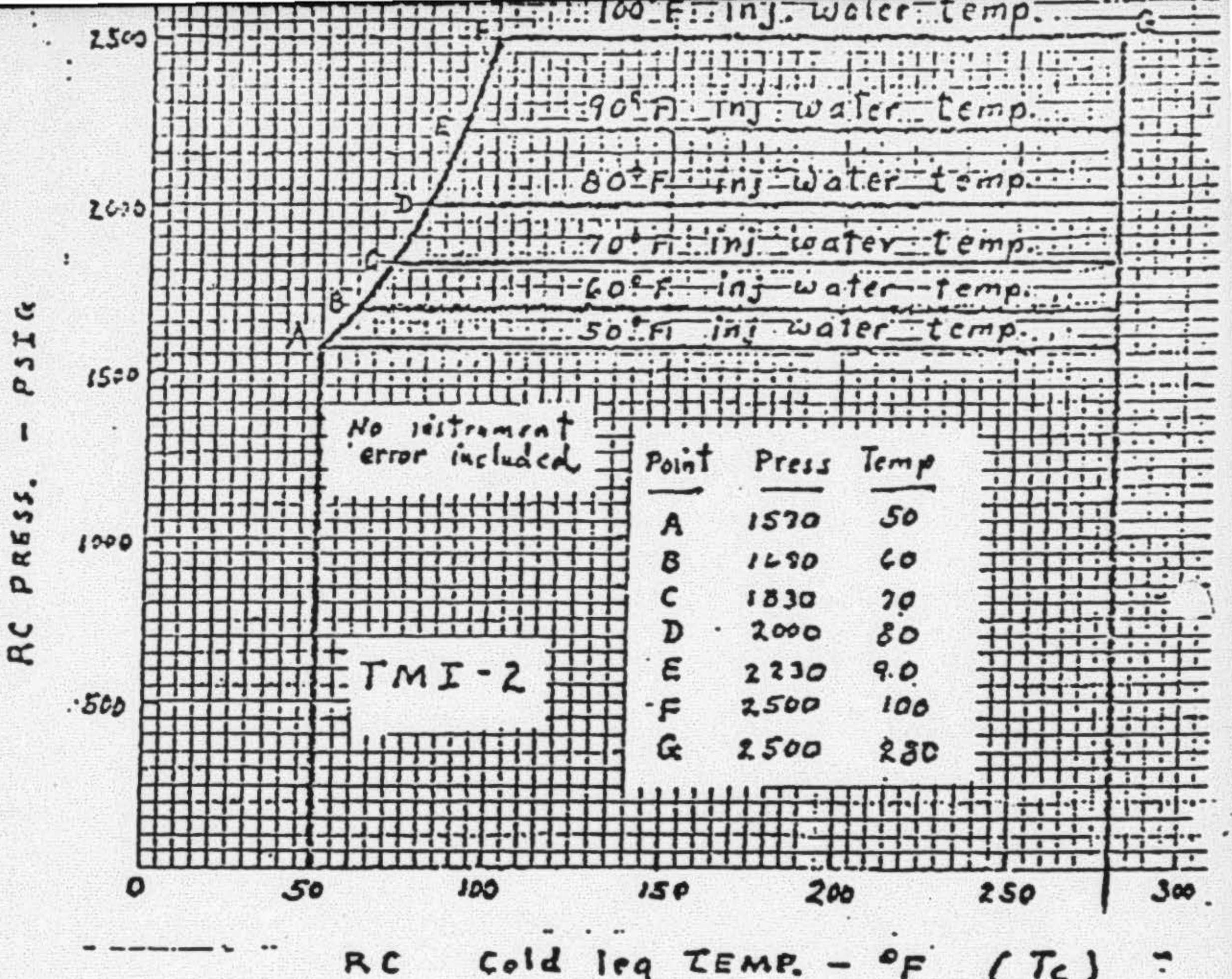
TABLE B

ALLOWABLE OPERATING ENVELOPE FOR REACTOR VESSEL NDT LIMITS

Prepared by D. B. Dexter 5-3-79

Reviewed by C. E. Harris 5-3-79

Approved by Gordon R. Skillman



Point	Press	Temp
A	1570	50
B	1680	60
C	1830	70
D	2000	80
E	2230	9.0
F	2500	100
G	2500	280

TABLE B

ALLOWABLE OPERATING ENVELOPE FOR REACTOR

VESSEL NDT LIMITS

Prepared by [signature] 5-3-79

Reviewed by C. E. [signature] 5-3-79

Approved by [signature]