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October 23, 1975
GQL 1636

File Cy.

Director of Nuclear Reactor Regulation
Attn: R. W. Reid, Director
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Docket No. 50-289
Operating License No. DPR-50
Three Mile Island Nuclear Station, Unit 1 (TMI-1)

Attached please find Technical Report GED 0002 which supplies the information that was requested in your letter of September 15, 1975.

Please note that the some of the information contained on Table 2 of this report does not correspond to similar information submitted as part of our Technical Specification Change Request #17 (August 8, 1975) for the following reasons:

1. "Steel thickness, ft." under items a. and b. of our August submittal does not correspond to like values in Table 2 of GED 0002 in that the report quotes FSAR nominal values and the August submittal values were developed using the gross weight, surface area and density of the steel.

2. "Exposed area, ft^2" under items c. and e. of our August submittal does not include some B&W supplied equipment which is included in Table 2 items 3 and 5 of GED 0002.

3. "Reactor Building Free Volume ft^3" is explained in GED 0002 section 4.0.

4. "Concrete thickness, ft" under item f. of our August submittal differs from GED 0002 since GED 0002 reflects a model approximately twice as thick and uninsulated on either side where the August submittal gave concrete thickness for an infinite slab perfectly insulated on one side.

5. "Exposed surface area, ft^2" under item d. of our August submittal catagorized the Nuclear Services Cooling Water System as stainless steel.

6. "Exposed area, ft^2" under item f. of our August submittal was not based on the most recent as built data.

We trust that this submittal adequately answers your questions, and should you have any further questions please contact me.

Sincerely,

R. C. Arnold
Vice President

RCA:CWS:tas

File: 20.1.1 / 7.7.4.3.9

Attachment: Technical Report No. GED 0002

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Technical Report No. GED 0002

Three Mile Island Nuclear Station Unit #1

Emergency Core Cooling System

Evaluation of Containment Input Parameters

October, 1975

Prepared by: J. F. Fritzen

Reviewed by: B. F. Hernady

Approved by: R. M. Klingaman 10/31/75

Metropolitan Edison Company

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1.0 INTRODUCTION:

This report provides the as-built details and characteristics of the Three Mile Island Nuclear Station Unit #1 (TMI-1) Reactor Containment and Reactor Building Emergency Cooling Systems and provides an evaluation demonstrating the overall conservatism of these parameters to those stated in Babcock and Wilcox Topical Report BAW-10103.

2.0 BACKGROUND

By letter dated September 15, 1975, Met-Ed was requested to provide justification for the input parameters used in BAW-10103 by comparison with the appropriate values for TMI Unit #1. The input parameters of concern were those used in the calculations of containment backpressure and included net free containment volume, passive heat sinks, starting time of containment cooling systems, containment initial conditions, containment spray water temperatures and fan-cooler heat removal rate.

3.0 NET FREE CONTAINMENT VOLUME

BAW-10103 assumes a net free containment volume of 2,205,000 cubic feet. The total gross internal TMI-1 containment volume and the internal structures and equipment volumes which are subtracted to obtain the TMI-1 net free volume are identified in Table 1, The as-built net free volume of the TMI-1 containment is 2,122,482 cubic feet or 82,518 cubic feet less than that assumed in the B&W generic report. In order for the net free volume of 2,205,000 cubic feet to be exceeded, the TMI-1 containment diameter would have to be about 2 feet larger than nominal. Since the original construction specifications required the diameter of the containment liner to be held to within 10 inches of nominal, it is concluded that the TMI Unit #1 net free volume cannot exceed that specified in BAW 10103. Therefore, the TMI-1 net free volume is more conservative than that assumed for the generic model.

4.0 PASSIVE HEAT SINKS

The input parameters used by B&W in the generic analysis to model the reactor building heat sinks are identified in Table 2. Included in Table 2 are the corresponding parameters for the TMI-1 reactor building heat sinks. Table 3 contains the detailed listing of the metallic passive heat sinks within the TMI-1 containment which were used to develop the comparison of Table 2. The passive containment heat sinks identified in Table 3 were determined from a detailed review and material take-off of construction drawings. Metal surfaces above 250°F and metal totally embedded in concrete and not in contact with metal having exposed surfaces were not included as a passive heat sinks. The external surface sheet of reflective metal insulation on components above 250°F was included as a passive heat sink.

Since all metallic heat sinks involved thin sections and since the total weight of metal used in the generic analysis exceeded the TMI-1 values, it was concluded that the generic metallic heat sink parameters were conservative. It should be further noted that, although the total weight of internal concrete at TMI-1 exceeds that which would be calculated using the generic parameters, the generic input parameters on internal concrete surface area and thickness will result in maximizing short term heat removal. Similarly, the assumption for the generic model that the containment external walls are 4.0 feet thick rather than 3.5 foot thickness for TMI-1 does not effect the short term heat removal rates due to the poor conductivity of concrete. Therefore, use of the 4.0 foot concrete thickness has virtually no effect on containment back pressure.

In addition, during the development of the generic input parameters, it was determined by B&W that the TMI-1 represented the worst case containment design

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of all B&W 177-fuel assembly, lowered-loop, nuclear steam systems from the standpoint of size and heat sinks. In order to confirm the overall conservatism of the generic inputs, the minimum containment back pressure transient resulting from an 8.55 $ft.^2$ double ended break was calculated for the TMI-1 building using the method outlined in Section 4.3.6.1 of BAW10104. The actual TMI-1 input parameters identified in Table 3 including the actual exterior containment concrete thickness identified in Table 2 were used as inputs. A containment net free volume of 2.126×10^6 cubic feet, which slightly more conservative than that identified in Table 1, was used. The generic model parameters was used in all other instances. The results of this analysis are presented in Table 4 and demonstrated that the TMI-1 reactor building yields a higher containment pressure transient than that calculated by the generic containment model described in Section 4.4 of BAW-10103.

5.0 CONTAINMENT INITIAL CONDITIONS

Section 4.4 of BAW-10103 states that the initial reactor building conditions were assumed to be 100°F, 13.7 psia and 100% relative humidity. A review of the operating data from TMI-1 for the period of December 1974 through October 1975 indicates that containment pressure nearly always varies from +0.2 psig up to +1.0 psig above atomspheric pressure. Therefore, with regard to initial pressure conditions, the generic model is conservative.

The TMI-1 Reactor Building was designed for average normal operating interior temperatures between 90°F and 110°F. Calculations have previously been performed on the effect on maximum containment pressure resulting from a 20°F increase in average initial containment temperature. These calculations indicate that the peak pressure during the LOCA is increased by 0.4 psig. Since the assumptions used in these calculations are those which will maximize the transient pressure effects, it is concluded that a 20°F decrease in initial temperature will lower the minimum containment back pressure by less than 0.4 psig. As noted from a review of Table 4 a reduction of TMI-1 peak back pressure by 0.4 psig will still result in a higher containment peak pressure transient for TMI-1 than that calculated by the generic containment model.

A 100% relative humidity was used in the generic analysis and the TMI-1 analysis described in Section 4.0 above since it represents a conservative value and operating data concerning relative humidity are not readily available.

6.0 CONTAINMENT SPRAY WATER TEMPERATURES

The generic model assumes the building spray to be at 40°F. The spray solution at TMI-1 is a mixture of solutions from three tanks (i.e. Sodium Thiosulfate Tank, Sodium Hydroxide Tank and Borated Water Storage Tank). Each of these three tanks is electrically heat traced through use of redundant heaters to maintain the tank contents greater than 40°F. Therefore, the BAW 10103 input parameters on containment spray water temperature are conservative for the TMI-1.

In addition, the generic model assumes the spray flow rate is 1800 gpm for each of the two spray systems. This flow rate is the maximum permitted by TMI-1 emergency procedures to ensure pump run out does not occur. Since the design flow rate for the each TMI-1 spray system is 1500 gpm, the generic model spray flow rate is considered suitably conservative.

7.0 COOLER HEAT REMOVAL RATES

Figure 1 presents a comparison of the heat removal rate per cooler used in BAW-10103 and the maximum predicted heat removal rate of a TMI-1 Reactor Building Coolers. The predicted performance of the TMI-1 Coolers is based on an inlet cooling water temperature of 32°F which is the minimum operational value. As illustrated by Figure 1, less heat will be removed by the TMI-1 coolers than assumed to be removed in the generic analysis. Therefore, the generic model will underpredict containment back pressure and is conservative.

8.0 STARTING TIME OF CONTAINMENT COOLING SYSTEMS

BAW-10103 assumes no starting time delays for the Reactor Building Emergency Cooling Fans. For TMI-1, this neglects the time delays associated with the following:

a. a 2.4 sec electrical loading delay is imposed on the Emergency Cooling Fan System under ESF conditions even when no loss of offsite power occurs,

b. start-up time of the Reactor Building Emergency River Water pumps, and

c. the time required to fill the Reactor Building Emergency River Water pump column.

Figure 2 presents a comparison of the spray pump starting delay times assumed in the generic analysis and the actual delay times which would exist for the TMI-1 spray system. Under worst case conditions, the TMI-1 spray headers could be operational 1.8 and 6.9 sec prior to that assumed by the generic model. However, the overall generic model will still predict lower containment back pressures for the following reasons:

1. A review of Figure 6-10 of BAW 10103 indicates that the spray systems are actuated after peak containment back pressure has been reached and at a time when the rate of change of containment back pressure is small. Figure 6-10, therefore, indicates that actuation of the spray system does not substantially reduce containment pressure.

2. Based on the conservative fan cooler heat removal rates used in the generic model, the assumed heat removed during the first 65 seconds of the accident is still more than that which can occur from the TMI-1 containment cooling systems.

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3. The zero starting time delay assumed for the fan coolers further assures that the generic model will overpredict the heat removal which can occur from the TMI-1 containment cooling systems.

9.0 SUMMARY

The TMI-1 as built parameters which can effect containment back pressure during a LOCA have been compared to the input parameters used to perform the ayalysis described in BAW-10103. This evaluation demonstrates that the input parameters of BAW-10103 will conservatively underpredict the containment back pressure transient which would occur under a Loss of Coolant Accident at TMI-1.

Table 1

TMI #1 Net Free Volume

1.	Gross volume inside liner	2,341,479 cu. ft.
2.	Structural	
	a) Concrete walls	127,584 cu. ft.
	b) Concrete floor	50,400 cu. ft.
	c) Structural Steel (including polar crane, grating, 1 motor stand, 1 pump stand)	5,120 cu. ft.
	d) Platform Steel	155 cu. ft.
3.	Heating & Ventillation Equipment (i.e. Ducts, Piping, Coils)	2,092 cu. ft.
4.	Electrical Equipment	570 cu. ft.
5.	RC System (Fluid volume only, excludes metal surface volume)	12,186 cu. ft.
6.	Volume of Secondary Side Equipment (Steam generators only)	6,983 cu. ft.
7.	Core Flood Tanks & Piping	3,219 cu. ft.
8.	RC Pump Motor Housings	408 cu. ft.
9.	CRDM Stator, Position Indicator, Motor Tube, and Closure Insert	87 cu. ft.
10.	Fuel Handling & Reactor Service Equipment	473 cu. ft.
11.	Reactor Vessel & Steam Generator Support Skirts	126 cu. ft.
12.	Misc. Piping	
	a) Pipe	7,897 cu. ft.
	b) Hangers	274 cu. ft.
	c) Sleeves for Penetrations	127 cu. ft.
	d) GAI Equipment	1,138 cu. ft.
	e) Motor Operators & B&W Supplied Coolers	158 cu. ft.
13.	Net Free Volume	2,122,482 cu. ft.

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Table 2

Comparison of Passive Heat Sinks

Parameter	Generic Model	TMI-1
1. Reactor Building Walls including the concrete wall, carbon steel liner and anchors:		
Exposed area, ft^2	67,410	63,870
Paint thickness, ft.	0.00083	0.00083
Steel thickness, ft.	0.05504	0.03125
Concrete thickness, ft.	4.0	3.5
Steel Weight, lbs.	1,818,020	922,145
2. Reactor Building Dome including concrete, carbon steel liner and anchors:		
Exposed area, ft^2	18,375	18,400
Paint thickness, ft.	0.00083	0.00083
Steel thickness, ft.	0.06546	0.03125
Concrete thickness, ft.	3.0	3.0
Steel Weight, lbs.	58,939	26,566
3. Painted Internal Carbon Steel:		
Exposed area, ft^2	249,000	355,323
Paint thickness, ft.	0.00083	0.00083
Steel thickness, ft.	0.03125	~ 0.0238 (average)
Steel weight, lbs.	3,812,812	4,139,647
4. Unpainted Internal Carbon Steel:		
Exposed area, ft^2	36,000	126
Steel thickness, ft.	0.03125	~ 0.00713 (average)
Steel Weight, lbs.	55,125	440
5. Unpainted Stainless Steel:		
Exposed area, ft^2	10,000	45,697
Steel thickness, ft.	0.03125	~ 0.0124 (average)
Steel weight, lbs.	154,175	278,671
6. Internal Concrete:		
Exposed area, ft^2	160,000	87,443
Paint thickness, ft.	0.00083	0.00083
Concrete thickness, ft.	1.0	~ 4.0 (average)
Weight, lbs.	23,200,000	25,629,696
7. Summary by Metallic Heat Sinks:		
Total Painted Carbon Steel, lbs.	5,689,771	5,088,358
Total Unpainted Carbon Steel, lbs.	55,125	440
Total Unpainted Stainless Steel, lbs.	154,175	278,671
Total Metal, lbs.	5,899,071	5,367,469

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8. Thermophysical Properties

Material	Thermal Conductivity BTU/hr - ft °F	Heat Capacity BTU/ft^3 °F
Concrete	0.92	22.62
Carbon Steel	27.0	58.8
Stainless Steel	9.1836	54.263
Paint	0.6215	40.42

Table 3

WEIGHTS AND SURFACE AREAS OF PAINTED AND BARE METAL SURFACES
EXPOSED TO THE REACTOR BUILDING ATMOSPHERE
AT
THREE MILE ISLAND NUCLEAR STATION, UNIT #1

Categories	Painted Metal (1) Weight, lbs	Painted Metal (1) Surface, ft^2	Bare Metal (5) Weight, lbs	Bare Metal (5) Surface, ft^2	Material
I. Heating & Ventilating					
1. Cooling coils (2)	-	-	83,830	223,810	Cu
2. Ventilation Ducting	162,463	61,884	-	-	C.S.
3. Cooling Water Piping	26,940	1,257	-	-	C.S.
4. Miscellaneous (3)	227,731	35,795	-	-	C.S.
II. Instruments & Appurtenances					
1. Mounting Brackets, Instr. Racks	1,134	102	-	-	C.S.
2. Channel Protection for Instr. Tubing	2,150	190	-	-	C.S.
III. GAI Supplied Electrical Equipment					
1. Electrical Penetrations	-	-	4,035	772	S.S.
2. Junction Boxes	309	99	60	15	C.S.
3. Pull & Special Boxes	146	47	56	11	C.S.
4. Terminal Boxes	801	256	8	2	C.S.
5. Conduit	170,500	19,072	-	-	C.S.
6. Tray & Wire Way	27,500	3,601	-	-	C.S.
7. Receptacles & Fittings, etc.	4,304	1,377	-	-	C.S.
8. Hangers	33,850	10,832	-	-	C.S.
9. Panels	727	232	-	-	C.S.
10. Communications Equipment	262	158	-	-	C.S.
11. Lighting Fixtures	-	-	174	66	C.S.
IV. GAI Small Piping Systems					
1. Barn Pipe & Equipment	-	-	54,728	6,484	S.S.
2. Painted Pipe & Equipment	45,026	4,708	-	-	C.S.
3. Insulation on Piping & Equipment	-	-	16,356	13,630	S.S.
4. Pipe Hangers	39,527	7,193	-	-	C.S.
5. Manual Valves	2,070	115	2,530	140	C.S/S.S.
6. Motor Operated Valves & Operators	2,394	224	-	-	C.S.

Categories	Painted Metal Weight, lbs	Painted Metal Surface, ft^2	Bare Metal Weight, lbs	Bare Metal Surface, ft^2	Material
V. GAI Large Piping Systems					
1. Building Spray System	-	-	33,100	3,590	S.S.
2. Core Flooding System	-	-	38,485	880	S.S.
3. Emergency F.W.	10,441	635	-	-	C.S.
4. Intermediate Cooling Water System	13,940	1,350	-	-	C.S.
5. Makeup & Purification System	-	-	5,055	336	S.S.
6. Nuclear Services Cooling Water System	72,772	5,557	142	32	C.S.
7. Pressurizer Relief	-	-	823	71	S.S.
8. Insulation Surface, Normally Hot Pipes	-	-	10,487	8,739	S.S.
9. Insulation Surface, Normally Cold Pipes	-	-	2,383	1,986	S.S.
10. Motor Operator's for Valves	14,434	1,008	-	-	C.S.
11. Pipe Hangers	94,669	9,688	-	-	C.S.
VI. Structural Steel					
1. Reactor Building Liner Plate	1,187,819	82,270	-	-	C.S.
2. Fuel Transfer Canal Liner	-	-	56,000	5,520	S.S
3. Support for Polar Crane	185,000	9,110	-	-	C.S.
4. Polar Crane	567,400	20,500	-	-	C.S.
5. Pipe Restraints	159,966	5,886	-	-	C.S.
6. Large Equipment Restraints	11,185	385	-	-	C.S.
7. Large Equipment Supports	78,594	3,913	-	-	C.S.
8. Steel Framing Inside Secondary Shield	128,448	17,671	-	-	C.S.
9. Steel Framing Outside Secondary Shield	1,234,797	83,845	-	-	C.S.
10. Normal Personnel Access Airlock	7,569	164	-	-	C.S.
11. Equipment Access Hatch and Emergency Personnel Access Airlock	119,813	2,182	-	-	C.S.
12. Special Access Platforms	13,753	1,993	-	-	C.S.
VII. B&W Supplied Equipment (4)					
1. Valves, Operators, and Coolers	28,235	1,844	-	-	C.S.
2. R.C. Pump Motor Housing	200,000	13,061	-	-	C.S.
3. CRDM Stator, Position Indicator, Motor Tube, & Closure Insert	-	-	42,780	2,773	S.S.
4. Fuel Handling & Reactor Service Equipment	231,816	15,139	-	-	C.S.
5. RC Vessel Support Skirt	30,332	1,981	-	-	C.S.
6. Mirror Insulation	-	-	1,760	114	C.S.
7. Steam Generator Support Skirt	31,388	2,050	-	-	C.S.
8. Core Flood Tanks	156,486	10,219	-	-	C.S.
9. Liquid Waste Disposal Equipment	-	-	10,014	650	S.S.
10. Reactor Bldg. Spray Nozzles	-	-	135	9	S.S.
11. Intermediate Cooling Equipment	775	50	-	-	C.S.

Notes:

1. Paint thickness is 10 mils nominal.

2. Included in B&W analysis for TMI-1 heat sink calculations even though zero time delay is assumed for Reactor Building Coolers.

3. Includes regulators, fans and motors, stiffners, hangers, and filters.

4. Surface areas based on 3/8 inch metal thickness.

5. In performing the specific TMI-1 back pressure calculations discussed in Section 4.0 of this report, B&W assumed that some of the bare material identified in this table as stainless steel was unpainted carbon steel. This is a conservative assumption.

Legend:

Cu	Copper
C.S.	Carbon Steel
S.S.	Stainless Steel

Table 4

CONTAINMENT - PRESSURE COMPARISON: TMI-1 & GENERIC

Time (sec)	Pressure (psig) TMI-1	Generic	(sec)	Pressure (psig) TMI-1	Generic
2.0	13.32	12.29	72	21.55	21.41
4.7	18.11	17.52	76	21.42	21.31
6.7	22.19	21.46	78	21.38	21.28
8.9	25.67	24.75	82	21.27	21.21
9.9	27.00	26.00	88	21.18	21.14
12	29.24	28.11	92	21.10	21.07
13	30.10	28.59	94	21.07	21.06
15	31.34	29.87	96	21.03	21.03
17	32.05	30.41	98	21.00	20.99
19	32.46	30.68	105	20.91	20.90
21	32.49	30.59	115	20.82	20.79
23	31.87	29.54	125	20.69	20.69
25	30.67	28.71	135	20.60	20.52
27	29.43	27.69	145	20.47	20.38
29	28.38	26.61	155	20.36	20.23
31	27.53	25.77	165	20.25	20.09
33	26.74	25.11	175	20.14	19.94
35	26.09	24.53	185	20.01	19.79
37	25.53	24.08	195	19.89	19.63
39	25.04	23.69			
42	24.42	23.22			
46	23.70	22.77			
48	23.32	22.50			
52	22.81	22.10			
56	22.38	21.84			

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Figure 1

R.B. FAN COOLER HEAT REMOVAL

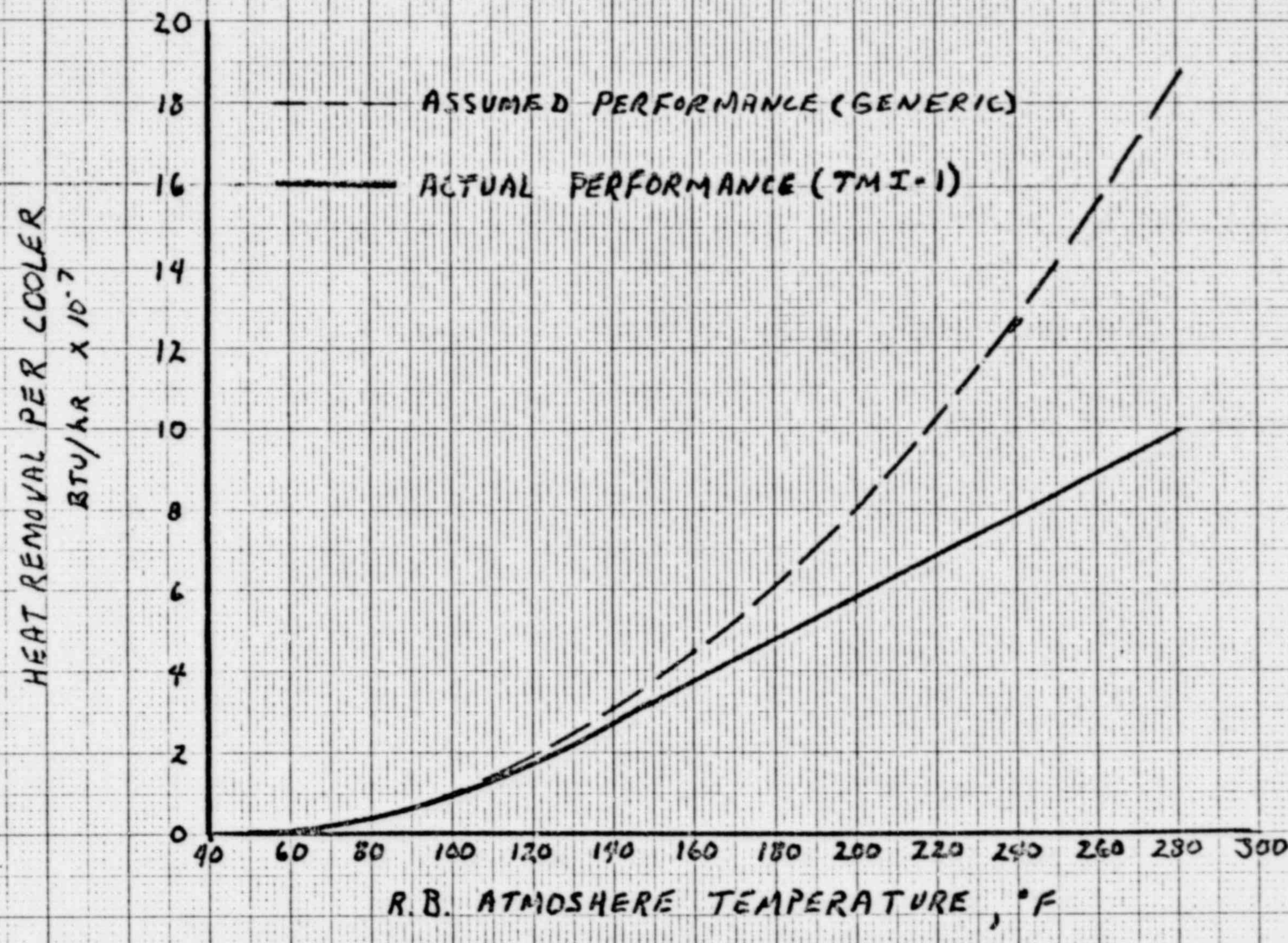

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Figure 2

COMPARISON OF BUILDING SPRAY DELAY TIMES