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SORENSEN,G.C. Washington Public Power Supply System
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SUBJECT: Submits addl info on Insp Rept 50-397/86-12 re equipment qualification.

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Docket No. 50-397

June 1, 1989
G02-89-103

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
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Gentlemen:

Subject: NUCLEAR PLANT NO. 2
ADDITIONAL INFORMATION RELATIVE TO
INSPECTION 50-397/86-12, EQUIPMENT QUALIFICATION

Reference: See Attachment 1

On March 29, 1989, Mr. A. Toth and Mr. R. Wilson of the NRC met with the Supply System to examine information regarding qualification of Limitorque motor operators toward resolution of the remaining open item on the subject audit. As a result of that meeting, the Supply System committed to provide two additional submittals. One was for the data from our test of grease relief valves with shipping caps in place (an Executive Summary had been provided previously). The second request was for an expanded technical analysis of the test data which would allow reaching the conclusion that Supply System motor operators in containment were qualified prior to the subject audit without T-drains in place (T-drains were installed during the 1986 outage).

As promised, a copy of the grease relief valve test data is attached. A copy has been provided to the WNP-2 Sr. Resident Inspector. The T-drain technical analysis is also attached (Attachment 2).

Very truly yours,

GC Sorensen

G. C. Sorensen, Manager
Regulatory Programs (MD 280)

JER/db

cc: JB Martin - NRC
NS Reynolds - BCP&R
RB Samworth - NRC
DL Williams - BPA/399
NRC Site Inspector - 901A

IE01

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Attachment 1

Reference: 1. Letter GI2-86-0060, R.F. Heishman to G.C. Sorensen, subject "Inspection No. 50-397/86-12", dated July 30, 1986.

2. Letter G02-86-0885, G.C. Sorensen to J.B. Martin, subject "Equipment Qualification Audit, Audit No. 50-397/86-12", dated September 17, 1986.

3. Letter G02-87-0154, G.C. Sorensen to J.B. Martin, subject "Equipment Qualification Audit, Audit No. 50-397/86-12", dated April 30, 1987.

4. Letter, R.J. Pate to G.C. Sorensen, subject "NRC Enforcement Actions Related to Inspection No. 50-397/86-12", dated December 16, 1987.

5. Letter G02-88-023, G.C. Sorensen to NRC, subject "NRC Inspection Report 86-12", dated January 20, 1988.

6. Letter G02-88-215, G.C. Sorensen to A.D. Johnson, subject "Additional Information Equipment Qualification", dated October 13, 1988.

7. Letter G02-88-239, G.C. Sorensen to J.B. Martin, subject "Impaired Function Testing of Limitorque Gearbox Relief Valves (Test Report EQR 88-43)", dated November 16, 1988.

8. Letter, D.F. Kirsch to G.C. Sorensen, subject "NRC Inspection at WNP-2", dated November 25, 1988.

Attachment 2

TECHNICAL ANALYSIS OF WNP-2 IN-CONTAINMENT LIMITORQUE MOTOR OPERATORS WITHOUT T-DRAINS INSTALLED

WNP-2 has eight (8) Limitorque motor operators inside containment. Prior to the time of the equipment qualification audit in May 1986, an outage was underway and a part of the outage work was conduct of a comprehensive program to examine configuration issues of the motor operators relative to identified concern areas. This internal Supply System program identified the need to install T-drains in these eight (8) motor operators. A Nonconformance Report was initiated and provided to the NRC EQ audit team at the entrance meeting. The T-drains were installed prior to startup from that 1986 refueling outage to comply with Limitorque's standard configuration for RH insulated motors.

This analysis addresses environmental qualification of the motor operators without T-drains installed, for consideration relative to the period prior to installation of the T-drains.

Motor "T" Drain Design Feature

Initial test programs (1968) conducted by Limitorque did not employ a motor drain design feature. The design feature was added around 1972 when testing to IEEE-382-1972 was conducted (Ref. 3). To our knowledge, through discussions with Limitorque, this feature was not directly resultant from any test program anomaly or failure.

The design intent of the T-drains is to allow any condensation buildup internal to the Limitorque's motor to drain out and preclude possible starting or running impairment due to the postulated condensate buildup. The degree of condensate buildup has never been quantified to our knowledge. The T-drain also provides a second vent path into the motor housing and thus a potentially negative effect of this design feature is present. The design provides a path to allow accident steam to be drawn in through the T-drain(s) during motor running or pressure equalization. The other vent path is via the conduit connection between the motor and the limit switch compartment. Should the Limitorque operator be positioned in such a way that condensate/steam/spray entering the limit switch compartment could drain into the motor housing via the conduit pathway, then T-drains might provide sufficient drainage if flow rates were sufficiently low. Mounting of the motor below the limit switch compartment is not recommended by Limitorque and no in-containment configuration of this type exists on WNP-2.

The principle question associated with the T-drain design feature is, "Can enough condensate accumulate in the motor, during an accident, to impair proper functioning?". Thus, conditions that cause condensation (i.e., where condensation heat transfer is the dominant mode) are critical to assessing this question.

As will be shown later, the very first Limitorque tests (without the T-drain design feature) were sufficiently harsh enough and condensation heat transfer dominated the test conditions such that the WNP-2 plant specific steam/temperature/pressure conditions were adequately enveloped. Thus the condensation conditions produced during a WNP-2 LOCA are not sufficient to require the T-drain design feature to insure the motor's safety function is achieved.

The reasoning and data presented conclude that the motor T-drains are not an essential design feature for WNP-2 accident conditions and, therefore, the qualification was not compromised during the period from November 30, 1985 until their installation in May 1986.

Motor Similarity

The Limitorque test program that demonstrates adequate performance without T-drains is described in Report 600198. This program tested a Reliance motor that contained a Class H insulation. This is reported by Reliance to have been a precursor to their standard Class H, Type "RH" insulation. WNP-2 in-containment Limitorque operators employ only the Class H, Type "RH" insulation. Limitorque Test Report 600376A is the qualification test report generally cited by Limitorque for qualification of these motors in BWR containments. Other than T-drains, the only configuration similarity issue of interest is the difference in insulation systems. We have contacted both Reliance and Limitorque to obtain details on these Class H insulation systems and assess the differences. Clearly, if the insulation system in either the early Limitorque test (600198) or the later test (600376A) was significantly superior, the condensation buildup could possibly be tolerated to a greater degree by the superior insulation system.

Reliance reports that the older Class H system was a precursor to the "RH" system used now and that there were some differences. This information is however, proprietary and applicability of the 600198 qualification test report to the "RH" insulation system should be handled through Limitorque. Generally though, Reliance believes their "RH" insulation system design is superior to the early CLass H system used in the 600198 Limitorque test. Limitorque has stated that they will certify that the early 600198 test is applicable to the motor operators that employ the "RH" insulation system. Thus the testing conducted under 600198 can be used to assess the safety significance of the need for T-drains under WNP-2 accident conditions.

WNP-2 Environmental Condition & Limitorque Operator Response

WNP-2 is a Boiling Water Reactor (BWR). Equipment in containment is to be qualified to the WNP-2 plant specific temperature and pressure profiles shown on Figure 1, plus margin. We generally use the BWR generic profile, as detailed in NUREG 0588, which provides more than the IEEE-323 recommended margin of 15°F above peak temperature levels. Limitorque Test 600198 tested a motor operator without T-drains to a temperature/pressure/steam profile greater than the WNP-2 specific profile. This is also shown on Figure 1. A 9°F margin was obtained above the WNP-2 plant specific profile. This is adequate because the WNP-2 profile contains a considerable superheat steam region and the 600198 test was performed under saturated steam conditions.

In 1981 the Supply System commissioned a test for our WNP-1 project to obtain a realistic understanding of the temperature response of a motor operator when subjected to a superheated steam environment (Ref. 2). As shown in Figure 2, the operator's surface (housing surface) temperature rises rapidly to the saturation temperature of steam at the test chamber pressure (327^{o}F, 85 psig) in 45 seconds. Even though the chamber pressure was quickly reduced to 70 psig, the surfaces of the operator remained at the original saturation temperature. Other parts of the operator (i.e., motor stator and limit switch base) also show a somewhat slower but rapid temperature increase.

During the initial period (0-1 minute), condensation on the outside surfaces is the dominant heat transfer mode. Within this region (i.e., when the temperature of the operator's surface is below the saturation temperature), condensation heat transfer is very effective and temperature of the exposed surfaces of the operator increase rapidly. A two to three minute plateau or transition period follows this where the temperature of the surface of the operator stays near the saturation temperature. Latent heat of evaporation plays a role in this leveling. The condensate that accumulated evaporates as the radiative and convective heat transfer mechanisms attempt to raise the surface above the saturation temperature.

After the condensate has evaporated (i.e., operator surfaces are now dry), the final phase is a region where the dominant heat transfer mode is thermal radiation and convection. During this region, heat transfer is much slower. This is because the temperature of the surface of the operator is above the saturation temperature of the steam. It takes approximately 30 minutes for the internal mounting base of the limit switch compartment to rise to within 10^{o}F of the test's superheat level (Ref. 2). Test data of the motor's stator shows similar behavior. The internals of the motor lags the housing surface but leads the internal limit switch mounting base in it's climb to maximum temperature level. The motor's temperature will easily reach the maximum level within thirty minutes.

The WNP-2 plant specific profile (Figure 1, 1a) has a peak temperature of 320^{o}F which is approximately 39^{o}F above the saturation temperature (approximately 50 psia, 281^{o}F). This condition exists for approximately 45 minutes. This is more than enough time for the phenomenon that occurred in the superheat test described above to occur. Condensation heat transfer should cause rapid heatup (within one (1) minute) of the operators surface to approximately 281^{o}F, level off, and after a few minutes, start the slow climb toward the peak drywell temperature. At the end of approximately five (5) minutes of accident exposure, our operators should be dry. At the end of 21 minutes, the LOCA temperature is dropping and the surfaces of the operator should be near 310^{o}F. They then will follow (lag) the decreasing profile until a relatively long term stable period of temperature occurs which is at or below the saturation temperature. The operators then will again be subjected to condensation exposure.

Reference 1 demonstrates operability of a motor operator, without T-drains installed, at steam temperatures exceeding the WNP-2 containment accident profile. Unlike the superheat test or the WNP-2 LOCA profile, the 600198 test was performed at saturated steam conditions, therefore, at higher pressures. The peak levels were 329°F and 90 psig. The operator surfaces would have experienced a rapid temperature increase via the condensation heat transfer mode up to 329°F within the first minute. As there was no superheat region, there would have been no drying out of this condensation. Thus any condensation that was formed in the motor would have remained and added to accumulation later in the test program (i.e., the post LOCA soak). These test conditions are also shown on Figure 1.

By using graphical approximation of the data from Reference 2, the surface temperature of a Limitorque operator inside the WNP-2 containment can be estimated. This is shown by Curve A in Figure 3. Note that the level portion of operators surface temperature response curve for the WNP-2 LOCA occurs at 281°F. Applying the same methodology to the test results of Reference 1 leads to Curve B in Figure 3. Comparison of these curves results in the conclusion that the Limitorque motor operator was exposed to hotter and wetter conditions by the 600198 test which did not have installed T-drains than the WNP-2 operators would experience during a LOCA. Figure 3 also shows that the operators temperature response to the 600198 test contain sufficient margin to satisfy the IEEE 323 peak temperature margin requirement.

In addition, the 600198 test greatly exceeded the WNP-2 specific profile for the remaining seven (7) days of the test. After seven (7) days of the WNP-2 postulated LOCA, the temperature conditions have decreased to 165°F, which is near the non accident condition maximum of 150°F inside containment (see Figure 1A).

Conclusion

The very first Limitorque steam tests (without the T-drain design feature) were sufficiently harsh and wet to envelop WNP-2 requirements with adequate margin. Condensation heat transfer dominated the test conditions much more than they would in the superheated WNP-2 plant specific steam conditions. Therefore, the condensation buildup conditions produced during a WNP-2 LOCA are not sufficient to require T-drain design feature to insure the motor's safety function is achieved.

The configuration of WNP-2 operators before May 1986 without T-drains does not invalidate their qualification. Thus, T-drains for WNP-2 motors were not a required design feature unless the mounting configuration would allow condensate to drain from the limit switch housing into the motor via the conduit connection. As WNP-2 has no operators inside containment configured in this manner, the installations did not require T-drains.

T-drains were added to the WNP-2 in-containment motors in May of 1986 to defuse any NRC concerns with our Limitorque operators prior to our restart following the refueling outage and have been maintained in that configuration. For the present, the Supply System intends to maintain this configuration.

References

1. WCAP-7410-L-V1 Appendix C, Franklin Institute Research Laboratories Final Report F-C2232-01, Limitorque No. 600198, "Test of a Limitorque Valve Operator Under a Simulated Reactor Containment Post Accident Steam and Chemical Environment," January 2, 1969.

2. Babcock & Wilcox Document #51-1132772-00, "Final Report for In-containment Type Limitorque Actuator Steam Line Break Qualification," July 31, 1982.

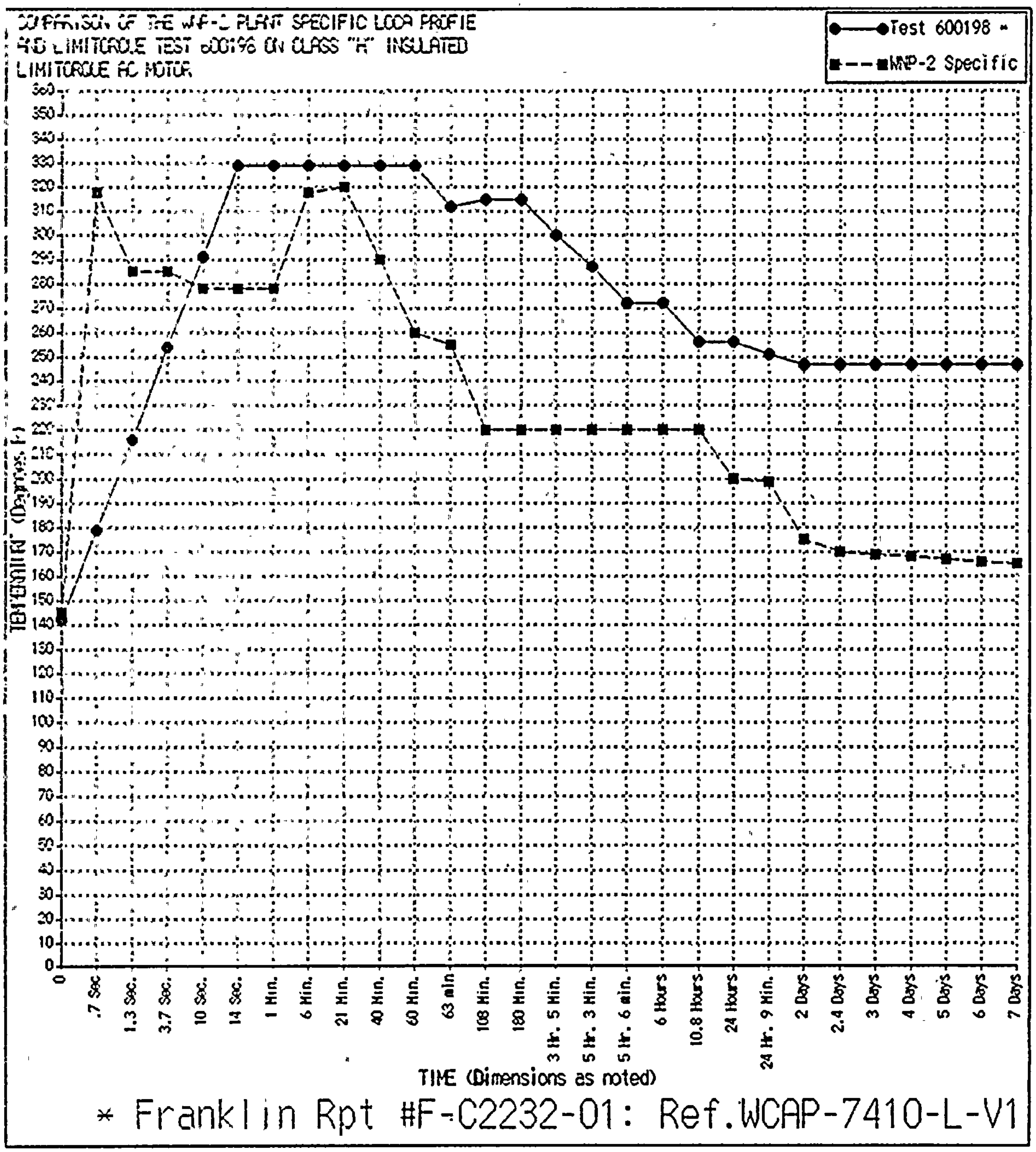
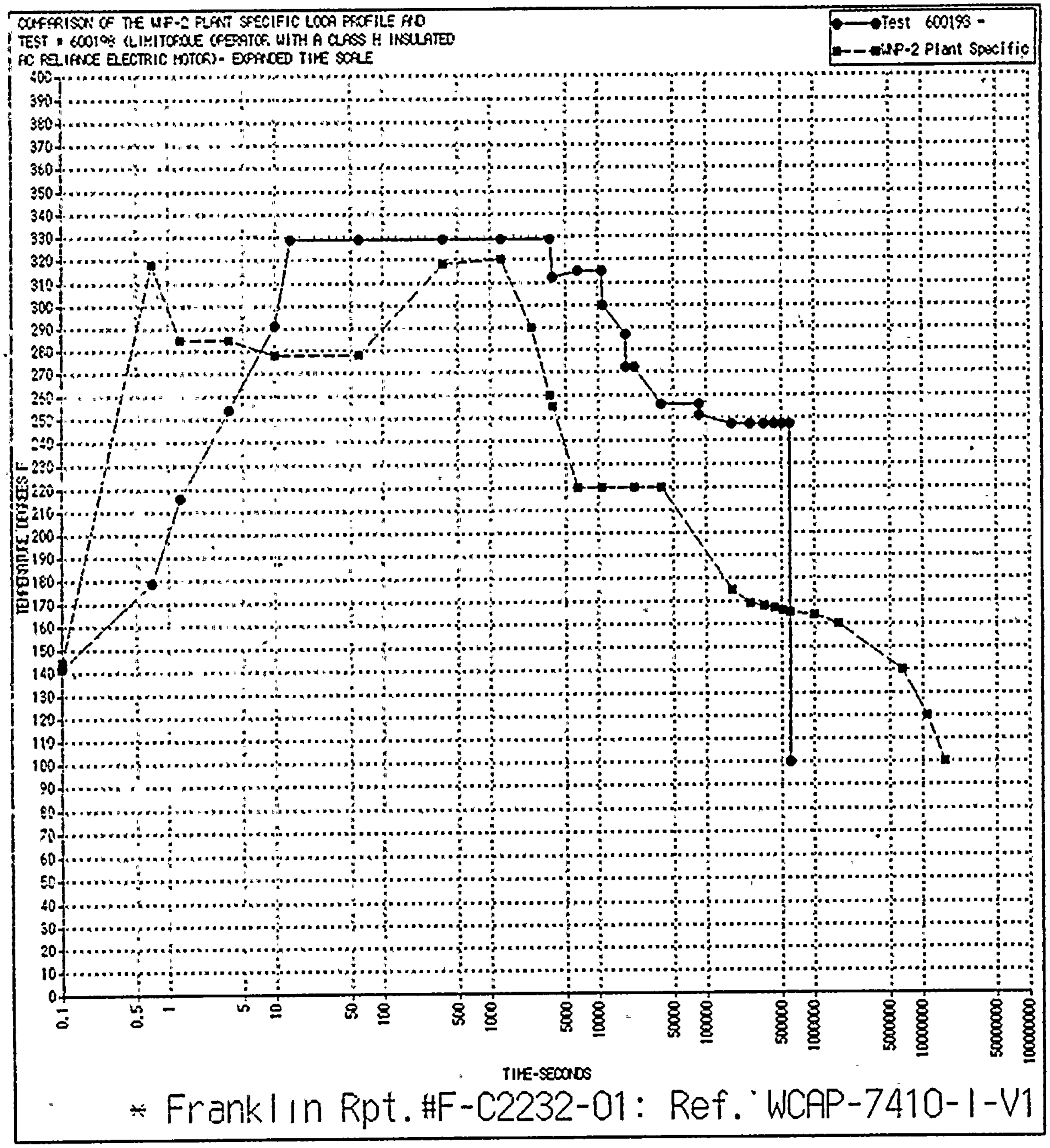
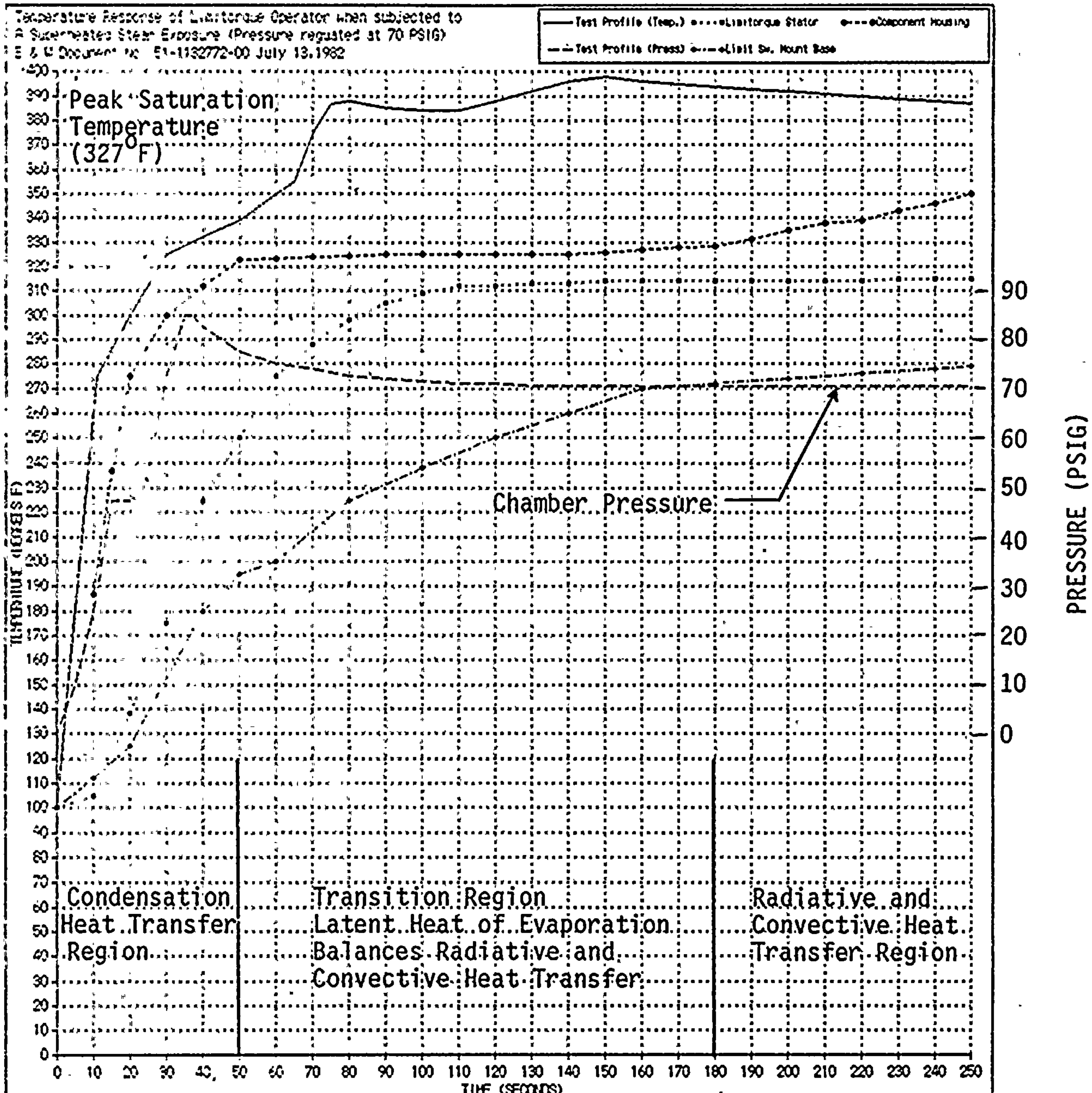

COMPARISON OF THE WNP-2 PLANT SPECIFIC LOCA PROFILE
AND LIMITORQUE TEST 600198 ON CLASS "H" INSULATED
LIMITORQUE AC MOTOR
Test 600198 *
WNP-2 Specific
TEMPERATURE (Degrees F)
TIME (Dimensions as noted)
0
.7 Sec
1.3 Sec.
3.7 Sec.
10 Sec.
14 Sec.
1 Min.
6 Min.
21 Min.
40 Min.
60 Min.
63 min
108 Min.
180 Min.
3 Hr. 5 Min.
5 Hr. 3 Min.
5 Hr. 6 min.
6 Hours
10.8 Hours
24 Hours
24 Hr. 9 Min.
2 Days
2.4 Days
3 Days
4 Days
5 Days
6 Days
7 Days
* Franklin Rpt #F-C2232-01: Ref.WCAP-7410-L-V1

FIGURE 1



COMPARISON OF THE WNP-2 PLANT SPECIFIC LOCA PROFILE AND
TEST # 600198 (LIMITORQUE OPERATOR WITH A CLASS H INSULATED
AC RELIANCE ELECTRIC MOTOR)- EXPANDED TIME SCALE
Test 600198 -
WNP-2 Plant Specific
TEMPERATURE DEGREES F
TIME-SECONDS
0.1
0.5
1
5
10
50
100
500
1000
5000
10000
50000
100000
500000
1000000
5000000
10000000
50000000
100000000
* Franklin Rpt.#F-C2232-01: Ref. WCAP-7410-I-V1

FIGURE 1a



Temperatures From Limitorque Benchmark Test 681023

FIGURE 2

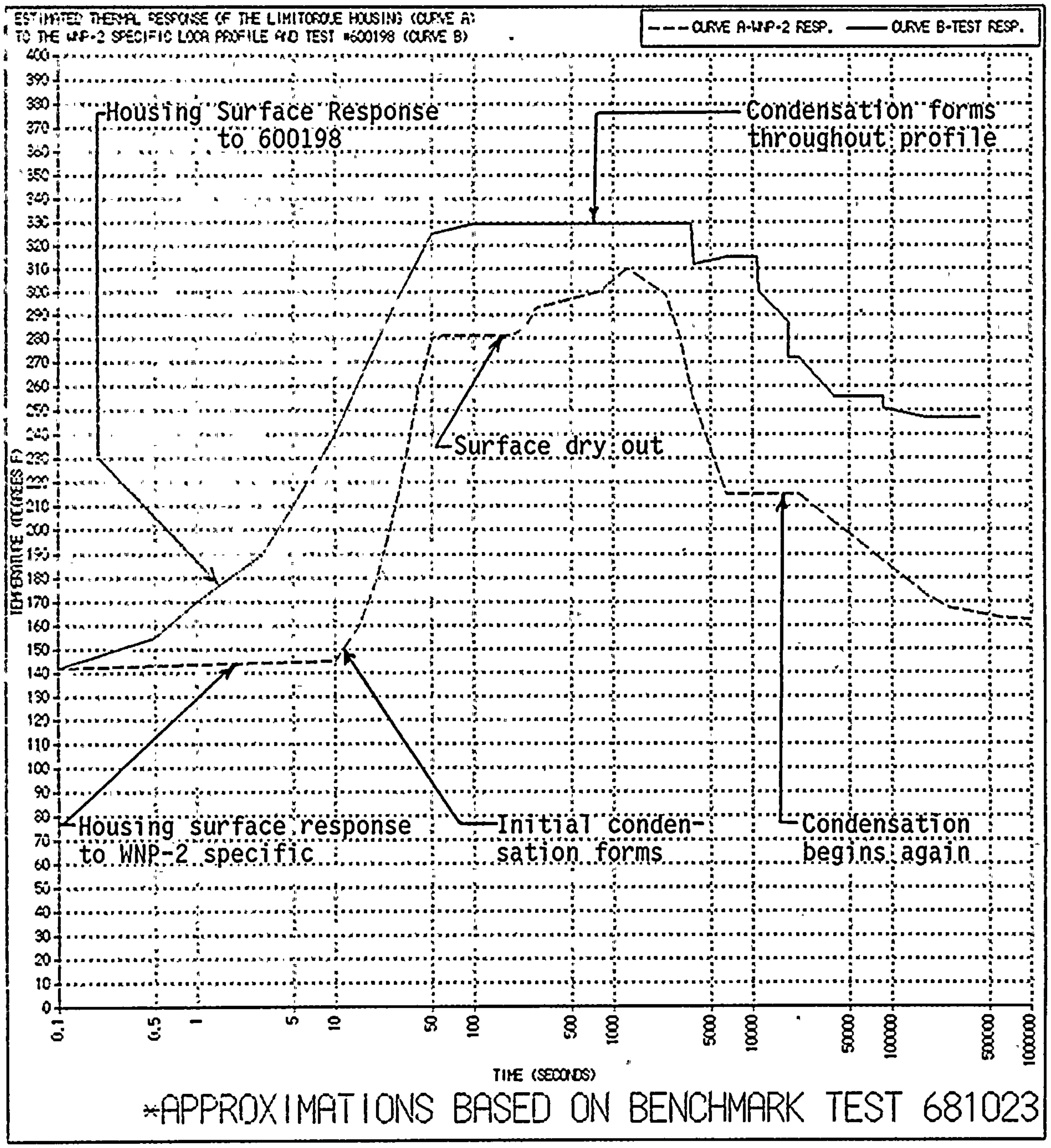

ESTIMATED THERMAL RESPONSE OF THE LIMITORQUE HOUSING (CURVE A) TO THE WNP-2 SPECIFIC LOCA PROFILE AND TEST #600198 (CURVE B)
--- CURVE A-WNP-2 RESP.
—— CURVE B-TEST RESP.
Housing Surface Response to 600198
Condensation forms throughout profile
Surface dry out
Housing surface response to WNP-2 specific
Initial condensation forms
Condensation begins again
TEMPERATURE (DEGREES F)
TIME (SECONDS)
*APPROXIMATIONS BASED ON BENCHMARK TEST 681023

FIGURE 3