MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

April 4, 1984

NUCLEAR PRODUCTION DEPARTMENT

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Mr. Denton:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
License No. NPF-13
File 0260/0272/0756
Responses to NRC Request for Additional Information on Hydrogen Control
AECM-84/0114

REFERENCES:

1. Letter from Mr. T. N. Novak to Mr. S. H. Hobbs, dated December 8, 1983
2. Letter HGN-015 from Mr. S. H. Hobbs to Mr. H. R. Denton, dated February 9, 1984
3. Letter AECM-84/0091 from L. F. Dale to H. R. Denton, dated March 9, 1984.

In reference 1, the Nuclear Regulatory Commission (NRC) requested additional information (RAI's) from the Hydrogen Control Owners Group (HCOG) regarding the 1/4 scale test facility and other hydrogen control subjects. Some of these RAI's were with regard to earlier submittals made by Mississippi Power & Light (MP&L).

In reference 2, HCOG indicated which of these RAI's they would address and which would be addressed by MP&L.

In reference 3, MP&L endorsed this division of responsibility. This letter contains the following responses to the RAI's which MP&L agreed to address:

B001
1/1

MISSISSIPPI POWER & LIGHT COMPANY

Questions

Equipment Qualification Branch: Questions 2-5

Chemical Engineering Branch: Questions 3-6

Yours truly,

L. F. Dale
Manager of Nuclear Services

DBH/SHH:sad
Attachment

cc: Mr. J. B. Richard (w/a)
Mr. R. B. McGehee (w/o)
Mr. T. B. Conner (w/o)
Mr. G. B. Taylor (w/o)

Mr. Richard C. DeYoung, Director (w/a)
Office of Inspection & Enforcement
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Mr. J. P. O'Reilly, Regional Administrator (w/a)
U.S. Nuclear Regulatory Commission
Region II
101 Marietta St., N.W., Suite 2900
Atlanta, Georgia 30303

Attachment to
AECM-84/0114

REQUEST FOR ADL 'TIONAL INFORMATION
¼ SCALE MARK III
H_2 COMBUSTION TEST PROGRAM

Equipment Qualification Br...ch

Question

2. In letter August 13 and 23, 1983, MP&L has deleted certain essential equipment required for a hydrogen burn event, and is evaluating deleting other equipment. The applicant should provide justification for the deletions.

Response

In MP&L's letter AECM-83/0671, from Mr. L. F. Dale to Mr. H. R. Denton, dated October 17, 1983, Table 3 in Attachment 2 lists all equipment and components removed from the list of equipment required to survive a hydrogen burn. Justification for these deletions was provided in Table 3.

Klsdl

Attachment to
AECM-84/0114

REQUEST FOR ADDITIONAL INFORMATION
¼ SCALE MARK III
H_2 COMBUSTION TEST PROGRAM

Equipment Qualification Branch

Question

3. The applicant should explain why the time scale on the equipment temperature response curves provided in the letter of August 23, 1983, does not correlate with the scale on the wetwell temperature curves.

Response

The time scale on the equipment temperature response curves provided in the August 23, 1983, submittal (see figure 3, 6, 9 in Attachment 2, AECM-83/0479) corresponds to the typical temperature time histories of hydrogen burn tests conducted in the 1/20 scale facility (see Figure 1 in Attachment 1, AECM-83/0479). The time scale at t = 0.0 seconds represents the start of hydrogen burns in the 1/20 scale tests.

In the wetwell temperature time history curves (see Figures 2, 8, 14, 35, and 41 in Attachment 3, AECM-83/0479), the thermal environments are the result of deflagration type burns, as predicted by CLASIX-3. The time scale t = 0.0 seconds represents the break initiation, not the time of hydrogen ignition.

The results of the CLASIX-3 analysis were not used to define the thermal environment for the equipment thermal responses in the August 23, 1983, submittal; hence, the two should not be correlated.

Klsd2

REQUEST FOR ADDITIONAL INFORMATION
¼ SCALE MARK III
H_2 COMBUSTION TEST PROGRAM

Equipment Qualification Branch

Question

4. It appears from the equipment temperature response curves that the initial temperature of all the equipment is considered the same irrespective of the energized condition of the equipment. Justification is required as to why the energized condition for certain components e.g. solenoid valve, pump motor etc., will not result in higher initial temperatures.

Response

I. Background

Three typical pieces of equipment were selected to provide a basis upon which the effects of steady diffusion flames could be evaluated (Reference 1). These were the hydrogen igniter assembly, pressure transmitter, and solenoid valves. The data used to evaluate the thermal response of the selected equipment were obtained from full-scale estimates based upon the 1/20-scale test results. The relevant data for equipment evaluation consisted of the gas temperature profile, flow velocity, and radiant heat fluxes from both the flame and hot grating at the HCU floor elevation. Each piece of equipment was evaluated based on data in the most severe burning location for that piece of equipment in the test facility. The containment sprays were credited only with lowering the free containment gas temperature; the effects of spray impingement on equipment was conservatively neglected. The radiant heat flux data were assumed to act as a steady-state heat load to the appropriate equipment surfaces independent of equipment temperature.

The equipment was assumed to have an initial surface temperature of 135°F. This boundary condition was applied to all the selected equipment irrespective of the energized condition of the equipment. Our evaluation which is discussed below provides evidence that considering the energized condition will not result in higher initial surface temperatures. However, future evaluation will reconsider the case basis, and the effect of the energized condition on the initial steady state temperature will be incorporated in future equipment survivability studies.

II. Hydrogen Igniter Assembly

The igniter assembly is an 8" x 8" x 6" stainless steel box with a removable access cover. It houses the transformer and terminal strip mounted on a stainless steel plate and also contains the associated wiring. The glow plug extends out through the front and is assumed to be insulated from the box by the glow plug mount. The assembly is shown in Figure 1.

The igniters are activated when the water level in the reactor pressure vessel is at or below the top of active fuel. When energized, the transformer in the igniter box assembly has an internal heat load of 25 watts. To determine the steady-state, normal operating temperature of

the igniter assembly, a HEATING-3 (reference 3) calculation was made using an 80°F surface temperature in a normal containment operating environment of 80°F. The igniter assembly was assumed to have a flat temperature profile of 80°F prior to activation of the igniters. Next the steady state temperature of the activated igniter was calculated utilizing an appropriate HEATING-3 model similar to that used in Reference 2 and is shown in Figure 2. The appropriate electrical load from the igniter operation was also included in the transformer region.

This model, besides considering heat transfer from the environment through the component, also considers radiative and convective heat transfer across air spaces. Best estimate thermal properties were utilized in this model. Generally, a two-dimensional (2-D) analysis, as used here, has been shown to provide a reasonable estimate of equipment thermal response.

The resulting temperature distribution is shown in Figure 2. This yields a maximum steady state temperature of 128°F at the transformer. The results of this analysis can be compared with the original assumption of a flat temperature profile across the equipment of 135°F. This confirms that the assumption of 135°F is conservative for the initial temperature of the equipment response curve.

III. Pressure Transmitter

Pressure transmitters consist of the sensing module and the associated electronic circuitry. The electronic components are enclosed in a cast aluminum housing which is connected to the stainless steel sensing module housing. The pressure transmitter is shown in Figure 3.

The pressure transmitter can be considered operating at all times, with a maximum theoretical heat load of less than 1.0 watt. The consideration of heat loads for this piece of equipment is not necessary since the internal heat generated is very small and will quickly be convected to the environment. Therefore the assumed initial temperature of 135°F is conservative.

IV. Solenoid Valve

Previously, solenoids were evaluated against the thermal environment in the wetwell due to containment isolation valves in this area. In AECM-83/0671 dated October 17, 1983, these valves were removed from the list of equipment required to survive a hydrogen burn and justification for their removal was given. The solenoid valves remaining which must be operable after a hydrogen generation event are for the actuators of Automatic Depressurization System (ADS) relief valves. These valves are located inside the drywell which will experience a different thermal environment than the containment. Although the solenoids are energized during the period of ADS relief valve operation, they are not continuously energized during the transient as in the case of the igniter transformer.

REQUEST FOR ADDITIONAL INFORMATION
¼ SCALE MARK III
H_2 COMBUSTION TEST PROGRAM

The heat load for the solenoid is 10.5 watts for the AC/AC and 17.4 for the AC/DC. This is lower than that of the transformer. The solenoid valves are also in direct contact with the environment which allows a higher rate of heat transfer to the atmosphere. In the analyses performed in the August submittal to the NRC (Reference 1), the transformer box dimensions are similar to those of the solenoid.

Based on the above conditions, the initial surface temperature of the solenoid valve is expected to be lower than that of the transformer box when both are in the energized condition. The assumption of 135°F surface temperature is thus valid.

V. References

1. Letter from L. F. Dale to H. R. Denton dated August 23, 1983 (AECM-83/0479), "Supplementary Response to NRC Letter on Hydrogen Control."

2. Letter from L. F. Dale to H. R. Denton, dated January 19, 1982, (AECM-82/26), "Report on Equipment Survivability for a Hydrogen Generation Event."

3. HEATING-3 - A UNIVAC 1110 Heat Conduction Program, ORNL-TM-3208, W. P. Turner and Simantov, February 1971.

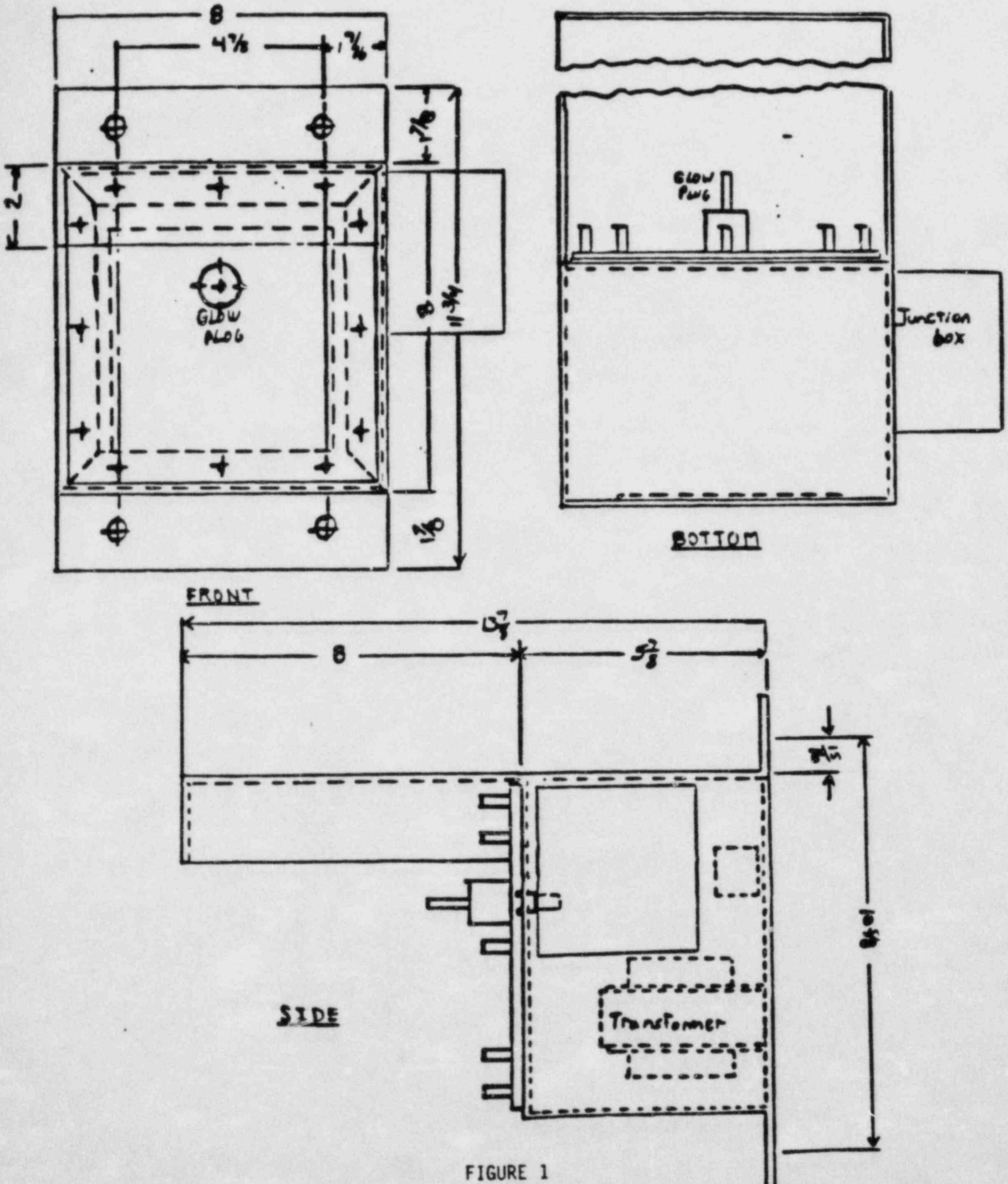
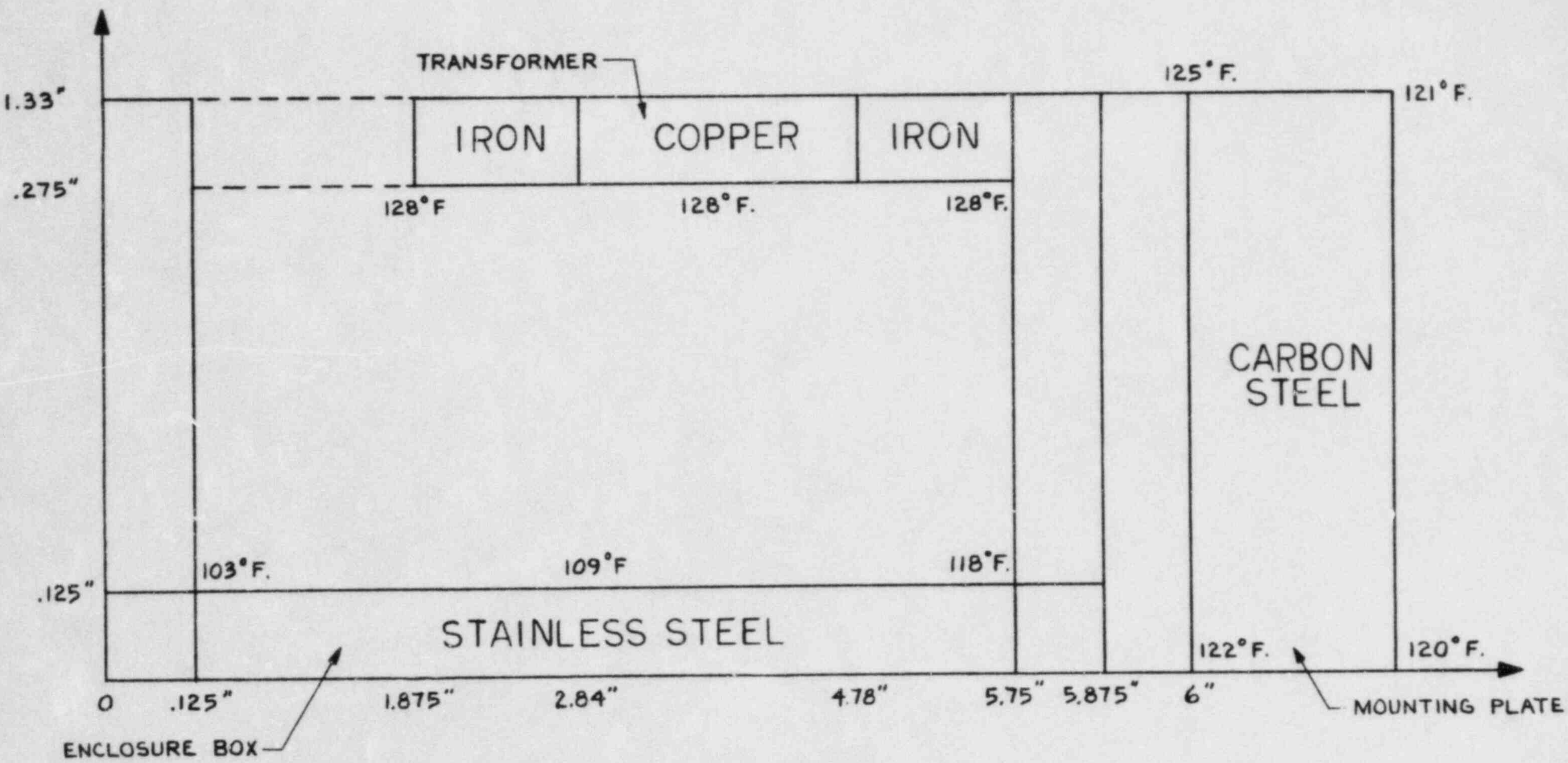


FIGURE 1

H_2 IGNITER ASSEMBLY



IGNITER STEADY STATE TEMPERATURE

FIGURE 2

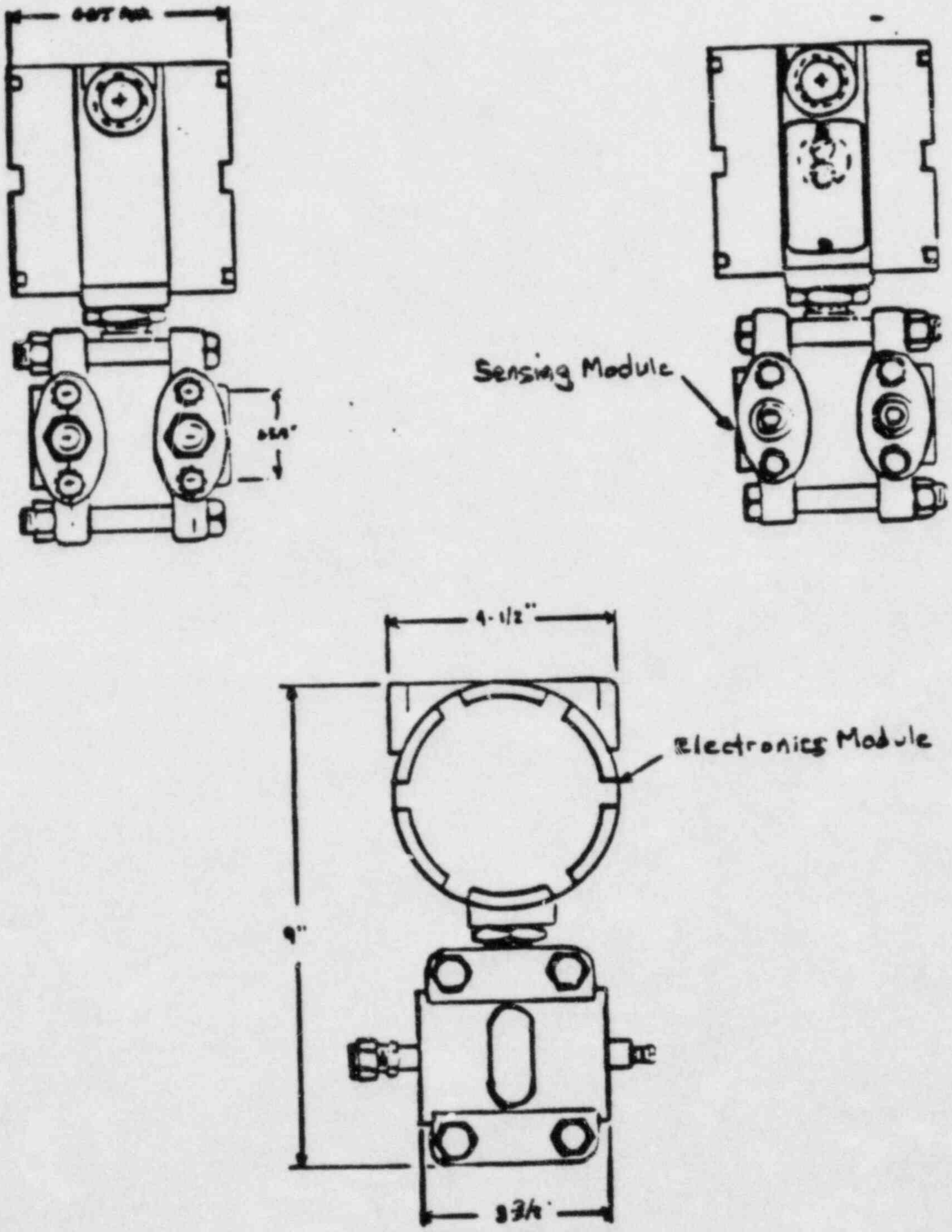


FIGURE 3

PRESSURE TRANSMITTER

REQUEST FOR ADDITIONAL INFORMATION
¼ SCALE MARK III
H_2 COMBUSTION TEST PROGRAM

Equipment Qualification Branch

Question

5. The surface temperature of the equipment is not to be measured during the qualification testing. The applicant should provide the surface temperature of the equipment during qualification testing by using the same analytical method used to calculate surface temperature of the equipment during a hydrogen burn event.

Response

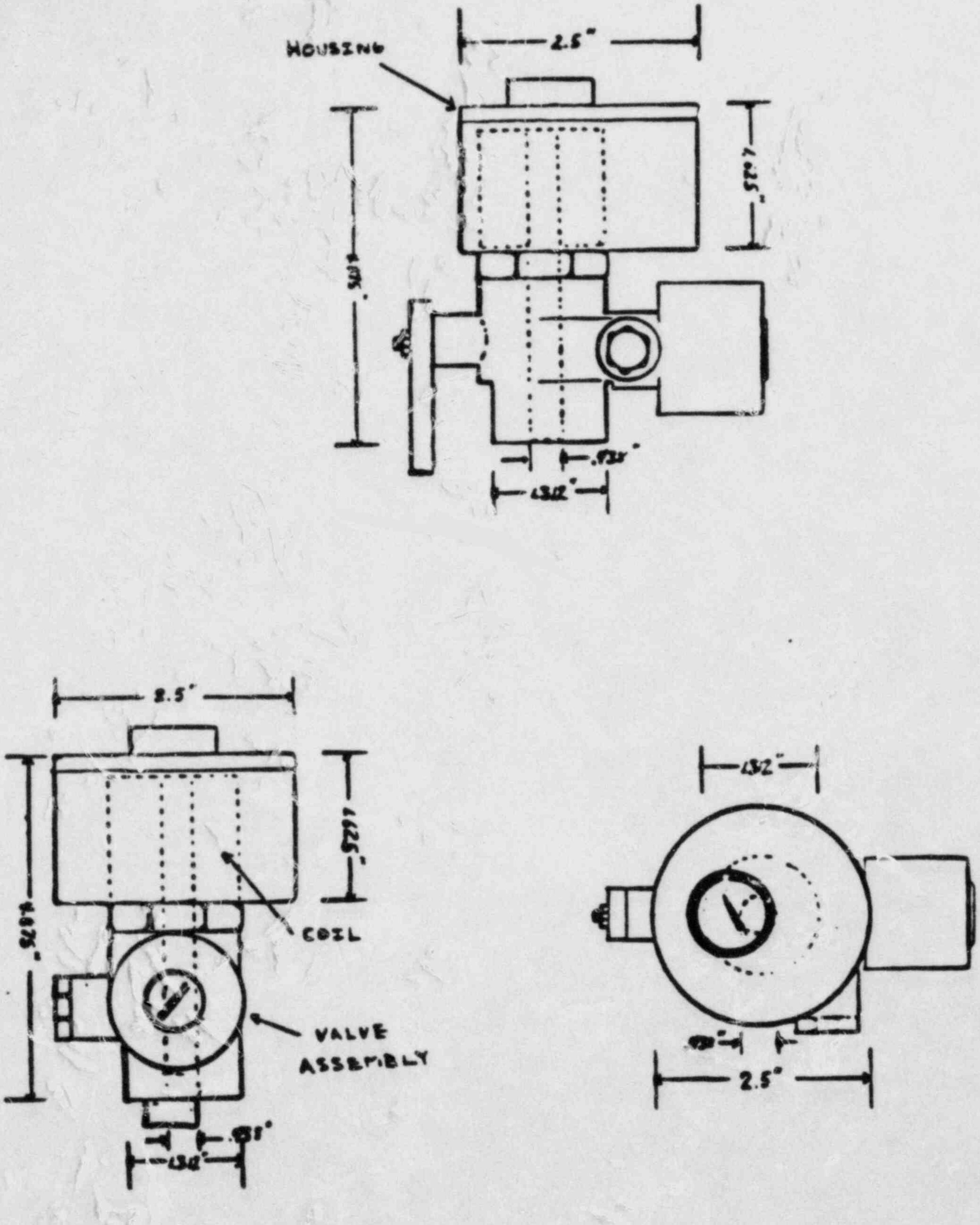
In submittals AECM-83/0455 (dated August 13, 1983) and AECM-83/0479 (dated August 23, 1983), the thermal responses of the solenoid valve, the pressure transmitter and the hydrogen igniter assembly were evaluated in a hydrogen combustion environment to demonstrate that their surface temperatures remained below their respective qualification temperature. These components were selected from the list of equipment required to survive a hydrogen burn and represented the limiting components.

In order to demonstrate that the outer surface temperature of these components follows closely the ambient gas temperatures during the qualification testing, similar calculations were performed using the same analytical method and models (see Figures 1, 2 and 5). It should be noted however, that the modes of heat transfer in the qualification test and burn environments are significantly different. The qualification environment is characterized by condensation while heat transfer in the burn environment is controlled by radiation and convection.

Results of the analysis show that the surface temperature of the solenoid valve follows the ambient temperature closely throughout the transient (see Figures 3 and 4). In the case of the pressure transmitter, the calculated surface temperature is lower than the qualification temperature when the environment is initially dry. When the NUREG-0588 qualification environment dictates 100% relative humidity (after the first 10 minutes), condensing heat transfer becomes the controlling heat transfer mechanism between the equipment and the atmosphere, and the surface temperature approaches the ambient temperature immediately (see Figures 6 and 7).

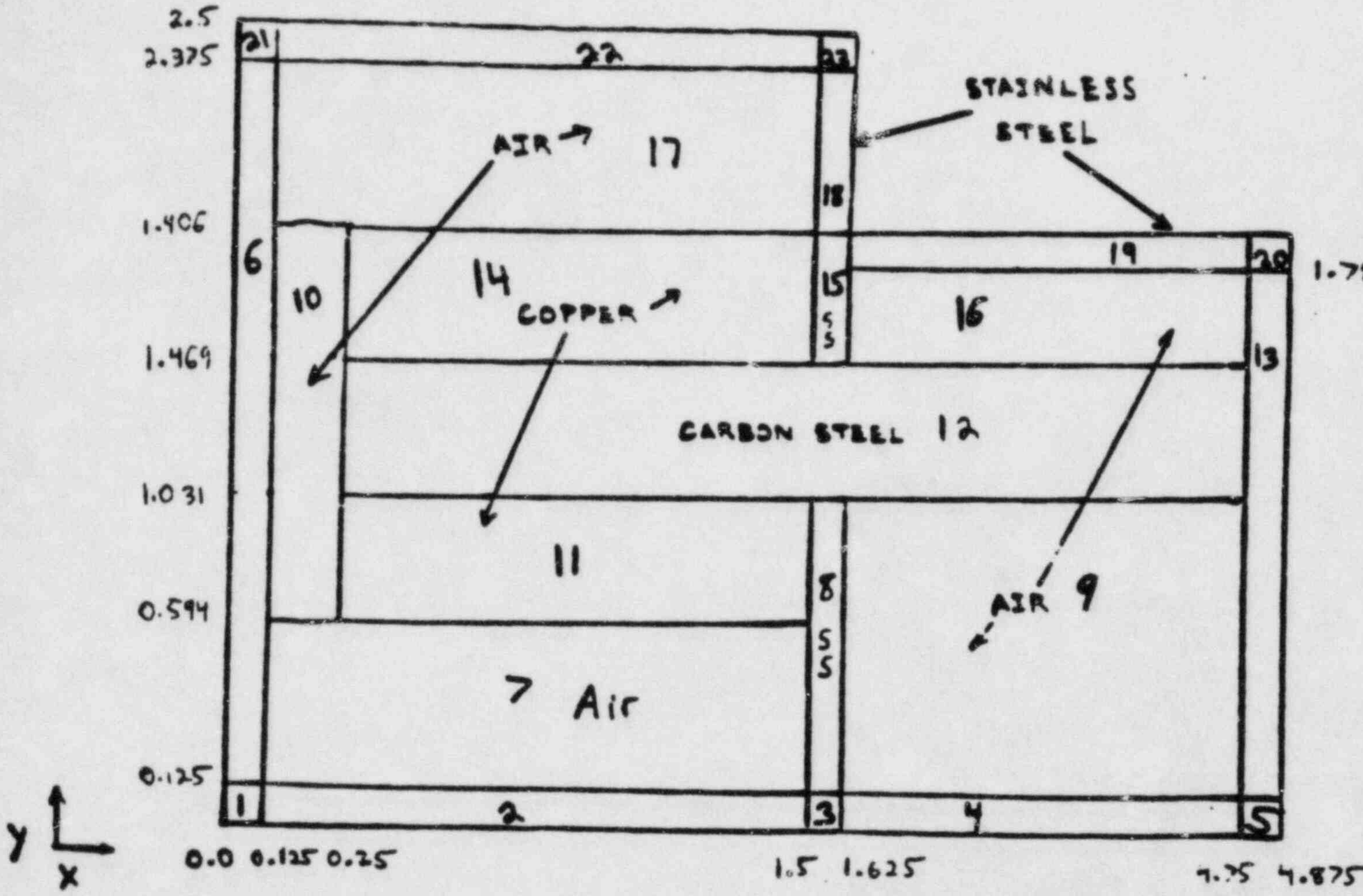
In the hydrogen igniter qualification program, the oven temperature and the surface temperature of igniter were measured. These temperatures as well as the qualification environment are superimposed in Figure 8, and all these temperature profiles follow each other closely.

Results of our analysis demonstrate that the surface temperature of the equipment is essentially the same as the qualification temperature. This prediction is confirmed by the igniter qualification program. Hence, it is appropriate to assume that the equipment qualification temperature corresponds to the equipment surface temperature reached during testing.



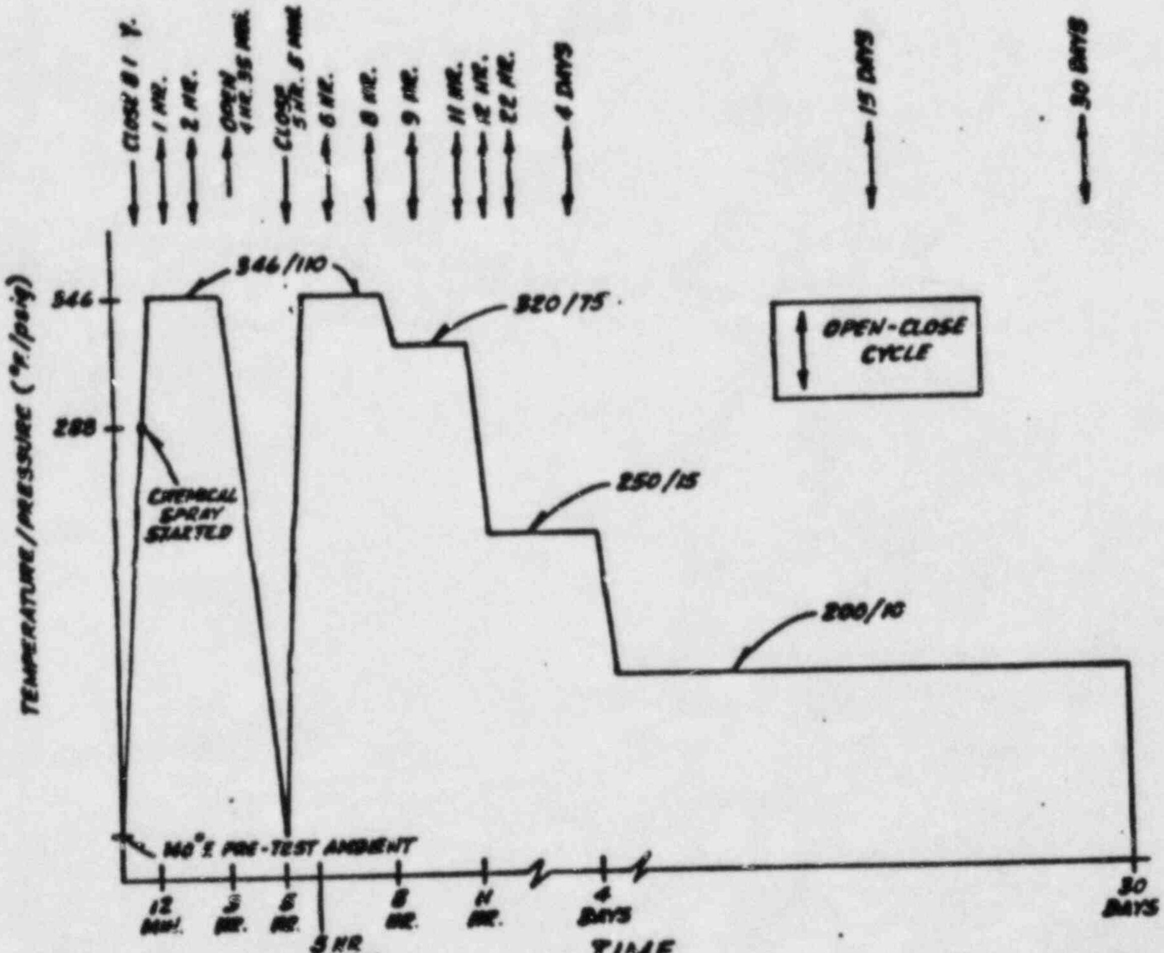
SOLENOID VALVE

FIGURE-1



2-D SOLENOID VALVE

FIGURE-2



ACTUAL TEMPERATURE/PRESSURE PROFILE FOR SIMULATION OF LOSS-OF-COOLANT ACCIDENT (LOCA)

ENVIRONMENTAL QUALIFICATION TEMPERATURE PROFILE
FOR SOLENOID VALVE

FIGURE-3

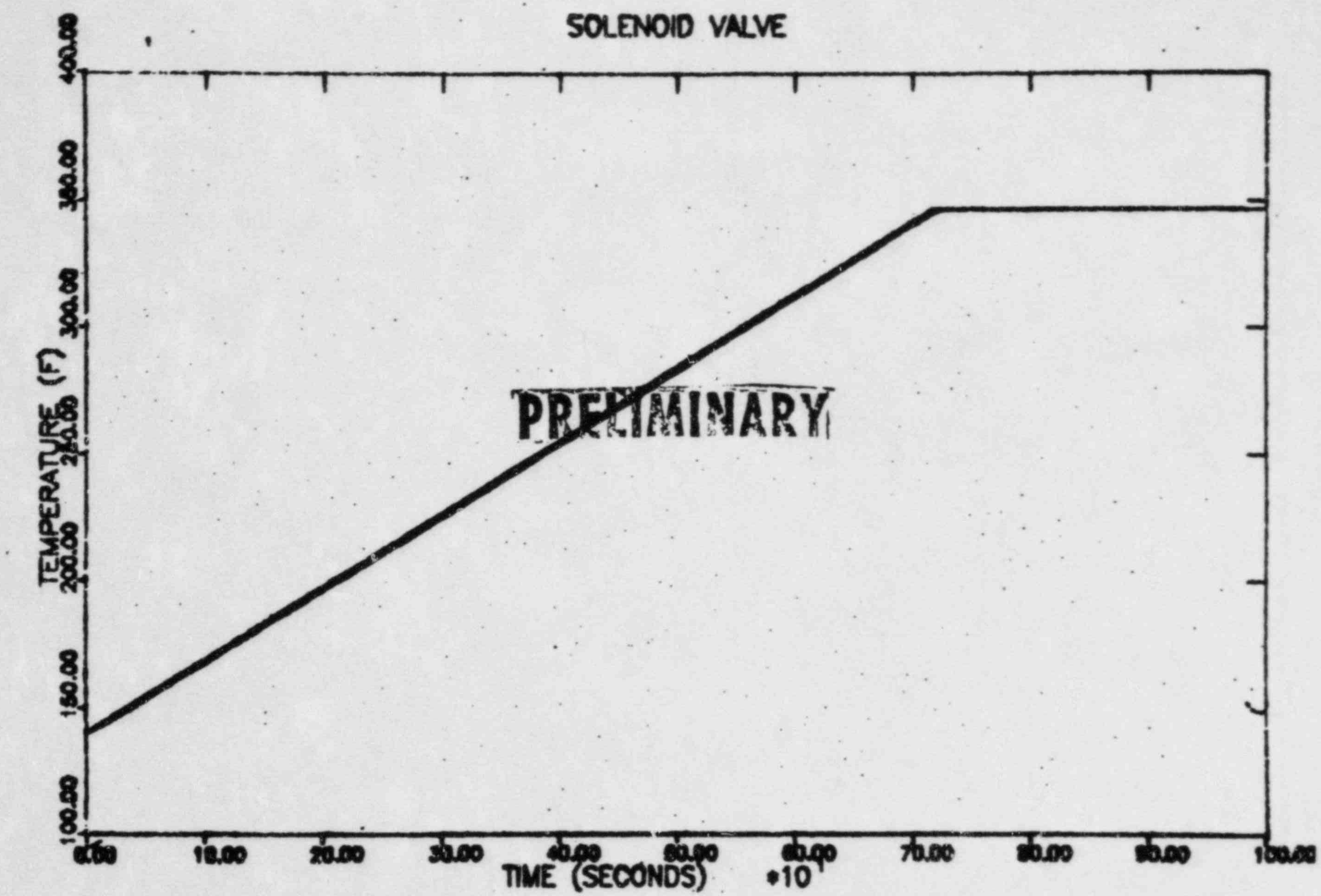
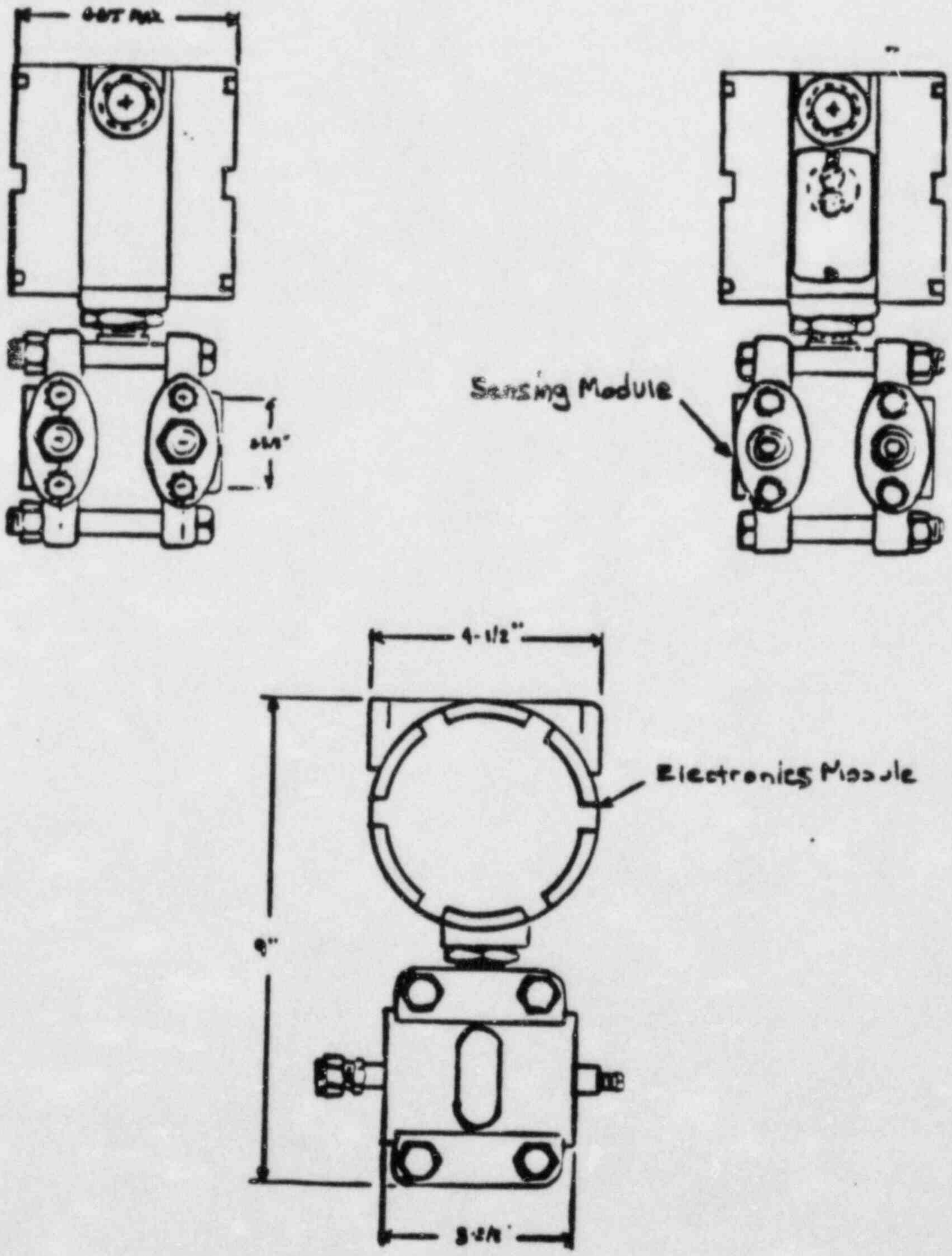
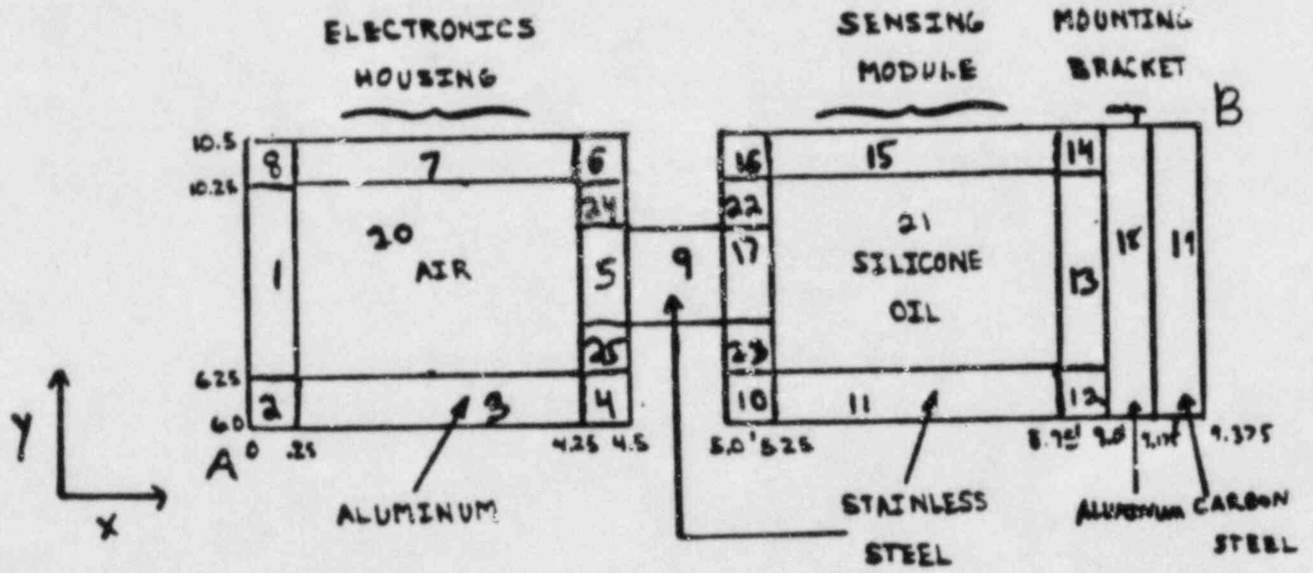

SOLENOID VALVE
TEMPERATURE (F)
100.00
150.00
200.00
250.00
300.00
350.00
400.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
TIME (SECONDS) *10
PRELIMINARY

FIGURE-4



PRESSURE TRANSMITTER

FIGURE-5



2-D PRESSURE TRANSMITTER MODEL

FIGURE-6

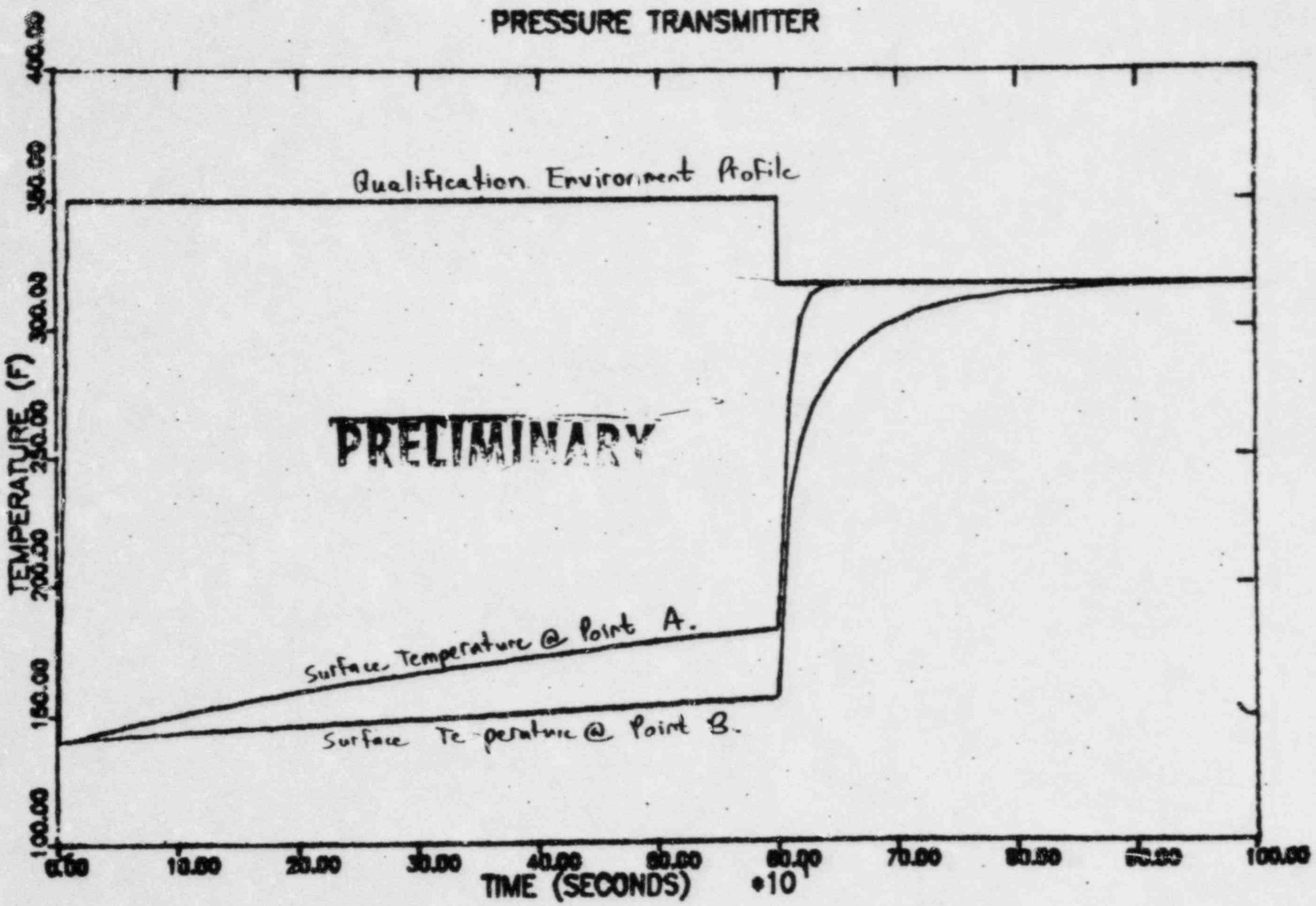
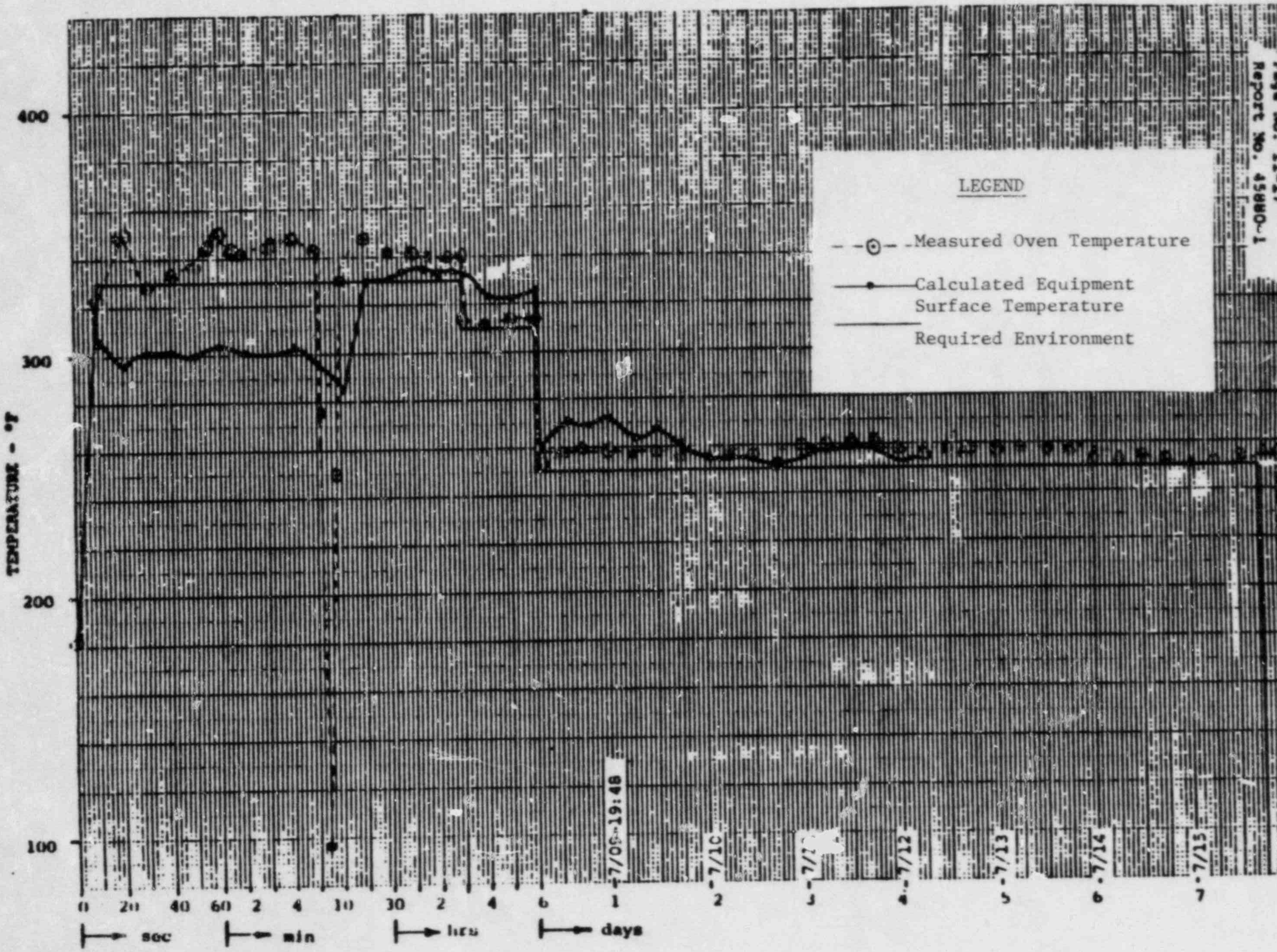

PRESSURE TRANSMITTER
Qualification Environment Profile
PRELIMINARY
Surface Temperature @ Point A.
Surface Te-perature @ Point B.
TEMPERATURE (F)
400.00
350.00
300.00
250.00
200.00
150.00
100.00
0.00
10.00
20.00
30.00
40.00
60.00
70.00
80.00
100.00
TIME (SECONDS) *10

FIGURE-7



H_2 IGNITER SURFACE TEMPERATURE AND TEST PROFILE

FIGURE-8

Attachment to
AECM-84/0114

REQUEST FOR ADDITIONAL INFORMATION
¼ SCALE MARK III
H_2 COMBUSTION TEST PROGRAM

Chemical Engineering Branch

Question

3. Describe in detail how the effect of sprays was incorporated in the analysis of equipment thermal response based on the data from 1/20 scale model experiments. Were the gas temperatures in the 1/20 scale model measured with sprays on or was the effect of sprays determined analytically?

Response

The 1/20th scale tests did not model containment sprays (See References 1, 2, and 3). In order to conservatively evaluate the potential effects that containment sprays would have on equipment survivability, MP&L took credit only for the cooling of the gases which were being recirculated from the upper parts of the containment and were feeding the flame base. Details on how this effect was factored into the equipment survivability analysis are provided in Attachment 2 of Reference 1 and Attachment 1 of Reference 2.

Subsequently, in response to an inquiry by NRC consultants (Sandia), MP&L provided additional information on the potential effects of containment sprays on equipment survivability (See Reference 3). As indicated by this information, it is expected that containment sprays will provide much greater cooling for the environment than what was assumed in these analyses. The actual spray effectiveness will be demonstrated in tests conducted in the 1/4 scale test facility and will be factored into the final equipment survivability analysis.

References

1. Letter AECM-83/0455 from Mr. L. F. Dale to Mr. H. R. Denton, dated August 13, 1983.

2. Letter AECM-83/0479 from Mr. L. F. Dale to Mr. H. R. Denton, dated August 23, 1983.

3. Letter AECM-83/0659 from Mr. L. F. Dale to Mr. H. R. Denton, dated October 25, 1983.

REQUEST FOR ADDITIONAL INFORMATION
¼ SCALE MARK III
H_2 COMBUSTION TEST PROGRAM

Chemical Engineering Branch

Question

4. Justify your statement that only the equipment located in the wetwell, below the elevation of 140 feet will be affected by standing flame on the surface of the suppression pool.

Response

In the October 17, 1983, submittal (AECM-83/0671), Table 2 in Attachment 2 lists all equipment inside the containment (outside the drywell) that is required to remain functional after a hydrogen burn. The list shows that equipment of the same system or equipment performing a similar function is distributed throughout the containment. The limiting components which were selected from the list of equipment were evaluated based upon the most severe environment measured at locations where that piece of equipment could be located. These locations were below the elevation of 140 feet and were either in the wetwell or in the hot chimney areas. The environment at these locations was significantly more severe than was observed in the upper containment during the 1/20 scale tests.

Attachment to
AECM-84/0114

REQUEST FOR ADDITIONAL INFORMATION
¼ SCALE MARK III
H_2 COMBUSTION TEST PROGRAM

Chemical Engineering Branch

Question

5. Justify why the motor operator on one of the RHR valves (E12-F042B) and power and instrumentation cables on one of the RHR valves were not included in the list of equipment whose survival during hydrogen burn has to be demonstrated.

Response

In an August 23, 1983, submittal (AECM-83/0479) and an October 17, 1983, submittal (AECM-83/0671) to the NRC, MP&L provided detailed discussions on the approach in selecting essential equipment and methodology adopted in survivability studies. Table 2 of Attachment 2 in the October submittal presents all essential equipment inside the containment but outside the drywell; the RHR valve (E12-F042B) with its associated components (motor operators, power, and instrument cables) are included.

Klsd9

REQUEST FOR ADDITIONAL INFORMATION
¼ SCALE MARK III
H_2 COMBUSTION TEST PROGRAM

Chemical Engineering Branch

Question

6. Based on the information discussed in your submittal you state that safety related equipment could survive a diffusion flame burn of the hydrogen released by oxidation of 25% of zirconium. Provide the calculations and data to support this position.

Response

Attachment 2 to MP&L's submittal AECM-83/0455 dated August 13, 1983, provided a description of the equipment survivability analysis which had been performed. These included many computations performed with the CLASIX-3 code, preliminary analyses using thermal environments from the 1/20 scale tests, and analyses using simulated spray thermal environments from 1/20 scale tests. There was discussion that a sustained hydrogen production rate of 0.4-0.8 lb/sec would only result in 25% metal-water reaction prior to significant core damage. Based on preliminary results it was suggested that selcted components would be able to survive these conditions. However, MP&L recognizes that the test data obtained for the 1/20 scale tests are not sufficient to provide a complete assessment of equipment survivability. Therefore, MP&L has endorsed the HCOG commitment to conduct testing in a 1/4 scale Mark III containment mock up. The thermal profiles measured in this facility will be used to provide a complete assessment of equipment survivability.