ATTACHMENT C

EVALUATION OF ALTERNATE REACTOR COOLANT PUMP TRIP CRITERIA FOR THE R. E. GINNA NUCLEAR POWER PLANT

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An evaluation has been performed to determine if an alternate RCP trip criteria can be developed to increase the likelihood that the RCP's will not be tripped for a steam generator tube rupture (SGTR). The potential methods which were considered as the basis for a revised RCP trip criteria are discussed below.

1. RCS pressure with normal instrument uncertainties.

   The current criteria for tripping the RCP's for a LOCA based on RCS pressure requires that the uncertainties associated with abnormal containment conditions be included in the trip criteria. However, the normal instrument uncertainties could be utilized in setting the trip criteria for a SGTR which is not expected to result in abnormal containment conditions. For Ginna, the RCP trip criteria based on RCS pressure with normal instrument uncertainties is 1285 psia.

2. Reactor coolant subcooling

   This method would provide a direct indication of the need for pump trip. However, the potential benefit with respect to increased margin to pump trip must be assessed considering the uncertainty associated with this criteria, which includes process errors, transmitter errors, and normal instrument accuracy. For Ginna, the uncertainty in the subcooling monitor with normal containment conditions is 30°F.

3. Secondary pressure dependent RCS pressure

   With the current method of using RCS pressure, the trip criteria is conservatively derived assuming that the secondary pressure is at the

secondary safety valve setpoint. For this proposed method, a minimum RCS pressure trip criteria would be continuously evaluated based on the actual secondary pressure. With normal containment conditions, the criteria for pump trip would be a primary-to-secondary pressure differential less than 186 psia. This value includes a 100 psi pressure differential to promote primary-to-secondary heat transfer and an 86 psi allowance to account for the uncertainties associated with RCS and secondary pressures.

4. Reactor vessel inventory instrumentation system

It is expected that a RCP trip criteria based on the use of vessel inventory instrumentation would provide adequate discrimination between a SGTR and small break LOCA. However, a significant amount of analysis would be required for small break LOCA's to confirm the feasibility of using this instrument and to establish the appropriate pump trip criteria. Additional analyses would also be required for SGTR's to evaluate the discriminating ability of this instrument. In addition, substantial equipment modifications may be required. Although this system may provide a viable criteria for RCP trip in the longer term, it would not be practical as a short term improvement.

5. Reactor coolant pump current

It has been suggested that the RCP current would provide a good indication of the need to trip the RCP's since the pump current is directly related to the density of the fluid being pumped. However, it would require an extensive analysis and experimental effort to characterize the relationship between the pump current and the need for tripping the RCP's for small break LOCA's and also for a SGTR. This method would also require that qualified pump current instrumentation be available in the control room for use by the operator. Because of the extensive development effort associated with this method, it was not considered further as an alternative pump trip criteria for short term application.

Thus, the three alternate methods of establishing RCP trip criteria based on RCS pressure with normal instrument uncertainty, RCS subcooling, and secondary

pressure dependent RCS pressure were evaluated to determine the margin to reactor coolant pump trip following a SGTR. For this evaluation, several analyses of SGTR events were performed for the Ginna plant using the LOFTRAN computer program. These analyses were performed using best estimate parameters to provide a realistic assessment of the alternate pump trip criteria. The objective of this effort was (1) to identify the most effective of the proposed trip criteria, and (2) to demonstrate that this criteria provides significant margin to reactor coolant pump trip for a design basis SGTR event, i.e. a double-ended rupture of a single tube. The basic analysis was performed for a double-ended tube rupture on the outlet side of the steam generator with the plant at nominal full power operating conditions. This analysis was also extended to consider the effect of tube rupture size and location and the effect of power level. The cases which were analyzed are summarized in the following table.

SGTR Cases Analyzed

Case No.	Break Size (ft^2)	Break Location	Power Level
1	0.0049 (D.E.)	Outlet side of SG	100 percent
2	0.0033	Outlet side of SG	100 percent
3	0.0049 (D.E.)	Inlet side of SG	100 percent
4	0.0049 (D.E.)	Outlet side of SG	70 percent

The RCS pressure, reactor coolant subcooling and the primary-to-secondary differential pressure were determined as a function of time for each of the cases and the results are presented in Figures 1 to 3. The respective RCP trip criteria are also shown on the figures. The results shown in Figures 1 to 3 indicate that each of the alternate RCP trip criteria would allow continued pump operation for some SGTR's which could occur. However, the use of a secondary pressure dependent RCS pressure criteria provides the most potential of the three criteria in preventing RCP trip for a SGTR. This was also the only method which did not result in pump trip for all of the cases

analyzed. To demonstrate the effectiveness of the alternate criteria for the actual Ginna SGTR event, the primary-to-secondary pressure differential and the RCS pressure obtained from the Ginna data are presented in Figures 4 and 5, respectively, and the calculated RCS subcooling based on the LOFTRAN analysis of the Ginna event is presented in Figure 6. The results in Figure 4 demonstrate that the primary-to-secondary pressure differential criterion would have permitted continued pump operation during the Ginna SGTR event, whereas the results in Figures 5 and 6 indicate that the subcooling and single-valued RCS pressure criteria would not have.

The use of a secondary pressure dependent RCS pressure criterion has one disadvantage in that both the primary and secondary pressures must be observed in determining if the RCP's should be tripped, at a time when both parameters are changing rapidly. To facilitate the use of this criterion, Figure 7 shows a curve with the RCS pressure criteria for pump trip as a function of secondary pressure which could be provided in the procedures. Although this analysis indicates that a secondary pressure dependent RCS pressure criterion would be successful in preventing pump trip for a SGTR, this method has not been tested under typical operating conditions. The application of this method should be verified under simulated accident conditions to demonstrate that an operator can effectively use this criterion to prevent pump trip for a SGTR.

It is not expected that any of the alternate criteria considered would prevent pump trip for a SGTR if the instrument uncertainties associated with adverse containment conditions are used in establishing the criteria. Thus, the current criterion based on RCS pressure with the uncertainties associated with abnormal containment conditions would continue to be used to trip the RCP's in the event of a LOCA which results in adverse containment conditions. If normal containment conditions exist, which would be expected following a SGTR event, the alternate criterion using the secondary pressure dependent RCS pressure would be applied. This alternate criterion would also provide the required pump trip protection for a small LOCA which does not result in an early indication of abnormal containment conditions, because it is based on the same 100 psi primary-to-secondary pressure differential which was used in establishing the current single-valued RCS pressure criterion. Whenever the

need for pump trip is addressed in the procedures, the operator would be required to evaluate the containment conditions and to select the appropriate criterion depending upon the containment conditions. This approach would prevent RCP trip for a design basis SGTR, while still providing for a required pump trip in the event of a LOCA.

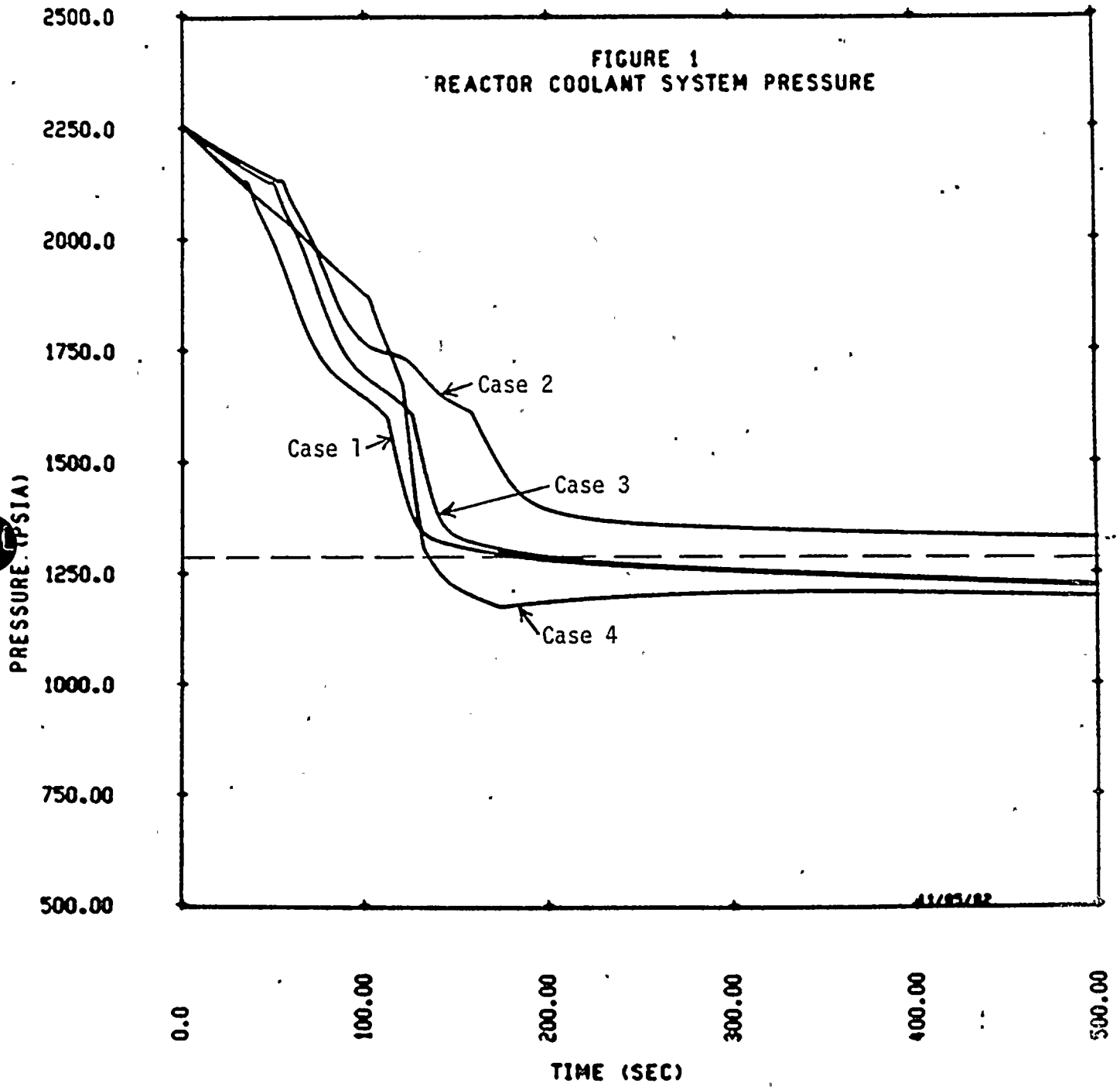


FIGURE 1
REACTOR COOLANT SYSTEM PRESSURE
2500.0
2250.0
2000.0
1750.0
1500.0
1250.0
1000.0
750.00
500.00
PRESSURE (PSIA)
Case 1
Case 2
Case 3
Case 4
0.0
100.00
200.00
300.00
400.00
500.00
TIME (SEC)

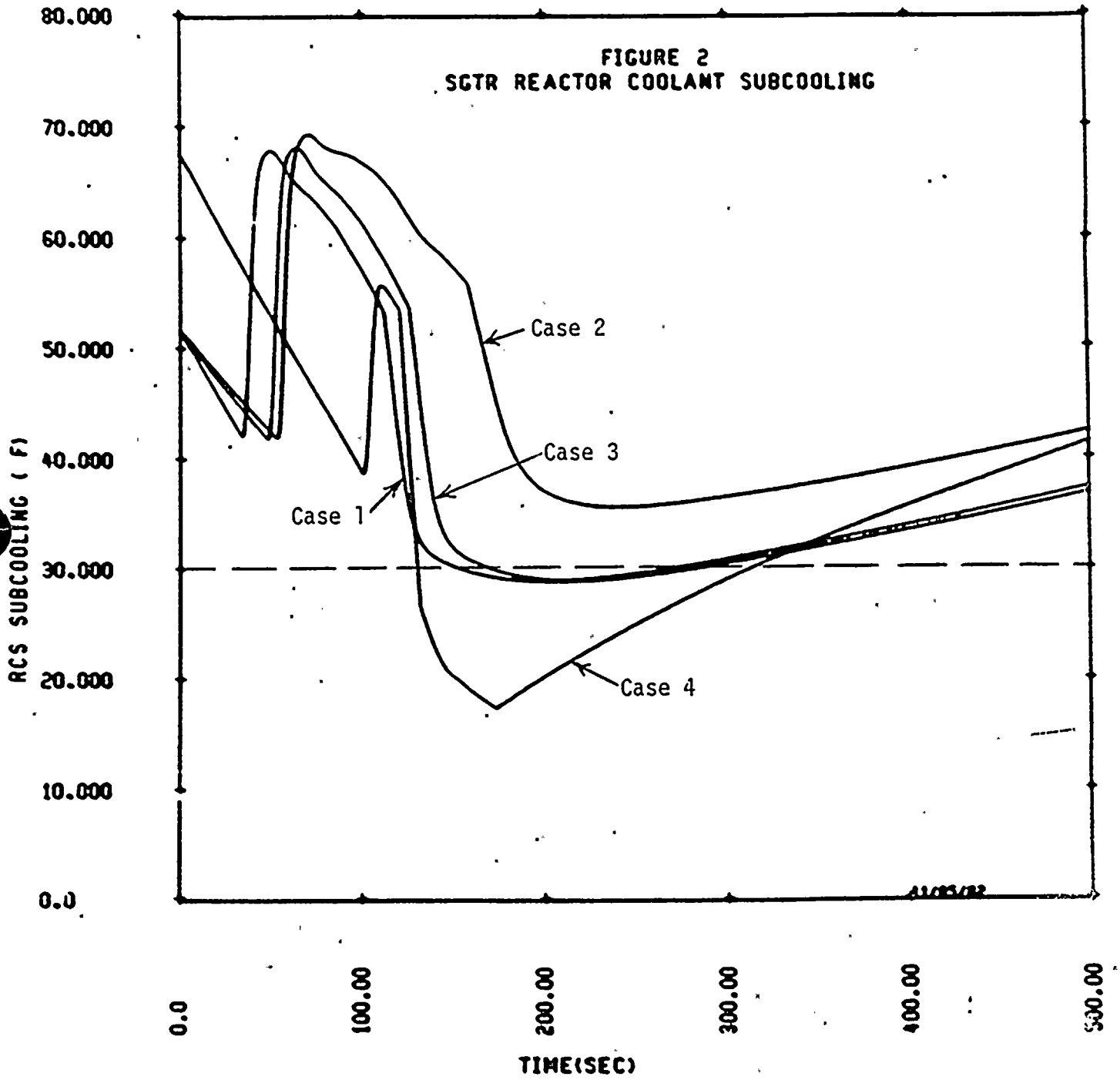


FIGURE 2
SGTR REACTOR COOLANT SUBCOOLING
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0.0
RCS SUBCOOLING (F)
Case 1
Case 2
Case 3
Case 4
0.0
100.00
200.00
300.00
400.00
500.00
TIME(SEC)

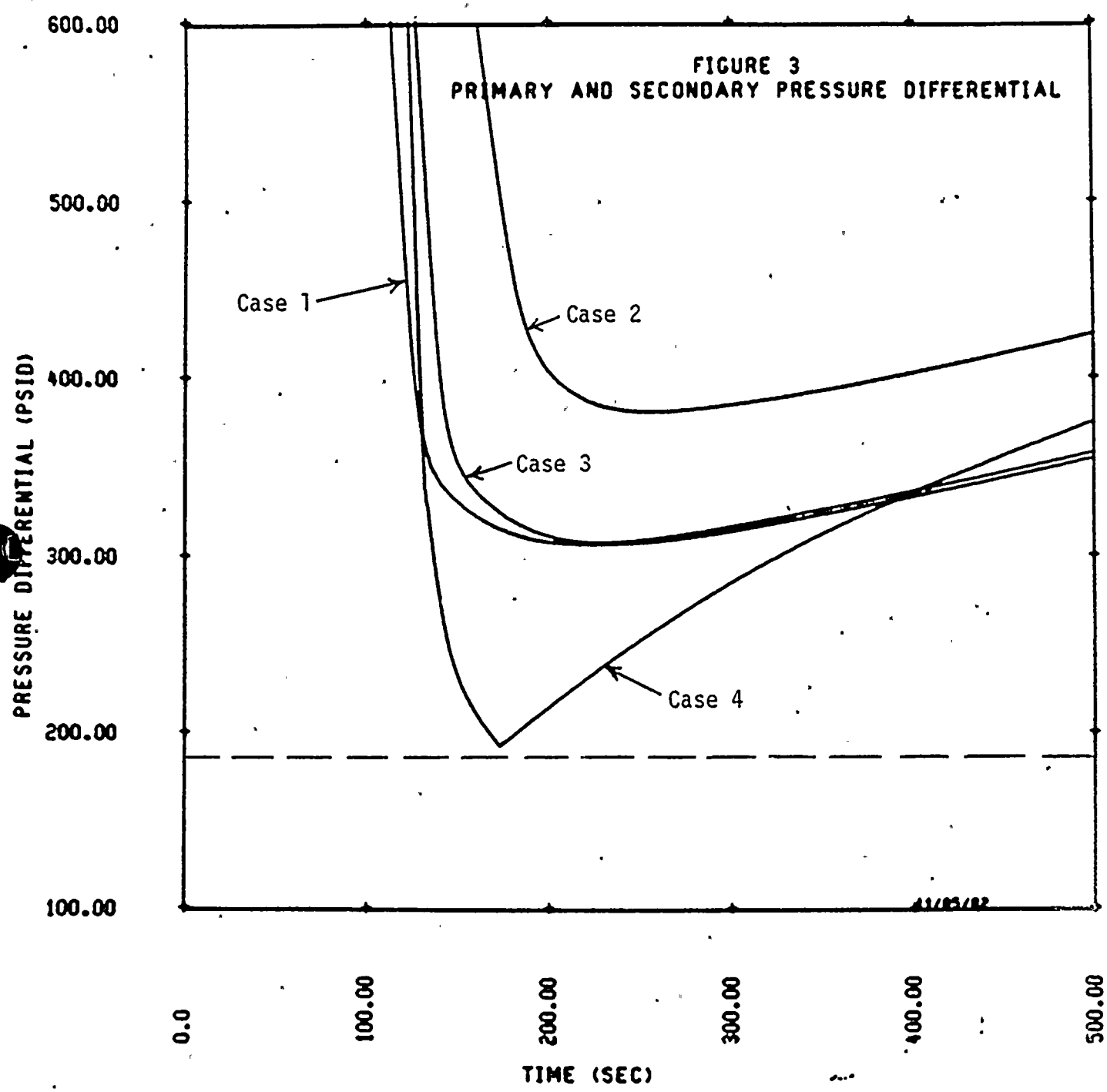


FIGURE 3
PRIMARY AND SECONDARY PRESSURE DIFFERENTIAL
600.00
500.00
400.00
300.00
200.00
100.00
PRESSURE DIFFERENTIAL (PSID)
Case 1
Case 2
Case 3
Case 4
0.0
100.00
200.00
300.00
400.00
500.00
TIME (SEC)

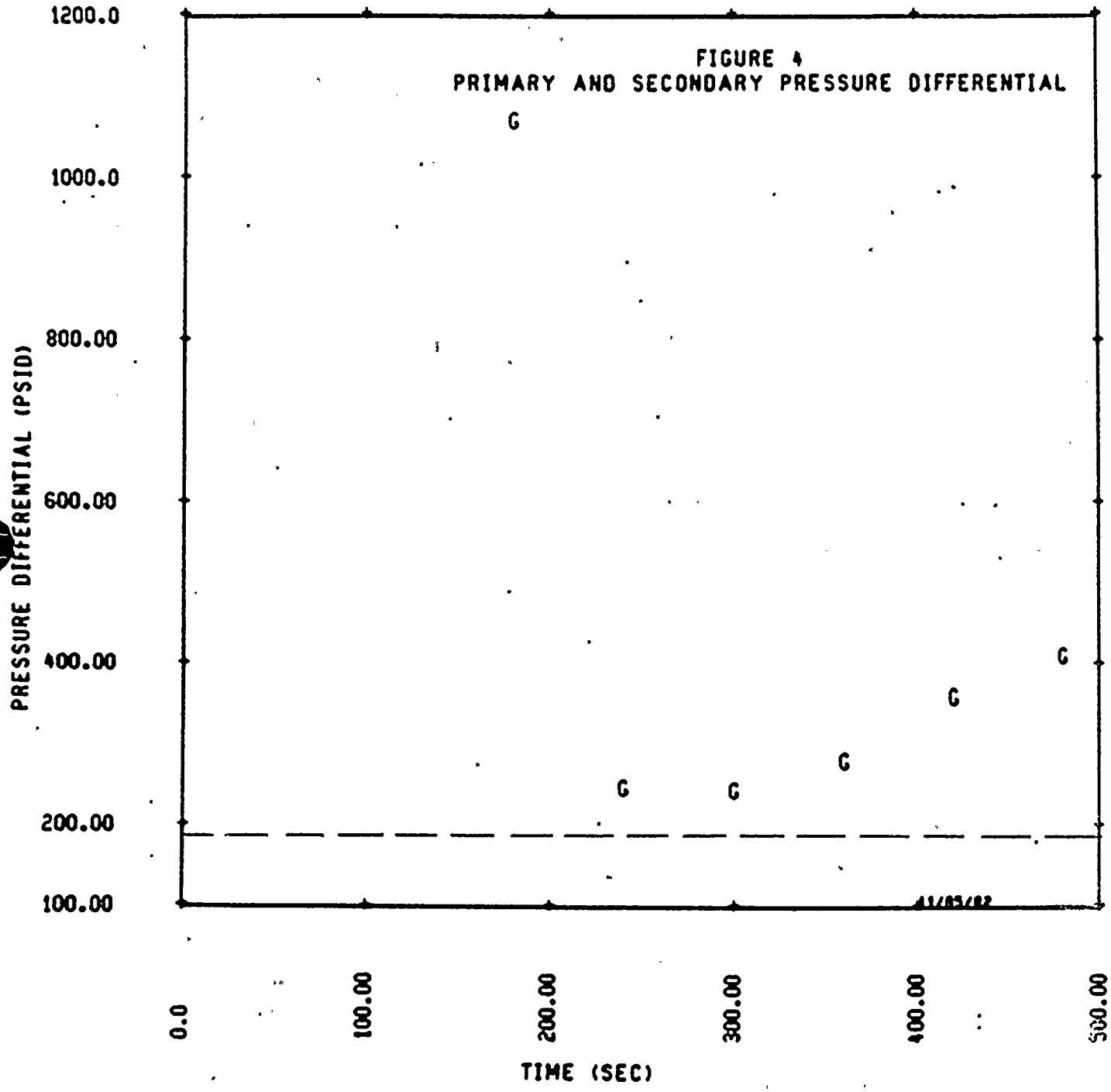


FIGURE 4
PRIMARY AND SECONDARY PRESSURE DIFFERENTIAL
PRESSURE DIFFERENTIAL (PSID)
1200.0
1000.0
800.00
600.00
400.00
200.00
100.00
0.0
100.00
200.00
300.00
400.00
500.00
TIME (SEC)
G
G
G
G
G
G
G
01/05/82

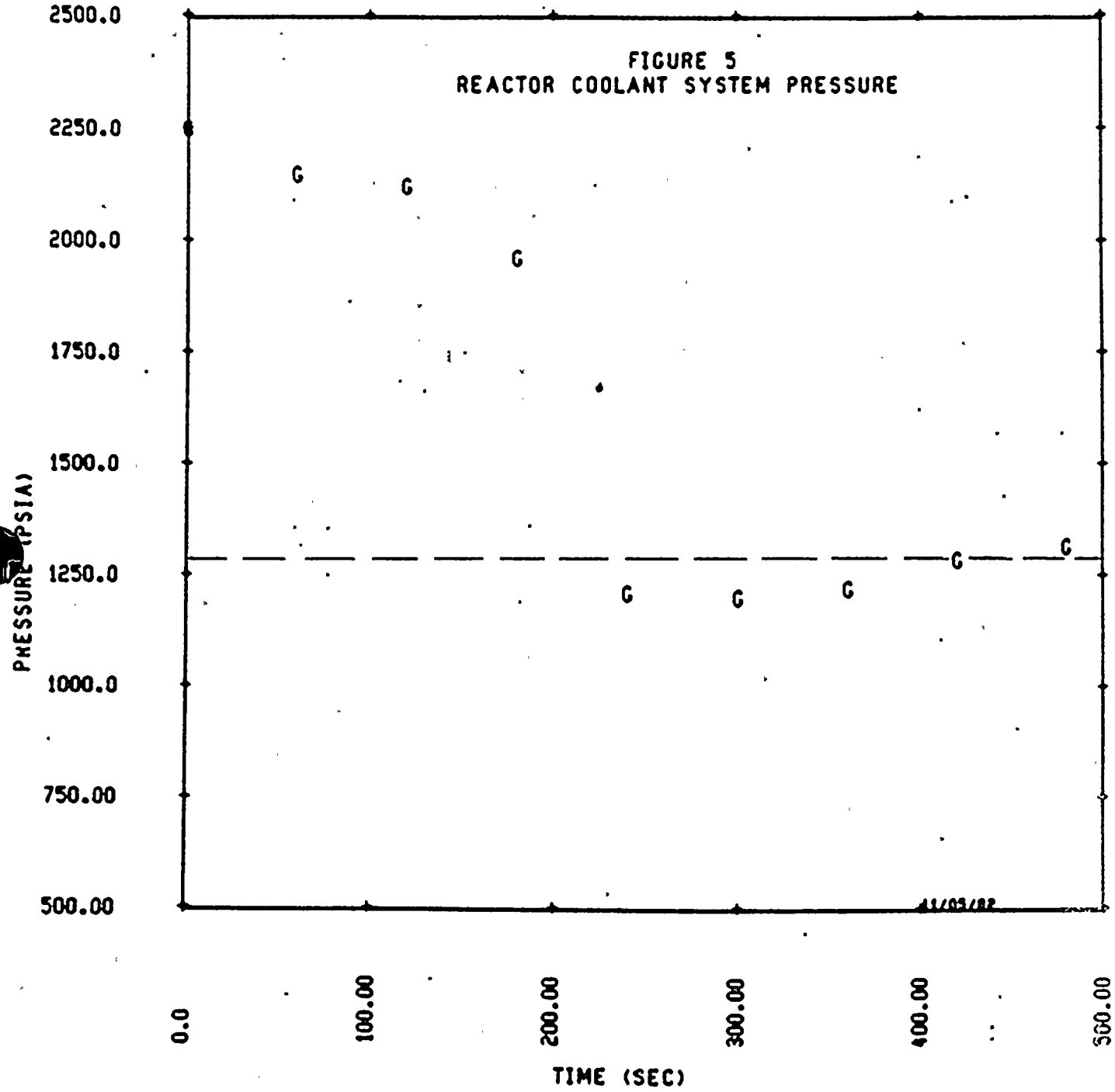


FIGURE 5
REACTOR COOLANT SYSTEM PRESSURE
2500.0
2250.0
2000.0
1750.0
1500.0
1250.0
1000.0
750.00
500.00
PRESSURE (PSIA)
0.0
100.00
200.00
300.00
400.00
500.00
TIME (SEC)

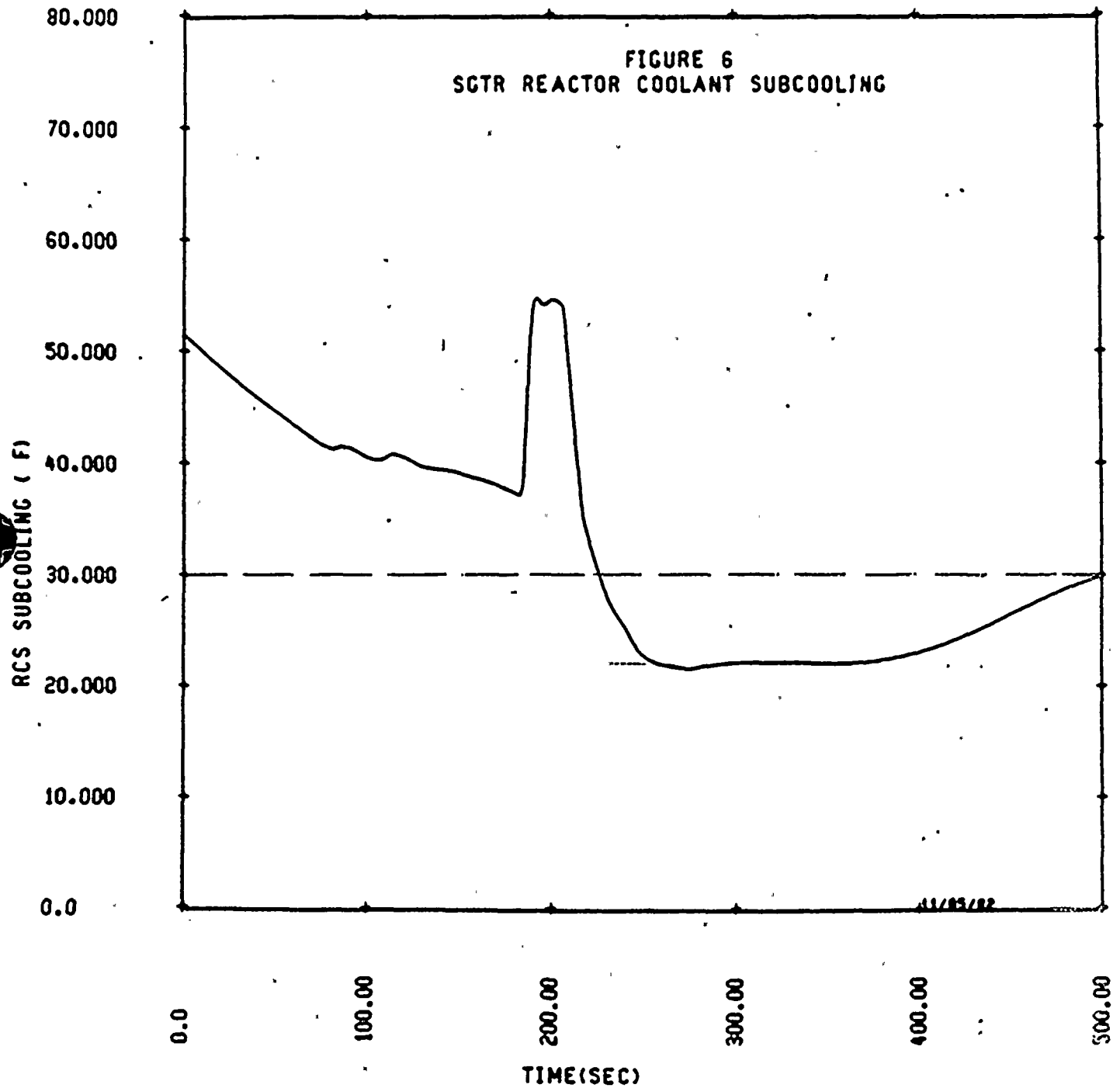
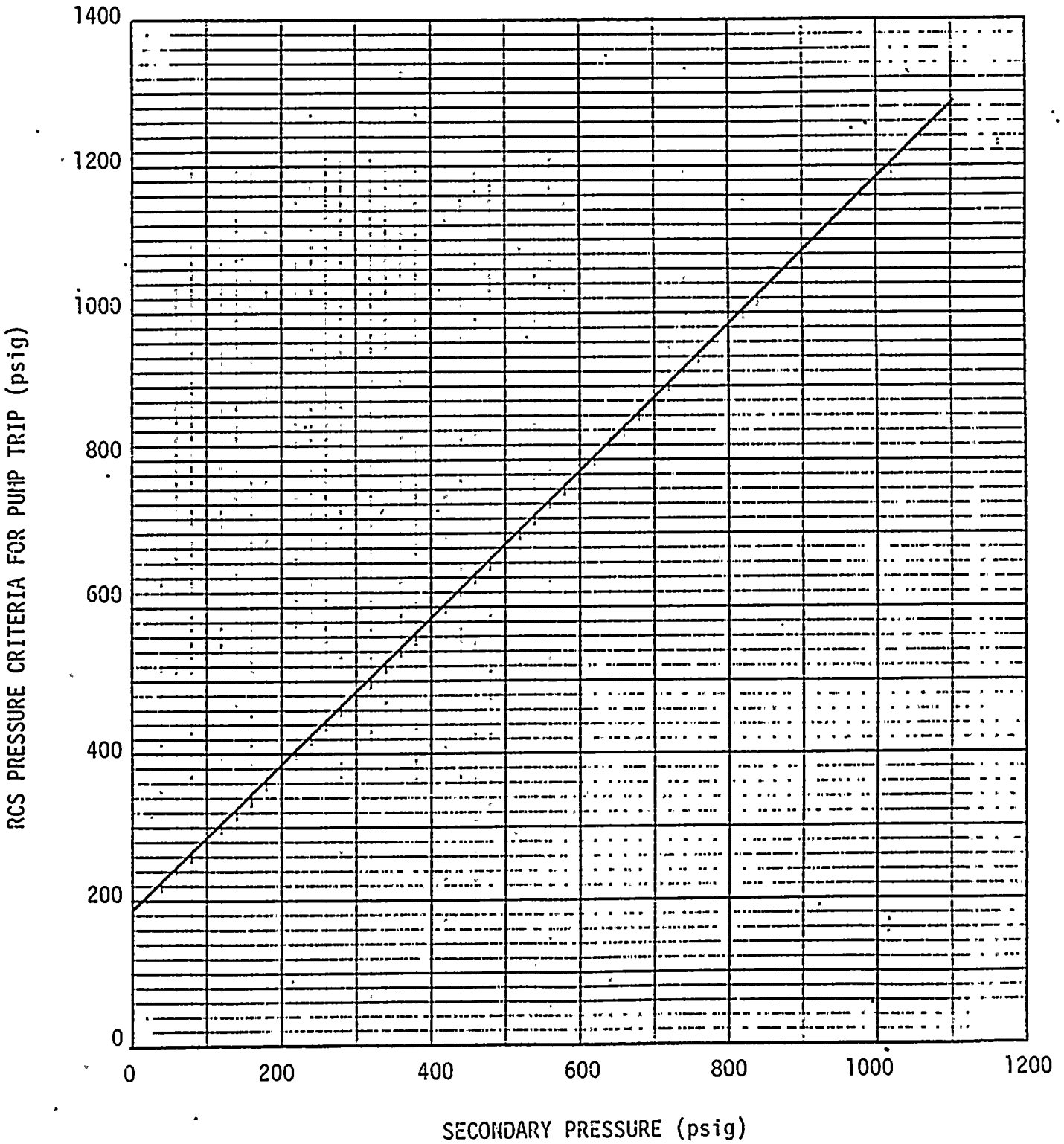


FIGURE 6
SGTR REACTOR COOLANT SUBCOOLING
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0.0
RCS SUBCOOLING (F)
0.0
100.00
200.00
300.00
400.00
500.00
TIME(SEC)

FIGURE 7

RCS PRESSURE CRITERIA FOR REACTOR COOLANT PUMP TRIP AS A FUNCTION OF SECONDARY PRESSURE



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