GPU Service

TECHNICAL DATA REPORT

TDR NO. 239

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PROJECT NO. 1100/G0103

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DEPARTMENT/SECTION Systems Eng./Plant Analysis

RELEASE DATE 1/27/81

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PROJECT:

Report to GORB
Action Item #375

DOCUMENT TITLE:

Oyster Creek NGS: Reactor Water Level Transient of July 17, 1980

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ABSTRACT:

At the 81st meeting of the General Office Review Board a presentation was given by Mr. J. L. Sullivan, Manager of Operations at the Oyster Creek N.G.S. on a startup transient that occurred July 17, 1980. In an effort to obtain more information regarding this matter, GORB Action Item 375 was issued to Mr. R. F. Wilson for response. The response to these items have been completed by the Plant Analysis Section of System Engineering. All available information and data relating to the subject transient have been reviewed and analyzed. The following then, are brief summaries of the results of investigation of each of the Action Item questions.

1. Several possible situations have been postulated in this report which might have occurred during the transient with more serious consequences than what took place. These situations are safety-bounded, however, by the most limiting loss-of-coolant inventory transient - a complete loss of feedwater flow. An excerpt from the "Analysis of the Loss of Feedwater Transient with Isolation Condenser Actuation" developed by EXXON Nuclear Co., Inc. is included in response to the triple-low level transient that occurred on May 2, 1979. Briefly, it calculated that if feedwater flow goes to zero 3.5 seconds after a scram from 100% reactor power, and a level of 12.34' TAF, approximately 19,300 lbm of coolant inventory is lost by the time the MSIVs (Main Steam Isolation Valve) are signaled to close by a "low-low" indication. A minimum downcomer

1. (Continued)

water level of 5.36' TAF occurs at 35 seconds. It is worth noting that about 4 seconds after a full power scram the power level is close to 7%. This is the maximum power the isolation condensers are capable of handling. As is discussed, the plant was operating at close to 7% reactor power during the worst period of the July 17 transient, and the water inventory loss was approximately only 11,600 lbm. This occurred just prior to the reactor scram on "low" level, when the bypass valves were full open. Since feedwater was operable, the level was immediately raised to the normal point.

2. We believe that the G. E. analysis concerning the effective coolant density is the major contributing effect in the cause of the triple-low level signal received during the event. However, the data illustrates a strong contributing effect from the partial separation of annulus and core areas, and some possible effects from the presence of a pressure wave.

3. We agree with members of the plant operations staff that the torus level indication should be upgraded. Since increasing the physical size of the meter to a point where accurate readings would be obtained is impractical, we see the use of a digital indication for this application as the best overall solution. However, it is suggested that until any instrumentation changeout can be made, the time between readings taken from the level indicator be spaced as far apart as possible, so that any level difference is as large as possible, and will be noticeable enough so as to be read, and not "lost" due to the accuracy with which the operator can read the scale.

As is evident from these summaries, several areas related to operational control of the plant are in need of upgrade. Each has safety related considerations which must be treated to preclude similar events from happening, possibly more severe than those that occurred during this transient.

A series of curves of the various plant parameters important to an understanding of the transient have been generated to illustrate their behavior during this period. This information was obtained from that supplied from the plant as part of the PSMS digital trend record. Additionally, notations have been made on some of the curves showing points of interest.

Corrective Action

(1) Reactor water level indication

Although the sudden opening of the bypass valves may not happen again as it did, there might be a failure at some point in the future which would cause a similar set of conditions of occur. In this case a quick and early automatic scram would prevent a more severe transient. We understand that at present a wide range instrument has been installed which measures the core area level, but only when the RCR pumps are not running. This is due to the fact that the core area level is effected by a number of hydraulic forces present during plant operation which will not allow the actual reading and the real core level to be the same. Although this indicator may not provide an absolute measurement of the true level, it might be possible to correlate readings obtained, with those of the annulus, thus developing a data base for determining what the normal range of level operation is with respect to the annulus. Tracking of this core level vs. the annulus level would additionally assist in the measure of communicability between the two regions. The primary purpose of this indicator, however, would be to transmit rapid changes in core area level as would be experienced during water level transients. It is expected that any change in indicator level should be accurate, to a high degree of a similar level change in the core area. It is this data that would be of paramount importance during future transient analysis where annulus/core area separation is a factor. Investigation into the necessary engineering design information associated with this arrangement should be initiated to determine the feasibility of employing an indicator/recorder instrument in this application for full time operation.

(2) RBCCW System Isolation

As a result of the spurious RBCCW isolation that occurred during the initial phases of the July 17 transient, reexamination of the design bases for the initiation should be reviewed. It appears that if the RBCCW system can be isolated without an actual loss of coolant, then the possibility exists for several temperature related problems to develop in the drywell before automatic initiation of containment spray would occur. Any other response would require operator action such as a reset of RBCCW or an initiation of containment spray. A request from the plant staff to the Plant Analysis Section to analyze the design bases behind RBCCW isolation and containment spray will be forwarded to the appropriate Engineering Section for response. In the meantime, the plant has taken steps to insert a time delay in the RBCCW isolation circuitry, which will hopefully preempt any further unnecessary isolations.

(3) Torus Level Readout Instrumentation

Analysis of the functional operability requirements of the present torus level measurement system should be completed, and an improved system proposed. Two possible schemes for consideration are:

(1) a. Replacement of present vertical scale instrument with one having a digital display and/or recorder trace capability, and

b. Possible control board location change.

(2) a. Decrease in measurement frequency to allow better vertical scale resolution, and

b. Procedure to calculate straight-line, or curve fits to data points, and

c. Any attendant technical specification changes required.

(4) Computer Analysis

Additional analysis of this transient is to be performed by the Safety Analysis and Plant Control Section of Systems Engineering. Part of this analysis will include the use of the RETRAN computer code. RETRAN will identify, more specifically, results of situations more serious than those that took place, but which might have occurred during the course of the transient. A summary of this work can be forwarded to the GORB, if desired.

(5) Industry Distribution

Despite the fact that it was a non-reportable event, the NSAC (Nuclear Safety Analysis Center) people have expressed interest in this transient analysis. Consequently, we will make arrangements to forward a copy of this report to them, after obtaining the necessary approvals.

(6) Data Collection and Storage

Gathering all the data for this event was difficult and time consuming. Although we recognize that there is limited capability for automatic collection of data at Oyster Creek, we recommend that for all significant events (e.g., reactor trips, etc.) the data base on the Prime Computer should be stored on magnetic tape and all control room strip chart recorders should be stored in one place for ease of analysis. This will be helpful not only if the event turns out to be unusual, but also data from routine events are necessary to benchmark computer codes and training simulators.

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TITLE Oyster Creek NGS: Reactor Water Level Transient	PAGE 1 OF 4

REV	SUMMARY OF CHANGE	APPROVAL	DATE
1	Introduction (Abstract), Page 1 a) Added following to distribution: J. R. Thorpe, J. A. Camire, K. R. Goddard	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Introduction (Abstract) Page 2 a) Change "triple-low level indication received" to "triple-low level signal received" b) Changed "the separation of" to "the partial separation of"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Introduction (Abstract) Page 3 a) Changed "is with response to the annulus" to "is with respect to the annulus" b) Changed "area separation design is a factor" to "area separation is a factor"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Main Abstract, Page 2 a) Changed "triple-low level indication received" to "triple-low level signal received" b) Changed "from the separation of" to "from the partial separation"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Question No. 1 response, Page 4 a) Changed "triple low level actuation" to "triple low level signal actuation" b) Changed "of a triple low was" to "of a triple-low signal condition was" c) Changed "that a triple-low condition was" to "that a triple low signal condition was" d) Changed "triple low water/level signals" to "triple low water level signals"	J. A. Camire P. S. Walsh	3-11-81 3-19-81

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REV	SUMMARY OF CHANGE	APPROVAL	DATE
1	Question No. 1 response, Page 5 a) Changed "of the triple low level in both" to "of the triple low level signal in both" b) Changed "the triple low indication of the" to "the triple low signal indication during the" c) Changed "At the point when the triple-low signal initiated" to "At the time when the bypass valves opened and a triple-low signal initiated" d) Changed "that the triple-low occurred" to "that the triple-low signal occurred" e) Changed "and a "level" was reached" to "and a pressure difference was reached" f) Changed "to the triple-low initiation" to "to the triple-low signal initiation" g) Changed "by the computer, but that" to "by the computer, and that"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Question No. 1 response, Page 6 a) Changed "seal destruction, and the pumps would" to "seal destruction, if the pumps were not"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Question No. 1 response, Page 7 a) Changed "lost the level would" to "lost the true water level would" b) Changed "loss, but would maintain the artifically high indicated level. This indication" to "loss, while maintaining an artifically high mixture level. The indication" c) Deleted "Compounding the indication descrepancy, is the fact that no direct indication of the core area level was operable" d) Changed "It is assumed" to "It was evidently assumed" e) Changed "time a triple-low trip was" to "time a triple-low signal was"	J. A. Camire P. S. Walsh	3-11-81 3-19-81

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REV	SUMMARY OF CHANGE	APPROVAL	DATE
1	Question No. 2 response, Page 9 a) Changed "lowering the water level continuously until a triple-low water level was reached" to "lowering the true water level continuously until a triple-low level signal was received" b) Changed "13d" to and" c) Changed "for the triple-low level to be reached" to "for the triple-low level signal to be received" d) Changed "cause the triple-low level, but" to "cause the triple-low level signal, but" e) Changed "for triple-low level initiation" to "for triple low level signal initiation"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Question No. 2 response, Page 10 a) Changed "Although there is no data or indicator reading reflecting the vessel level inside the shroud" to "Although the indicator for measuring level inside the shroud area was not operational during the event" b) Changed "the triple-low level transmitters should" to "the triple-low level switches should" c) Changed "the annulus region, now momentarily stagnant, and the leveling" to "the annulus region, and the leveling" d) Changed "why the triple-low level on the event" to "why the triple-low level signal indication on the event" e) Changed "board annunciator for triple-low to "board annunciator alarm for triple-low indication" f) Changed "from the separation". to "from the partial separation"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Question No. 3 response, Page 12 a) Changed "could then be completed from" to could then be computed from"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Corrective Action, Page 13 a) Changed "steps to insert a time delay in the RBCCW" to "steps to have a time delay inserted in the RBCCW"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Appendix A, Page 1 and 2 a) Changed "Sequence of Events" to "Plant Reported Sequence of Events" b) Added "p.m." to list of times.	J. A. Camire P. S. Walsh	3-11-81 3-19-81

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REV	SUMMARY OF CHANGE	APPROVAL	DATE
1	Appendix B, all curves a) Added specific times for each tic mark on "TIME" axis on all transient curves. b) Added "ANNULUS" to those transient curves labeled only "Reactor Water Level"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Appendix C, Cover Page a) Changed "Recirculation flow = gallons/minute" to "Recirculation flow=gallons/minutes x .01"	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Appendix H, Cover Page, Test a) Changed "Oyster Creek - LER 80-52/3L"to "Oyster Creek - LER 38/3L" b) Replaced LER 80-52 with LER 80-38	J. A. Camire P. S. Walsh	3-11-81 3-19-81
1	Table of Contents a) Changed "Oyster Creek - LER 80-52/3L" to "Oyster Creek - LER 80-38/3L"	J. A. Camire P. S. Walsh	3-11-81 3-19-81

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REPORT TO GORB

Action Item No. 375

Oyster Creek N.G.S.: Reactor
Water Level Transient of
July 17, 1980

ABSTRACT

At the 81st meeting of the General Office Review Board a presentation was given by Mr. J. L. Sullivan, Manager of Operations at the Oyster Creek N. G. S. on a startup transient that occurred July 17, 1980. In an effort to obtain more information regarding this matter, GORB Action Item 375 was issued to Mr. R. F. Wilson for response. The contents of the Action Item are as follows:

1. Investigate July 17 startup transient, including possible resulting events, to determine seriousness of situation. (Note: If appropriate, results should be forwarded to NSAC and Owners Group.)

2. Identify, if possible, why the triple-low level signal was received during the July 17, 1980 startup transient.

3. Investigate the leak rate determination capability (accuracy, etc.). (If improvements are found to be necessary, they should be added to the list of corrective items, taking their proper place in the priority.)

The response to these items have been completed by the Plant Analysis Section of Systems Engineering. All available information and data relating to the subject transient have been reviewed and analyzed. The following then, are brief summaries of the results of investigation of each of the Action Item questions:

1. Several possible situations have been postulated which might have occurred during the transient with more serious consequences than what took place. These situations are safety-bounded, however, by the most limiting loss-of-coolant inventory transient - a complete loss of feedwater flow. An excerpt from the "Analysis of the Loss of Feedwater Transient with Isolation Condenser Actuation" developed by EXXON Nuclear Co., Inc., is included in Appendix E. This document was generated in response to the triple-low level transient that occured on May 2, 1979. Briefly, it calculated that if feedwater flow goes to zero 3.5 seconds after a scram from 100% reactor power, and a level of 12.34' TAF, approximately 19,300 lbm of coolant inventory is lost by the time the MSIVs (Main Steam Isolation Valve) are signaled to close by a "low-low" indication. A minimum downcomer water level of 5.36' TAF occurs at 35 seconds. It is worth noting at this point that about 4 seconds after a full power scram the power level is close to 7%. This is the maximum power the isolation condensers are capable of handling. As is discussed, the plant was operating at close to 7% reactor power during the worst period of the July 17 transient, and the water inventory loss was approximately only 11,600 lbm. This occurred just prior to the reactor scram on "low" level, when the bypass valves were full open. Since feedwater was operable, the level was immediately raised to the normal point.

2. We believe that the G.E. analysis concerning the effective coolant density is the major contributing effect in the cause of the triple-low level signal received during the event. However, the data illustrates a strong contributing effect from the partial separation of annulus and core areas and some possible effects from the presence of a pressure wave.

3. Before a final decision can be made in dealing with the question of torus level indication, further analysis must be made. Specifically, the functional operability requirements of the present measurement system should be defined from the original design criteria. As this is better understood, an effort to match the present arrangement with human factor engineering principles can be attempted. In the near future, a major review of the entire Oyster Creek control room instrumentation is to be undertaken in this manner. Two possible solutions which might be considered in this review are presented.

As is evident from these summaries, several areas related to operational control of the plant are in need of upgrade. Each has safety related considerations which must be treated to preclude similar events from happening, possibly more severe than those that occurred during this transient.

A series of curves of the various plant parameters important to an understanding of the transient have been generated to illustrate their behavior during this period. This information was obtained from that supplied from the plant as part of the PSMS digital trend record. Additionally, notations have been made on some of the curves showing points of interest.

GORB Action Item No. 375

Question No. 1: Investigate July 17, 1980 startup transient, including possible resulting events, to determine seriousness of situation. (Note: if appropriate, results should be forwarded to NSAC and Owners Group.)

Response: The following is a brief summary of the events that occurred during the July 17, 1980 transient. At approximately 8:30 p.m. on the night of July 17, 1980 operators were attempting to control reactor pressure during a normal ascent to power with the pressure regulator system. As pressure in the vessel continued to rise it was realized that the regulating system was not operating properly, in that the bypass valves were not opening to adjust the increasing pressure. Some control rods were subsequently inserted by the operator. All their attempts to open the bypass valves at this time failed. When the vessel pressure reached 1050 psig, the "D" EMRV (Electromatic Relief Valve) automatically opened until the pressure dropped to 1000 psig, at which point it closed. Coincident with the valve closure, an automatic RBCCW (Reactor Building Closed Cooling Water) isolation was received. The operator pushed the reset and manually opened the isolation valves. During the time the relief valve was open, a sharp rise in water level was indicated. This was caused by "swell", the voiding and flashing of the reactor water to steam, pushing the observed level upwards. After the EMRV closed, the level dropped. As the pressure control was still not functioning after the relief valve closure, vessel pressure began to increase again, but at a slower rate reflecting the effect of control rod insertion commenced earlier. In order to avoid a second opening of the EMRV, the operator decided to try checking the reset mechanism for the #2 vacuum trip. Despite the presence of a light indication which supposedly signaled a properly reset vacuum trip, when the reset was engaged the bypass valves immediately opened in an effort to set vessel pressure at the demand value which by now had been set very low. Realizing this, the operator instantly tripped the #2 vacuum trip causing the bypass valves to reclose. During the short period of time when the valves were open, a second sharp rise in water level was indicated, much larger than that produced by the EMRV, but caused by the same voiding mechanism. Steam flow and feed flow sharply increased, as they would be expected to behave during a rapid depressurization event. Since the bulk boiling and resulting voiding in the core is a negative reactivity effect, the flux dropped immediately also, as evidenced by the APRM (Average Power Range Monitor) curve. After the valves closed, pressure drop was arrested, the voids were collapsed, and the rapid drop in indicated level momentarily terminated at the "true, solid" water level, before turning upward. This "true" level, approximately 10'11" TAF (Top of Active Fuel), was below the "low" water level trip point, and the reactor scrammed. However, the feed flow was able to immediately raise the level to the normal range of about 13'6" TAF (see Appendix B). The drop in level was produced by two effects: the excessive loss of vessel water inventory caused by a higher steam flow vs. feed flow during depressurization, and the surge effect, or 'splash', caused by the fall of water after void collapse. This surging mechanism would temporarily cause the indicated annulus area to fall until the movement of water due to the pressure difference between the core and annulus reached equilibrium. This effect would serve to increase the magnitude of the level drop beyond what might be due to inventory loss.

No obvious reason can be determined for the spurious isolation of the RBCCW system upon closing of the EMRV. Normally, isolation should only occur upon a triple-low level signal actuation, but at that point no indication of a triple-low signal condition was apparent. We understand that it is possible for a spurious trip to have occurred without any actuation due to the fact that this isolation circuitry is new and was just installed during the last spring outage. The possibility also exists that a triple-low signal condition was in effect at some point during the EMRV evolution which, although it did not trip the event recorder or the annunciator alarm, might have caused the RBCCW isolation relay to trip out. RBCCW isolation is designed to occur after two of the four triple-low level switches are actuated. With the actuation of one switch, the event recorder should activate to note the actuation and to increase the speed of the chart paper. It was believed that the spurious RBCCW isolation signal was received after the EMRV had closed. This was based on verbal reconstruction of the events by the three senior reactor operators present in the control room during the event, not on any recorded information, since none is available. A more plausible explanation would have placed the isolation with the actual triple-low received at the time of the bypass valves opening. However, repeated discussions with the operators present at the time confirm the sequence of events correct as initially reported. So, it is difficult to determine why it is that the RBCCW isolation occurred at all during the EMRV closing.

Ruling out the assumption that it was a spurious affect, and therefore happened at that point in time only coincidently with the EMRV closure, we have attempted to find another reasonable cause for the isolation. After some review of the data, a plausible connection is that two triple-low switches were engaged at some point, and jumped "in" and "out" fast enough to avoid being detected by the triple-low annunciator and event recorder, probably because they are part of an old, slower acting circuitry, but not able to escape the notice of the newer RBCCW isolation electronics. The reverse was true during the bypass valve opening. The triple low water level signals jumped 'in' and 'out', slower than before, and were picked up by the event recorded circuitry, but this time not by the RBCCW insolation circuitry. The explanation for this, we believe, lies in the combination of signal speed and electro-mechanical component construction. Short, pulsed signals can cause effects which are not normally expected, due to the characteristics of the mechanical portions of relays. When signals are pulsed, unusual effects on the operation of the device become apparent. This is due to the fact that the pulse times in question are comparable to, say, the decay times for magnetic fields, or the times needed to overcome inertia. Further investigation of the triple low level circuitry and its components must be made to determine the extent to which these effects are present, before a complete undertstanding of the cause of the physical events that took place can be afforded.

The events are connected by the presence of the triple-low level signal in both cases. However, it can be seen that the absolute water level peaks of each transient do not match. The EMRV peak has been cut off by the scan frequency of the computer, but using a least squares fit for each side of the peak, the peak point was reconstructed. Additionally, the triple-low signal indication during the bypass valves opening transient occurs at a level much lower than its peak. After closer examination it can be seen that the difference in points is not overly large. (Note that these are measures of annulus levels not core area levels and only give us an indirect indication of what is occurring in the core area.) At the time when the bypass valves opened and a triple-low signal initiated, the two water level instruments measuring annulus level read 6.64' and 6.30', respectively. This is an average of 6.47' ± 0.17'.

When the EMRV level peak is reconstructed it is seen to have a top value of 6.18'. Assuming that a triple-low signal occured at that point, although it did not indicate as such, it should be allowed the same percentage range deviation as was present during the bypass valve peak. In this case, 6.18' ± 0.16'. Comparing the median values of both peaks, 6.47' vs. 6.18', the difference, 0.29' or about 3.5", is well within the 2-3% accuracy range of the triple-low instruments (3"-4.5"). Additionally, the upper range of the EMRV peak at 6.34', overlaps the lower range of the bypass valve peak at 6.30'. Although there is a similar basis for comparison of triple-low trip signals from the annulus area levels of the two depressurization events, the triple-low level signal was not obtained until the flow from the RCR (Reactor Coolant Recirculation) pumps were reduced as well. Fortunately, the computer scan occurred during the time when the recirculation flow was indicating a low flow condition. From the event recorder trace it is known that the triple-low signal occurred only for a very short time, perhaps milliseconds. And we have no way of knowing if the recirculation flow indicates the actual minimum or not. In any case, it is clear that more inventory was being lost from the vessel, at this time, than was being added, and a pressure difference was reached that activated all of the four triple-low switches, despite any setpoint variations. Since this low recirculation flow is important to the triple-low signal initiation mechanisms as will be discussed later, we must assume that some additional drop in recirculation flow, i.e. annulus/core separation, was present beyond what is indicated by the computer, and that it occurred between scans during the EMRV opening. Also, it may be said that if the RBCCW isolation occurred at this point, it may have done so from an initiation by only two triple-low relays, those whose setpoints are in the most conservative direction in relation to the others (See Appendix H).

It appears, after generating the curves of the various nuclear system parameters from the PSMS data supplied and comparing these curves with each other, that the actual sequence of events as viewed by the computer agrees for the most part with the general outline of events in the plant-submitted list of events, with the exception of some estimated times and absolute values of parameters.

In examining the seriousness of this event there are several possible situations which could have occurred during the transient. We have analyzed four events in which additional failures were assumed.

They are the following:

(a) Bypass valves failing to open for any reason;

(b) Bypass valves failing to reclose for any reason;

(c) RBCCW System fails to reset after trip isolation; and

(d) Erroneous reactor water level indication due to rapid depressurization.

A discussion of each is given below.

(A) Bypass valves failing to open for any reason.

Should the bypass valves have failed to open when they did, the pressure in the reactor would have continued to increase as before, with the EMRV lifting to relieve pressure. A controlled shutdown or manual scram could easily have been initiated and any excess pressure controlled with the isolation condensers. Feedwater flow, and all ECCS (Emergency Core Cooling Systems) were operable during this time. Similar action would, of course, be taken in the event the EMRV also failed to open, with other relief valves opening, and an automatic scram of the reactor occurring if the pressure reached the trip setpoint.

(B) Bypass valves failing to reclose for any reason.

Calculations of net inventory loss during a 25 second transient period when the steam flow jumped from a stable value due to the bypass valves opening, until valve closure, show that about 11,600 lbm of coolant were lost. Had the bypass valves remained open, a "low-low" level (7'2" TAF) would have been reached approximately 46 seconds after the initial opening, based on extrapolation of the available data. This "low-low" level assumably would isolate the reactor vessel if it was detected. However, the feedwater system would be capable of maintaining inventory. Evidence from analysis of the parameters, notably water level, show that due to "swell" of the apparent level the transmitter was "fooled", since indication on the Yarway read approximately 6.88' when in fact the "collapsed" level was only 3.76'. This was obvious when the bypass valves finally did close. More will be said on this in (D).

(C) RBCCW System fails to reset after trip isolation.

In the event of a spurious RBCCW isolation similar to the one that occurred, but one where the RBCCW fails to reset, the cooling water for the RCR pumps' seals would become overheated causing seal destruction, if the pumps were not eventually tripped manually. With the feedwater pumps operable, enough injection water should be available to make up any loss of inventory adequately, despite feeding through the RCR pumps and lines, since after the EMRV reclosed the reactor would again be essentially isolated, except for leakage by the RCR pump seals. With the loss of RBCCW, temperatures in the drywell would rise due to pump seal leakage, and the loss of cooling water to the drywell coolers. However, containment spray would have been available if temperatures or pressures warranted its use.

(D) Erroneous reactor water level indication due to rapid depressurization.

When a rapid depressurization in the reactor vessel occurs for whatever reason, the reaction of the water level is to be drawn upwards to some higher level. This is caused by the mass of fluid rapidly escaping from the vessel, and by the void formation in the water caused by the presence of bulk boiling in the core. The difference between the level indicated during this time, and the level that would be measured without voiding, the "collapsed" level, may be significant. During the transient period when the bypass valves were opened, the maximum indicated reading was 6.88' (14.05' TAF). However, after the valves closed, and the "collapsed" level was again established, the reading was 3.76' (10.93' TAF). This is a difference of 3.12'. As net inventory is lost the true water level would gradually drop to reflect the loss, while maintaining an artifically high mixture level. The indication problem is a critical area of importance arising out of this transient as far as our analysis is concerned, and there seems to be no obvious solution. It was evidently assumed during design that communication between the annulus area and the core area would always be maintained such that the annulus area level would be strongly representative of the core water level. However, the results of this transient, and at least one other, show that there are times when this communication can be lost, or severely reduced. During one five second period of the transient, the RCR pumps dropped 53-88% in flow at which time the annulus level dipped slightly, showing a level on one meter of 13.47' TAF, when at the same time a triple-low signal was present corresponding to a collapsed water level of 4.67' TAF! Further analysis of this phenomena is made in the response to Question No. 2.

Summary

These situations are safety-bounded by the most limiting loss-of-coolant inventory transient - a complete loss of feedwater flow. An excerpt from the "Analysis of the Loss of Feedwater Transient with Isolation Condenser Actuation" developed by EXXON Nuclear Co., Inc., is included in Appendix E. This document was generated in response to the triple-low level transient that occured on May 2, 1979. Briefly, it calculated that if feedwater flow goes to zero 3.5 seconds after a scram from 100% reactor power, and a level of 12.34' TAF, approximately 19,300 lbm of coolant inventory is lost by the time the MSIVs (Main Steam Isolation Valve) are signaled to close by a "low-low" indication. A minimum downcomer water level of 5.36' TAF occurs at 35 seconds. It is worth noting at this point that about 4 seconds after a full power scram the power level is close to 7%. This is the maximum power the isolation condensers are capable of handling.

As was discussed, the plant was operating at close to 7% reactor power, during the worst period of the July 17 transient, and the water inventory loss was approximately 11,600 lbm. This occured just prior to the reactor scram on "low" level, when the bypass valves were full open. Since the feedwater system remained operable the level was immediately raised to the normal point.

Question No. 2: Identify, if possible, why the triple-low level signal was received during the July 17, 1980 startup transient.

Response: There are several possible reasons for a triple-low level indication occuring at Oyster Creek during the July 17 transient:

(a) Annulus/Core Area Separation;
(b) Pressure Wave; and
(c) Effective Coolant Density.

A discussion of each is presented as follows.

(A) Annulus/Core Area Separation. The Annulus/Core area separation theory assumes that due to the rapid depressurization of the vessel, a reduction in flow from the recirculation pumps occurred making it impossible for enough feedwater to enter the core area, thereby restricting its access to the source of cooling water. This scenario obviously has important repercussions for a plant of Oyster Creek's design. With continued heat production in the core, and continued pressure reduction in the vessel, the remaining water in the core area would be heated to steam, thus lowering the true water level continuously, until a triple-low level signal was received.

The possibility of this separation was presented to G.E. by the NRC. G.E. rejected the possibility of any long term pump cavitation and the resultant annulus/core separation. Their remarks can be examined in Appendix D, Questions 2 and 4. Basically, G.E. maintains that the principle cause of the observed low pump flow condition was the reduction in driving head produced by the density difference between the annulus and core area, not cavitation. At RCR (Reactor Coolant Recirculation) pump minimum speed conditions this is the major component of flow, and during the transient, voiding and flashing in the vessel a) reduced the net positive suction head, and b) increased hydraulic losses. For these reasons then it was observed that almost immediately after all the bypass valves were opened, all five of the RCR pumps showed low readings on their flow recorders (See Appendix B). However, G.E. maintains that even with a total loss of RCR flow it would require more than a minute and a half of boil-off for the triple-low level signal to be received. We agree with this portion of the G.E. analysis and have concluded that this mechanism alone did not cause the triple-low level signal, but was a major contributing factor.

(B) Pressure Wave. The pressure wave theory was initially believed to have been the most logical mechanism for triple-low level signal initiation. The wave fronts generated by the closure of the EMRV, and the bypass valves arrive at the uppermost tap of the transmitter first, causing the instrument to interpret the presence of a level lower than is actually present. During the July transient, this wave was believed to have been strong enough to cause initiation of the triple-low signal. However, no mention of this effect is found in the G.E. explanation, and if this effect is in fact present, it is certainly masked and/or outweighed by the sharp water level drop, seen on the reactor level curve #2 as a valley between two peaks, caused by the reduction in recirculation pump flow. Although no visible effects of a pressure wave are evident, we cannot completely rule out the possibility of some impact on the transient.

(C) Effective Coolant Density. According to the G.E. analysis (see Appendix D) either a true reduced water level, or a reduced 'effective coolant density' will cause a triple-low level signal. The 'effective coolant density' is defined as the void fraction in the separator standpipes. During the transient event it is postulated that the core area was close to a void fraction of 34%. Although the indicator for measuring level inside the shroud area was not operational during the event, an idea of the level can be seen by examining the curves of annulus reactor water level. The sharp level increases observed are attributable to the "swell" in volume of coolant caused by the depressurization of the vessel. The formation of vapor voids displaces the liquid coolant and causes the free surface as interpreted by the instrumentation to be moved upwards, when in fact the true "collapsed" level is less that the original level because of a net loss of inventory. This is seen graphically when, after the bypass valves close, the voids collapse and the annulus level drops to approximately 3.80'.

As calculated by G.E., during vessel depressurization the 'effective coolant density' was such that the triple-low level switches should not have actuated, since the void fraction was still below that necessary for actuation. However, at the point when the vessel pressure was close to its minimum, the flows of the recirculation pumps were severely restricted due to the reduction in NPSH effect of the near saturation conditions. The net loss in water inventory was at its maximum and level in the core area dropped due to continued steam production. The drop in the annulus level is attributable to both the increased feedwater flow sharply cooling the water in the annulus region, and the leveling off of pressure drop in the vessel. As these effects will serve to collapse the voids, the level indicates a drop. The recirculation pumps then recovered and reestablished flow to the vessel. These events occurred in a very short time frame, and this explains why the triple-low level signal indication on the event recorder was seen to trip "in" and "out" in such a short time, and consequently neither activated the control board annunciator alarm for triple-low indication, nor caused RBCCW system isolation.

Summary

We believe that the G.E. analysis as outlined above in (C) is the best estimate for the cause of the triple-low level indication received during the July 17, 1980 Oyster Creek event. However, the data illustrates a strong contributing effect from the partial separation of annulus and core areas and some possible effects from the presence of a pressure wave.

Question No. 3: Investigate the leak rate determination capability (accuracy, etc.). (If improvements are found to be necessary, they should be added to the list of corrective items, taking their proper place in the priority.)

Response: The leak rate determination capability refers to the identified and unidentified leakage of reactor coolant into the primary containment. The following excerpt from the technical specifications for Oyster Creek outlines the requirements for leak rate determination:

> 3.3 Reactor Coolant
>
> D. Reactor Coolant System Leakage
>
> "Reactor coolant leakage into the primary containment from unidentified sources shall not exceed 5 gpm. In addition, the total leakage in the containment, identified and unidentified shall not exceed 25 gpm. If these conditions cannot be met, the reactor will be placed in the cold shutdown condition."

At the present time, the standard procedures for the operating personnel at the plant calls for a torus level reading every 8 hours. Assuming the maximum technical specification unidentified leakage of 5 gpm occurs to the torus during this time, the plant operator would need a device capable of accurately estimating a change of 2400 gallons in the torus. The maximum and minimum water volumes in the torus are specified at 92,000 cu. ft. and 82,000 cu. ft., respectively. At a temperature of 60°F, this equates to a maximum of 688,211 gallons and a minimum of 613,405 gallons or a difference of 74,705 gallons. The two full scale torus level indicators at the plant are calibrated for a 40" water range, or 1870 gallons per inch of torus water height. The problem in reading these meters becomes apparent when realizing that on a typical 6" meter scale graduated for 40" of height, one inch is about 5/32" of the meter scale. Therefore, an operator checking for a technical specification violation using the vertical meters on the control board would be required to determine a difference in pointer reading of about 3/16" over an eight hour period on a meter that is only knee high.

It should be noted that although unidentified leakage finds its way to the torus, the drywell sump will also accumulate leakage from unidentified sources. The total will be the sum of the two. ~~Therefore,~~ an even smaller amount of torus level increase may need to be determined to assess its contribution to the entire unidentified leakage volume, prior to comparison with technical specification limits.

There are two recorders which monitor the torus level in the control room in addition to the two level indicators. These recorders are located on a back panel in a different area from the indicators. One is labeled as a "wide range" recorder and the other as "a narrow range," although they both have relatively narrow range scales when compared to the 40" indicators. The "narrow range" recorder measures torus level from +3" to +7", a span of 4"

(7,480 gallons). The "wide range" recorder reads level from -5" to +15", a range span of 10" (18,700 gallons). Tracking of the torus level by these recorders is automatic. A hard copy trace is conveniently made, which can be later used for trending or leakage calculations. However, there are times during plant operation evolutions when these recorders are not on scale and the torus level measurement for technical specifications must be made from the indicators.

Summary

Before a final decision can be made in dealing with the question of torus level indication, further analysis must be made, specifically, the functional operability requirements of the present measurement system should be defined from the original design criteria. As this is better understood, an effort to match the present arrangement with human factor engineering principles can be attempted. In the near future, a major review of the entire Oyster Creek control room instrumentation is to be undertaken in this manner. Two possible solutions which might be considered in this review are presented below:

(1) A review of the technical specifications concerning torus level and identified/unidentified leakage may find that an increase in the time between torus level readings may be sufficient, with present instrumentation, to obtain on indicated rate of leakage. Given some constant leakage into the torus, for instance, the measurement of the level as followed by the operators would be a series of data points which could be fit with a straight line. The maximum leakage could then be computed from that line and compared with technical specification limits. The possibility of a change in the technical specifications in regard to these limits should also be considered.

(2) A changeout of the present vertical level indicators is the plant preferred method for dealing with this problem. It is suggested that the merits of a digital indicator be thoroughly examined. With a digital LED type readout little reading error should remain, precluding the necessity for allowing large periods of time to pass between indicator readings to minimize error. Additionally, a wide range recorder could be installed, compatible with the scale of the indicator. It would be of some value in trending or computing leakage rates, when the situation warranted, as during those times when the "narrow" and "wide" range level recorders were unable to track. In the event that an instrument changeout is decided upon as the correct solution, a re-evaluation of the location of these instruments on the control board might also be in order.

GORB ACTION ITEM NO. 375

Corrective Action

(1) Reactor water level indication

Although the sudden opening of the bypass valves may not happen again as it did, there might be a failure at some point in the future which would cause a similar set of conditions to occur. In this case a quick and early automatic scram would prevent a more severe transient. We understand that at present a wide range instrument has been installed which measures the core area level, but only when the RCR pumps are not running. This is due to the fact that the core area level is effected by a number of hydraulic forces present during plant operation which will not allow the actual reading and the real core level to be the same. Although this indicator may not provide an absolute measurement of the true level, it might be possible to correlate readings obtained, with those of the annulus, thus developing a data base for determining what the normal range of level operation is with respect to the annulus. Tracking of this core level vs. the annulus level would additionally assist in the measure of communicability between the two regions. The primary purpose of this indicator, however, would be to transmit rapid changes in core area level as would be experienced during water level transients. It is expected that any change in indicated level should be accurate, to a high degree, of a similar level change in the core area. It is this data that would be of paramount importance during future transient analysis where annulus/core area separation is a factor. Investigation into the necessary engineering design information associated with this arrangement should be initiated to determine the feasibility of employing an indicator/recorder instrument in this application for full time operation.

(2) RBCCW System Isolation

As a result of the spurious RBCCW isolation that occurred during the initial phases of the July 17 transient, reexamination of the design bases for the initiation should be reviewed. It appears that if the RBCCW system can be isolated without an actual loss of coolant, then the possibility exists for several temperature related problems to develop in the drywell before automatic initiation of containment spray would occur. Any other response would require operator action such as a reset of RBCCW or an initiation of containment spray. A request from the plant staff to the Plant Analysis Section to analyze the design bases behind RBCCW isolation and containment spray will be forwarded to the appropriate Engineering Section for response. In the meantime, the plant has taken steps to have a time delay inserted in the RBCCW isolation circuitry, which will hopefully preempt any further unnecessary isolations.

(3) Torus Level Readout Instrumentation

Analysis of the functional operability requirements of the present torus level measurement system should be completed, and an improved system proposed. Two possible schemes for consideration are:

1. (a) Replacement of present vertical scale instrument with one having a digital display and/or recorder trace capability, and
   (b) Possible control board location change.

2. (a) Decrease in measurement frequency to allow better vertical scale resolution, and
   (b) Procedure to calculate straight-line, or curve fits to data points, and
   (c) Any attendant technical specification changes required.

(4) Computer Analysis

Additional analysis of this transient is to be performed by the Safety Analysis and Plant Control Section of Systems Engineering. Part of this analysis will include the use of the RETRAN computer code. RETRAN will identify, more specifically, results of situations more serious than those that took place, but which might have occurred during the course of the transient. A summary of this work can be forwarded to the GORB if desired.

(5) Industry Distribution

Based on analysis of this transient; despite the fact that it was a non-reportable event, the NSAC (Nuclear Safety Analysis Center) people have expressed interest in this transient analysis. Consequently, we will make arrangements to forward a copy of this report to them, after obtaining the necessary approvals.

(6) Data Collection and Storage

Gathering all the data for this event was difficult and time consuming. Although we recognize that there is limited capability for automatic collection of data at Oyster Creek, we recommend that for all significant events (e.g. reactor trips, etc.) the data base on the Prime Computer should be stored on magnetic tape and all control room strip chart recorders should be stored in one place for ease of analysis. This will be helpful not only if the event turns out to be unusual, but also data from routine events are necessary to benchmark computer codes and training simulators.

Report to GORB

Action Item No. 375

Appendix A

Original Plant Sequence
of Events

PLANT REPORTED
SEQUENCE OF EVENTS

8:30-8:35 pm	Increasing power and attempting to control Reactor Pressure with EPR/MPR and Bypass Valve opening. Reactor level (feedwater) controls were in manual mode. Bypass Valves not responding. Tried Bypass Valves opening jack with no success.
8:35-8:38	With pressure increasing to ~1050 psig, "D" ERV opened to reduce pressure. "D" stayed open for 14 seconds until pressure dropped to ~1000 psig at which point it closed. At this point operators received RBCCW isolation signal and the 3 RBCCW isolation Valves to the Drywell closed. Operator pushed the reset and manually opened the Isolation Valves. Other than the Isolation Alarms for RBCCW no other related alarms or signals were present.
8:36-8:41	With EMRV "D" closed and the Turbine Pressure Control still not functioning, reactor pressure started increasing from 1000 psig to ~1032 psig at which point, because of Control Rod insertion and resultant power decrease, the pressure started to turn around and slowly decrease.
8:41:30	Operator at the pressure control still unable to control Rx pressure with normal controls (Bypass valves) and thinking pressure increasing to ERV set point, went to back panel and reset the #2 Vacuum Trip. This action caused the Bypass Valves to open on demand causing rapid depressurization of the Reactor from ~1028 psig to 944 psig.
8:41:33	Operator realizing the effect of the Bypass Valve opening, tripped the #2 Vacuum Trip causing the Bypass Valves to go closed. Just prior to this action the rapid depressurization and the high coolant temperature caused voiding in all regions of the Reactor vessel with corresponding level increase of ~2 feet and loss of suction on Recirc. Pumps resulting in low Recirc. flow.
8:41:47	When the Bypass Valves closed the pressure change and resulting Hydraulic disturbance caused the Rx triple low sensors (4) to actuate (Bounce in and out) and pick up the event recorder. At this time there was no heavy loss of inventory and the sensor actuation is believed to have been caused by the pressure transient sensed in the annulus and in the reference leg of the sensors. With the configuration of this instrument the reference leg senses from the annulus and the variable leg senses from the Top of the Core region. It is believed that the pressure transient was seen first in the reference leg and this created an imbalance in the DP to actuate the sensors.
8:42:11	With the Bypass valves closed, the pressure started increasing and Reactor Water level decreased due to collapse of the steam voids. Reactor Level decreased to the Low Level scram setpoint and the Reactor scrammed. Reactor level further decreased to approximately 37" on the Yarway (~10'3" above top of core). The operator then increased level manually and maintained approximately 75" on Yarway (13'5"TAF).

8:43 pm Reactor pressure continued to decrease and experienced same operation with pressure below saturation temperature and resultant flashing to steam as evidenced by recirc flow and Temperature.

Reactor shutdown continued with mode switch in shutdown and the Reactor Coolant was brought to less than 212°F at 6:30 a.m.

The NRC was notified of the scram at 9:40 and later updated via the hot line at 4:15 a.m. on the condition and results of our investigation.

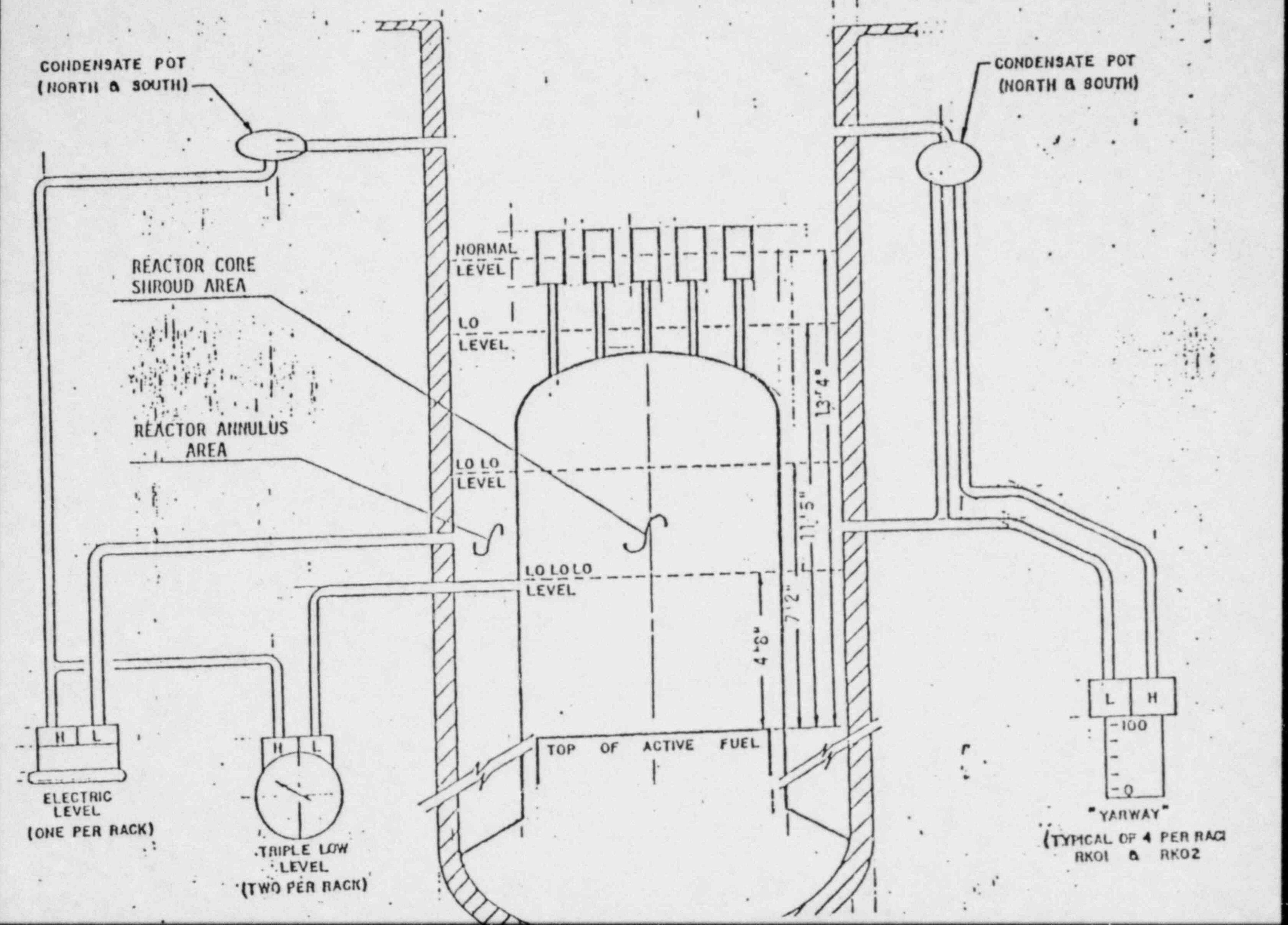
An investigation was conducted of the events and parameters associated with the scram. Participating in the investigation were the following personnel: A. H. Rone, K. O. E. Fickeissen, N. Howey, J. L. Sullivan and John Thomas of the NRC.

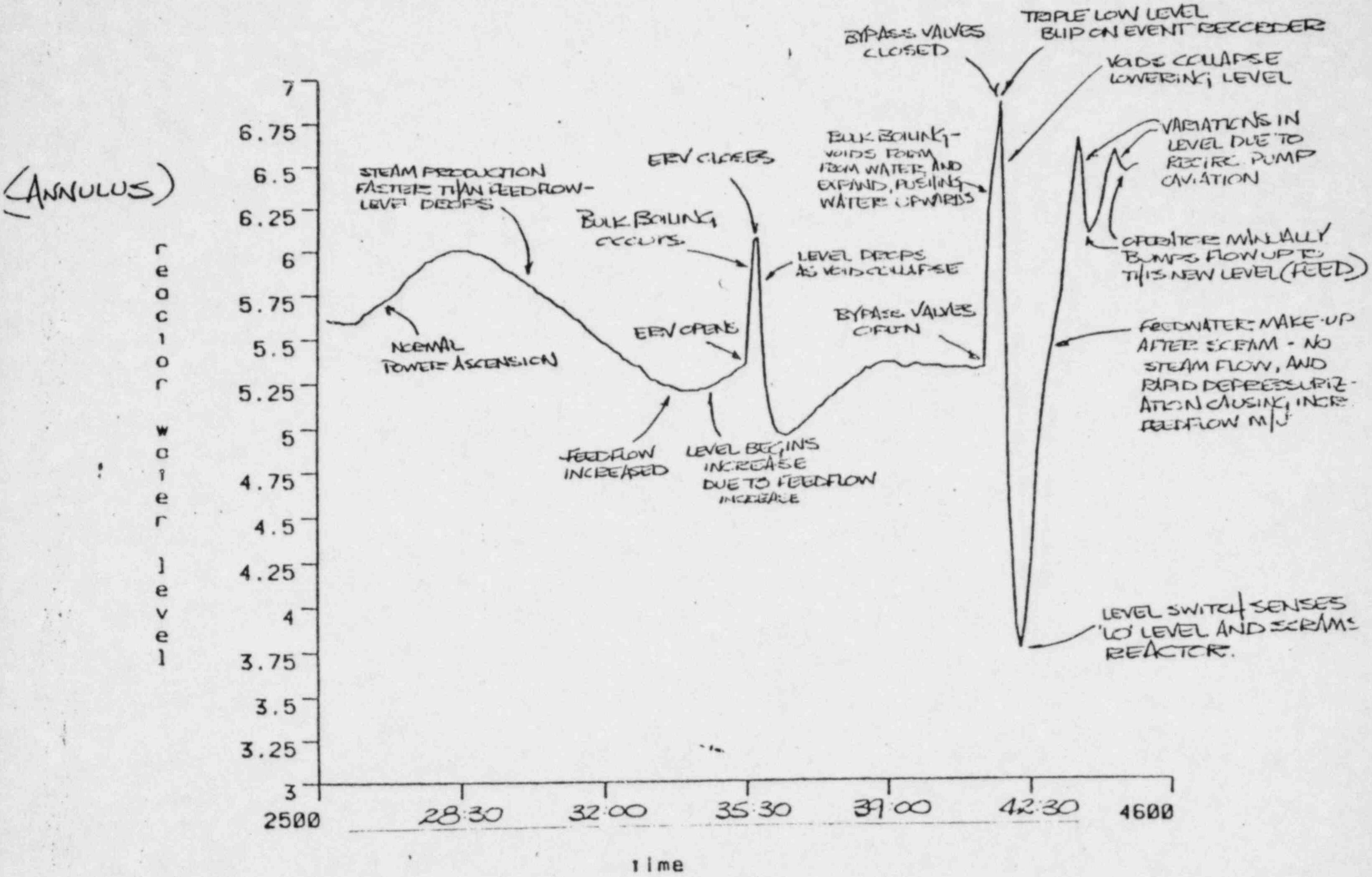
<u>Report to CORB</u>

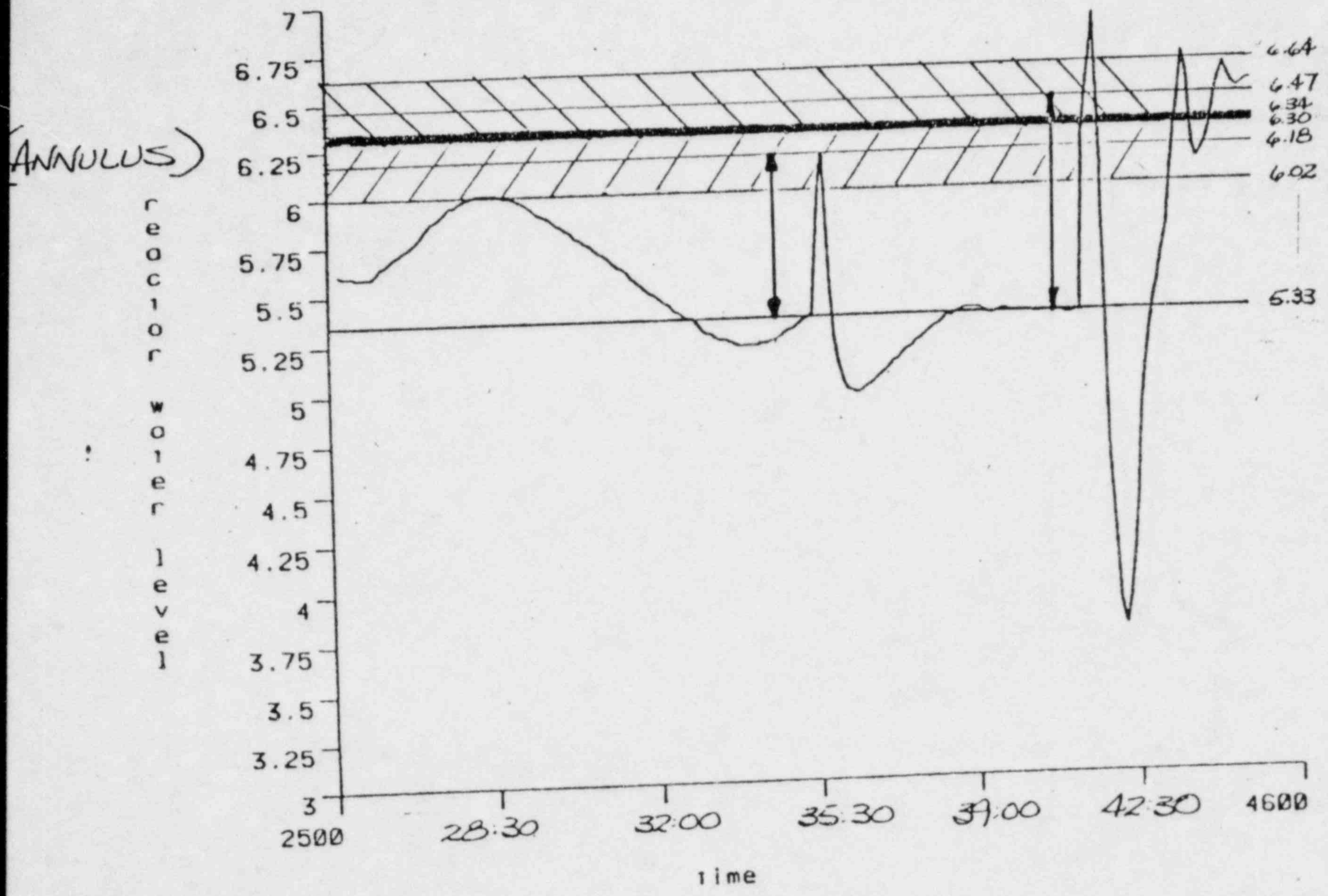
Action Item No. 375

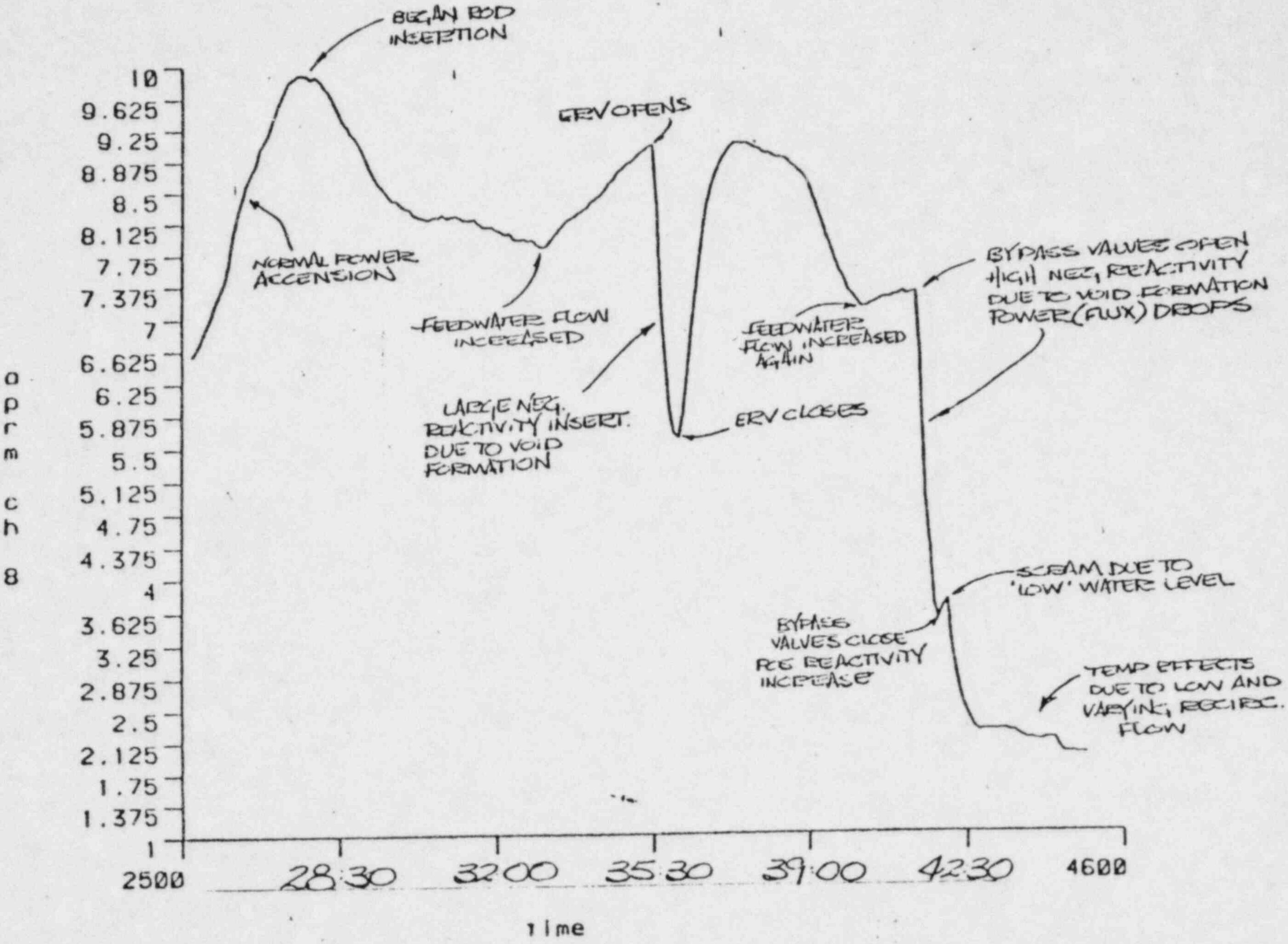
<u>Appendix B</u>

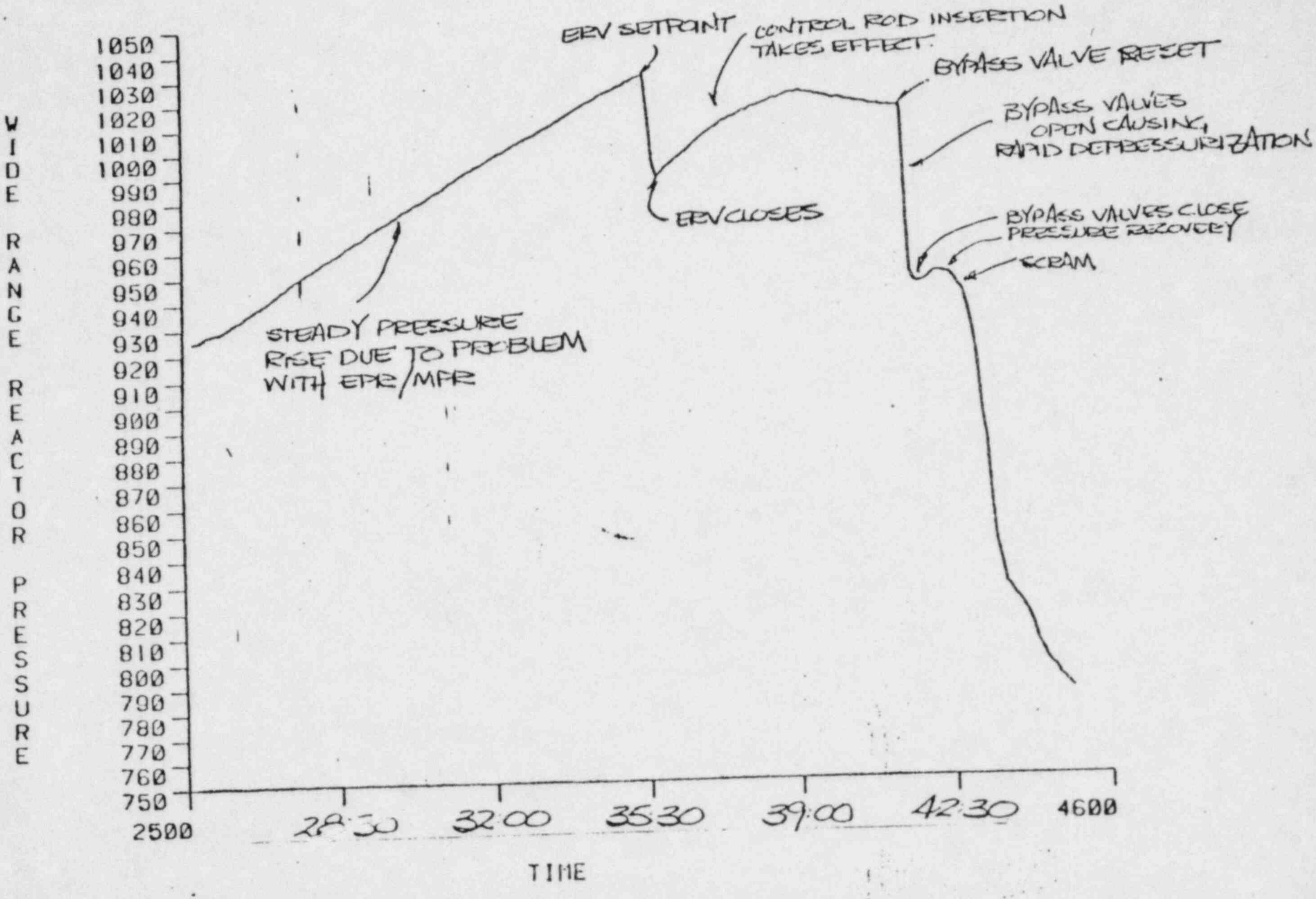
Transient Curves

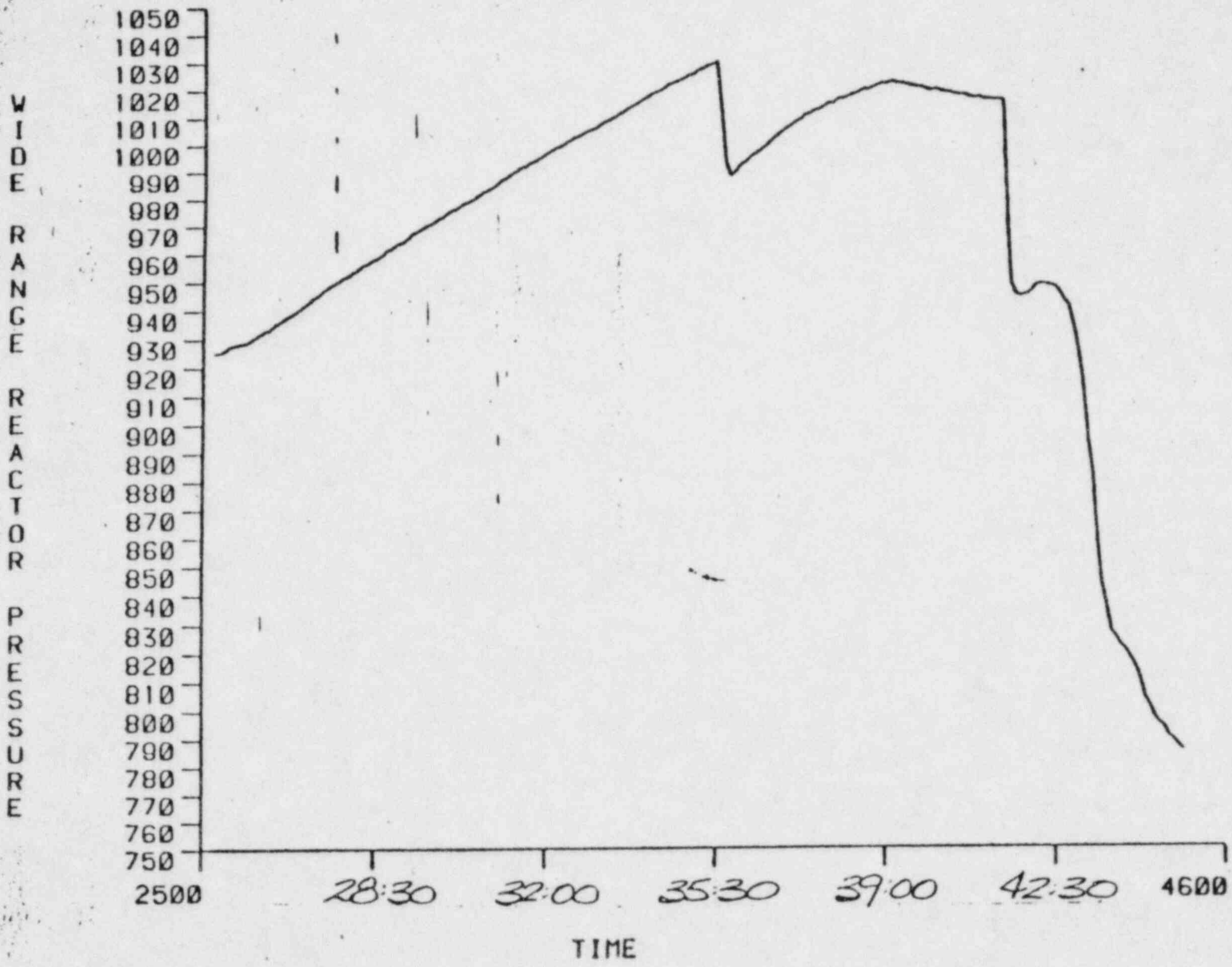

CONDENSATE POT
(NORTH & SOUTH)
CONDENSATE POT
(NORTH & SOUTH)
REACTOR CORE
SHROUD AREA
REACTOR ANNULUS
AREA
NORMAL
LEVEL
LO
LEVEL
LO LO
LEVEL
LO LO LO
LEVEL
13'4"
11'5"
7'2"
4'8"
TOP OF ACTIVE FUEL
H
L
ELECTRIC
LEVEL
(ONE PER RACK)
H
L
TRIPLE LOW
LEVEL
(TWO PER RACK)
L
H
100
0
"YARWAY"
(TYPICAL OF 4 PER RACI
RKO1 & RKO2

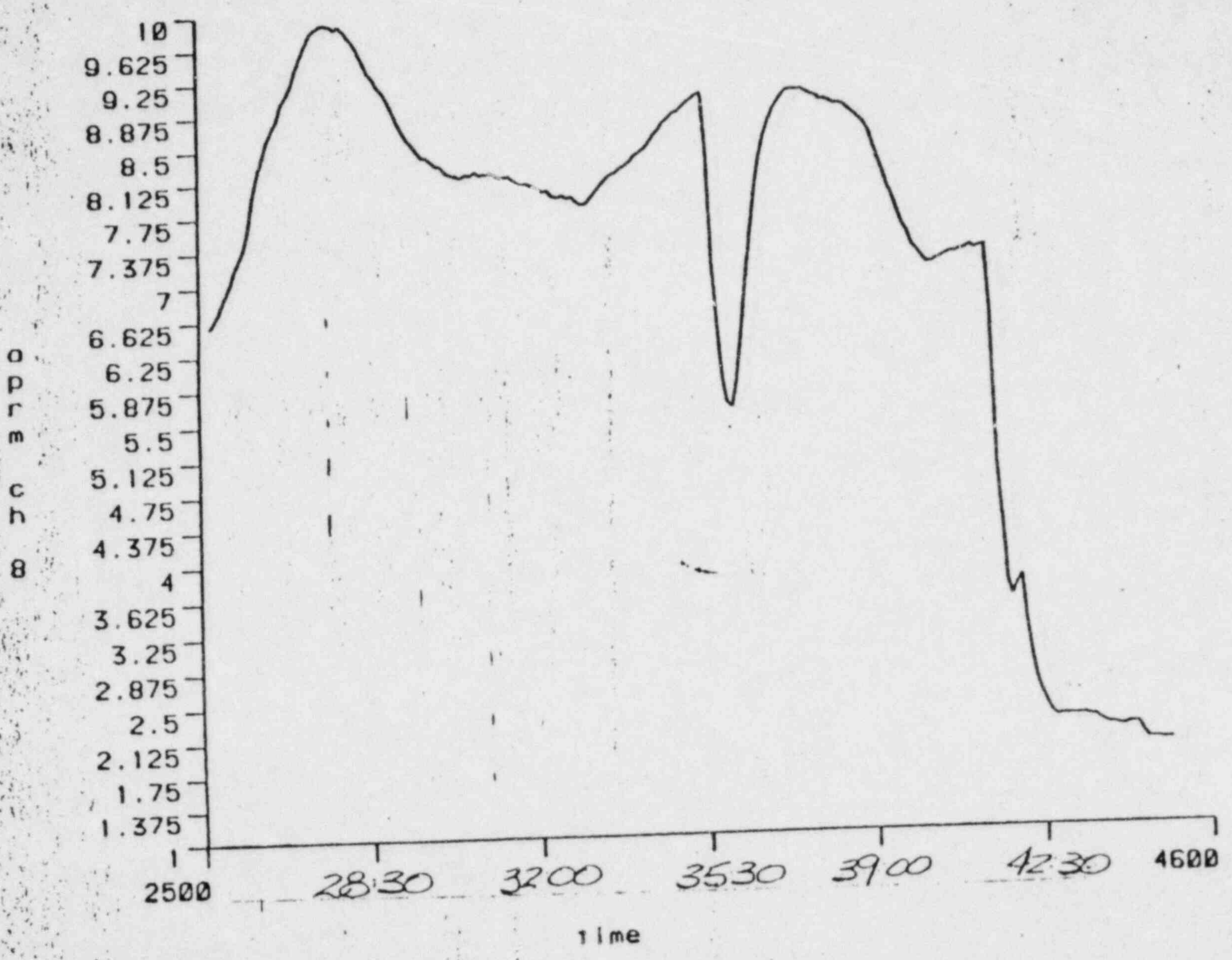

(ANNULUS)
reactor water level
7
6.75
6.5
6.25
6
5.75
5.5
5.25
5
4.75
4.5
4.25
4
3.75
3.5
3.25
3
2500
28:30
32:00
35:30
39:00
42:30
4600
time
NORMAL POWER ASCENSION
STEAM PRODUCTION FASTER THAN FEEDFLOW - LEVEL DROPS
FEEDFLOW INCREASED
LEVEL BEGINS INCREASE DUE TO FEEDFLOW INCREASE
ERV OPENS
BULK BOILING OCCURS
ERV CLOSES
LEVEL DROPS AS VOIDS COLLAPSE
BYPASS VALVES OPEN
BULK BOILING - VOIDS FORM FROM WATER AND EXPAND, PUSHING WATER UPWARDS
BYPASS VALVES CLOSED
TRIPLE LOW LEVEL BLIP ON EVENT RECORDER
VOIDS COLLAPSE LOWERING LEVEL
VARIATIONS IN LEVEL DUE TO RECIRC PUMP CAVIATION
OPERATOR MANUALLY BUMPS FLOW UP TO THIS NEW LEVEL (FEED)
FEEDWATER MAKE-UP AFTER SCRAM - NO STEAM FLOW, AND RAPID DEPRESSURIZATION CAUSING INCR FEEDFLOW M/U
LEVEL SWITCH SENSES 'LO' LEVEL AND SCRAMS REACTOR.


(ANNULUS)
reactor water level
7
6.75
6.5
6.25
6
5.75
5.5
5.25
5
4.75
4.5
4.25
4
3.75
3.5
3.25
3
2500
28:30
32:00
35:30
39:00
42:30
4600
time
6.64
6.47
6.34
6.30
6.18
6.02
5.33


BEGAN ROD INSERTION
NORMAL POWER ACCENSION
FEEDWATER FLOW INCREASED
ERV OPENS
LARGE NEG. REACTIVITY INSERT. DUE TO VOID FORMATION
ERV CLOSES
FEEDWATER FLOW INCREASED AGAIN
BYPASS VALVES OPEN HIGH NEG. REACTIVITY DUE TO VOID FORMATION POWER (FLUX) DROPS
SCRAM DUE TO 'LOW' WATER LEVEL
BYPASS VALVES CLOSE POS REACTIVITY INCREASE
TEMP EFFECTS DUE TO LOW AND VARYING RECIRC. FLOW
10
9.625
9.25
8.875
8.5
8.125
7.75
7.375
7
6.625
6.25
5.875
5.5
5.125
4.75
4.375
4
3.625
3.25
2.875
2.5
2.125
1.75
1.375
1
aprm ch 8
2500
28:30
32:00
35:30
39:00
42:30
4600
time


WIDE RANGE REACTOR PRESSURE
1050
1040
1030
1020
1010
1090
990
980
970
960
950
940
930
920
910
900
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
2500
28:30
32:00
35:30
39:00
42:30
4600
TIME
STEADY PRESSURE RISE DUE TO PROBLEM WITH EPR/MPR
ERV SETPOINT
ERV CLOSES
CONTROL ROD INSERTION TAKES EFFECT.
BYPASS VALVE RESET
BYPASS VALVES OPEN CAUSING RAPID DEPRESSURIZATION
BYPASS VALVES CLOSE
PRESSURE RECOVERY
SCRAM


WIDE RANGE REACTOR PRESSURE
1050
1040
1030
1020
1010
1000
990
980
970
960
950
940
930
920
910
900
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
2500
28:30
32:00
35:30
39:00
42:30
4600
TIME


10
9.625
9.25
8.875
8.5
8.125
7.75
7.375
7
6.625
6.25
5.875
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5.125
4.75
4.375
4
3.625
3.25
2.875
2.5
2.125
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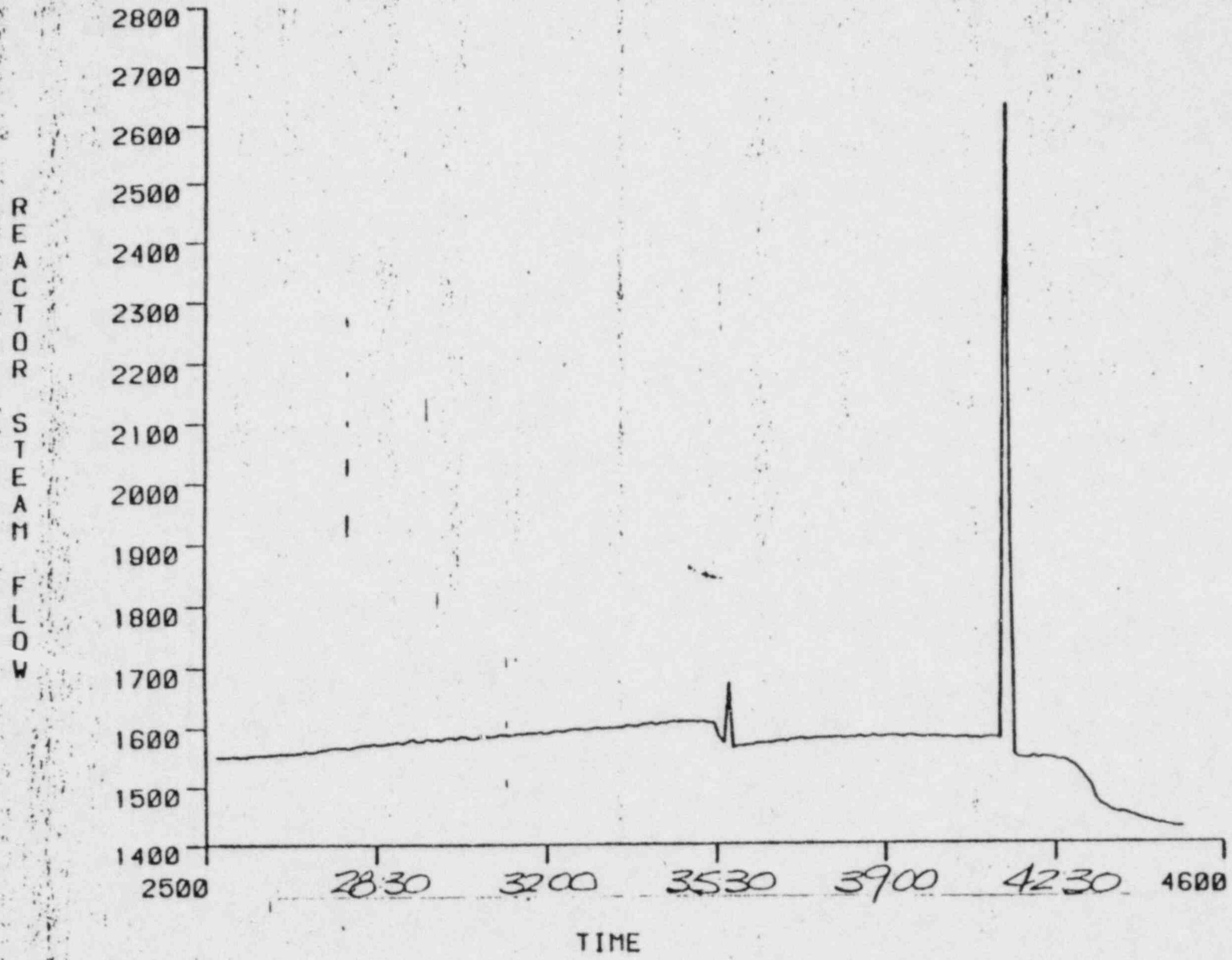
1.375
1
oprm ch 8
2500
28:30
32:00
35:30
39:00
42:30
4600
time


REACTOR STEAM FLOW
2800
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
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2830
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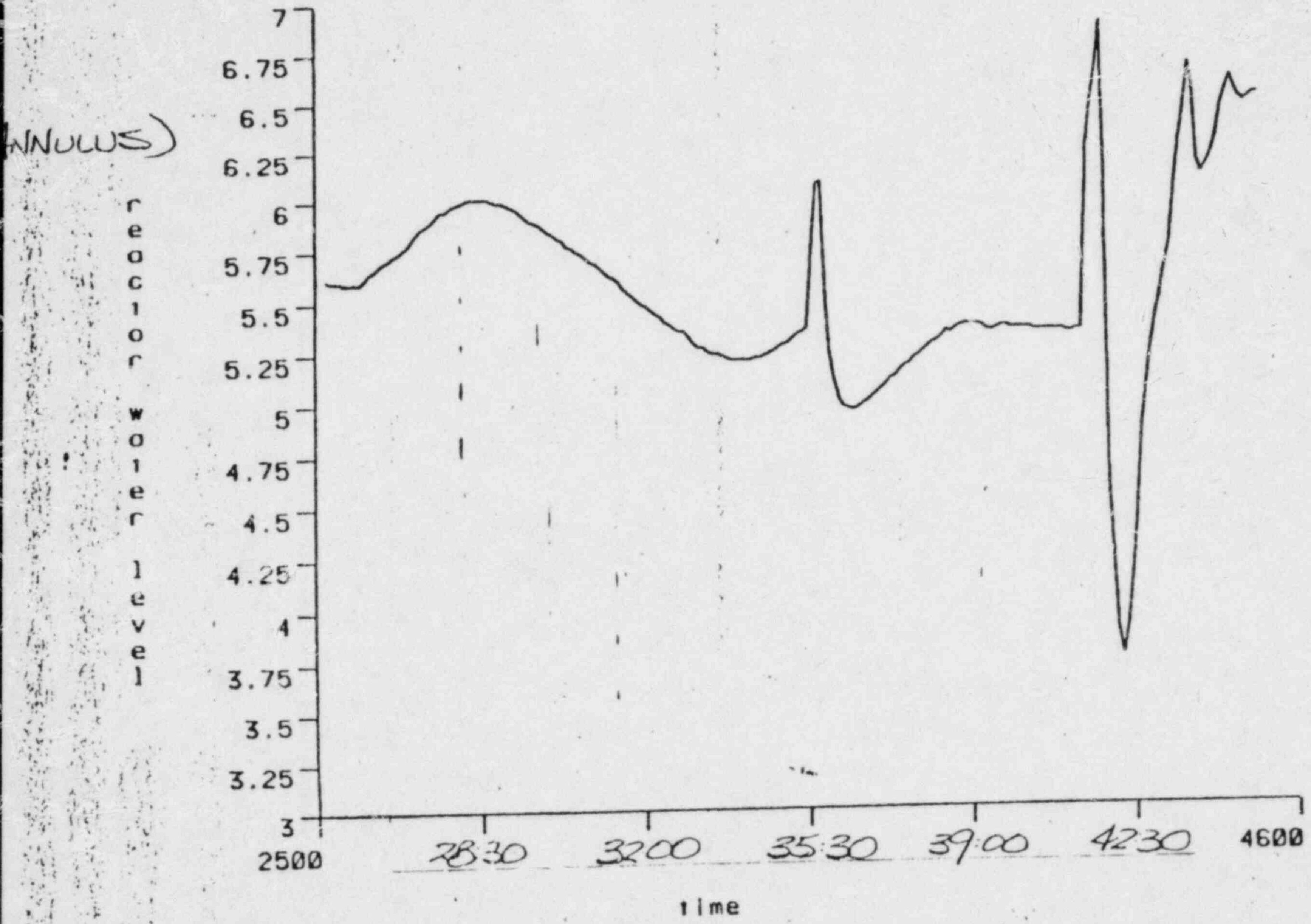
3530
3900
4230
4600
TIME


ANNULUS)
reactor water level
7
6.75
6.5
6.25
6
5.75
5.5
5.25
5
4.75
4.5
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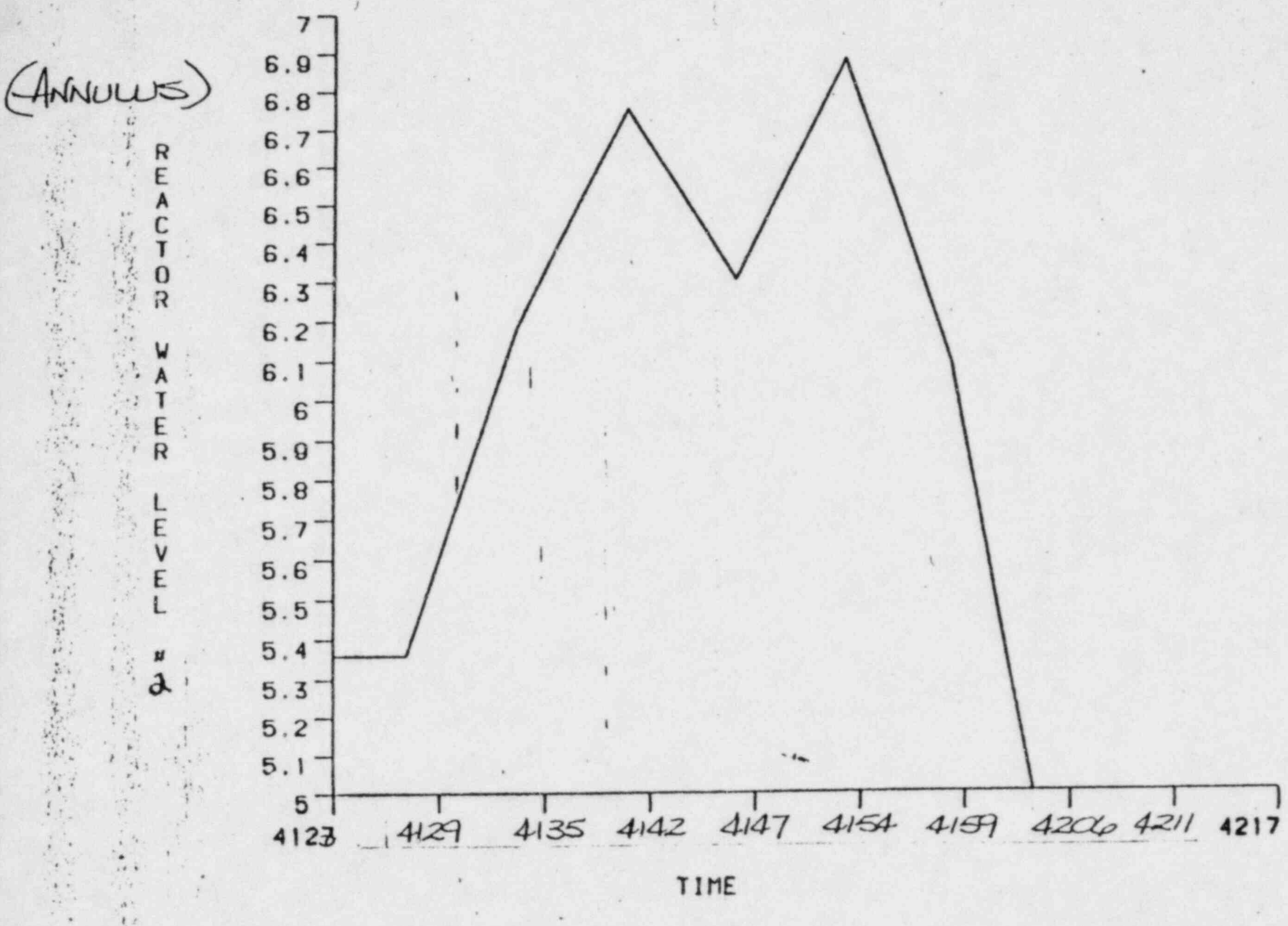
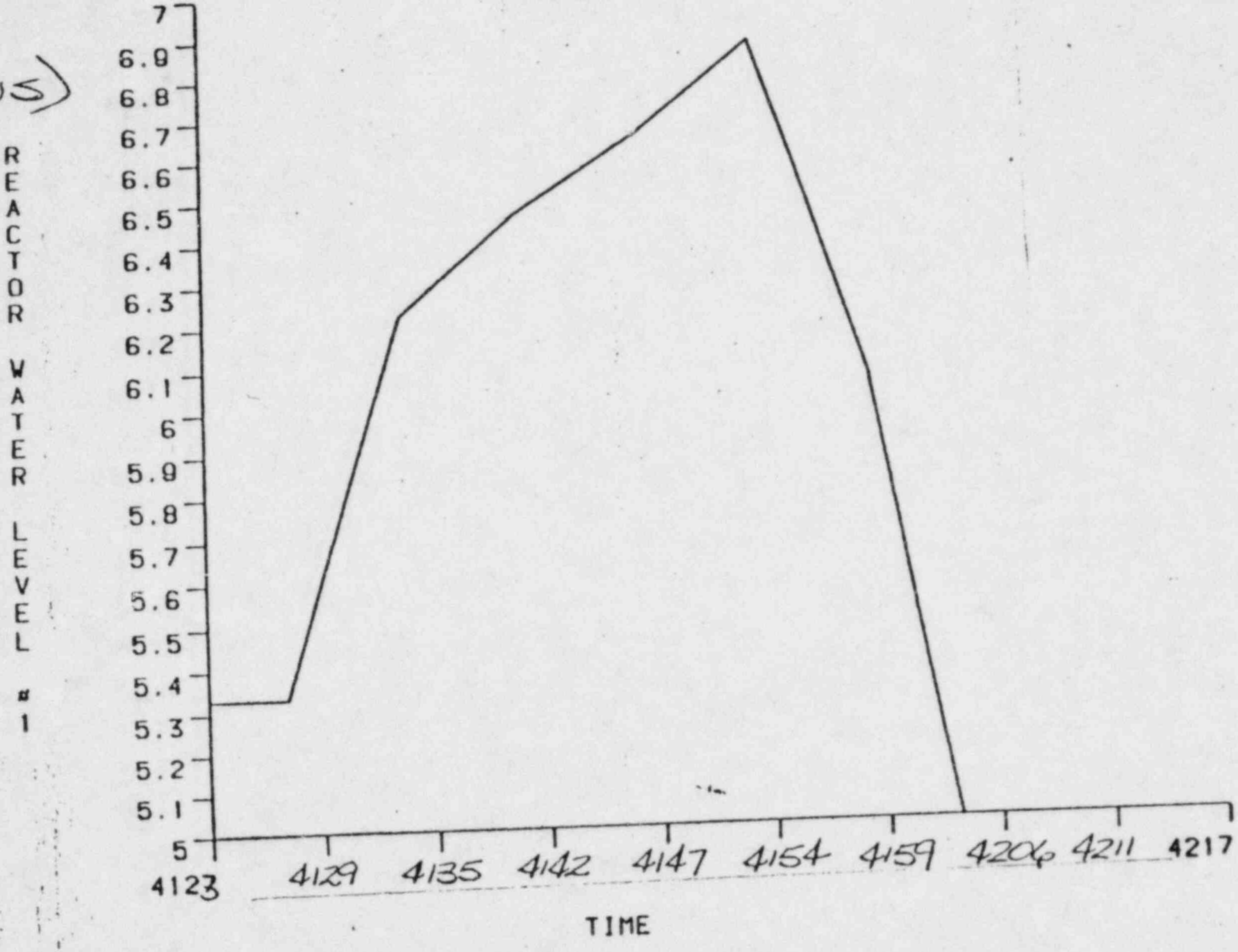
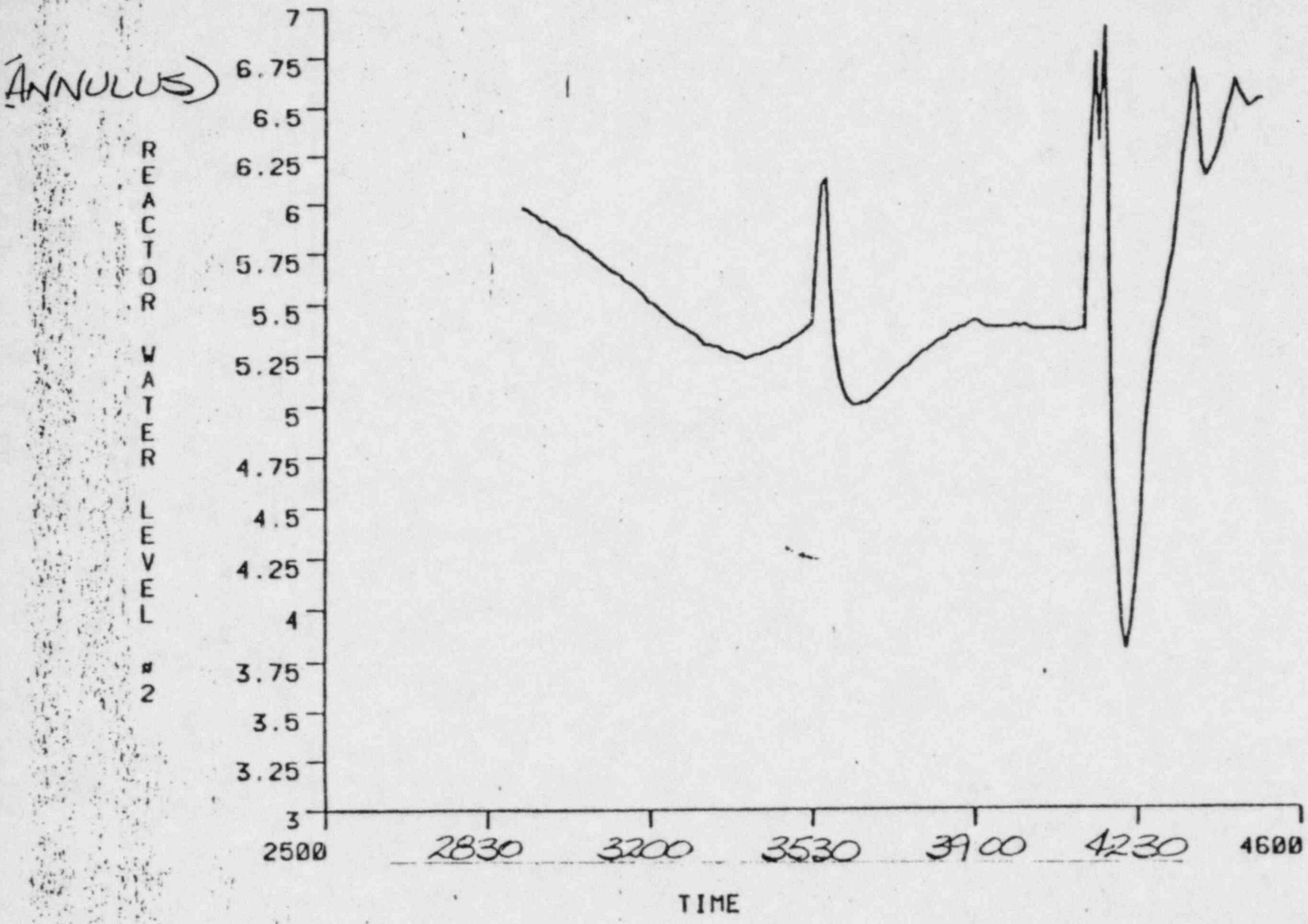
35:30
39:00
4230
4600
time

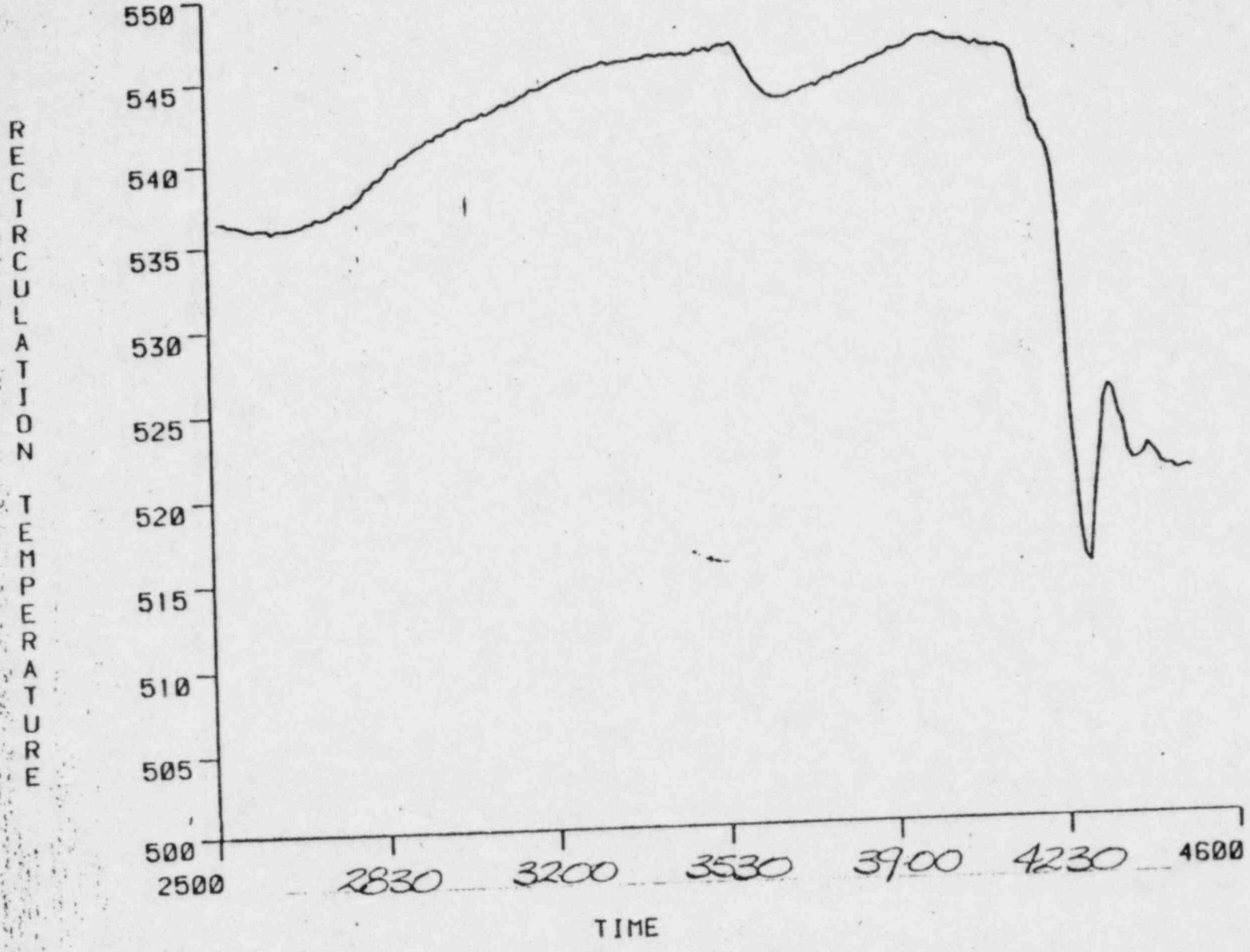

(ANNULUS)
REACTOR WATER LEVEL # 2
7
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4123
4129
4135
4142
4147
4154
4159
4206
4211
4217
TIME

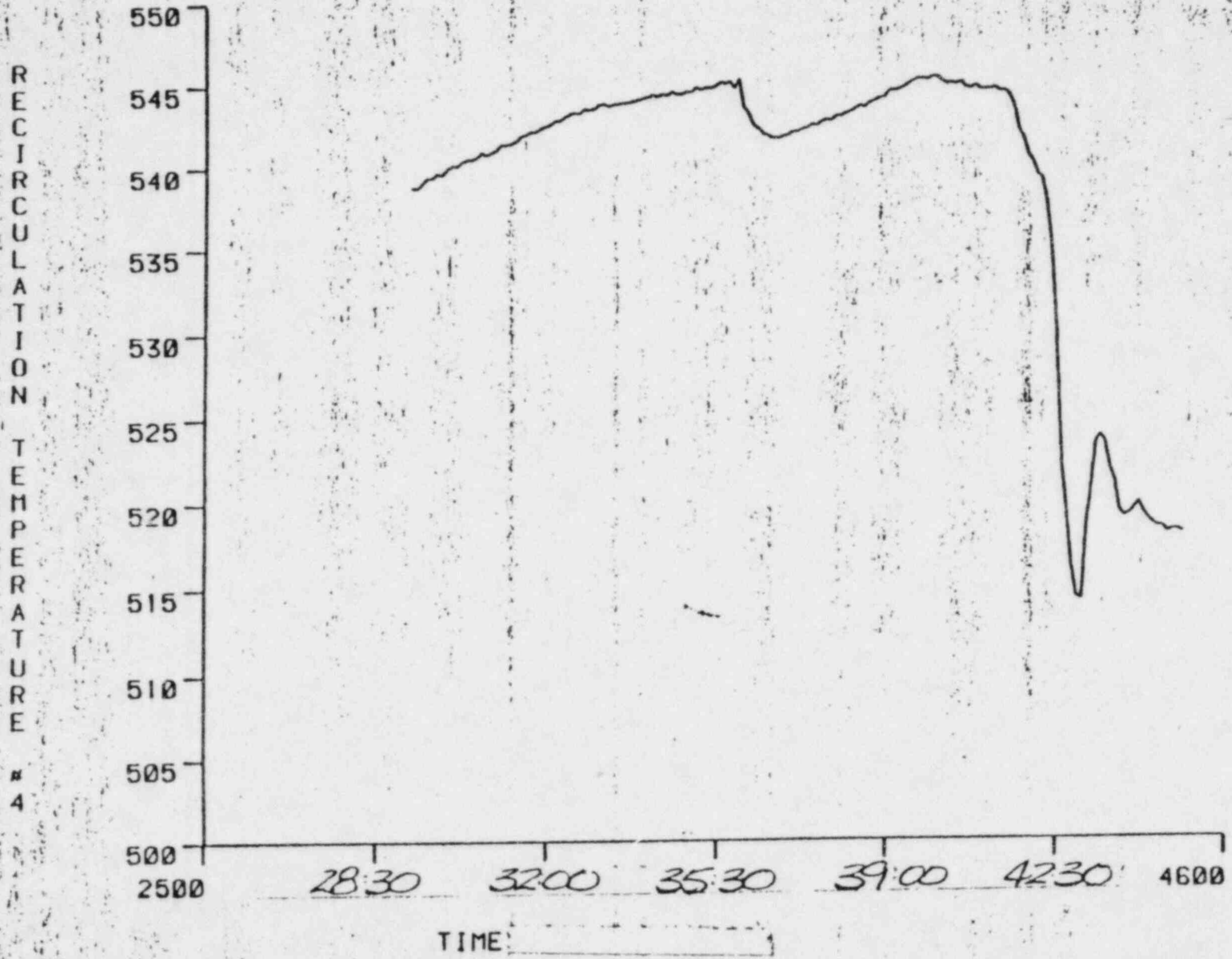
NNULUS)

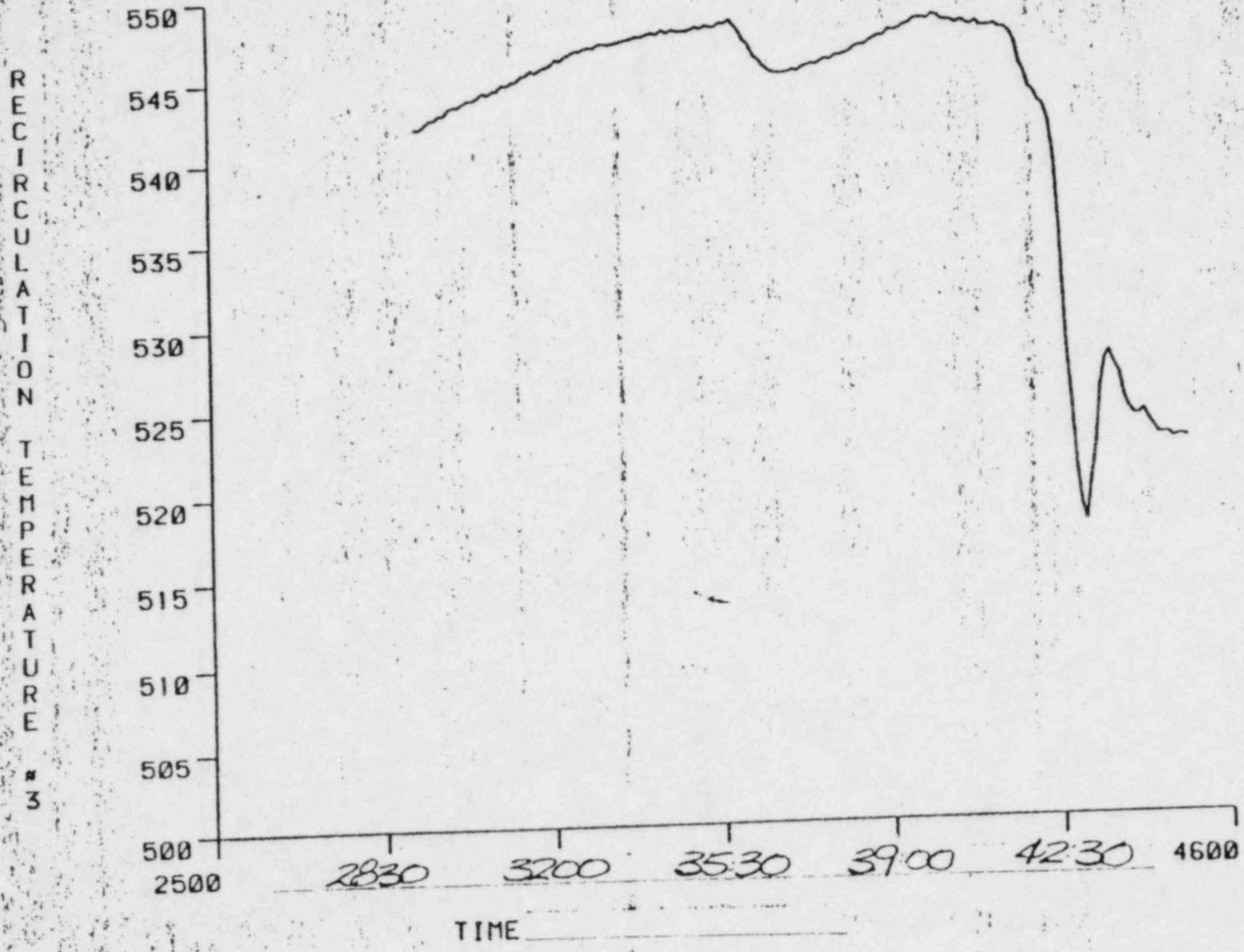


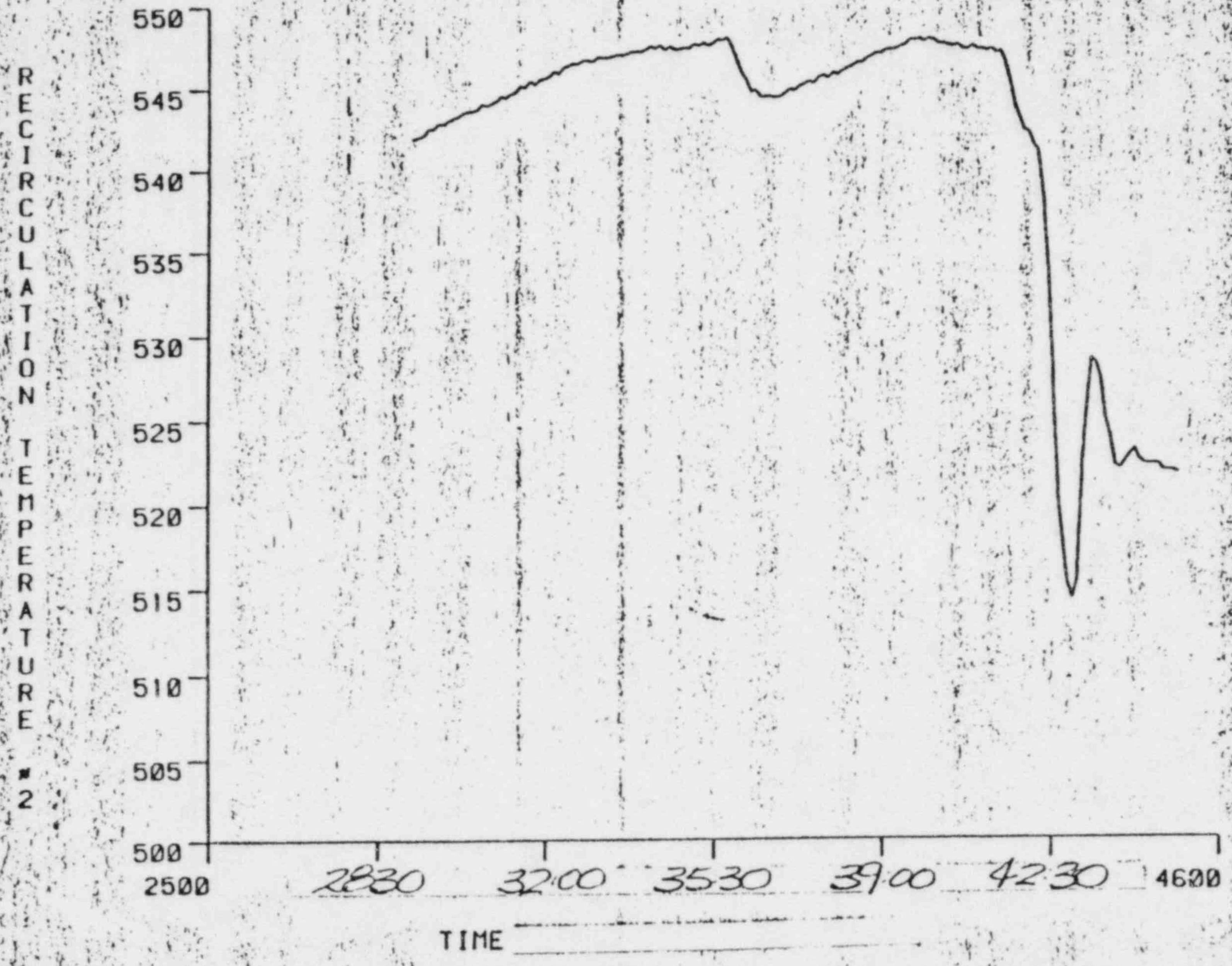
REACTOR WATER LEVEL # 1
7
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4123
4129
4135
4142
4147
4154
4159
4206
4211
4217
TIME

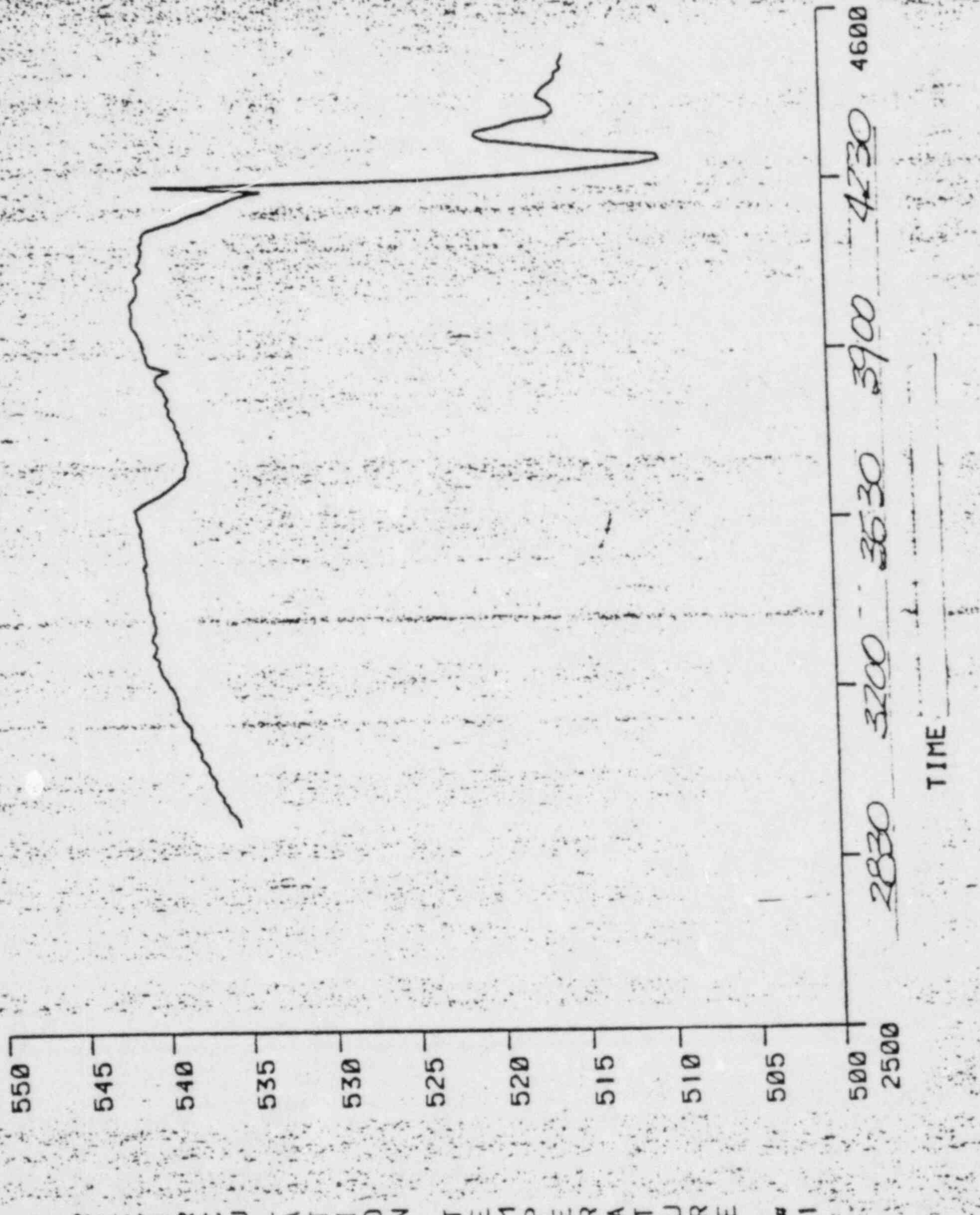

ANNULUS)
REACTOR WATER LEVEL #2
7
6.75
6.5
6.25
6
5.75
5.5
5.25
5
4.75
4.5
4.25
4
3.75
3.5
3.25
3
2500
2830
3200
3530
3900
4230
4600
TIME

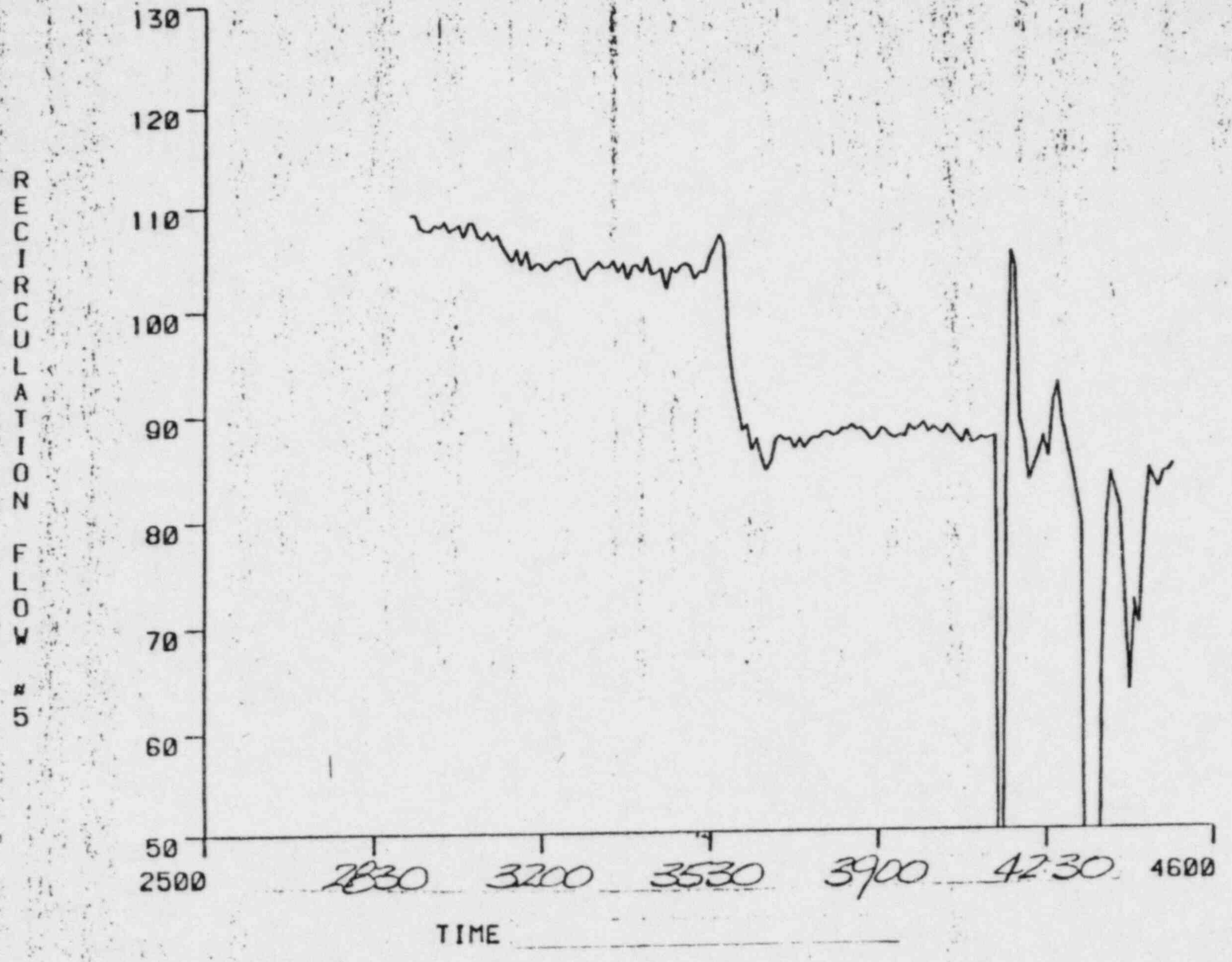

550
545
540
535
530
525
520
515
510
505
500
RECIRCULATION TEMPERATURE
2500
2830
3200
3530
3900
4230
4600
TIME

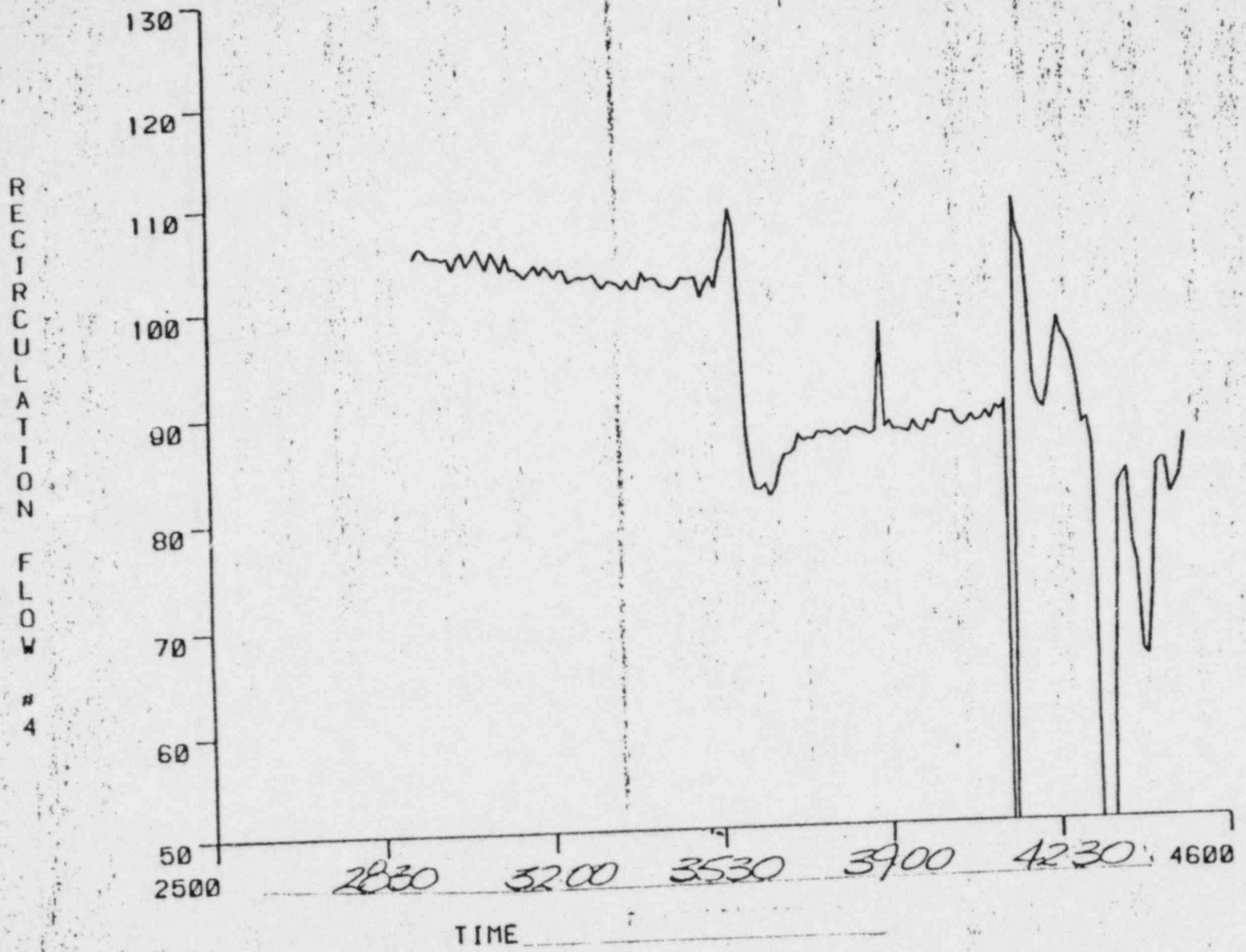

RECIRCULATION TEMPERATURE #4
550
545
540
535
530
525
520
515
510
505
500
2500
28:30
32:00
35:30
39:00
42:30
4600
TIME

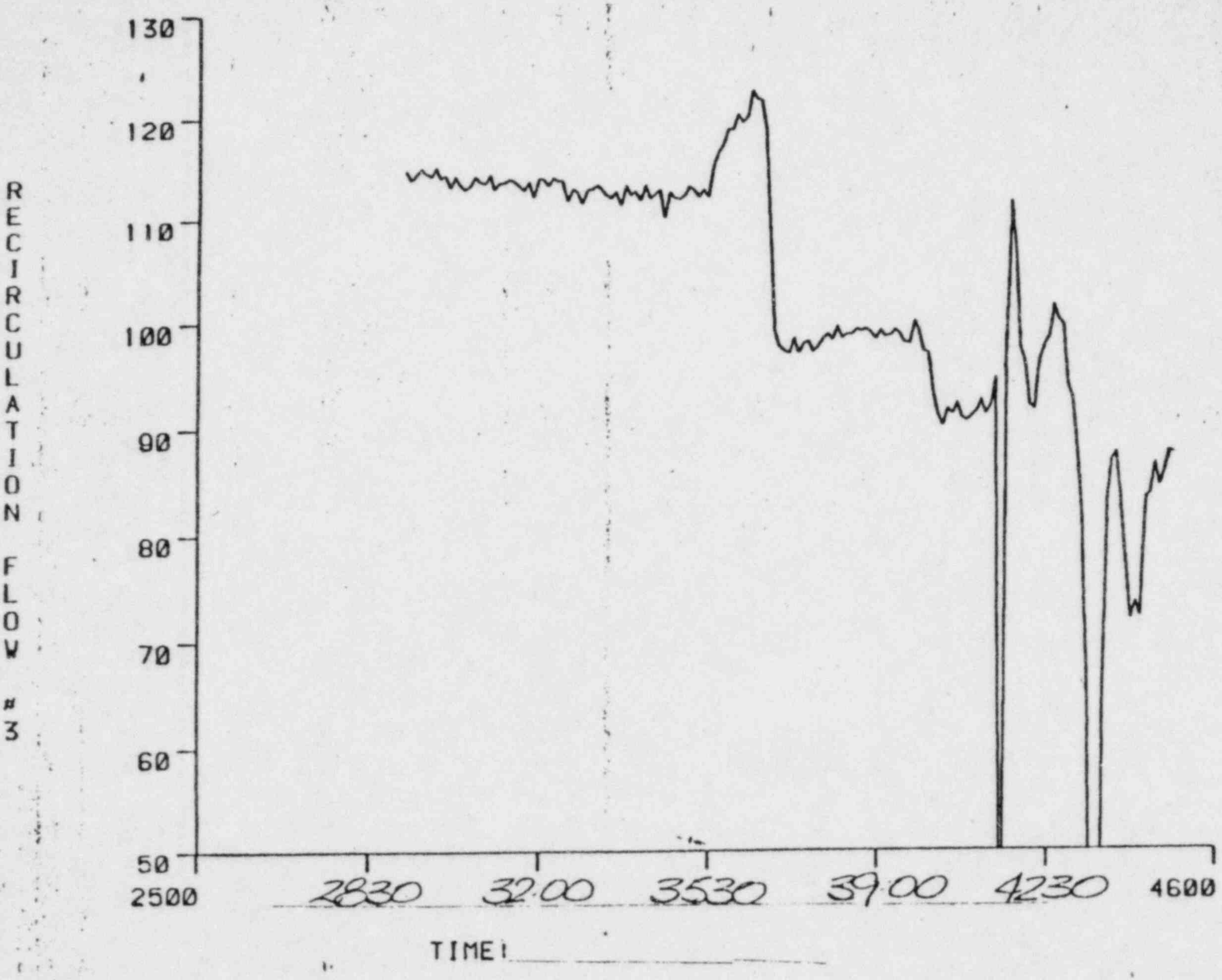

RECIRCULATION TEMPERATURE #3
550
545
540
535
530
525
520
515
510
505
500
2500
2830
3200
35:30
39:00
42:30
4600
TIME

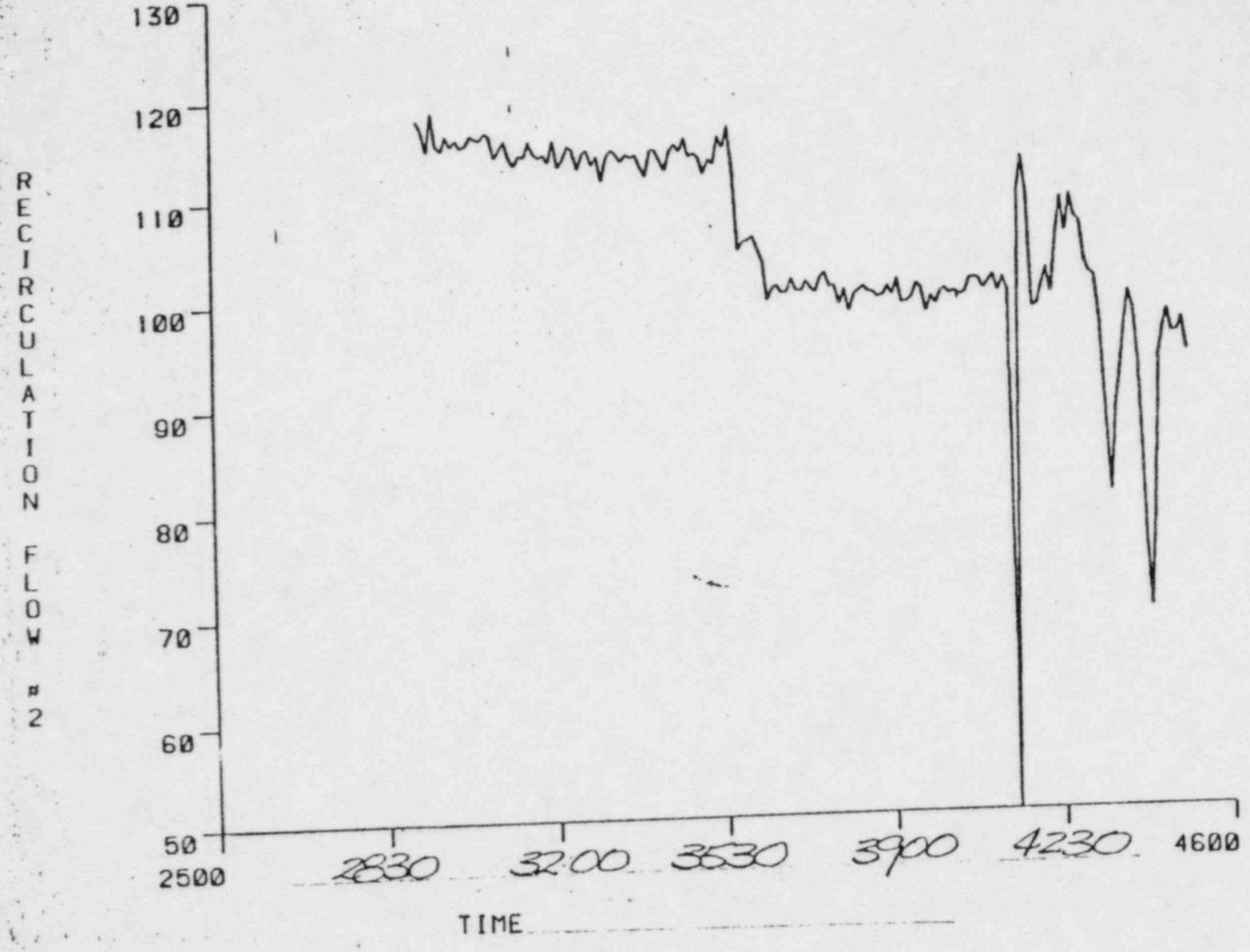

RECIRCULATION TEMPERATURE #2
550
545
540
535
530
525
520
515
510
505
500
2500
2830
32:00
35:30
39:00
42:30
4600
TIME

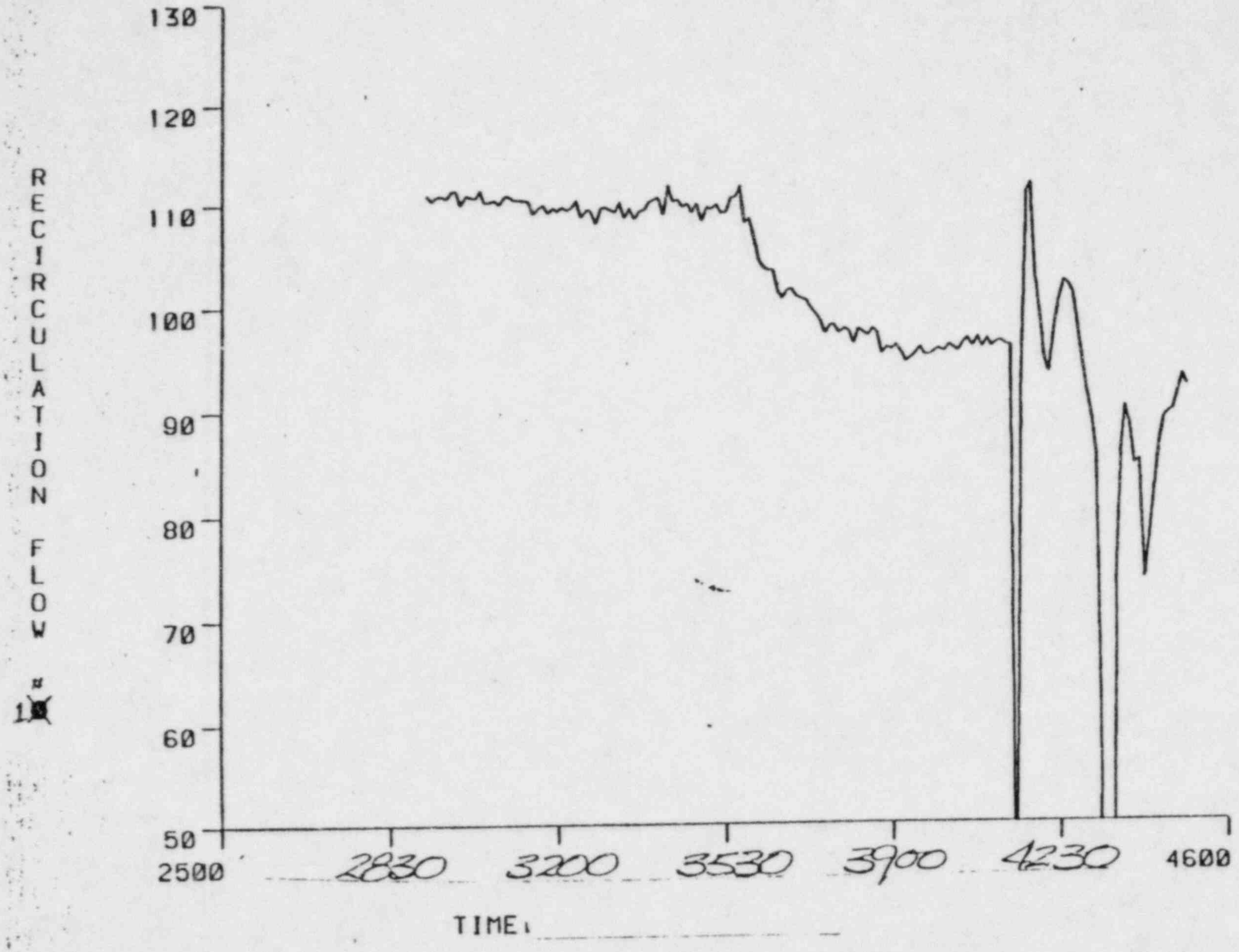

RECIRCULATION TEMPERATURE #1
550
545
540
535
530
525
520
515
510
505
500
2500
2830
3200
3530
3900
4230
4600
TIME

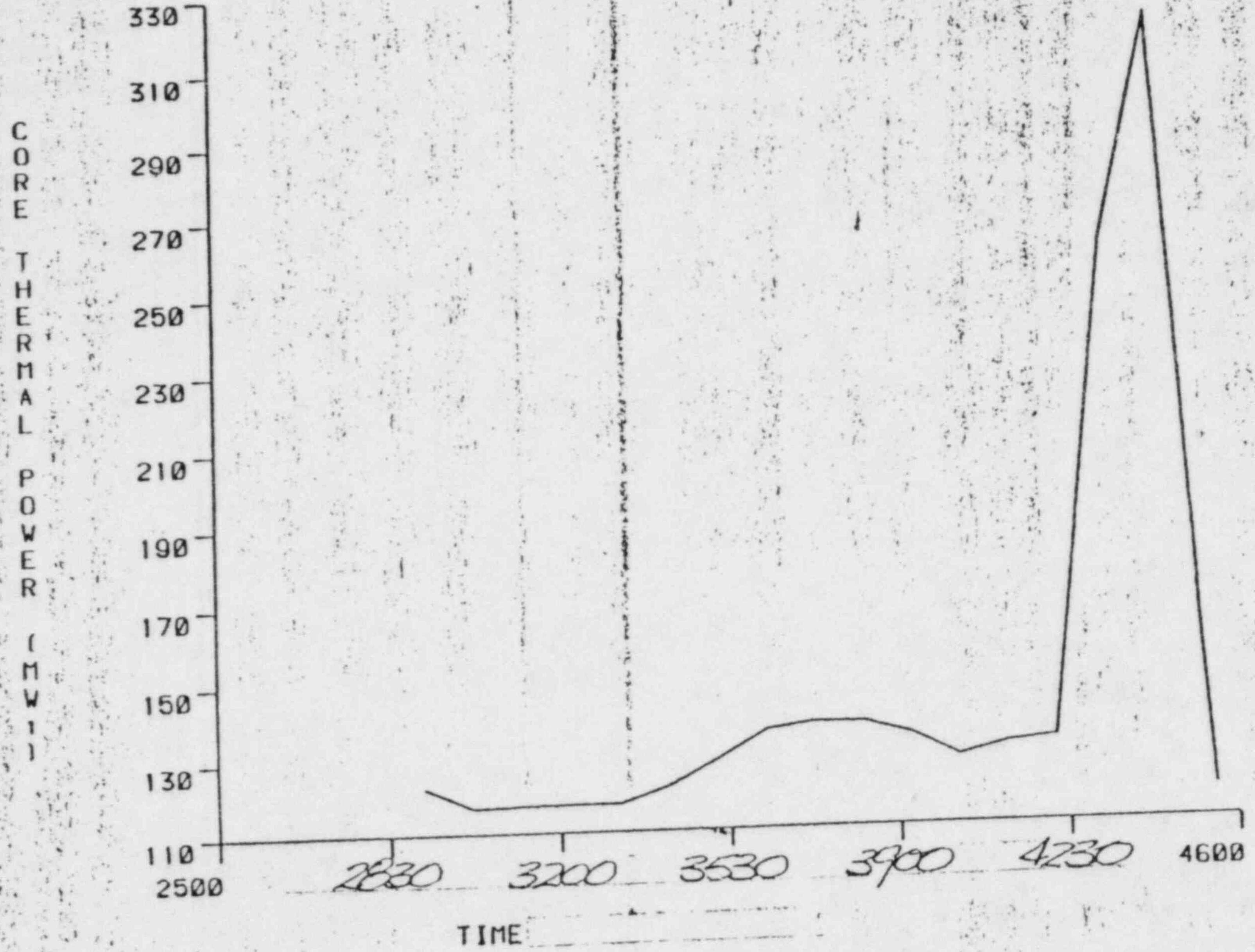

RECIRCULATION FLOW #5
130
120
110
100
90
80
70
60
50
2500
2830
3200
3530
3900
4230
4600
TIME

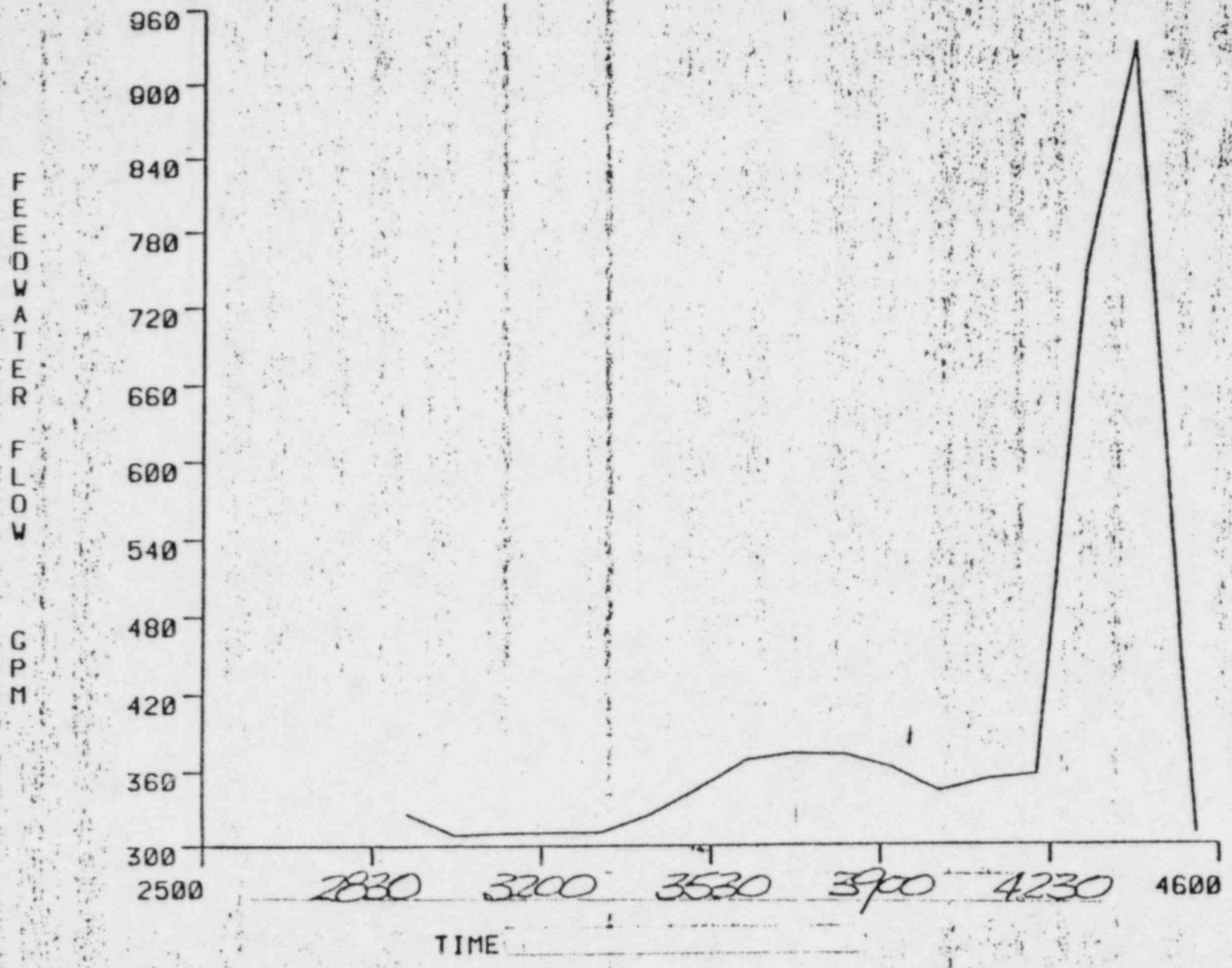

RECIRCULATION FLOW #4
130
120
110
100
90
80
70
60
50
2500
2830
3200
3530
3900
4230
4600
TIME


RECIRCULATION FLOW #3
130
120
110
100
90
80
70
60
50
2500
2830
32·00
3530
39·00
4230
4600
TIME:


RECIRCULATION FLOW #2
130
120
110
100
90
80
70
60
50
2500
2830
3200
3530
3900
4230
4600
TIME


RECIRCULATION FLOW # 1Ø
130
120
110
100
90
80
70
60
50
2500
2830
3200
3530
3900
4230
4600
TIME:


CORE THERMAL POWER (MW)
330
310
290
270
250
230
210
190
170
150
130
110
2500
2830
3200
3530
3900
4230
4600
TIME


FEEDWATER FLOW GPM
960
900
840
780
720
660
600
540
480
420
360
300
2500
2830
3200
3530
3900
4230
4600
TIME

Report to GORB

Action Item No. 375

Appendix C

PSMS Transient Digital Data

Note: The units given below for the parameters indicated should be used when working with the PSMS data.

Feedwater flow = Thousands of lb/hr
Steam flow = Thousands of lb/hr
Recirculation flow = gallons/minute x .01

```
JCP&L     COMOF                                                                  07/18/80  17:45        PRT001

*************************************************************************************************************************
*************************************************************************************************************************
*                                                                                                                      **
*                                                                                                                      **
*                                                                                                                      **
*      WWW   WWW   WWWW          W                                                                                     **
*       W   W   W  W   W         W                                                                                     **
*       W   W      W   W         W                                                                                     **
*       W   W      WWWW          W                                                                                     **
*    W  W   W      W             W                                                                                     **
*    W  W   W   W  W             W   W                                                                                 **
*     WW     WWW   W             WWWWW                                                                                 **
*                                                                                                                      **
*                                                                                                                      **
*                                                                                                                      **
*     WWW    WWW   W   W   WWW   WWWWW                                                                                 **
*    W   W  W   W  WW WW  W   W  W                                                                                     **
*    W      W   W  W W W  W   W  W                                                                                     **
*    W      W   W  W W W  W   W  WWWW                                                                                  **
*    W      W   W  W   W  W   W  W                                                                                     **
*    W   W  W   W  W   W  W   W  W                                                                                     **
*     WWW    WWW   W   W   WWW   W                                                                                     **
*                                                                                                                      **
*                                                                                                                      **
*                                                                                                                      **
*************************************************************************************************************************
*************************************************************************************************************************
```

Sheet 1

Transient & Scram of 7/17/80

```
 OUTPUT FROM PSMS DIGITAL TREND

M  D  H  M  S   RSTFLO RPRWID RPRNAR REACWL REACWL CTHPOW
                  1      1      1      1      2      1
               ✓NLB/HR  PSIG   PSIG   FEET   FEET   MWTH

7 17 20 29 231581.50 966.81 978.56   5.95   5.97 122.61
7 17 20 29 291577.50 967.63 979.69   5.93   5.96 117.03
7 17 20 29 351577.50 968.63 980.75   5.91   5.94 117.03
7 17 20 29 411581.50 969.94 981.88   5.89   5.93 117.03
7 17 20 29 471580.00 970.56 983.00   5.88   5.90 117.03
7 17 20 29 531580.00 971.94 984.06   5.87   5.90 117.03
7 17 20 29 591579.00 972.75 985.06   5.85   5.88 117.03 —
7 17 20 30  51583.50 974.13 986.13   5.83   5.87 117.03
7 17 20 30 111583.50 975.31 987.19   5.82   5.84 117.03
7 17 20 30 171582.50 975.94 988.19   5.80   5.83 117.03
7 17 20 30 231586.00 977.31 989.31   5.79   5.82 117.03
7 17 20 30 291585.00 978.25 990.38   5.76   5.80 117.51
7 17 20 30 351582.50 978.88 991.38   5.75   5.78 117.51
7 17 20 30 411582.50 980.13 992.44   5.73   5.76 117.51
7 17 20 30 471587.50 981.69 993.69   5.72   5.75 117.51
7 17 20 30 541585.50 982.56 994.94   5.70   5.73 117.51
7 17 20 30 591585.00 983.50 996.19   5.68   5.71 117.51
7 17 20 31  61586.00 984.75 997.38   5.67   5.69 117.51
7 17 20 31 111588.50 986.31 998.63   5.65   5.67 117.51
7 17 20 31 171587.50 937.19 999.81   5.63   5.65 117.51
7 17 20 31 231587.50 988.631601.00   5.61   5.64 117.51
7 17 20 31 291588.50 989.631002.13   5.60   5.63 117.64
7 17 20 31 361590.00 990.941003.19   5.58   5.60 117.64
7 17 20 31 421590.00 991.561004.31   5.55   5.59 117.64
7 17 20 31 471591.00 992.941005.38   5.53   5.57 117.64
7 17 20 31 531591.00 993.631006.44   5.51   5.55 117.64
7 17 20 31 591592.50 994.881007.50   5.49   5.53 117.64
7 17 20 32  51591.00 996.061008.50   5.47   5.50 117.64
7 17 20 32 111591.00 997.061009.50   5.46   5.49 117.64
7 17 20 32 171594.50 998.311010.50   5.44   5.47 117.64
7 17 20 32 231593.50 998.751011.50   5.42   5.45 117.64
7 17 20 32 291593.501000.001012.44   5.41   5.43 117.77
7 17 20 32 351596.001001.001613.44   5.38   5.41 117.77
7 17 20 32 411597.001002.191014.44   5.37   5.39 117.77
7 17 20 32 481597.001002.941015.69   5.35   5.38 117.77
7 17 20 32 541597.001004.001016.31   5.34   5.37 117.77
7 17 20 32 591597.001004.751017.25   5.34   5.35 117.77
7 17 20 33  61598.501005.381018.19   5.31   5.34 117.77
7 17 20 33 111599.501006.691019.06   5.28   5.32 117.77
7 17 20 33 171598.501007.691020.00   5.26   5.29 117.77 73
```

OUTPUT FROM PSMS DIGITAL TREND

```
M  D  H  M  S  RSTFLO RPRWID RPRNAR REACWL REACWL CTHPOW
                 1      1      1      1      2      1
              KMLB/HR  PSIG   PSIG   FEET   FEET   MWTH

7 17 20 33 241598.501008.311021.00   5.26   5.29 117.77
7 17 20 33 291599.501009.301022.13   5.24   5.28 122.24 35
7 17 20 33 351599.501010.501023.25   5.23   5.28 122.24
7 17 20 33 411599.501011.691024.44   5.23   5.26 122.24
7 17 20 33 471603.501012.941025.56   5.22   5.25 122.24
7 17 20 33 541602.001013.941026.69   5.21   5.25 122.24
7 17 20 33 591602.001015.131027.75   5.20   5.24 122.24
7 17 20 34  51604.501016.131028.88   5.20   5.23 122.24
7 17 20 34 111605.501017.311029.94   5.20   5.22 122.24
7 17 20 34 181607.001018.441030.94   5.20   5.23 122.24
7 17 20 34 231604.501019.661031.94   5.20   5.24 122.24
7 17 20 34 291667.001020.131032.94   5.21   5.24 129.03
7 17 20 34 361607.001021.501034.19   5.21   5.25 129.03
7 17 20 34 411609.501022.311034.88   5.22   5.26 129.03
7 17 20 34 481609.501022.941036.13   5.23   5.27 129.03
7 17 20 34 531609.501023.691036.69   5.24   5.27 129.03
7 17 20 35  01609.501024.881037.88   5.26   5.29 129.03
7 17 20 35  51609.501025.581038.50   5.27   5.30 129.03
7 17 20 35 111610.501026.751039.38   5.28   5.32 129.03
7 17 20 35 181609.501027.441040.19   5.30   5.33 129.03
7 17 20 35 231610.501028.441041.00   5.32   5.35 129.03 STARTED MANUAL ROD
7 17 20 35 301607.601029.061041.81   5.33   5.37 136.51
7 17 20 35 351608.001029.751042.56   5.35   5.39 136.51 <-- ERV OPENED "D"  ] RBCCW
7 17 20 35 411586.001012.811024.19   5.74   5.76 136.51                     ] ISOLATION
7 17 20 35 481574.00 993.191004.28   6.06   6.08 136.51                     ]
7 17 20 35 531674.00 988.60 999.94   6.07   6.11 136.51 <- ERV RESET        ]
7 17 20 36  01566.50 989.631002.25   5.53   5.57 136.51       ↑
7 17 20 36  51569.00 991.941004.13   5.23   5.28 136.51
7 17 20 36 111569.00 993.191005 .75   5.10   5.14 136.51     PRESSURE
7 17 20 36 171570.50 994.881607.13   5.01   5.05 136.51     CONTROL
7 17 20 36 231571.50 996.661008.63   4.97   5.01 136.51     STILL
7 17 20 36 291574.00 997.561010.25   4.96   4.99 138.18     NOT
7 17 20 36 351574.00 999.601011.81   4.95   4.99 138.18     FUNCTIONING
7 17 20 36 411574.001000.751013.50   4.96   5.00 138.18
7 17 20 36 471575.001002.191015.00   4.98   5.00 138.18
7 17 20 36 541576.501003.631016.44   4.99   5.02 138.18       |
7 17 20 36 591577.501005.131017.81   5.01   5.04 138.18       |
7 17 20 37  61576.501006.131619.09   5.03   5.06 138.18       |
7 17 20 37 111580.001607.441020.13   5.05   5.08 138.18       ↓
7 17 20 37 171580.001008.561021.25   5.07   5.10 138.18
```

OUTPUT FROM PSHS DIGITAL TREND

```
M  D  H  M  S  RSTFLO RPRWID RPRNAR REACWL REACWL CTHPOW
                 1      1      1      1      2      1
               K MLB/HR PSIG   PSIG   FEET   FEET   MWTH

7 17 20 37 241581.501010.131022.63   5.10   5.13 137.97
7 17 20 37 291580.001010.831023.31   5.11   5.15 137.97
7 17 20 37 361580.001012.061024.56   5.14   5.17 137.97
7 17 20 37 411581.501012.441025.19   5.16   5.18 137.97
7 17 20 37 471581.501013.561026.06   5.17   5.21 137.97
7 17 20 37 541581.501014.751027.19   5.20   5.23 137.97
7 17 20 37 591531.501014.681027.69   5.21   5.25 137.97
7 17 20 38  51582.501016.251028.50   5.23   5.26 137.97
7 17 20 38 111582.501016.381029.25   5.25   5.28 157.97
7 17 20 38 181581.501017.311030.19   5.27   5.30 137.97
7 17 20 38 241582.501017.941030.69   5.28   5.31 137.97
7 17 20 38 291582.501018.691031.31   5.30   5.32 134.64
7 17 20 38 361585.001019.881032.19   5.33   5.35 134.64
7 17 20 38 411562.501019.751032.63   5.32   5.35 134.64
7 17 20 38 481583.501020.751033.50   5.34   5.37 134.64
7 17 20 38 531586.001021.381033.88   5.35   5.37 134.64
7 17 20 38 591583.501022.061034.50   5.36   5.39 134.64
7 17 20 39  51583.501021.941034.94   5.36   5.40 134.64
7 17 20 39 121585.001022.811035.25   5.36   5.40 134.64
7 17 20 39 181585.001022.191035.13   5.36   5.38 134.64
7 17 20 39 231585.001021.941034.94   5.35   5.37 134.64
7 17 20 39 291532.501021.751034.38   5.33   5.37 128.30
7 17 20 39 351586.001021.251033.94   5.33   5.37 128.30
7 17 20 39 411585.001020.881033.50   5.34   5.37 128.30
7 17 20 39 481583.501020.631033.00   5.35   5.37 128.30
7 17 20 39 531582.501020.131032.81   5.35   5.37 128.30
7 17 20 40  01582.501019.501032.38   5.34   5.38 128.30
7 17 20 40  51583.501019.881032.25   5.34   5.37 128.30
7 17 20 40 111582.501019.381031.94   5.34   5.38 128.30
7 17 20 40 171581.501018.811031.56   5.34   5.37 128.30
7 17 20 40 231581.501018.561031.25   5.34   5.36 128.30
7 17 20 40 301581.501018.061030.94   5.33   5.36 131.51
7 17 20 40 351580.001017.811030.56   5.33   5.36 131.51
7 17 20 40 411581.501017.941030.25   5.33   5.36 131.51
7 17 20 40 471531.501017.061029.88   5.33   5.36 131.51
7 17 20 40 541580.001016.631029.50   5.33   5.36 131.51
7 17 20 40 591580.001016.941029.31   5.33   5.36 131.51
7 17 20 41  61579.001016.131028.88   5.33   5.35 131.51
7 17 20 41 121580.001016.131028.63   5.32   5.35 131.51
7 17 20 41 171581.501015.881028.44   5.32   5.35 131.51
```

1. Pressure control Not Functioning

PRESSURE PEAKS AGAIN

Turns around as a result of manual rod insertion

Needs verification could be due to the flow

```
OUTPUT FROM PSMS DIGITAL TREND

M  D  H  M  S  RSTFLO RPRWID RPRNAR REACWL REACWL CTHPOW
                  1      1      1      1      2      1
               KNLB/HR  PSIG   PSIG   FEET   FEET   MWTH

7 17 20 41 231581.501016.001028.19     5.33     5.36 131.51 ← BP valves OPENED
                                                               by Reset VAc trip # 2
7 17 20 41 291579.001015.381027.88     5.33     5.36 132.71
7 17 20 41 352632.50 975.44 986.81     6.22     6.18 132.71 ← BP valves closed by operator tripping VAc trip # 2
7 17 20 41 421934.00 948.63  -1.00     6.46     6.75 132.71
7 17 20 41 471553.00 944.69  -1.00     6.64     6.30 132.71 ← TRIPLE LOW LEVEL (4)
7 17 20 41 541547.00 944.19  -1.00     6.87     6.88 132.71
7 17 20 41 591547.00 944.69  -1.00     6.05     6.03 132.71
7 17 20 42  61546.00 945.94  -1.00     4.61     4.63 132.71 } Reactor Scram
7 17 20 42 111549.50 948.13  -1.00     4.23     4.26 132.71 }
7 17 20 42 171546.00 948.38  -1.00     3.88     3.92 132.71
7 17 20 42 231548.50 948.38  -1.00     3.76     3.80 132.71
7 17 20 42 291547.00 947.88  -1.00     3.90     3.93 259.43 Disregard Thermal Power
7 17 20 42 351547.00 947.38  -1.00     4.15     4.18 259.43  Since it is based on
7 17 20 42 411543.50 945.44  -1.00     4.45     4.48 259.43  feed flow mainly!
7 17 20 42 481543.50 942.75  -1.00     4.85     4.88 259.43
7 17 20 42 531542.00 940.56  -1.00     5.03     5.08 259.43  ≈ NO DECAY HEAT
7 17 20 42 591536.00 934.06  -1.00     5.25     5.27 259.43
7 17 20 43  61531.00 925.44  -1.00     5.39     5.40 259.43
7 17 20 43 111522.50 913.31  -1.00     5.49     5.48 259.43
7 17 20 43 181510.50 893.81  -1.00     5.64     5.63 259.43
7 17 20 43 231500.50 882.06  -1.00     5.75     5.74 259.43
7 17 20 43 301476.50 858.75  -1.00     6.03     6.00 320.55
7 17 20 43 351467.00 843.13  -1.00     6.26     6.23 320.55
7 17 20 43 411462.50 835.31  -1.00     6.42     6.39 320.55
7 17 20 43 481457.00 827.06  -1.00     6.66     6.66 320.55
7 17 20 43 531453.50 825.06  -1.00     6.53     6.55 320.55
7 17 20 44  01452.00 822.25  -1.00     6.17     6.19 320.55
7 17 20 44  61452.50 820.69  -1.00     6.10     6.12 320.55
7 17 20 44 121449.00 818.00  -1.00     6.14     6.17 320.55
7 17 20 44 171446.00 814.94  -1.00     6.20     6.22 320.55
7 17 20 44 231442.50 810.44  -1.00     6.29     6.30 320.55
7 17 20 44 301439.00 804.06  -1.00     6.44     6.44 171.23
7 17 20 44 351438.00 801.25  -1.00     6.52     6.51 171.23
7 17 20 44 421435.00 797.13  -1.00     6.59     6.61 171.23
7 17 20 44 471432.50 794.94  -1.00     6.53     6.55 171.23
7 17 20 44 531433.00 793.69  -1.00     6.48     6.51 171.23
7 17 20 44 591430.00 790.25  -1.00     6.46     6.47 171.23
7 17 20 45  51428.00 789.06  -1.00     6.48     6.49 171.23
7 17 20 45 121427.00 786.75  -1.00     6.50     6.51 171.23
7 17 20 45 171427.50 785.13  -1.00     6.50     6.51 171.23
```

NARROW RANGE OFF SCALE

```
            OUTPUT FROM PSMS DIGITAL TREND

M  D  H  M  S  RSTFLO RPRWID RPRNAR REACWL REACWL CTHPOW
                  1      1      1      1      2      1
               MLB/HR   PSIG   PSIG   FEET   FEET   MWTH

7 17 20 45 241424.00 782.94  -1.00   6.50   6.51 118.13
7 17 20 45 291422.60 782.44  -1.00   6.50   6.51 118.13
7 17 20 45 351419.50 780.50  -1.00   6.49   6.49 118.13
7 17 20 45 411420.00 779.56  -1.00   6.47   6.48 118.13
7 17 20 45 471419.50 777.81  -1.00   6.44   6.45 118.13
7 17 20 45 531417.00 776.88  -1.00   6.43   6.44 118.13
7 17 20 46   01417.00 775.38  -1.00   6.42   6.42 118.13
7 17 20 46   61415.50 773.69  -1.00   6.40   6.41 118.13
7 17 20 46 131415.50 772.44  -1.00   6.39   6.39 118.13
7 17 20 46 181415.50 771.00  -1.00   6.38   6.39 118.13
7 17 20 46 251414.50 770.00  -1.00   6.37   6.38 118.13
7 17 20 46 321414.00 768.19  -1.00   6.35   6.36 110.46
7 17 20 46 371413.50 767.31  -1.60   6.34   6.35 110.46
7 17 20 46 441413.00 766.00  -1.00   6.33   6.33 110.46
7 17 20 46 501411.50 764.75  -1.00   6.30   6.31 110.46
7 17 20 46 541413.50 764.38  -1.00   6.29   6.30 110.46
7 17 20 47   01412.00 762.69  -1.00   6.26   6.27 110.46
7 17 20 47   71410.50 761.13  -1.00   6.24   6.24 110.46
7 17 20 47 141410.00 760.25  -1.00   6.22   6.23 110.46
7 17 20 47 191408.50 759.00  -1.00   6.21   6.22 110.46
7 17 20 47 261409.00 757.44  -1.00   6.20   6.20 109.16
7 17 20 47 311407.50 756.81  -1.00   6.18   6.19 109.16
7 17 20 47 371405.50 755.25  -1.00   6.16   6.16 109.16
7 17 20 47 431405.50 754.25  -1.00   6.15   6.15 109.16
7 17 20 47 491404.50 753.66  -1.00   6.13   6.14 109.16
7 17 20 47 561403.00 751.81  -1.00   6.11   6.12 109.16
7 17 20 48   01400.50 750.88  -1.00   6.09   6.11 109.16
7 17 20 48   71402.00 749.63  -1.00   6.08   6.09 109.16
7 17 20 48 141400.00 748.63  -1.00   6.07   6.08 109.16
7 17 20 48 201399.50 746.94  -1.00   6.06   6.06 109.16
7 17 20 48 261397.00 745.94  -1.00   6.04   6.04 109.21
7 17 20 48 321397.00 745.00  -1.00   6.03   6.03 109.31
7 17 20 48 371396.50 744.00  -1.00   6.02   6.03 109.21
7 17 20 48 441394.50 742.56  -1.00   6.00   6.01 109.21
7 17 20 48 501392.50 741.56  -1.00   5.99   6.00 109.21
7 17 20 48 551394.00 740.13  -1.00   5.98   5.99 109.21
7 17 20 49   21392.00 738.88  -1.00   5.97   5.98 109.21
7 17 20 49   71391.50 738.13  -1.00   5.96   5.97 109.21
7 17 20 49 141391.00 736.69  -1.00   5.96   5.96 109.21
7 17 20 49 191392.50 735.44  -1.00   5.95   5.96 109.21
```

```
        OUTPUT FROM PSMS DIGITAL TREND

M  D  H  M  S   RSTFLO RPRWID RPRNAR REACWL REACWL CTHPOW
                  1      1      1      1      2      1
                MLB/HR  PSIG   PSIG   FEET   FEET   MWTH

7 17 20 49 261392.50 734.75  -1.00   5.95   5.96 109.21
7 17 20 49 311389.00 733.00  -1.00   5.94   5.95 112.48
7 17 20 49 371387.00 731.81  -1.00   5.93   5.94 112.48
7 17 20 49 441387.00 730.31  -1.00   5.93   5.94 112.48
7 17 20 49 491388.00 729.13  -1.00   5.94   5.94 112.48
7 17 20 49 561385.00 727.63  -1.00   5.93   5.94 112.48
7 17 20 50  11385.50 726.44  -1.00   5.94   5.94 112.48
7 17 20 50  81385.00 724.63  -1.00   5.94   5.94 112.48
7 17 20 50 131383.00 723.75  -1.00   5.94   5.95 112.48
7 17 20 50 191383.50 721.81  -1.00   5.94   5.94 112.48
7 17 20 50 251380.00 720.56  -1.00   5.94   5.94 113.04
7 17 20 50 321380.00 719.13  -1.00   5.94   5.95 113.04
7 17 20 50 381378.50 717.63  -1.00   5.94   5.95 113.04
7 17 20 50 431378.00 716.44  -1.00   5.94   5.94 113.04
7 17 20 50 501377.00 714.94  -1.00   5.94   5.94 113.04
7 17 20 50 551378.00 713.75  -1.00   5.94   5.94 113.04
7 17 20 51  01376.00 711.94  -1.00   5.94   5.94 113.04
7 17 20 51  81374.00 710.44  -1.00   5.94   5.94 113.04
7 17 20 51 131373.00 709.38  -1.00   5.94   5.95 113.04
7 17 20 51 201372.50 707.50  -1.00   5.94   5.95 113.04
7 17 20 51 251371.50 706.31  -1.00   5.95   5.95 112.43
7 17 20 51 311368.50 705.19  -1.00   5.95   5.96 112.43
7 17 20 51 371367.00 703.75  -1.00   5.96   5.96 112.43
7 17 20 51 431366.00 702.38  -1.00   5.96   5.96 112.43
7 17 20 51 491364.50 700.69  -1.00   5.96   5.96 112.43
7 17 20 51 561361.50 698.94  -1.00   5.96   5.96 112.43
7 17 20 52  21362.00 698.00  -1.00   5.96   5.96 112.43
7 17 20 52  71361.50 696.31  -1.00   5.96   5.97 112.43
7 17 20 52 141360.50 695.06  -1.00   5.96   5.96 112.43
7 17 20 52 201359.50 693.63  -1.00   5.97   5.97 112.43
7 17 20 52 251360.50 692.13  -1.00   5.97   5.97 112.79
7 17 20 52 301359.50 690.94  -1.00   5.98   5.97 112.79
7 17 20 52 371355.50 689.19  -1.60   5.98   5.98 112.79
7 17 20 52 431354.00 688.00  -1.60   5.98   5.98 112.79
7 17 20 52 501353.00 686.50  -1.00   5.98   5.98 112.79
7 17 20 52 551352.00 685.31  -1.00   5.98   5.99 112.79
7 17 20 53  11351.00 683.81  -1.06   5.99   5.99 112.79
7 17 20 53  71350.00 682.38  -1.00   5.99   5.99 112.79
7 17 20 53 131348.50 681.38  -1.00   5.99   6.00 112.79
7 17 20 53 201348.50 679.94  -1.00   6.00   6.00 112.79
```

JCP&L COMOF

```
  WWW   WWW   WWWW        W
   W   W   W  W   W       W
   W   W      W   W       W
   W   W      WWWW        W
W  W   W      W           W
W  W   W   W  W           W   W
 WW     WWW   W           WWWWW

 WWW    WWW   W   W  WWW  WWWWW
W   W  W   W  WW WW W   W W
W      W   W  W W W W   W WWWW
W      W   W  W   W W   W W
W      W   W  W   W W   W W
W   W  W   W  W   W W   W W
 WWW    WWW   W   W  WWW  W
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Sheet 2

Transient & SCRAM of 7/17/80

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          OUTPUT FROM PSMS DIGITAL TREND

 M  D  H  M  S  APRM     APRM     APRM     APRM     APRM     APRM     APRM     APRM    FWTEMP  FWFLOW
                  1        2        3        4        5        6        7        8       1        1
                % F PR   % F PR   % F PR   % F PR   % F PR   % F PR   % F PR   % F PR   DEG F    GPM

 7 17 20 29 23   6.84     8.57    10.73     8.94     9.78     7.84     7.49     8.67  113.22  325.64  8.61
 7 17 20 29 29   6.75     8.49    10.65     8.86     9.67     7.75     7.42     8.58  113.13  308.69  8.52
 7 17 20 29 35   6.68     8.43    10.63     8.80     9.59     7.69     7.36     8.52  113.13  368.69
 7 17 20 29 41   6.60     8.38    10.63     8.74     9.53     7.65     7.32     8.45  113.22  308.69
 7 17 20 29 47   6.54     8.32    10.59     8.68     9.47     7.59     7.27     8.38  113.19  308.69
 7 17 20 29 53   6.46     8.27    10.56     8.66     9.39     7.55     7.23     8.37  113.16  308.69
 7 17 20 29 59   6.44     8.27    10.53     8.62     9.38     7.52     7.23     8.32  113.13  308.69
 7 17 20 30  5   6.38     8.24    10.48     8.57     9.33     7.49     7.17     8.28  113.16  308.69
 7 17 20 30 11   6.40     8.22    10.49     8.57     9.34     7.48     7.19     8.27  113.06  308.69
 7 17 20 30 17   6.38     8.23    10.50     8.53     9.34     7.48     7.22     8.20  113.13  308.69
 7 17 20 30 23   6.34     8.18    10.47     8.51     9.30     7.42     7.20     8.17  113.06  308.69
 7 17 20 30 29   6.31     8.16    10.47     8.51     9.25     7.41     7.17     8.16  113.16  310.23
 7 17 20 30 35   6.31     8.17    10.47     8.49     9.26     7.42     7.18     8.14  113.19  310.23
 7 17 20 30 41   6.34     8.15    10.52     8.51     9.29     7.44     7.26     8.17  113.06  310.23
 7 17 20 30 47   6.36     8.16    10.57     8.51     9.30     7.42     7.30     8.16  113.06  310.23
 7 17 20 30 54   6.39     8.19    10.61     8.52     9.34     7.45     7.34     8.20  113.13  310.23
 7 17 20 30 59   6.41     8.17    10.63     8.51     9.35     7.44     7.35     8.16  113.13  310.23
 7 17 20 31  6   6.44     8.19    10.66     8.52     9.38     7.45     7.38     8.17  113.06  310.23
 7 17 20 31 11   6.45     8.18    10.68     8.51     9.39     7.44     7.40     8.18  113.06  310.23
 7 17 20 31 17   6.45     8.16    10.70     8.49     9.38     7.42     7.40     8.16  112.97  310.23
 7 17 20 31 23   6.40     8.13    10.69     8.48     9.33     7.41     7.38     8.13  112.97  310.23
 7 17 20 31 29   6.38     8.13    10.66     8.48     9.31     7.42     7.35     8.13  112.97  310.74
 7 17 20 31 36   6.38     8.14    10.64     8.48     9.31     7.41     7.34     8.14  113.03  310.74
 7 17 20 31 42   6.31     8.12    10.62     8.45     9.25     7.36     7.32     8.10  113.06  310.74
 7 17 20 31 47   6.32     8.07    10.57     8.40     9.24     7.33     7.27     8.05  113.03  310.74
 7 17 20 31 53   6.32     8.02    10.58     8.38     9.24     7.33     7.26     8.05  112.91  310.74
 7 17 20 31 59   6.30     8.05    10.59     8.38     9.24     7.33     7.27     8.05  112.97  310.74
 7 17 20 32  5   6.27     8.08    10.55     8.37     9.20     7.28     7.23     8.02  112.97  310.74
 7 17 20 32 11   6.23     8.03    10.55     8.32     9.17     7.27     7.22     7.99  112.97  310.74
 7 17 20 32 17   6.19     7.97    10.52     8.29     9.13     7.23     7.16     7.96  112.94  310.74
 7 17 20 32 23   6.20     7.97    10.51     8.30     9.12     7.24     7.16     7.97  112.91  310.74  8.06
 7 17 20 32 29   6.20     7.96    10.48     8.25     9.13     7.22     7.15     7.91  112.94  311.25
 7 17 20 32 35   6.16     7.92    10.47     8.22     9.10     7.20     7.13     7.89  112.94  311.25
 7 17 20 32 41   6.13     7.89    10.50     8.23     9.08     7.19     7.15     7.91  113.03  311.25
 7 17 20 32 48   6.12     7.89    10.48     8.21     9.06     7.17     7.12     7.88  112.97  311.25
 7 17 20 32 54   6.10     7.91    10.48     8.22     9.06     7.16     7.09     7.89  112.94  311.25
 7 17 20 32 59   6.07     7.92    10.44     8.17     9.01     7.13     7.05     7.84  112.88  311.25
 7 17 20 33  6   6.10     7.90    10.42     8.17     9.04     7.16     7.05     7.80  112.91  311.25
 7 17 20 33 11   6.09     7.91    10.44     8.18     9.02     7.20     7.05     7.81  112.94  311.25
 7 17 20 33 17   6.15     8.00    10.47     8.24     9.10     7.35     7.12     7.88  113.03  311.25
```

```
OUTPUT FROM PSMS DIGITAL TREND

                                                                         FWTEMP FWFLOW
                                                     APRM   APRM   APRM    1      1
                         APRM   APRM   APRM   APRM    6      7      8    DEG F   GPM
D  H  M  S   APRM   APRM   3      4      5    % F PR % F PR % F PR
              1      2    % F PR % F PR % F PR
            % F PR % F PR

17 20 33 24   6.23   8.14  10.49   8.28   9.20   7.51   7.18   7.95 112.91 311.25
17 20 33 29   6.33   8.31  10.55   8.34   9.28   7.64   7.24   8.02 112.91 325.12
17 20 33 35   6.39   8.43  10.59   8.41   9.34   7.77   7.29   8.08 112.91 325.12
17 20 33 41   6.47   8.53  10.63   8.45   9.42   7.88   7.33   8.13 112.97 325.12
17 20 33 47   6.51   8.61  10.65   8.47   9.45   7.95   7.37   8.15 112.97 325.12
17 20 33 54   6.56   8.69  10.69   8.52   9.50   8.02   7.42   8.20 112.91 325.12
17 20 33 59   6.63   8.75  10.73   8.54   9.55   8.09   7.47   8.23 112.84 325.12
17 20 34  5   6.66   8.81  10.76   8.57   9.58   8.13   7.50   8.27 112.84 325.12
17 20 34 11   6.70   8.87  10.80   8.63   9.63   8.20   7.56   8.33 112.97 325.12
17 20 34 18   6.77   8.92  10.84   8.66   9.70   8.27   7.63   8.37 112.88 325.12
17 20 34 23   6.81   8.95  10.86   8.69   9.75   8.30   7.66   8.41 112.84 346.18 · 8.75
17 20 34 29   6.89   9.02  10.92   8.74   9.83   8.37   7.73   8.47 112.94 346.18
17 20 34 36   6.98   9.10  11.01   8.84   9.92   8.45   7.82   8.56 112.84 346.18
17 20 34 41   7.03   9.15  11.04   8.88   9.97   8.50   7.87   8.61 112.88 346.18
17 20 34 48   7.11   9.23  11.09   8.94  10.06   8.58   7.95   8.70 112.84 346.18
17 20 34 53   7.16   9.27  11.12   8.98  10.11   8.63   7.99   8.74 112.84 346.18
17 20 35  0   7.25   9.33  11.20   9.05  10.20   8.69   8.09   8.80 112.78 346.18
17 20 35  5   7.27   9.34  11.23   9.06  10.24   8.71   8.12   8.82 112.78 346.18
17 20 35 11   7.30   9.38  11.26   9.09  10.27   8.75   8.16   8.87 112.75 346.18
17 20 35 18   7.35   9.41  11.29   9.14  10.33   8.81   8.23   8.92 112.69 346.18
17 20 35 23   7.38   9.46  11.31   9.18  10.36   8.86   8.27   8.96 112.69 346.18
17 20 35 30   7.43   9.51  11.34   9.21  10.41   8.91   8.30   9.01 112.66 369.29 <— "D" ERV OPENED (power down)
17 20 35 35   7.45   9.52  11.36   9.23  10.42   8.92   8.32   9.02 112.66 369.29
17 20 35 41   6.79   8.96  10.84   8.70   9.65   8.25   7.56   8.33 112.69 369.29
17 20 35 48   5.48   7.88   9.84   7.66   8.28   7.04   6.27   7.08 112.66 369.29 <— "D" ERV REJET (power up)
17 20 35 53   4.85   7.33   9.36   7.16   7.65   6.43   5.68   6.48 112.63 369.29
17 20 36  0   4.23   6.80   8.88   6.69   7.05   5.88   5.20   5.92 112.59 369.29
17 20 36  5   3.89   6.51   8.60   6.44   6.74   5.61   4.95   5.64 112.59 369.29 5.99
17 20 36 11   3.81   6.42   8.53   6.38   6.69   5.55   4.94   5.59 112.53 369.29
17 20 36 17   4.08   6.65   8.73   6.61   7.00   5.82   5.23   5.87 112.53 369.29
17 20 36 23   4.56   7.04   9.09   6.99   7.52   6.28   5.73   6.37 112.44 369.29
17 20 36 29   5.16   7.52   9.52   7.45   8.14   6.84   6.30   6.95 112.47 373.91
17 20 36 35   5.72   7.96   9.94   7.88   8.70   7.32   6.83   7.48 112.38 373.91
17 20 36 41   6.25   8.38  10.34   8.27   9.23   7.77   7.30   7.95 112.38 373.91
17 20 36 47   6.64   8.70  10.63   8.57   9.63   8.11   7.65   8.30 112.38 373.91
17 20 36 54   6.94   8.94  10.84   8.79   9.91   8.37   7.90   8.54 112.38 373.91
17 20 36 59   7.13   9.09  10.98   8.93  10.09   8.54   8.07   8.70 112.31 373.91
17 20 37  6   7.28   9.22  11.09   9.05  10.23   8.66   8.19   8.83 112.31 373.91
17 20 37 11   7.38   9.29  11.15   9.11  10.34   8.76   8.25   8.91 112.34 373.91
17 20 37 17   7.46   9.37  11.23   9.19  10.42   8.84   8.33   8.99 112.31 373.91 9.23
```

```
         OUTPUT FROM PSMS DIGITAL TREND

M  D  H  M  S   APRM    APRM    APRM    APRM    APRM    APRM    APRM    APRM   FWTEMP FWFLOW
                  1       2       3       4       5       6       7       8       1      1
                % F PR  % F PR  % F PR  % F PR  % F PR  % F PR  % F PR  % F PR  DEC F  ~~GPM~~ KLB/HR

7 17 20 37 24    7.51    9.41   11.26    9.23   10.47    8.88    8.37    9.04 112.28 373.40
7 17 20 37 29    7.52    9.43   11.27    9.23   10.48    8.90    8.38    9.65 112.22 373.40
7 17 20 37 36    7.53    9.43   11.30    9.26   10.51    8.88    8.40    9.04 112.22 373.40
7 17 20 37 41    7.55    9.45   11.27    9.26   10.51    8.90    8.40    9.05 112.09 373.40
7 17 20 37 47    7.54    9.43   11.26    9.24   10.49    8.90    8.38    9.02 112.22 373.40
7 17 20 37 54    7.51    9.38   11.23    9.21   10.42    8.85    8.31    8.99 112.16 373.40
7 17 20 37 59    7.52    9.39   11.22    9.19   10.44    8.84    8.32    8.98 112.06 373.40
7 17 20 38  5    7.44    9.31   11.20    9.17   10.36    8.77    8.31    8.93 112.16 373.40
7 17 20 38 11    7.41    9.31   11.19    9.14   10.34    8.77    8.28    8.93 111.97 373.40
7 17 20 38 18    7.39    9.28   11.17    9.13   10.33    8.75    8.25    8.91 111.97 373.40
7 17 20 38 24    7.34    9.23   11.14    9.09   10.29    8.70    8.23    8.88 111.88 373.40
7 17 20 38 29    7.34    9.24   11.13    9.09   10.29    8.71    8.20    8.88 111.88 363.13
7 17 20 38 36    7.29    9.23   11.09    9.08   10.25    8.68    8.16    8.86 111.94 363.13
7 17 20 38 41    7.26    9.18   11.09    9.03   10.20    8.63    8.12    8.81 111.84 363.13
7 17 20 38 48    7.16    9.09   11.01    8.97   10.11    8.56    8.05    8.77 111.91 363.13
7 17 20 38 53    7.16    9.64   10.98    8.94   10.06    8.53    8.03    8.72 111.81 363.13
7 17 20 38 59    7.10    8.96   10.92    8.88   10.60    8.44    7.97    8.66 111.81 363.13
7 17 20 39  5    7.62    8.83   10.84    8.79    9.92    8.31    7.89    8.58 111.72 363.13
7 17 20 39 12    6.87    8.52   10.75    8.62    9.77    8.09    7.77    8.42 111.81 363.13
7 17 20 39 18    6.71    8.23   10.67    8.46    9.62    7.84    7.66    8.27 111.66 363.13
7 17 20 39 23    6.59    8.02   10.59    8.34    9.50    7.61    7.55    8.13 111.72 363.13
7 17 20 39 29    6.39    7.75   10.47    8.16    9.30    7.30    7.41    7.94 111.66 343.61
7 17 20 39 35    6.25    7.57   10.40    8.05    9.17    7.09    7.30    7.83 111.56 343.61
7 17 20 39 41    6.08    7.39   10.30    7.93    9.00    6.88    7.17    7.66 111.63 343.61
7 17 20 39 48    5.90    7.21   10.20    7.77    8.79    6.66    7.02    7.51 111.53 343.61
7 17 20 39 53    5.81    7.13   10.13    7.70    8.70    6.58    6.94    7.43 111.53 343.61
7 17 20 40  0    5.66    6.93   10.02    7.59    8.55    6.42    6.79    7.28 111.50 343.61
7 17 20 40  5    5.58    6.94    9.93    7.55    8.48    6.35    6.73    7.23 111.63 343.61
7 17 20 40 11    5.52    6.88    9.91    7.48    8.41    6.29    6.68    7.16 111.53 343.61
7 17 20 40 17    5.44    6.82    9.87    7.44    8.33    6.22    6.60    7.09 111.50 343.61
7 17 20 40 23    5.44    6.84    9.88    7.45    8.34    6.23    6.60    7.10 111.44 343.61
7 17 20 40 30    5.47    6.85    9.91    7.48    8.37    6.25    6.63    7.13 111.44 353.37
7 17 20 40 35    5.48    6.87    9.93    7.50    8.38    6.27    6.65    7.15 111.38 353.37
7 17 20 40 41    5.52    6.90    9.96    7.53    8.41    6.30    6.68    7.18 111.41 353.37
7 17 20 40 47    5.53    6.91    9.98    7.54    8.43    6.31    6.70    7.20 111.38 353.37
7 17 20 40 54    5.56    6.92   10.01    7.55    8.46    6.84    6.73    7.20 111.38 353.37
7 17 20 40 59    5.58    6.93   10.02    7.56    8.48    6.35    6.74    7.22 111.34 353.37 7.36'
7 17 20 41  6    5.61    6.95   10.03    7.57    8.51    6.38    6.77    7.23 111.31 353.37
7 17 20 41 12    5.63    6.93   10.03    7.59    8.51    6.36    6.76    7.27 111.31 353.37
7 17 20 41 17    5.64    6.93   10.03    7.57    8.51    6.36    6.77    7.23 111.25 353.37
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OUTPUT FROM PSMS DIGITAL TREND

   D  H  M  S   APRM     APRM     APRM     APRM     APRM     APRM     APRM     APRM    FWTEMP  FWFLOW
                  1        2        3        4        5        6        7        8       1       1
                % F PR   % F PR   % F PR   % F PR   % F PR   % F PR   % F PR   % F PR  DEG F    GPM  KLB/HR

7 17 20 41 23    5.66     6.95    10.03     7.59     8.52     6.38     6.79     7.25  111.28  353.37
7 17 20 41 29    5.65     6.95    10.03     7.59     8.54     6.38     6.81     7.26  111.25  356.96
7 17 20 41 35    4.94     6.51     9.48     7.05     7.74     5.79     6.02     6.53  111.25  356.96
7 17 20 41 42    3.35     5.49     8.20     5.77     6.02     4.50     4.38     4.97  111.22  356.96
7 17 20 41 47    2.74     5.09     7.73     5.29     5.38     4.03     3.78     4.39  111.31  356.96
7 17 20 41 54    2.02     4.59     7.19     4.72     4.62     3.43     3.08     3.79  111.19  356.96
7 17 20 41 59    1.85     4.47     7.07     4.58     4.46     3.29     2.96     3.53  111.09  356.96
7 17 20 42  6    1.97     4.52     7.18     4.64     4.69     3.37     3.26     3.65  111.19  356.96 4.16
7 17 20 42 11    1.93     4.54     7.30     4.66     4.77     3.42     3.34     3.73  111.22  356.96 ←REACTOR SCRAM
7 17 20 42 17    1.46     4.23  [illegible] 4.25     4.15     3.04     2.76     3.22  111.09  356.96
7 17 20 42 23    1.13     4.06  [illegible] 3.97     3.74     2.79     2.36     2.88  111.13  356.96
7 17 20 42 29    0.88     3.91     6.20     3.75     3.44     2.59     2.05     2.64  111.09  744.72
7 17 20 42 35    0.73     3.80     6.03     3.63     3.25     2.47     1.89     2.48  111.06  744.72
7 17 20 42 41    0.61     3.71     5.95     3.52     3.11     2.37     1.75     2.36  110.84  744.72
7 17 20 42 48    0.52     3.62     5.85     3.43     2.99     2.27     1.63     2.26  110.69  744.72
7 17 20 42 53    0.51     3.63     5.84     3.44     2.95     2.28     1.59     2.22  110.53  744.72
7 17 20 42 59    0.49     3.60     5.81     3.44     2.93     2.28     1.55     2.23  110.31  744.72
7 17 20 43  6    0.51     3.60     5.81     3.42     2.93     2.27     1.55     2.23  110.13  744.72
7 17 20 43 11    0.49     3.63     5.78     3.42     2.93     2.25     1.52     2.23  109.91  744.72
7 17 20 43 18    0.49     3.66     5.79     3.40     2.93     2.25     1.52     2.23  109.69  744.72
7 17 20 43 23    0.49     3.63     5.79     3.40     2.96     2.25     1.52     2.23  109.63  744.72
7 17 20 43 30    0.49     3.61     5.79     3.40     2.91     2.25     1.50     2.23  109.34  929.18
7 17 20 43 35    0.47     3.69     5.71     3.38     2.85     2.23     1.50     2.21  109.28  929.10
7 17 20 43 41    0.47     3.69     5.70     3.38     2.85     2.23     1.56     2.21  109.19  929.10
7 17 20 43 48    0.50     3.60     5.72     3.40     2.87     2.24     1.52     2.17  109.00  929.10
7 17 20 43 53    0.49     3.60     5.73     3.38     2.88     2.23     1.47     2.14  105.94  929.10
7 17 20 44  0    0.49     3.62     5.76     3.38     2.91     2.23     1.50     2.12  108.66  929.10
7 17 20 44  6    0.47     3.60     5.76     3.28     2.91     2.23     1.50     2.12  108.66  9[illegible].10
7 17 20 44 12    0.49     3.60     5.73     3.38     2.91     2.23     1.50     2.10  108.53  929.10
7 17 20 44 17    0.49     3.60     5.74     3.38     2.91     2.23     1.50     2.10  108.41  929.10
7 17 20 44 23    0.49     3.60     5.74     3.37     2.91     2.23     1.50     2.12  108.47  929.10
7 17 20 44 30    0.48     3.60     5.73     3.33     2.91     2.23     1.48     2.12  108.31  470.98
7 17 20 44 35    0.47     3.60     5.72     3.37     2.89     2.23     1.48     2.12  108.31  470.98
7 17 20 44 42    0.42     3.48     5.63     3.20     2.71     2.13     1.35     2.02  108.13  470.98
7 17 20 44 47    0.34     3.34     5.55     3.05     2.63     2.09     1.27     1.95  108.06  470.98
7 17 20 44 53    0.34     3.27     5.51     2.98     2.59     2.09     1.26     1.95  108.13  470.98
7 17 20 44 59    0.34     3.17     5.53     2.89     2.56     2.09     1.27     1.95  107.91  470.98
7 17 20 45  5    0.36     3.16     5.52     2.87     2.56     2.09     1.28     1.94  103.00  470.98
7 17 20 45 12    0.34     3.16     5.52     2.84     2.53     2.05     1.25     1.94  107.88  470.98
7 17 20 45 17    0.36     3.18     5.53     2.85     2.55     2.07     1.27     1.95  107.84  470.98 2.47
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```
 . .   OUTPUT FROM PSMS DIGITAL TREND

M  D  H  M  S  APRM    APRM    APRM    APRM    APRM    APRM    APRM    APRM    FWTEMP FWFLOW
                1       2       3       4       5       6       7       8        1      1
               % F PR  % F PR  % F PR  % F PR  % F PR  % F PR  % F PR  % F PR  DEG F   GPM

7 17 20 45 24   0.34    3.18    5.52    2.85    2.56    2.09    1.26    1.95 107.72 308.69
7 17 20 45 29   0.34    3.16    5.52    2.85    2.56    2.09    1.26    1.95 107.78 308.69
7 17 20 45 35   0.34    3.18    5.52    2.85    2.56    2.09    1.26    1.95 107.72 308.69
7 17 20 45 41   0.34    3.16    5.50    2.85    2.56    2.09    1.26    1.95 107.56 308.69
7 17 20 45 47   0.34    3.16    5.50    2.85    2.53    2.05    1.26    1.94 107.66 308.69
7 17 20 45 53   0.33    3.15    5.47    2.84    2.51    2.05    1.26    1.94 107.44 308.69
7 17 20 46  0   0.34    3.16    5.49    2.85    2.52    2.06    1.26    1.94 107.53 308.69
7 17 20 46  6   0.34    3.16    5.50    2.84    2.52    2.06    1.26    1.94 107.31 308.69
7 17 20 46 13   0.34    3.16    5.50    2.83    2.52    2.06    1.26    1.94 107.38 308.69
7 17 20 46 18   0.34    3.16    5.50    2.85    2.52    2.06    1.26    1.94 107.25 308.69
7 17 20 46 25   0.34    3.16    5.50    2.85    2.52    2.06    1.26    1.92 107.31 308.69
7 17 20 46 32   0.34    3.16    5.50    2.85    2.51    2.06    1.26    1.94 107.19 285.06
7 17 20 46 37   0.34    3.15    5.50    2.85    2.52    2.08    1.26    1.94 107.25 285.06
7 17 20 46 44   0.34    3.16    5.50    2.83    2.52    2.06    1.26    1.94 107.13 285.06
7 17 20 46 50   0.36    3.16    5.52    2.87    2.54    2.08    1.27    1.97 107.09 285.06
7 17 20 46 54   0.34    3.15    5.50    2.85    2.52    2.06    1.26    1.93 107.13 285.06
7 17 20 47  0   0.33    3.16    5.52    2.85    2.52    2.06    1.26    1.94 107.13 285.06
7 17 20 47  7   0.34    3.15    5.50    2.83    2.51    2.06    1.26    1.92 107.03 285.06
7 17 20 47 14   0.33    3.16    5.50    2.85    2.52    2.06    1.26    1.94 107.03 285.06
7 17 20 47 19   0.33    3.16    5.48    2.84    2.52    2.06    1.26    1.94 107.03 285.06
7 17 20 47 26   0.33    3.16    5.50    2.85    2.52    2.06    1.26    1.94 106.91 280.95
7 17 20 47 31   0.34    3.15    5.50    2.85    2.52    2.06    1.26    1.94 107.03 280.95
7 17 20 47 37   0.33    3.15    5.50    2.85    2.52    2.06    1.24    1.94 106.91 280.95
7 17 20 47 43   0.33    3.16    5.50    2.85    2.51    2.06    1.24    1.94 106.91 280.95
7 17 20 47 49   0.34    3.16    5.50    2.84    2.52    2.06    1.24    1.94 106.78 280.95
7 17 20 47 56   0.34    3.16    5.50    2.85    2.52    2.05    1.24    1.94 106.84 280.95
7 17 20 48  0   0.34    3.15    5.52    2.84    2.52    2.05    1.24    1.94 106.78 280.95
7 17 20 48  7   0.33    3.15    5.50    2.85    2.52    2.06    1.26    1.94 106.72 280.95
7 17 20 48 14   0.34    3.15    5.50    2.85    2.52    2.06    1.24    1.94 106.84 280.95
7 17 20 48 20   0.34    3.16    5.50    2.84    2.52    2.06    1.24    1.94 106.72 280.95
7 17 20 48 26   0.34    3.20    5.48    2.85    2.52    2.05    1.24    1.94 106.72 280.95
7 17 20 48 32   0.34    3.20    5.50    2.84    2.52    2.05    1.24    1.94 106.63 280.95
7 17 20 48 37   0.34    3.16    5.50    2.85    2.52    2.06    1.24    1.94 106.72 280.95
7 17 20 48 44   0.34    3.15    5.50    2.84    2.52    2.05    1.26    1.94 106.63 280.95
7 17 20 48 50   0.34    3.15    5.50    2.84    2.52    2.05    1.24    1.94 106.56 280.95
7 17 20 48 55   0.34    3.15    5.50    2.84    2.51    2.05    1.24    1.94 106.50 280.95
7 17 20 49  2   0.34    3.15    5.50    2.85    2.51    2.06    1.24    1.94 106.44 280.95
7 17 20 49  7   0.33    3.16    5.47    2.84    2.52    2.06    1.24    1.94 106.44 280.95
7 17 20 49 14   0.34    3.15    5.50    2.85    2.52    2.05    1.24    1.94 106.44 280.95
7 17 20 49 19   0.34    3.15    5.48    2.85    2.52    2.05    1.24    1.94 106.38 280.95 2.45
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```
   OUTPUT FROM PSMS DIGITAL TREND

                                                                         FWTEMP  FWFLOW
D  H  M  S   APRM     APRM     APRM     APRM     APRM     APRM     APRM     APRM       1       1
               1        2        3        4        5        6        7        8      DEG F    GPM
            % F PR   % F PR   % F PR   % F PR   % F PR   % F PR   % F PR   % F PR

7 20 49 26   0.33     3.15     5.49     2.84     2.52     2.05     1.24     1.94  106.38  200.95
7 20 49 31   0.34     3.16     5.50     2.84     2.52     2.05     1.24     1.94  106.38  290.71
7 20 49 37   0.34     3.15     5.50     2.85     2.51     2.05     1.24     1.94  106.31  290.71
7 20 49 44   0.33     3.15     5.48     2.85     2.52     2.05     1.23     1.94  106.25  290.71
7 20 49 49   0.34     3.15     5.50     2.84     2.51     2.06     1.24     1.94  106.31  290.71
7 20 49 56   0.34     3.15     5.50     2.84     2.52     2.05     1.24     1.94  106.16  290.71
7 20 50  1   0.33     3.16     5.48     2.85     2.51     2.05     1.24     1.94  106.25  290.71
7 20 50  8   0.33     3.16     5.49     2.84     2.52     2.05     1.24     1.95  106.16  290.71
17 20 50 13  0.34     3.15     5.48     2.84     2.51     2.05     1.23     1.94  106.16  290.71
17 20 50 19  0.33     3.15     5.48     2.84     2.52     2.05     1.24     1.94  106.09  290.71
17 20 50 25  0.34     3.15     5.48     2.84     2.52     2.05     1.24     1.94  106.09  292.25
17 20 50 32  0.33     3.15     5.48     2.84     2.51     2.05     1.23     1.94  105.97  292.25
17 20 50 38  0.33     3.12     5.48     2.80     2.48     2.03     1.23     1.92  106.00  292.25
17 20 50 43  0.30     3.16     5.48     2.82     2.48     2.03     1.23     1.92  106.03  292.25
17 20 50 50  0.33     3.19     5.48     2.85     2.51     2.05     1.24     1.94  105.91  292.25
17 20 50 55  0.33     3.15     5.48     2.84     2.51     2.05     1.23     1.94  105.97  292.25
17 20 51  0  0.33     3.15     5.48     2.84     2.51     2.05     1.23     1.95  105.84  292.25
17 20 51  8  0.33     3.15     5.48     2.84     2.51     2.05     1.23     1.94  105.84  292.25
17 20 51 13  0.34     3.16     5.48     2.84     2.51     2.05     1.24     1.94  105.91  292.25
17 20 51 20  0.33     3.15     5.48     2.84     2.51     2.05     1.23     1.94  105.84  292.25
17 20 51 25  0.34     3.15     5.46     2.84     2.51     2.05     1.23     1.94  105.84  290.20
17 20 51 31  0.33     3.15     5.48     2.84     2.51     2.05     1.23     1.94  105.84  290.20
17 20 51 37  0.33     3.15     5.48     2.84     2.52     2.05     1.23     1.94  105.84  290.20
17 20 51 43  0.34     3.15     5.48     2.84     2.51     2.05     1.24     1.94  105.84  290.20
17 20 51 49  0.33     3.15     5.48     2.84     2.51     2.05     1.20     1.94  105.84  290.20
17 20 51 56  0.33     3.15     5.46     2.84     2.51     2.05     1.21     1.92  105.75  290.20
17 20 52  2  0.33     3.15     5.46     2.85     2.51     2.05     1.23     1.94  105.84  290.20
17 20 52  7  0.33     3.15     5.46     2.84     2.48     2.03     1.20     1.94  105.69  290.20
17 20 52 14  0.33     3.15     5.46     2.84     2.51     2.05     1.20     1.94  105.69  290.20
17 20 52 20  0.33     3.15     5.46     2.84     2.51     2.05     1.22     1.92  105.75  290.20
17 20 52 25  0.34     3.12     5.48     2.85     2.52     2.06     1.22     1.94  105.75  291.22
17 20 52 30  0.33     3.11     5.46     2.84     2.51     2.05     1.20     1.94  105.69  291.22
17 20 52 37  0.34     3.14     5.48     2.84     2.51     2.05     1.23     1.94  105.63  291.22
17 20 52 43  0.33     3.16     5.46     2.84     2.51     2.03     1.23     1.92  105.63  291.22
17 20 52 50  0.33     3.14     5.46     2.84     2.51     2.05     1.20     1.94  105.63  291.22
17 20 52 55  0.33     3.13     5.46     2.85     2.51     2.05     1.22     1.94  105.66  291.22
17 20 53  1  0.34     3.11     5.46     2.85     2.51     2.05     1.23     1.94  105.63  291.22
17 20 53  7  0.34     3.13     5.48     2.84     2.51     2.05     1.23     1.94  105.56  291.22
17 20 53 13  0.34     3.13     5.46     2.84     2.51     2.05     1.20     1.94  105.56  291.22
17 20 53 20  0.33     3.11     5.46     2.84     2.51     2.05     1.20     1.92  105.56  291.22 2.43
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JCP&L   COMOF                                                                        07/18/80  17:36        PRT001

************************************************************************************************************************
************************************************************************************************************************
**                                                                                                                    **
**                                                                                                                    **
**                                                                                                                    **
**        WWW   WWW   WWWW          W                                                                                 **
**         W   W   W  W   W         W                                                                                 **
**         W   W      W   W         W                                                                                 **
**         W   W      WWWW          W                                                                                 **
**      W  W   W      W             W                                                                                 **
**      W  W   W   W  W             W   W                                                                             **
**       WW     WWW   W             WWWWW                                                                             **
**                                                                                                                    **
**                                                                                                                    **
**                                                                                                                    **
**       WWW    WWW   W   W   WWW   WWWWW                                                                             **
**      W   W  W   W  WW WW  W   W  W                                                                                 **
**      W      W   W  W W W  W   W  W                                                                                 **
**      W      W   W  W W W  W   W  WWWW                                                                              **
**      W      W   W  W   W  W   W  W                                                                                 **
**      W   W  W   W  W   W  W   W  W                                                                                 **
**       WWW    WWW   W   W   WWW   W                                                                                 **
**                                                                                                                    **
**                                                                                                                    **
**                                                                                                                    **
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Sheet 3

Transient & Scram of 7/17/80

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OUTPUT FROM PSMS DIGITAL TREND
                       -2
                  x10
M  D  H  M  S  RECFLO RECFLO RECFLO RECFLO RECFLO RECTEM RECTEM RECTEM RECTEM RECTEM
                  1      2      3      4      5      1      2      3      4      5
                 GPM    GPM    GPM    GPM    GPM   DEG F  DEG F  DEG F  DEG F  DEG F

7 17 20 29 23 110.81 117.67 114.69 104.77 109.09 535.47 541.81 541.97 538.69 540.63
7 17 20 29 29 110.28 116.81 113.89 105.69 109.13 535.59 541.91 541.97 538.69 540.78
7 17 20 29 35 110.72 114.69 114.38 105.63 107.88 535.78 542.03 542.19 539.00 540.94
7 17 20 29 41 110.75 118.41 114.98 104.89 107.64 536.09 542.41 542.47 539.31 541.22
7 17 20 29 47 110.47 115.23 114.50 104.77 107.58 536.16 542.41 542.53 539.31 541.22
7 17 20 29 53 111.17 114.69 114.25 104.77 108.13 536.44 542.72 542.78 539.59 541.53
7 17 20 29 59 111.27 116.14 115.05 104.58 107.88 536.47 542.72 542.78 539.50 541.53
7 17 20 30  5 109.89 115.11 114.02 104.77 108.48 536.72 542.91 543.16 539.88 541.81
7 17 20 30 11 110.75 115.66 114.31 103.61 107.52 536.91 543.06 543.28 540.06 541.91
7 17 20 30 17 110.59 114.92 113.16 104.77 107.81 536.84 543.16 543.28 540.06 541.97
7 17 20 30 23 110.50 115.17 114.19 105.25 108.13 537.03 543.38 543.50 540.31 542.28
7 17 20 30 29 111.30 116.09 113.34 103.97 107.03 537.25 543.50 543.66 540.41 542.41
7 17 20 30 35 110.05 115.78 112.91 104.64 108.31 537.22 543.50 543.66 540.41 542.41
7 17 20 30 41 110.11 115.66 113.28 105.50 108.25 537.44 543.59 543.81 540.56 542.47
7 17 20 30 47 110.27 116.27 114.14 104.58 107.03 537.72 543.94 544.13 540.84 542.78
7 17 20 30 54 109.86 116.03 113.64 103.58 106.75 537.66 543.84 544.00 540.69 542.66
7 17 20 30 59 110.66 113.63 113.47 105.25 107.45 537.81 543.94 544.19 540.84 542.84
7 17 20 31  6 110.66 114.69 114.31 104.41 106.66 537.97 544.13 544.25 541.00 543.00
7 17 20 31 11 110.27 115.48 112.94 103.36 107.14 538.25 544.38 544.56 541.31 543.28
7 17 20 31 17 110.28 113.89 113.53 105.02 106.11 538.25 544.31 544.50 541.31 543.22
7 17 20 31 23 110.23 113.03 113.53 103.48 105.38 538.25 544.50 544.69 541.38 543.38
7 17 20 31 29 110.17 113.95 113.89 103.55 104.64 538.50 544.63 544.75 541.53 543.50
7 17 20 31 36 108.92 113.63 113.64 103.06 105.73 538.78 545.00 545.06 541.81 543.75
7 17 20 31 42 109.38 115.30 113.28 102.69 104.32 538.84 544.94 545.13 541.91 543.81
7 17 20 31 47 109.77 114.14 112.83 103.30 105.56 539.06 545.28 545.38 542.09 544.13
7 17 20 31 53 109.00 113.70 113.58 103.78 103.84 539.00 545.13 545.28 542.09 544.13
7 17 20 31 59 169.50 113.95 112.23 102.94 104.34 539.06 545.38 545.50 542.28 544.19
7 17 20 32  5 109.13 113.28 113.95 103.73 104.34 539.16 545.44 545.59 542.41 544.31
7 17 20 32 11 109.56 115.36 113.89 103.23 103.73 539.31 545.59 545.72 542.53 544.50
7 17 20 32 17 109.22 112.77 113.34 102.63 104.16 539.59 545.88 546.03 542.78 544.69
7 17 20 32 23 109.56 113.47 114.02 103.30 104.58 539.69 545.78 545.97 542.78 544.75
7 17 20 32 29 110.20 114.75 113.70 103.17 104.41 539.94 546.09 546.22 543.00 544.94
7 17 20 32 35 108.55 114.44 113.70 102.14 104.77 540.06 546.22 546.34 543.16 545.06
7 17 20 32 41 109.22 112.52 111.78 102.39 104.83 540.19 546.34 546.53 543.28 545.22
7 17 20 32 48 109.13 114.02 112.86 102.56 104.77 540.13 546.34 546.53 543.22 545.22
7 17 20 32 54 107.94 114.31 112.64 102.45 103.61 540.50 546.53 546.69 543.50 545.38
7 17 20 32 59 109.41 112.89 111.55 102.50 102.81 540.31 546.53 546.75 543.44 545.44
7 17 20 33  6 109.50 113.64 112.80 102.81 103.67 540.25 546.47 546.75 543.50 545.44
7 17 20 33 11 109.22 111.30 112.89 102.08 103.97 540.50 546.69 546.97 543.75 545.59
7 17 20 33 17 109.03 113.64 113.28 101.53 104.52 540.50 546.69 546.97 543.81 545.72
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        OUTPUT FROM PSMS DIGITAL TREND

 M  D  H  M  S  RECFLO RECFLO RECFLO RECFLO RECFLO RECTEM RECTEM RECTEM RECTEM RECTEM
                  1      2      3      4      5      1      2      3      4      5
                 GPM    GPM    GPM    GPM    GPM   DEG F  DEG F  DEG F  DEG F  DEG F

 7 17 20 33 24 109.98 114.25 112.91 102.14 103.91 540.31 546.69 546.91 543.66 545.59
 7 17 20 33 29 108.48 113.89 112.30 102.02 103.97 540.31 546.75 546.97 543.75 545.66
 7 17 20 33 35 109.38 113.16 112.06 101.83 104.58 540.41 546.84 547.03 543.81 545.72
 7 17 20 33 41 108.36 113.77 112.67 101.34 103.48 540.41 546.84 547.13 543.88 545.72
 7 17 20 33 47 109.06 113.47 111.33 102.14 104.34 540.56 546.91 547.19 543.88 545.72
 7 17 20 33 54 109.19 113.70 113.22 101.47 102.88 540.63 547.03 547.28 543.94 545.83
 7 17 20 33 59 109.98 112.55 112.30 101.28 104.09 540.63 547.03 547.34 544.03 545.88
 7 17 20 34  5 110.23 111.63 112.67 102.88 104.09 540.69 547.03 547.34 544.13 545.88
 7 17 20 34 11 110.41 114.14 111.81 102.08 103.48 540.78 547.19 547.50 544.19 546.63
 7 17 20 34 18 108.86 114.19 113.28 102.33 104.89 540.84 547.34 547.56 544.31 546.03
 7 17 20 34 23 111.63 113.22 112.00 102.20 103.23 540.78 547.28 547.50 544.25 545.97
 7 17 20 34 29 110.08 112.16 112.39 101.53 103.42 540.84 547.41 547.72 544.38 546.09
 7 17 20 34 36 110.23 114.08 112.80 101.47 103.78 540.84 547.19 547.56 544.31 546.03
 7 17 20 34 41 109.53 114.69 110.14 101.22 101.89 541.00 547.34 547.72 544.50 546.16
 7 17 20 34 48 109.80 114.02 112.61 101.53 103.84 540.78 547.19 547.63 544.38 546.03
 7 17 20 34 53 169.00 115.30 112.00 102.33 103.36 540.84 547.19 547.63 544.38 546.09
 7 17 20 35  0 109.80 113.53 111.88 102.14 104.03 540.94 547.28 547.63 544.59 546.03
 7 17 20 35  5 108.13 113.70 112.19 102.20 104.22 540.94 547.28 547.72 544.50 546.09
 7 17 20 35 11 109.47 113.34 113.09 102.27 103.97 541.00 547.50 547.88 544.75 546.34
 7 17 20 35 18 109.22 111.78 112.83 100.50 102.81 541.00 547.41 547.78 544.63 546.22
 7 17 20 35 23 109.70 113.09 112.16 101.66 103.48 541.16 547.56 547.94 544.75 546.41
 7 17 20 35 30 108.69 112.67 112.86 102.39 103.42 541.06 547.41 547.88 544.75 546.22
 7 17 20 35 35 108.89 115.42 112.13 101.28 104.83 541.16 547.56 547.88 544.84 546.47 ← "D" ERV OPENED
 7 17 20 35 41 110.31 114.31 115.11 103.91 105.86 541.31 547.78 548.13 545.06 546.59
 7 17 20 35 48 110.47 116.39 116.45 104.95 106.97 541.31 547.72 548.06 545.00 546.53
 7 17 20 35 53 111.55 112.09 117.25 108.80 106.05 541.44 547.88 543.25 545.13 546.69 ← "D" ERV CLOSED
 7 17 20 36  0 107.88 104.16 118.77 106.97  97.38 541.06 547.34 547.94 544.75 546.47
 7 17 20 36  5 108.31 104.89 118.77  98.66  93.38 540.56 546.59 547.56 544.25 545.88
 7 17 20 36 11 106.59 105.62 120.30  88.14  91.13 539.94 545.78 547.03 543.59 545.28
 7 17 20 36 17 104.28 105.38 119.50  84.08  88.31 539.44 545.28 546.69 543.16 544.84
 7 17 20 36 23 103.55 104.22 120.05  82.22  88.86 539.06 544.63 546.03 542.41 544.25
 7 17 20 36 29 103.30 103.13 122.67  82.13  86.45 538.69 544.69 545.78 542.28 543.94
 7 17 20 36 35 103.30  99.39 121.89  82.70  87.52 538.25 544.31 545.38 541.91 543.59
 7 17 20 36 41 101.28 100.44 121.64  81.55  85.75 538.25 544.31 545.13 541.81 543.38
 7 17 20 36 47 100.61 100.67 118.66  82.33  84.59 538.19 544.31 545.00 541.66 543.28
 7 17 20 36 54 101.41 100.00 108.73  84.23  85.33 538.03 544.25 544.94 541.66 543.28
 7 17 20 36 59 101.47 100.06  99.16  85.39  87.41 538.13 544.31 544.94 541.75 543.28
 7 17 20 37  6 100.73 101.28  97.63  85.39  87.77 538.13 544.50 545.00 541.81 543.38
 7 17 20 37 11 100.55 100.22  97.23  85.84  87.31 538.34 544.75 545.13 542.03 543.59
 7 17 20 37 17 100.38 100.13  96.95  87.28  87.52 538.34 544.69 545.06 542.03 543.59
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OUTPUT FROM PSMS DIGITAL TREND

                      RECFLO RECFLO RECFLO RECFLO RECFLO RECTEM RECTEM RECTEM RECTEM RECTEM
 M  D  H  M  S          1      2      3      4      5      1      2      3      4      5
                       GPM    GPM    GPM    GPM    GPM   DEG F  DEG F  DEG F  DEG F  DEG F

 7 17 20 37 24       99.67 101.05  98.39  86.64  86.58 538.56 544.94 545.28 542.19 543.81
 7 17 20 37 29       99.06 100.41  97.05  86.88  87.50 538.56 545.06 545.38 542.28 543.88
 7 17 20 37 36       98.45 100.03  97.91  86.77  86.64 538.78 545.22 545.50 542.47 544.03
 7 17 20 37 41       97.20 101.41  98.11  87.41  87.28 538.78 545.13 545.44 542.41 543.94
 7 17 20 37 47       97.91 101.72  97.17  87.31  87.55 539.00 545.44 545.66 542.63 544.25
 7 17 20 37 54       97.91 100.59  97.59  87.44  87.55 539.22 545.59 545.78 542.78 544.38
 7 17 20 37 59       97.20 100.35  98.30  87.16  88.02 539.16 545.44 545.72 542.72 544.38
 7 17 20 38  5       97.53  98.88  98.75  87.50  88.08 539.38 545.72 545.97 543.00 544.63
 7 17 20 38 11       97.38 100.19  98.30  87.58  87.77 539.22 545.66 545.97 543.00 544.63
 7 17 20 38 18       96.22  98.17  99.52  87.09  87.89 539.38 545.88 546.09 543.16 544.75
 7 17 20 38 24       97.53  99.73  98.45  87.61  88.38 539.50 546.03 546.22 543.28 544.94
 7 17 20 38 29       97.23 100.03  98.75  87.73  88.31 539.81 546.16 546.47 543.44 545.06
 7 17 20 38 36       96.92 100.41  98.75  87.50  88.75 539.94 546.34 546.59 543.66 545.22
 7 17 20 38 41       97.63  99.94  99.22  87.41  88.31 539.88 546.34 546.59 543.59 545.22
 7 17 20 38 48       97.23  99.88  99.09  87.09  88.44 540.19 546.59 546.84 543.81 545.50
 7 17 20 38 53       95.28  99.42  99.23  87.44  88.02 540.31 546.75 546.97 543.94 545.59
 7 17 20 38 59       95.83  99.55  98.94  87.61  87.31 540.50 546.91 547.13 544.13 545.72
 7 17 20 39  5       95.61 100.38  98.36  87.77  87.64 540.50 546.91 547.13 544.19 545.78
 7 17 20 39 12       96.06  99.67  99.13  88.31  88.38 540.69 547.13 547.50 544.56 546.09
 7 17 20 39 18       95.36 101.05  98.55  87.52  88.25 540.69 547.13 547.41 544.56 546.09
 7 17 20 39 23       94.48  98.84  98.66  87.58  87.70 540.78 547.19 547.50 544.63 546.16
 7 17 20 39 29       94.78  98.91  99.16  87.41  87.47 540.94 547.34 547.72 544.75 546.22
 7 17 20 39 35       95.19  99.33  98.84  87.28  87.77 541.06 547.41 547.78 544.94 546.47
 7 17 20 39 41       95.83 100.55  98.02  88.31  87.61 541.31 547.72 548.06 545.13 546.69
 7 17 20 39 48       95.09 100.16  97.91  87.55  88.75 541.38 547.72 548.13 545.28 546.84
 7 17 20 39 53       95.09  97.95  99.97  87.25  88.19 541.38 547.78 548.13 545.28 546.84
 7 17 20 40  0       95.48  99.39  99.09  88.31  88.50 541.31 547.63 548.06 545.22 546.84
 7 17 20 40  5       95.64  98.63  97.23  87.86  88.98 541.38 547.78 548.31 545.38 546.97
 7 17 20 40 11       95.39  99.80  96.98  89.17  88.08 541.44 547.72 548.25 545.38 546.91
 7 17 20 40 17       96.03 100.00  93.38  89.11  88.56 541.16 547.50 548.06 545.13 546.75
 7 17 20 40 23       95.73  99.58  91.25  88.86  88.19 541.00 547.50 547.94 545.00 546.59
 7 17 20 40 30       95.42  99.77  90.20  89.05  87.89 541.00 547.41 547.94 545.00 546.59
 7 17 20 40 35       96.22  99.39  91.73  83.14  88.69 541.00 547.34 547.78 544.94 546.53
 7 17 20 40 41       96.67  99.61  91.25  87.73  88.19 541.16 547.41 547.94 545.06 546.59
 7 17 20 40 47       95.86 100.92  92.28  88.02  87.58 540.94 547.19 547.78 544.75 546.41
 7 17 20 40 54       96.77 100.98  90.94  88.75  87.63 540.69 547.13 547.63 544.69 546.22
 7 17 20 40 59       95.83 100.92  90.64  88.08  88.19 540.94 547.34 547.88 544.84 546.41
 7 17 20 41  6       96.64 100.60  91.06  88.31  87.03 540.78 547.13 547.56 544.63 546.16
 7 17 20 41 12       95.86 100.55  91.48  89.05  87.16 540.69 547.13 547.56 544.63 546.16
 7 17 20 41 17       96.28 101.22  92.53  88.31  87.52 540.63 547.03 547.56 544.63 546.09
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OUTPUT FROM PSMS DIGITAL TREND

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M  D  H  M  S  RECFLO RECFLO RECFLO RECFLO RECFLO RECTEM RECTEM RECTEM RECTEM RECTEM
                  1      2      3      4      5      1      2      3      4      5
                 GPM    GPM    GPM    GPM    GPM   DEG F  DEG F  DEG F  DEG F  DEG F

7 17 20 41 23  96.38  99.73  91.25  89.53  87.31 540.78 547.13 547.63 544.69 546.16 ← BP valves open
7 17 20 41 29  95.97 100.98  92.16  89.05  87.47 540.56 546.91 547.41 544.50 546.03
7 17 20 41 35  95.97  99.83  94.66  90.03  87.64 540.63 546.97 547.41 544.50 545.97 ← BP valves closed
7 17 20 41 42  31.09  47.13  27.38  10.59  10.53 540.41 546.22 547.19 544.31 545.72
7 17 20 41 47  90.39 109.13  95.55 109.31  79.98 539.50 545.13 546.59 543.59 544.75 ← TRIPLE LOW LEVEL (4)
7 17 20 41 54 110.84 112.67 111.63 105.92 105.31 538.34 543.75 545.22 542.19 543.28
7 17 20 41 59 111.75 108.95 107.20 104.89 103.78 537.81 543.00 544.63 541.66 542.72
7 17 20 42  6 102.94  98.11  97.69  98.72  89.42 536.78 542.19 543.66 540.63 541.44
7 17 20 42 11  99.48  98.27  96.31  91.48  87.61 536.22 542.03 543.44 540.19 541.16 ]REACTOR SCRAM
7 17 20 42 17  94.94 100.31  92.09  89.91  83.44 535.44 541.31 542.78 539.38 540.31
7 17 20 42 23  93.44 101.72  91.73  89.23  84.88 534.78 540.94 542.53 539.16 539.94
7 17 20 42 29  97.31  99.45  96.28  91.25  86.00 533.28 538.34 541.59 537.81 538.69 ← T= 538.69, P= 947.88, PSAT = 937 psig
7 17 20 42 35 100.41 105.02  97.84  95.03  87.67 529.88 533.59 539.06 534.78 535.91
7 17 20 42 41 102.20 108.55  98.55  97.81  85.63 524.41 527.47 534.41 529.56 530.75
7 17 20 42 48 101.89 105.25 101.53  96.19  91.06 517.53 520.56 528.69 522.22 524.53 ← T= 524.53, P= 942.75, PSAT = 830 psig    ΔP
7 17 20 42 53 101.05 108.80 100.16  95.52  92.70 514.41 517.84 525.28 519.38 521.25                                                Across
7 17 20 42 59  98.05 106.59  99.64  94.05  88.92 511.22 515.22 521.06 516.06 517.34                                                Pumps
7 17 20 43  6  94.78 106.17  94.11  91.73  86.88 509.75 514.28 518.59 514.34 515.50                                                ≈
7 17 20 43 11  91.73 102.33  92.70  87.70  84.66 509.91 515.38 517.66 514.22 515.13
7 17 20 43 18  89.23 101.28  87.77  88.25  82.22 514.63 521.97 520.16 518.56 519.31
7 17 20 43 23  85.56 100.92  81.23  85.63  79.31 516.97 525.22 522.13 520.75 521.75
7 17 20 43 30  52.39  96.53  62.02  49.09  -1.00 519.94 528.38 525.59 523.41 524.78 ← T= 524.78, P= 858.75, PSAT ≈ 832
7 17 20 43 35  -1.00  87.73  -1.60  -1.00  -1.00 520.63 528.16 527.16 523.84 525.59 ← T= 525.59, P= 843 , PSAT = 835
7 17 20 43 41  -1.00  89.41  -1.00  -1.00  -1.00 520.50 527.25 527.63 523.47 525.28 ← T = 525.28, P = 835.31, PSAT = 835
7 17 20 43 48  72.84  88.31  61.41  59.39  64.08 519.03 524.91 526.88 521.91 523.91
7 17 20 43 53  85.59  91.55  82.73  81.94  79.44 518.16 523.84 526.34 521.13 523.34
7 17 20 44  0  90.09  95.86  86.84  82.70  84.17 516.28 522.13 524.97 519.41 521.66
7 17 20 44  6  88.31  99.36  87.67  83.34  82.61 515.88 521.94 524.22 519.06 521.13
7 17 20 44 12  84.50  97.78  83.09  76.50  80.91 515.94 522.38 523.84 519.22 521.19
7 17 20 44 17  84.95  92.22  77.73  74.48  72.36 516.22 522.78 523.78 519.56 521.44 ← T= 521.44, P= 815, PSAT = 805 psig
7 17 20 44 23  73.61  77.35  72.02  66.34  63.59 516.84 523.09 524.09 519.88 522.00
7 17 20 44 30  77.30  69.39  73.55  65.80  72.02 516.63 522.47 523.53 519.28 521.69
7 17 20 44 35  82.13  78.70  72.20  71.66  69.83 516.41 522.22 523.09 518.84 521.31
7 17 20 44 42  86.48  92.89  83.44  83.50  79.02 516.00 522.19 522.66 518.56 520.81
7 17 20 44 47  88.98  95.67  83.61  84.11  84.53 515.69 522.19 522.66 518.41 520.69
7 17 20 44 53  89.42  97.53  86.58  84.31  83.47 515.72 522.16 522.69 518.38 520.75
7 17 20 44 59  89.72  95.31  84.47  80.84  82.70 515.31 521.81 522.41 518.09 520.44
7 17 20 45  5  91.48  95.39  86.03  81.81  84.14 515.50 521.78 522.53 518.22 520.50
7 17 20 45 12  93.11  96.73  87.86  82!73  84.14 515.31 521.78 522.53 518.22 520.63
7 17 20 45 17  91.98  93.50  87.52  86.55  84.95 515.22 521.66 522.41 518.03 520.53 ← T= 520.53, P= 785.13, PSAT = 800 psig
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                 OUTPUT FROM PSMS DIGITAL TREND

M  D  H  M  S  RECFLO RECFLO RECFLO RECFLO RECFLO RECTEM RECTEM RECTEM RECTEM RECTEM
                  1      2      3      4      5      1      2      3      4      5
                 GPM    GPM    GPM    GPM    GPM   DEG F  DEG F  DEG F  DEG F  DEG F

7 17 20 45 24  93.75  98.11  89.91  87.41  83.56 515.06 521.31 522.13 517.72 520.31
7 17 20 45 29  95.09  97.91  88.44  87.55  86.33 515.13 521.25 522.09 517.78 520.34
7 17 20 45 35  96.06  98.88  90.58  89.17  86.58 514.88 520.94 521.84 517.47 520.13
7 17 20 45 41  95.55 103.67  90.88  87.22  86.06 514.63 520.75 521.59 517.19 519.84
7 17 20 45 47  95.03 102.50  93.44  88.44  87.06 514.50 520.50 521.50 517.16 519.75
7 17 20 45 53  96.67  99.36  92.41  86.64  84.63 514.34 520.34 521.31 516.94 519.59
7 17 20 46  0  95.52 102.75  91.13  89.72  85.55 514.09 520.19 521.19 516.78 519.44
7 17 20 46  6  97.27 101.41  92.83  89.72  86.00 513,81 519.78 520.81 516.44 519.16
7 17 20 46 13  98.91 101.28  91.92  90.81  90.75 513.66 519.69 520.69 516.44 518.94
7 17 20 46 18  99.58 104.16  93.88  93.69  91.80 513.41 519.56 520.44 516.50 518.78
7 17 20 46 25  98.56  97.84  95.70  93.02  90.75 513.28 519.44 520.34 516.56 518.69
7 17 20 46 32 101.34  99.03  94.72  93.94  91.38 513.03 519.16 520.06 516.44 518.34
7 17 20 46 37  99.97 104.28  96.73  94.48  90.64 512.97 518.97 519.97 516.41 518.28
7 17 20 46 44 100.80 102.27  96.28  94.72  90.58 512.59 518.72 519.63 516.13 517.97
7 17 20 46 50 101.05 101.53  96.53  94.75  91.95 512.41 518.47 519.41 516.00 517.72
7 17 20 46 54 100.55 105.02  96.25  94.97  91.19 512.38 518.47 519.38 516.00 517.78
7 17 20 47  0 101.53 102.56  96.73  94.84  92.53 512.31 518.22 519.22 515.88 517.59
7 17 20 47  7 100.67 104.28  96.34  94.48  92.05 511.91 517.97 518.78 515.63 517.28
7 17 20 47 14 100.86 103.00  96.44  95.33  91.98 511.91 517.91 518.84 515.63 517.16
7 17 20 47 19 100.80 101.34  95.70  93.88  92.89 511.75 517.78 518.59 515.41 517.00
7 17 20 47 26 100.98 100.50  97.02  95.31  91.55 511.28 517.50 518.34 515.22 516.75
7 17 20 47 31 100.28 102.68  97.05  95.09  92.22 511 28 517.47 518.28 515.25 516.72
7 17 20 47 37 100.06 102.81  96.03  94.17  92.41 510.91 517.13 517.97 515.06 516.38
7 17 20 47 43 101.17 103.30  96.70  94.17  92.22 510.78 516.97 517.78 514.84 516.22
7 17 20 47 49 100.44 105.44  96.95  95.36  93.20 510.69 516.75 517.59 514.69 516.00
7 17 20 47 56 101.59 101.66  96.03  95.25  91.61 510.53 516.59 517.41 514.47 515.81
7 17 20 48  0 102.02 104.34  96.89  94.11  91.19 510.28 516.44 517.19 514.38 515.69
7 17 20 48  7 100.67 103.73  96.77  94.55  91.80 510.06 516.22 517.03 514.16 515.44
7 17 20 48 14 100.28 106.66  96.50  94.61  92.16 510.06 516.25 517.00 514.09 515.41
7 17 20 48 20  99.39 103.97  96.53  95.25  92.41 509.69 515.81 516.66 513.72 515.13
7 17 20 48 26 100.86 101.47  96.09  94.78  92.70 509.53 515.69 516.50 513.66 514.91
7 17 20 48 32 100.83 101.95  96.64  94.42  92.34 509.31 515.50 516.38 513.41 514.75
7 17 20 48 37 100.16 102.94  96.56  94.55  91.48 509.31 515.41 516.25 513.34 514.72
7 17 20 48 44 100.61 103.42  97.08  94.94  93.38 509.00 515.22 516.06 513.22 514.47
7 17 20 48 50 100.09 104.89  98.02  94.97  92.22 508.94 515.13 515.88 513.03 514.34
7 17 20 48 55 101.17 104.89  95.28  95.09  90.64 508.69 514.88 515.72 512.81 514.19
7 17 20 49  2 100.19 104.89  96.03  94.00  91.55 508.38 514.53 515.44 512.50 513.91
7 17 20 49  7 101.05 104.45  96.67  95.58  93.33 508.47 514.56 515.41 512.59 513.91
7 17 20 49 14 100.38 105.31  96.41  94.61  92.41 508.00 514.16 515.06 512.13 513.50
7 17 20 49 19 100.61 106.11  95.77  95.03  94.00 507.91 514.03 514.94 512.00 513.41
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          OUTPUT FROM PSMS DIGITAL TREND

M  D  H  M  S  RECFLO RECFLO RECFLO RECFLO RECFLO RECTEM RECTEM RECTEM RECTEM RECTEM
                 1      2      3      4      5      1      2      3      4      5
                GPM    GPM    GPM    GPM    GPM   DEG F  DEG F  DEG F  DEG F  DEG F

7 17 20 49 26 100.41 104.77  96.50  95.45  93.08 507.84 513.91 514.81 511.81 513.28
7 17 20 49 31 100.61 107.39  96.38  95.33  92.09 507.59 513.59 514.56 511.53 512.97
7 17 20 49 37 100.19 106.30  96.41  94.94  93.44 507.16 513.22 514.16 511.06 512.59
7 17 20 49 44 100.44 104.77  96.59  95.36  92.83 506.94 513.03 513.97 510.84 512.38
7 17 20 49 49 100.41 105.92  96.80  96.19  92.41 506.81 513.03 513.91 510.78 512.31
7 17 20 49 56 100.67 104.89  96.34  95.25  92.09 506.56 512.69 513.50 510.28 511.91
7 17 20 50  1  99.30 109.28  97.41  95.03  91.61 506.44 512.59 513.41 510.22 511.91
7 17 20 50  8 101.34 107.84  97.63  95.06  93.66 506.06 512.25 513.09 509.81 511.50
7 17 20 50 13 100.09 106.59  98.08  94.39  93.20 506.06 512.31 513.03 509.84 511.44
7 17 20 50 19 100.38 106.11  96.34  94.88  91.98 505.69 511.91 512.75 509.44 511.16
7 17 20 50 25  99.58 107.63  97.92  94.72  93.14 505.47 511.69 512.50 509.13 510.91
7 17 20 50 32 100.61 106.53  98.36  95.73  93.44 505.31 511.44 512.31 509.00 510.69
7 17 20 50 38  99.55 107.58  98.75  94.42  93.11 505.34 511.41 512.31 508.94 510.72
7 17 20 50 43  99.48 106.84 101.28  95.58  92.59 505.03 511.22 512.06 508.69 510.47
7 17 20 50 50 100.16 106.97 102.08  94.30  95.03 504.81 510.91 511.81 508.47 510.22
7 17 20 50 55  99.36 107.45 102.02  94.61  93.88 504.66 510.78 511.59 508.31 510.00
7 17 20 51  0  99.22 106.30 100.67  94.78  95.36 504.25 510.38 511.22 507.78 509.63
7 17 20 51  8  98.55 106.41 100.61  95.73  95.19 504.00 510.22 510.97 507.53 509.44
7 17 20 51 13  97.95 107.81 102.45  94.48  95.39 503.97 510.16 510.91 507.53 509.25
7 17 20 51 20  99.77 105.25 101.11  94.94  96.64 503.69 509.84 510.59 507.16 509.00
7 17 20 51 25  98.48 105.92  99.64  94.94  94.48 503.41 509.63 510.38 506.94 508.75
7 17 20 51 31  97.41 106.72 100.86  94.91  94.97 503.28 509.53 510.38 506.81 508.69
7 17 20 51 37  99.30 107.52 101.66  94.55  96.31 503.13 509.38 510.06 506.66 508.38
7 17 20 51 43  97.53 107.45 101.05  94.84  95.89 502.91 509.06 509.91 506.44 508.22
7 17 20 51 49 100.09 106.66 101.47  94.97  95.16 502.66 508.94 509.75 506.19 508.00
7 17 20 51 56  98.53 107.33 103.23  93.69  97.08 502.31 508.53 509.31 505.84 507.59
7 17 20 52  2  96.25 105.50 105.38  94.48  96.05 502.28 508.47 509.25 505.81 507.53
7 17 20 52  7  98.59 104.52 105.02  94.42  96.09 502.00 508.16 508.84 505.47 507.16
7 17 20 52 14  98.72 107.20 102.63  94.23  94.94 501.69 507.91 508.69 505.22 507.00
7 17 20 52 20  98.33 104.58 103.13  94.30  94.36 501.56 507.84 508.63 505.09 506.97
7 17 20 52 25  98.59 105.98 102.63  94.05  95.73 501.38 507.53 508.31 504.84 506.63
7 17 20 52 30  98.52 107.14 105.38  95.64  96.67 501.19 507.41 508.16 504.66 506.50
7 17 20 52 37  98.11 106.23 103.97  94.48  95.25 500.91 507.00 507.84 504.31 506.16
7 17 20 52 43  98.11 106.59 104.83  95.92  94.94 500.59 506.78 507.59 504.06 505.94
7 17 20 52 50  99.52 106.36 104.16  94.88  95.97 500.47 506.63 507.41 503.94 505.63
7 17 20 52 55  98.17 107.17 105.59  95.48  95.97 500.16 506.25 507.13 503.66 505.34
7 17 20 53  1  99.00 108.06 106.30  96.13  95.39 500.19 506.19 507.13 503.50 505.41
7 17 20 53  7  99.00 107.08 105.19  95.33  96.67 499.94 506.13 506.88 503.34 505.22
7 17 20 53 13  98.45 106.17 103.67  95.22  94.72 499.72 505.81 506.66 503.13 504.97
7 17 20 53 20  98.63 106.53 105.25  95.58  95.95 499.50 505.75 506.44 502.97 504.72
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Report to GORB

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Appendix D

G.E. Responses to Various
NRC and JCP&L Questions

Question 1:

Why was there a 10°F temperature increase in the recirculation loop with a corresponding decrease in pressure? How does that relate to pump cavitation?

Response:

Following the reactor scram, the feedwater flow rapdily increased by greater than 100%. This, coupled with reduced flow from the separators, resulted in a short-term non-equilibrium temperature reduction in the annulus. Consequently, the temperature in the recirculation lines decreased faster than that which can be attributed to the pressure decrease and equilibrium feedwater mixing. As the flow and mixing conditions begin to stabilize, the enthalpy in the annulus increases resulting in the approximate 10°F temperature increase noted in the recirculation lines. Ultimately, the mixing reaches an equilibrium condition and the recirculation line temperatures begin to decrease in accordance with the pressure decrease.

The increased feedwater flow and non-equilibrium mixing resulted in increased subcooling at the pump suction. As the mixing approaches equilibrium, the subcooling decreases, which decreases the available net positive suction head (NPSH), below a certain value of NPSH (dependent on the particular pump), ~~circulation~~ cavitation may occur.

Question 2:

Did the pumps actually cavitate or was the instrumentation fooled by two phase flow.

Response:

Using the classical definition, cavitation is said to exist in a closed rapidly flowing stream when the fluid vaporizes, forming bubbles in the steam which disturb the flow and by their subsequent collapse produce vibration, noise, and rapid flow deterioration. Pump cavitation is principally of concern in low pressure systems since the volumetric change associated with vaporization of water is much more significant at low pressure.

Pumps in high pressure systems are less sensitive to pump suction subcooling and do not have classical cavitation characteristics. This is supported by General Electric test data(1) which shows that with two phase flow at the pump suction, some loss in pump head is noted, but it does not rapidly go to zero. This also accounts for normal flow being indicated with saturated conditions or near saturation conditions existing at the suction of the pumps.

(1) NEDO-10329, "Loss-of-Coolant Accident and Emergency Core Cooling Models for General Electric Boiling Water Reactors", April 1971.

The transient data indicates that some pumps experienced saturated conditions at the pump suction for a short period of time. In this sense "cavitation" may have occurred. However, the classical cavitation concern is not regarded as the principal cause for the indicated low flow. Because the pumps were operating at minimum speed, most of the driving head comes from the density difference (natural circulation). During the transient, flashing acted to decrease the available NPSH and increase hydraulic losses resulting in momentary reduction in flow. A net increase in the ~~wold~~ fraction due to increased boiling in the core then occurred, which reestablished natural circulation flow conditions.

Questions 3:

Would the APRM's be expected to show a change due to changes in flow at the conditions which existed at the time of the transient?

Response:

Prior to the reactor scram, the APRM's would be expected to show effects of significant flow changes. However in the transient which occurred, the APRM's were reflecting effects of the rapid changes in pressure and flow variations. However the flow changes would be expected to appear as second order effects. After scram, the APRM's would not be expected to provide indications of core power level.

Question 4:

During pump cavitation is the annulus separated from the core region? During the Oyster Creek transient could this have resulted in a triple low level?

Response:

As noted in response to Question 2, in high pressure systems, pump cavitation does not result in large vapor fractions which would block the flow through the pump. Also, review of the transient data shows that at the low flow state, one recirculation loop was providing nearly normal flow. Thus, pump cavitation did not separate the annulus from the core region during the transient.

The triple low level signal was not due to loss of recirculation flow or separation of the core from the annulus. To boil-off the mass of liquid existing in the seprator stand pipes and region between the core spray sparger and the shroud head would require the recirculation flow to be zero for more than one and one-half minutes. Since a low flow indication prior to the triple low level signal existed only momentarily, (one indication in a 12 second period), the triple low level signal was not due to boil-off associated with annulus/core separation.

Question 5:

What is the significance of pump cavitation and how long can the pump be allowed to cavitate?

Response:

Pump cavitation can result in some performance degradation and, if allowed to continue for a long period of time, can result in damage to pump components. Per the tests referenced in response to Question 2, high pressure pumping system can operate with saturated and two-phase conditions at the suction inlet with only minor degradation in the pump head capacity curve.

The period that a pump can operate in cavitation is a function of pump component design constraints. The pump manufacturer should be consulted to provide equipment life-time estimates.

Question 6:

Under worst case conditions how long will pump cavitation occur? Will these conditions be self limiting or will they require operator action?

Response:

Boiling water reactors normally operate with about 25 BTU/LB subcooling in the recirculation loops. This subcooling is provided by feedwater flow and is sufficient to protect against pump cavitation during transient conditions. At the higher core flows, a core flow runback interlock exists at 20% feedwater flow to provide added protection.

Pump cavitation is most likely to occur when operating with low feedwater flows, i.e. minimum subcooling. This state occurs with low power, low recirculation flow operation associated with plant startup. If a rapid depressurization event should occur while in this mode, pump cavitation can occur at intermittent periods during the transient. Pump cavitation conditions would ultimately cease to exist once:

a) The source of the rapid depressurization was eliminated and the plant reached an equilibrium operational mode, or

b) Low low level is reached and automatically the vessel is isolated, the recirculation pumps are tripped.

The key point is that once the plant reaches a steady operational mode with feedwater flow available, cavitation conditions cannot exist.

NRC Questions on O.C. 7/17/80
transient (Round 2)

Question 1:

Provide an explanation why the triple low level signal occurred during the Oyster Creek transient.

Response:

Figure 1 depicts the triple low water level sensor system and its relation to key factor pressure vessel components.

It can be shown that the sensor reading (DP) is given by:

$$\Delta P = \Delta P_{SEP} + \Delta P_{Z} + \Delta P_{STRZ} - (408-376)\ \gamma_h - (541-408)\ \gamma^R$$

Where,

ΔP_{SEP}	Separator dynamic pressure loss
ΔP_{Z}	Elevation head above the core spray sparger (two phase mixture) indicative of the water level
ΔP_{SNTZ}	Elevation head of steam between the water surface and the upper pressure tap
$(408-375)\gamma_h$	Elevation head between the core spray sparger and penetration through the reactor pressure vessel
γ_h	Specific volume of saturated water in the vessel
$(541-408)\gamma_R$	Elevation head between the upper and lower tap reactor pressure vessel elevations
γ_R	Specific volume of instrument line water assumed to be at 100°F

Normally the steam dryer pressure drop would also appear in this equation, but because of the low core power and corresponding low steam flow (≈2% of rated) during the event this pressure drop was essentially zero. Therefore the water levels inside and outside the dryer skirt were the same. The triple low sensor is set to trip when the static cold water level is 121" to 123" below the upper tap. This corresponds to a DP in the range of -4.22 psi to -4.29 psi (including a correction for steam density).

During rated power and flow conditions, ΔP_{SEP} is approximately 10 psi. However, during low power and flow conditions such as existed during the event, ΔP_{SEP} is approximately zero and the triple low level indication will be observed if ΔP_Z is sufficiently reduced either by a true reduced water level or by a reduced effective coolant density (high void fraction in separator standpipes) above the core. The latter state momentarily occurred during the transient, resulting in the triple low level signal,

exit

Just prior to the opening of the bypass valves, the core exist quality was 1.64% and the void fraction was approximately 22%. With the rapid depressurization, the core exit quality increased to 3.06% (34% void fraction). The depressurization alone did not cause the DP to be less than -4.22 psi. However, considering the low recirculation flow prior to the triple low signal, the core exit quality was approximately 9% (56% void fraction) and the DP ≈-4.25 psi. In this case the water level was approximately 141 inches above the sparger, but the reduced effective coolant density could not offset the other elevation heads in the instrument loop. This resulted in the momentary triple low signal. The triple low indication was momentary because the low recirculation flow existed only for a very short time during the transient.

Question 2:

Could a triple low level signal have been the reason for the RBCCW isolation?

Response:

Analysis of the transient data shows that a triple low level signal was not present when the reactor building closed cooling water (RB CCW) isolation occurred.

Prior to the electromatic relief valve (ERV) opening and subsequent RB CCW isolation, the plant was operating at about 7% power, 34% flow with 5 BTU/LB subcooling. The ERV opening reduced pressure by about 42 psi. Saturation conditions in the recirculation loops were not reached during this depressurization as demonstrated by the flow and temperature data and supporting calculations. Additional voiding in the core was calculated to be small (~1% quality increase), and the triple low sensor pressure differential DP was calculated to be -3.25 psi. Since the triple low level sensor was not set to trip until the DP was less than -4.22 psi, a triple low level signal was not present when the RB CCW isolation occurred.

Question 3:

Was communication lost between the annulus and the core?

Response:

Analysis of the transient data indicates that local voiding in the recirculation loops may have momentarily reduced the flow in four of the five loops. However, the data indicate that this reduced flow state existed only momentarily, and that the voiding in the recirculation loops did not result in a complete vapor blockage in any pump or loop. Therefore, the communication of coolant between the annulus and the core was not lost during the transient.

Calculated void fractions within the recirculation pumps at the suction of the pumps were less than 32%. The steam quality at the suction of the pumps was calculated to be 2.66% based on the average recirculation loop temperature and assuming a constant enthalpy depressurization from steady operating conditions before the steam bypass valves opened. Because of the kinetic energy imparted to the two-phase mixture at the impeller periphery, an additional 0.05% steam quality is generated within the recirculation pumps. Since the majority of the fluid inside the pumps was greater than 68% liquid on a volume basis, a complete vapor blockage within the recirculation pumps would not occur.

Also, the recirculation pumps are located at the lowest point of the system, below the pressure vessel, and the piping does not contain inverted "U's" conducive to trapping vapor. Thus any vapor in or near the pumps would have a tendency to rise into the pressure vessel providing added assurance that a complete vapor blockage would not occur.

The reduction in recirculation flow is attributed to increased pressure losses in the recirculation loop due to two-phase flow, no net increase in the buoyancy between the core and the annulus, and a net decrease in pumping head (22% lower). This reduced flow state existed only momentarily (as indicated by the data) until the excess energy in the recirculation loop was removed by vaporization and additional voiding in the core (still an energy source) generates a buoyancy difference between the core and the annulus. This re-establishes the flow of coolant through the recirculation loop.

It is concluded that at no time did a complete vapor blockage, or state of pump cavitation, occur which resulted in the loss of communication of coolant between the annulus and the core.

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Appendix E

"Bounding Loss of Coolant
Inventory Transient for the
Oyster Creek Plant" by the
Exxon Nuclear Company, Inc.

BOUNDING LOSS OF COOLANT INVENTORY TRANSIENT FOR THE OYSTER CREEK PLANT

INTRODUCTION

The May 2 scram event is bounded by the most limiting loss-of-coolant inventory transient, the complete loss of feedwater flow. In contrast to the May 2 scram, which showed a net coolant inventory increase (8070 lbm) following initiation (1), the loss-of-feedwater-flow transient would involve a decrease in coolant mass inventory of approximately 19,000 lbm during the period from initiation until system isolation, as discussed below.

Previous loss-of-feedwater flow analyses (2a, 2c) were performed without the function of the isolation condensers. In those analyses, the reactor was allowed to pressurize with pressure equalization obtained with the relief valves. The utilization of relief valves provided additional conservatism in the analyses since the resulting mass inventory loss would follow system isolation. In both the previous and current analyses, the net change in system mass inventory would be about the same to the time of MSIV closure. The previous analyses assumed that, following the early stages of the event, the depressurization would be limited by operator control of the isolation condensers.

The loss-of-feedwater transient was re-analyzed, incorporating the function of the isolation condensers, to more realistically simulate the plant system responses as they would occur following initiation of the event. The results of the re-analysis and the modeling of the isolation condenser is described in the following sections.

ANALYSIS OF THE LOSS OF FEEDWATER TRANSIENT WITH ISOLATION CONDENSER ACTUATION

The loss-of-feedwater transient analysis was performed for a full core of ENC 8 x 8 fuel using the ENC Plant Transient Analysis Code PTSBWR2 (2b.) The transient was initiated from a full power level of 1930 MW. The initial water level was assumed to be one foot below normal operating level → 5.14' ON INSTR to minimize the initial system coolant inventory. System responses for the first 125 seconds of the transient are shown in Figures 1.1 and 1.2.

13.34
7.17
5.14

Feedwater flow decreases to zero in 3.5 sec, reducing the downcomer inventory. The downcomer water level falls rapidly, reaching the low level reactor scram setpoint (11 ft. - 5 in. above top of active fuel) at 4.5 sec. The low-low level setpoint (7 ft. - 2 in. above top of active fuel) is reached at 15 sec. At this point, the following events occur:

1. Main steam isolation valves (MSIV) begin closing (10 second closing time).
2. Main recirculation pumps trip.
3. Isolation condenser return valves signaled to open.
4. Core Spray pumps are signaled to start.

The reduced recirculation flow after the pumps trip significantly reduces the rate of change of downcomer water level. A minimum downcomer water level of 5.36 ft. above the top of the active core occurs at about 35 seconds. After MSIV closure, the isolation condenser heat removal system initiates system depressurization. The change in pressure vessel coolant inventory up to the time of MSIV closure is given by:

$$\Delta M_{system} = \int_{t=0}^{t\ MSIV_C} W_{fw} - \int_{t=0}^{t\ MSIV_C} W_{ms}$$

and was calculated to be - 19,300 lb_m. That is, more mass was lost in steam flow to the turbine than was made up in feedwater flow. The minimum critical power ratio does not decrease below its initial steady-state value, and the maximum dome pressure during the incident was 1047 psia, below the setpoint of the relief valves (1065 psia).

Beyond the first 125 seconds of the transient analyzed above, the sequence is straightforward. The limited amount of inventory makeup available from the control rod drive flow is not expected to raise downcomer level at a sufficient rate to clear the low-low level indication. Since the various safety systems have been actuated at this level, no credit is taken for operator intervention.

The system will continue to depressurize until core spray flow is introduced to the vessel at approximately 285 psig. The water level in the core at this point has been calculated to exceed the low-low-low level setpoint (4' 8" above the active fuel). This level estimation is based upon a fully collapsed level of the fluid mass at saturation conditions. Following initiation of core spray the level will recover and the event terminated.

ISOLATION CONDENSER MODEL

The Isolation Condenser is a model addition to the base PTSBWR2 code (2b). As part of the overall model, it receives steam flow from the first steamline node and returns condensed steam to the bottom of the downcomer. The return valve characteristics are shown in the Figure 1.3. A delay of 10 sec. from time of low-low level setpoint to start of valve opening and a 20 sec. opening time are assumed. The rated condenser flow was taken to be 330,000 lbs/hr per condenser.

EFFECT OF MODEL ADDITION TO PREVIOUS ANALYSIS

The Isolation Condenser Model is external to the basic calculations of the code, and would only be activated during a transient wherein the low-low level setpoint is reached. During no event previously analyzed (2a, 2c, 3), with the exception of the loss of feedwater transient, did the water level reach this setpoint. Thus, the model addition would not change the results of transients other than loss of feedwater.

- - -

REFERENCES

1. R. E. Collingham, J. D. Kahn, C. E. Leach, K. P. Galbraith, "Evaluation of the Oyster Creek Reactor Core Liquid Level Following the Inadvertent Reactor High Pressure Scram on May 2, 1979, XN-NF-79-49, May 11, 1979".

2. Amendment 76 to the Oyster Creek Nuclear Generating Station Facility Description and Safenty Analysis Report, Jan. 31, 1975.

   This document included the following reports:

   2a. JD Kahn and MS Foster, "Plant Transient Analysis of the Oyster Creek BWR with Exxon Nuclear 8x8 UO_2 Fuel Assemblies, XN-74-43, Revision 2, January 1975.

   2b. JD Kahn and MS Foster, "PTSBWR2 - Plant Transient Simulation Code for Boiling Water Reactors, XN-74-6, Revision 3, January 1975.

   2c. JD Kahn and MS Foster, "Plant Transient Analysis of the Oyster Creek BWR with Exxon Nuclear 7x7 UO_2 Fuel Assemblies, XN-74-41, Revision 2, January 1975.

3. JD Kahn, "Additional Plant Transient Analyses of the Oyster Creek BWR with Exxon Nuclear Fuel Assemblies, XN-75-51" September 1975.

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Appendix F

AI 8003-09
(Big Rock Point - LER 79-022)

AI No. 8003-09

OPERATING EXPERIENCE REVIEW
ACTION ITEM ASSIGNMENT FORM

I. EVENT DESCRIPTION

Unit/Docket No. Big Rock Point (50-155)

Source LER 79-022/01X-1

Event Date 8/22/79

Event/Cause Description

Design review of primary system water level sensors, LE RE09 (4 units) and LE RE08 (2 units) revealed that during postulated loss of coolant accident conditions the automatic initiation of reactor scram, containment isolation, core spray, and reactor depressurization that are initiated by these systems might not function due to flashing that could occur in the reference line during rapid depressurization of the primary system. No hazard to the public occurred. Reportable per tech spec 6.9.2.A(9). This item represents a generic design shortcoming that was identified by the NSSS vendor. The temperature compensation features of all six sensors were modified and calibration and set-point specifications were approved by technical specification change (amendment 31) dated 11/2/79.

II. APPLICABILITY

Preliminary review of this event indicates possible applicability in the following area(s):

Procedures ☐

Systems ☒ ECCS

Components ☒ Type Primary water level sensors

Mfg. Yarway

Model No.

Operations ☐

Maintenance ☐

Training ☐

Design ☒

Radiological Protection ☐

Other ☐

Supplementary Information Enclosed Yes ☐ No ☒

GPU Service

TR PA 5071
DATE

TASK RECORD

SECTION MANAGER * A. H. Rone SECTION DEPT.

TITLE OPERATING EXPERIENCE REVIEW PROJECT

ITEM NUMBER 1 6	CARD 7	ACT 8	AI NUMBER 9 20	FILE NUMBER 21 25	TARGET DATE 26 31	SECT. MGR. 32 35
PA5071	A	A	800309	13021	101580	AHR

PLANT ANALYSIS RECOMMENDATION 36 68	COMMITMENT DOCUMENT 69 79	SEQ 80
PRIMARY WATER LEVEL SENSOR	DOC: 155	0
RESPONSE DURING LOCA	LER: 79-022	1
RECOMMENDATION:		2
1. DETERMINE THE APPLICABILITY		3
OF THIS DESIGN REVIEW TO O.C.		4
AND SPECIFY ANY RESULTING		5
CORRECTIVE ACTION		6
		7
		8
		9

ATTACHMENTS

COMPLETION REQUIRED BY

ORIGINATOR DATE

ADDITIONAL DESCRIPTION

RESPONSIBLE ENGINEER DATE

SECTION MANAGER DATE

PLANT ANALYSIS MANAGER DATE

CC:

A000 0024

Report to GORB

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Appendix G

Response from Oyster
Creek (A. H. Rone) to
PA-193

Inter-Office Memorandum

JCP&L / GPU

e: December 19, 1980

ject: Response to Request for Assistance contained in letter from P. S. Walsh to K. O. E. Fickeissen, Jr. Subject Oyster Creek Transient of July 17, 1980

P. S. Walsh

Location: Oyster Creek

This memo is intended to respond to the question posed in the subject letter relative to the Oyster Creek July 17, 1980 event. For clarity the questions are restated herein followed by the response.

<u>Question</u> 1. What caused the Reactor Building Closed Cooling Water isolation? Is the depressurization by the EMRV opening and closing related to the RBCCW isolation? Can we expect similar isolations to occur in the future? Can we or should we prevent similar future isolations? Please verify by list those combinations of signals that will cause isolation of the Reactor Building Closed Cooling Water (RBCCW) system as occurred during the transient.

<u>Response</u> During the 1980 Refueling Outage the RBCCW System isolation valves were modified such that they isolate on triple low level or on coincident signals of high drywell pressure (2 psig) and low low Rx water level (7'2" ATAF).

Prior to this modification RBCCW isolation was a manual operator action.

At the time RBCCW isolated during this event none of the automatic isolation signals were known to be in. This determination is based upon inspection of the event recorder traces and operator recollection of the plant status immediately preceding, and during, the isolation event. It should be noted that the drywell high pressure and low low water level signals actuate several other automatic actions, none of which occurred at this time. Had the isolation been due to a triple low level event the event recorder should have initiated at the time the isolation occurred. The same relays are involved in initiating the event recorder as are used in the isolation logic for RBCCW. It is possible, however, for a slight difference in contactor arm tensions to allow one contact to remain closed while the other opens if the relay armature travels only part way. This condition is highly unlikely since it would have to occur for more than one relay, but is possible particularly for trip signals which are "pulse-like" in nature.

It should be stressed that the coupling of the RBCCW isolation event to the same general time period as the operation of the D-EMRV is not supportable by any recorded evidence. The time frame was established based upon the recollection of the Shift Supervisor (SRO), Group Operating Supervisor (SRO) and the undersigned (SRO), all present in the control room at the time of the event.

The undersigned interviewed the aforementioned operating personnel separately following the event and found no major disagreements between their recounting of the events and that of the undersigned.

However, it is recognized that severe time frame distortion can occur under stressful situations, and it is possible, though not highly likely, that the RBCCW isolation actually occurred at the time of the known triple low level event. This possibility was immediately recognized but was discounted based upon subsequent discussions by the aforementioned licensed personnel present in the control room and their common recounting of the event.

In summary, the isolation of the RBCCW remains an enigma.

Question 2. How was it determined that the triple low level indication had been activated? Event recorder? Control board alarm? Alarm printer? If triple low level initiation is an isolation signal for RBCCW, why was there no isolation? Was the isolation relay unable to trip during the time the triple low signal was "in"? Is it a time delay relay/ system? Slow acting? Dirty contacts? How was it determined that the triple low level indication subsequently "bounced out"? Is it possible to determine the period of time that elapsed between the "in" and "out" indications? If not, can an estimate be made? Please forward a copy of the event recorder output for the transient period (7/17/80, 20:25:23 to 20:49:19) showing reactor water level during this period.

Response The triple low level indication was determined based upon the event recorder. The event recorder monitors the status of four relays which correspond to the four triple low low level sensors. The triple low level event was characterized by the momentary simultaneous operation of all four relays. The pulse duration was indeterminately short and appeared as a line retraced upon itself. No alarms or other indications were observed to be present indicative of a triple low level condition.

It should be noted that the determination that a triple low level event had occurred was made subsequent to the reactor scram and restablization of plant parameters. The timing between the scram signal and triple low level event was superimposed upon data extracted from the plant computer in a best estimate fashion.

It cannot be explained why an isolation of the RBCCW did not occur at the time of the triple low level event other than to assume that it did occur and was not correctly placed in time. This possibility is addressed above in the response to question one.

Question 3. What would have happened if the bypass valves had remained open longer? Would the event have become more severe?

Response The response to this question can only be answered by detailed analytical modeling of this event and/or other similar depressurization scenarios. It is conjectured that a longer depressurization interval would not have produced any results significantly more severe than those experienced during this event. This conclusion is based upon the fact that the depressurization did not threaten the ability to maintain adequate core cooling, even though the reactor was not scrammed and operating under high voided conditions. Operation at less than 354 MWt (~18% power) is permissable at any pressure and is used as part of the licensing basis for the plant.

Question 4. Our docket currently analyzes the spurious opening of one bypass valve or EMRV. Should we analyze the opening of all bypass or relief valves at both high and low power?

Response Whereas it is expected that the results of such analysis will yield few surprises, it may prove interesting to perform the suggested analysis factoring in operator errors and equipment malfunctions which could result in operation at intermediate power under extremely high voided conditions.

Consider the following scenario:

1) Plant is operating at approximately 50% power when a failure occurs in the pressure regulator.
2) All nine bypass valves open as a result of the failure and a depressurization of the reactor begins.
3) The operator transfers the mode switch out of Run to Startup. This action will not cause a scram and will block the closure at the MSIV's and the scram attendant thereto which is designed to prevent operation at power when less than 825 psig.

Although the above scenario is unlikely, it requires only one equipment malfunction and one operator error to yield a condition of high power and high voids.

Question 5. What human errors and mechanical failures contributed to the event? Could better procedures or human-engineered controls help prevent future errors during startup?

Response The event was initiated by failure of the No. 2 vacuum trip to reset although the available indications indicated that a reset had occurred. The event was aggravated by the operator reseting the #2 vacuum trip while the pressure regulator was set to a value lower than Rx pressure. The available instrumentation and controls used to monitor the plant during the event were satisfactory.

During the post event analysis conducted by the Plant Staff and the NRC operator actions were discussed and were considered to be good overall. Furthermore, no procedural deficiencies were identified as contributing factors to the event. However, a procedural change was made to test that #2 vacuum trip does indeed reset while the Rx is still low in pressure.

There is an additional safety concern which was not addressed in any of the discussions related to this event. Prior to modifying the RBCCW isolation valves to automatically isolate on the aforementioned signals, there existed only one mechanism which would cause a loss of the drywell coolers. That mechanism was a Containment Spray System auto start signal. This assured that some mechanism for cooling the containment would be in effect upon loss of the drywell coolers.

It has now been demonstrated that another mechanism exists for loosing drywell cooling via isolation of the RBCCW drywell, and that this condition can occur under conditions which do not cause an auto start of containment spray.

The consequences of a loss of drywell cooling event could yield containment temperatures well in excess of those for which the containment is designed. The drywell liner design temperature is 280°F and under these conditions assuming an adiabatic heat up of the drywell, the liner temperature would tend toward the temperature of the reactor vessel (i.e. 549°F at 1020 psig). This could lead to a loss of containment integrity, distortion and or loss of Rx water level indication, as well as loss of function of other equipment inside containment critical to safety. It should be stressed that the operator would have little or no indication that the containment was heating up other than drywell pressure increases and some temperature instrumentation in the control room.

It is requested that Plant Analysis investigate the concern discussed above to determine the realistic maximum temperature that a loss of drywell cooling could yield, and the time required to reach the maximum allowable containment temperature. Based upon this evaluation, recommendation should be made to the Project Engineering Group within Technical Functions to modify the RBCCW System isolation logic to eliminate this as a possible mechanism for a loss of drywell cooling event.

An Engineering Request is being forwarded to D. Grace, together with a copy of this memo, asking for an improved containment temperature monitoring system.

Emergency procedures are being revised, consistent with the G. E. Emergency Procedure Guidelines and the time table related thereto, to provide operator actions for high drywell temperature symptoms.

A. H. Rone

A. H. Rone
Engineering Manager

AHR:dh

cc: R. Barrett
~~[illegible]~~
J. T. Carroll, Jr.
J. DeBlasio
K. O. E. Fickeissen, Jr.
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D. Grace
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M. Laggart
J. P. Maloney
J. L. Sullivan, Jr.
N. G. Trikouros

Report to GORB

Action Item No. 375

Appendix H

Oyster Creek - LER 80-38/3L

"Drift of Triple - Low Water
Level Switches"

OYSTER CREEK NUCLEAR GENERATING STATION
Forked River, New Jersey 08731

License Event Report
Reportable Occurrence No. 50-219/80-38/3L

Report Date

September 25, 1980

Occurrence Date

August 26, 1980

Identification of Occurrence

Exceeding a limiting condition for operation as per Technical Specifications, Section 3.1, Table 3.1.1, Function G.2, when reactor triple low water level sensor RE18B exceeded its required setpoint during surveillance testing.

This event is considered to be a reportable occurrence as defined in the Technical Specifications, paragraph 6.9.2.b.1.

Conditions Prior to Occurrence

Steady State Power

Power:	Reactor	1568 MWt
	Generator	491 MWe
Flow:	Recirculation	12.1×10^4 gpm
	Feedwater	5.76×10^6 lb/hr

Description of Occurrence:

On Tuesday, August 26, 1980, at approximately 1130 hours, while performing routine surveillance testing of the reactor triple low water level sensors, RE18B tripped at a level which was less conservative than that specified in the Technical specifications.

Tests on all level sensors yielded the following data:

Pressure Switch Designation		Desired Manometer Reading at Trip Point ("H_2O)	As Found ("H_2O)	As Left ("H_2O)
System I	RE18A	≤126	123	123
	RE18C	≤126	123	123
System II	RE18B	≤126	128	123
	RE18D	≤126	126	123

The "As Found" value of 128" H_2O corresponds to a water level 54" above the active fuel. The Technical Specification limit is 56".

Apparent Cause of Occurrence

Sensor Repeatability

Analysis of Occurrence

Failure of pressure switch RE18B to actuate at its prescribed setpoint would have delayed initiation of reactor triple low water level indications. However, due to the existing logic configuration, the redundant switch, RE18D, would have actuated to initiate the required functions at the required Technical Specification limit. The safety significance of this event is considered to be minimal since sensor RE18B's non-conservatism resulted only in a temporary loss of redundancy in the system.

Corrective Action

Reactor triple low level sensor RE18B was reset to trip with its prescribed limits.

An engineering study is in progress regarding the feasibility of replacing the existing sensors with a solid state system.

Failure Data

ITT Barton Differential Pressure Indicating Switch
Switch Model #288A
Adjustable Range 0-150 inches H_2O

Report to CORB

Action Item No. 375

Appendix I

NRC Inspection Report for
July 9 - August 1, 1980
Report No. 50-219/80-25
(partial)

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

Region I

Report No. 50-219/80-25

Docket No. 50-219

License No. DPR-16 Priority -- Category C

Licensee: Jersey Central Power and Light Company
Madison Avenue at Punch Bowl Road
Morristown, New Jersey 07960

Facility Name: Oyster Creek Nuclear Generating Station

Inspection at: Forked River, New Jersey

Inspection conducted: July 9 - August 1, 1980

Inspectors: R Keimig, for 8-19-80
L. Briggs, Senior Resident Reactor Inspector date signed

J Thomas 8/15/80
J. Thomas, Resident Reactor Inspector date signed

date signed

Approved by: R Keimig 8-19-80
R. R. Keimig, Chief, Reactor Projects date signed
Section No. 1, RO&NS Branch

Inspection Summary:

Inspection on July 9 - August 1, 1980 (Report No. 50-219/80-25)

Areas Inspected: Routine inspection by the resident inspectors (139 hours) of: followup of operational events that occurred during the inspection; review of plant operations (startup); tours of the facility; log and record reviews; and followup of IE Bulletins and Circulars.

Results: No items of noncompliance were identified.

DETAILS

1. Persons Contacted

J. Carroll, Station Manager
K. Fickeissen, Support Superintendent
W. Garvey, Director, Station Administration
E. Growney, Engineering Supervisor, Acting
T. Johnson, Supervisor, Station I&E Maintenance
J. Maloney, Operations Supervisor
J. Sullivan, Plant Superintendent

The inspectors also interviewed other licensee personnel during the course of the inspection including management, clerical, maintenance, and operations personnel.

2. Operational Events

On July 17, 1980 at 8:35 p.m. during power ascension following plant startup, operators attempted to control reactor pressure by operation of the steam bypass valves (BPV's). The operators reduced the pressure setpoints on both the mechanical pressure regulator (MPR) and the electrical pressure regulator (EPR) but the BPV's failed to open. Control rod insertion was begun, but before the heatup and pressure increase could be terminated, one electromatic relief valve (ERV) opened at a reactor pressure of 1050 psig. In about 20 seconds pressure decreased to 1000 psig. and the ERV reseated. When the ERV shut, a spurious automatic isolation of the reactor building closed cooling water (RBCCW) system occurred. The RBCCW isolation was immediately reset and flow restored. As reactor system pressure again increased, it was determined that the low condenser vacuum trip number 2 might not be properly reset even though the trip reset light was energized. The trip reset was actuated by the operator. This action caused all nine BPV's to open fully. As reactor pressure decreased rapidly due to opening of the BPV's the operator tripped shut the BPV's. The resultant pressure transient caused a momentary triple low water level indication (Technical Specification value of 4 feet 8 inches or greater above the top of the active fuel) on the event recorder followed 24 seconds later by a reactor water low level scram (Technical Specification value of greater than 11 feet 5 inches above the top of the active fuel). Following the incident a thorough review was conducted by the inspector and licensee representatives of the instrument recorder charts, the event recorder chart, and the process computer print-out. In addition, interviews were conducted with the on-shift reactor operators and supervisors. The investigation led to the following conclusions:

-- The recirculation loop isolation valves remained open on all five loops allowing sufficient water flow between the core and annulus regions to provide accurate water level indication on both the Yarway and GEMAC instruments. Indicated water level on these instruments, which have both reference and variable taps in the annulus region, did not go lower than 6 inches below the low level scram setpoint.

-- No alarm actuations, automatic containment isolations, or emergency core cooling system actuations that would have indicated a double low water level condition (7 feet 2 inches above the top of the active fuel) occurred.

-- No isolation of the RBCCW system occurred at the time of the event recorder indication of triple low water level.

-- The triple low water level indicated by the event recorder was apparently caused by a hydraulic disturbance in the annulus area of the reactor vessel resulting from rapid closure of the BPV's. The triple low level sensor is a differential pressure switch with a high pressure tap on the core spray system sparger in the core area and a low pressure tap in the annulus area. When the BPV's closed, the rapid pressure increase in the steam headers and the annulus region in conjunction with the time lag associated with equalization of pressure across the steam dryers, caused the pressure in the annulus to be momentarily higher than the pressure in the core region. This caused a momentary erroneous indication of triple low water level that activated the event recorder. The indication was of short enough duration that the electrical relays in the RBCCW isolation circuit were not activated.

Subsequent surveillance testing was performed on the RBCCW isolation system to determine the cause of the momentary RBCCW isolation upon closure of the electromatic relief valve. All isolation actuation signals (triple low water level by itself or double low water level with high drywell pressure) were tested and no malfunctions were found. The cause of the RBCCW isolation was determined to be a spurious momentary actuation of the isolation circuitry.

Investigation of the malfunction of the low condenser vacuum trip revealed that misadjustment of a limit switch on the trip mechanism caused the indicating lights in the control room to indicate the trip as reset when in fact it was not.

The limit switch was adjusted and the low condenser vacuum trip was tested satisfactorily. The licensee has agreed to change Procedure 201.2, "Plant Heatup to Hot Standby", to require verification of bypass valve operability prior to reaching full operating pressure to preclude recurrence of pressure control problems on startup.

Attachment 2

Question 1.

Do the Recirculation Pumps have a vibration trip or alarm, which may indicate pump cavitation? What do the procedures tell the operator to do? How long does he have to do required action?

Response

Each recirculation pump does have a vibration alarm. The alarm is set at .4g's and annunciates in the control room. During the events of July 17, 1980 none of these alarms annunciated. The action required by procedure for a pump high vibration situation requires the operator to: a) check pump speeds to ensure all pumps are in unison, b) adjust out of sync pump if necessary and reset alarm, c) if alarm will not reset, change pump speeds and try to reset alarm, d) if alarm will still not reset remove the pump from service.

No time limit is specified for carrying out these actions. However, discussions with the pump manufacturer indicate that it would be hours before mechanical damage would occur.

Question 2.

Did the Recirculation Pumps show decreased amperage when recirculation flow decreased?

Response

Unusual or off normal pump motor amperages were not noticed by the operator during this event.

Question 3.

Could there have been a core-annular region disconnect when recirculation flow went to zero or cavitated? If so, how long before a manual action is necessary? How is this addressed in the emergency procedures?

Response

As long as there is no physical blockage in all the recirculation lines then there can be no "disconnect". The worse situation that can occur is that the reactor shroud and the core region will act as a manometer. The zero recirculation flow indicated during the transient does not necessarily mean there was no flow, but only that the flow was at the lower end of instrument sensitivity. This low recirculation flow is not unexpected during transients of this nature.

Question 4.

What do procedures tell operator for appropriate action when recirculation flow goes to zero?

Response

While the symptom of no recirculation flow is not specifically addressed by emergency procedures, there is an emergency procedure which addresses the closure of the recirculation loop valves. This is part of the scram procedure (Station Procedure 532) and warns against closing off all five (5) loops.

Question 5.

What does the operator do if he gets a triple low alarm? Is this addressed in the emergency procedures?

Response

The procedure for a triple-low level alarm requires that the operator do the following:

a. confirm with other level indicators,
b. check that at least two (2) recirculation loops have both the suction and discharge valves are open,
c. verify core spray pump operating,
d. verify ADS actuation if other required signals are present.

Other plant emergency procedures that address pipe breaks also include specific actions for the operator, if a triple low level alarm occurs.

Question 6.

What effect does the operation of the recirculation pumps have on level measurement?

Response

The Oyster Creek Station has several diverse water level measurement devices. All the reactor vessel water level measurement devices utilized at the Oyster Creek facility are delta-P devices and some take measurements in the vessel annular region while others measure inside the core shroud. Since these are delta- P devices, the operation of recirculation pumps will affect the water level measurement especially those measurments inside the shroud. Our letter dated October 30, 1980 partially describes the differences between the inside the shroud indications versus the annulus indications. It should be noted that the mixture level inside the shroud during normal power operations (power > 10%) is always up to the top of the moisture separators. It is the separators which actually separate the water from the steam mixture.

Question 7.

Indicate whether your procedures instruct the operator to keep RBCCW available when it is beneficial for transient mitigation, if it automatically isolates during an event.

Response

Yes, the plant emergency procedures do address the steps to be taken to keep the RBCCW available for those transients for which RBCCW is beneficial for transient mitigation. This is identified in Station Procedure 507.1, (Reactor Building Closed Cooling Water System failures) Sections 4.4.1 and 4.4.2.