ATTACHMENT 16
Sheet 1 of 2
Significant Adverse Condition Investigation Report
Form CAP-NGGC-0205-1-16

Action Request/Nuclear Condition Report Number: 111308 **Event Time: 13:34**
Facility: RNP **Event Date: 11/19/03**
Unit: 2
Investigators: Bruce Gerwe, Richard Hightower, Brad Dolan, John Little, John Valentino, Grant Chappell, Frank Modlin, Scott Jackson, Vic Smith

1. Event Description

During the development and review of Revision 0 of Engineering Change [redacted] two postulated fire time critical transient conditions were identified. These conditions, if not mitigated could result in an unrecoverable plant operating condition.

If a postulated fire were to occur causing specific circuit damage, operator actions to mitigate the transient would have to be taken in less than 10 minutes from the onset of circuit damage. Based on current RNP analysis criteria, operator mitigating actions taken outside the control room required in less than 10 minutes are not considered acceptable due to the limited amount of time that the Control Room Staff would have to detect equipment malfunction, determine its effect and then take mitigating actions. The time transient conditions identified include:

a) A postulated fire event that causes the spurious operation (closing) o[redacted] This scenario would cause loss of [redacted] in less than one minute and if operating at the time, could result in the loss of the [redacted]
b) A postulated fire event that causes the operation of bot[redacted] concurrently. This scenario potentially would cause loss of an unrecoverable amount of RCS inventory in less than 10 minutes.

Both these time transient conditions could occur given a fire of sufficient magnitude in one of the following two fire zones:

[redacted]

[redacted] which is comprised of 8 additional fire zones, including the [redacted]s an Appendix R III.G.3 safe shutdown fire area, requiring alternate or dedicated shutdown from outside the Fire Area.

2. **Problem Description**

Problem Statement

Two postulated fire induced circuit failure cases have been identified that require the development of new thermal hydraulic cases to determine the potential impact to the Appendix R Safe Shutdown methodology. The identified cases had not previously been analyzed for impact to the Appendix R Safe Shutdown methodology. Mitigating actions (automatic system / component actuations, control room operator actions or manual actions taken outside the control room) must be accomplished before exceeding allowable operating parameters, or before unrecoverable conditions exist. It is likely that operator actions taken to mitigate these events may not be completed rapidly enough to assure safe shutdown can be accomplished as currently evaluated.

For purposes of this discussion, an unrecoverable condition is defined as a condition which results in fuel clad damage, rupture of any primary coolant boundary or rupture of the containment boundary.

Problem Discussion

One of the Appendix R Performance Goals requires reactor coolant inventory to be maintained within the indicating range of the pressurizer level instrumentation, and control of reactor cooling system pressure.

[redacted] has identified two potential fire induced circuit failure cases, which if not mitigated could compromise this requirement. The postulated conditions are based on the reasonable assumption that two concurrent spurious operations of safe shutdown equipment occur during the event. Appendix R analysis requires the licensee to assume the fire event damages cables in the fire area causing spurious signals to be implanted from one cable to another or from one conductor to another within the same cable. This in turn, results in components being energized and moving to a position opposite of their desired safe shutdown position. Appendix R also requires for III.G.3 fire areas, that a loss of off-site power must be assumed at the onset of the event. However, the loss of off-site power cannot be used to the benefit of the scenario. The postulated cases are described below:

Case No. 1 -

For a postulated fire in Fire Zone [redacted] Dedicated Shutdown is credited using the [redacted] which is supplied power from the Dedicated Shutdown Bus. Spurious closure [redacted] during this event. Should the [redacted] be running to support normal operation, the potential exists to damage to the pump and or associated piping, such that the Reactor Coolant make-up function is not maintained.

Based on the Appendix R Safe Shutdown Analysis [redacted] could spuriously operate, resulting in both valves being closed at the same time for a fire in Fire Zone [redacted]. Since Primary Water and Boron Injection Systems are not part of the Appendix R Safe Shutdown Analysis, they are assumed to fail as a result of the postulated fire. The [redacted] are also designed without high discharge or low suction pressure pump protection. During normal operation, any two of the three pumps may be running.

In this postulated case, Off-Site Power is conservatively assumed to be available, supplying power to the Emergency and Dedicated Shutdown Busses. The [redacted] is supplied electrical power from the Dedicated Shutdown Bus and the [redacted] are supplied electrical power from [redacted] respectively. With off-site power available under this scenario, [redacted]. Also, with off-site power available and the [redacted] unaffected by the initial consequences of the fire, they could be available for [redacted]

Case No. 2 –

For the second postulated case, [redacted] spuriously open. This case identifies a potential uncontrollable loss of Reactor Coolant Inventory. This is because both of the [redacted] are open and cannot be closed during the postulated fire event.

[redacted] are motor operated valves which are supplied electrical power from [redacted] which is supplied electrical power from [redacted] As such, a Loss of Offsite Power must be assumed concurrent with the postulated fire. Because the postulated fire may damage Emergency Diesel Generator circuits, including the EDG output breakers, the Emergency Diesel Generators cannot be credited for this fire scenario. As such, the normally open [redacted] cannot be closed due to the loss of electrical power to [redacted]

The [redacted] are closed by de-energizing 125VDC power that supplies their circuits. However, this manual action taken outside the control room does not take place for approximately 10 minutes following entry into the Safe Shutdown procedures. Based on lessons learned from TMI, following the opening of the [redacted] Therefore, the operator actions taken to mitigate this event cannot be accomplished in the required time frame.

<u>Consequences</u>

No actual fire events or loss of safe shutdown capability have occurred. This NCR deals only with postulated fire events. These postulated fire events could cause the Appendix R performance goals and objectives not to be met. In the case of spurious closing of [redacted]s potentially lost leading to potential loss of natural cool down capability. In the case of spurious opening of [redacted] an uncontrollable loss of RCS inventory could occur leading to core uncovery.

Immediate notification was made to the NRC on November 19, 2003. LER 2003-03 is scheduled to be submitted by January 20, 2004.

Initial Extent of Condition

Initially, this condition appeared to be limited to a postulated fire in either [redacted] or [redacted] with the spurious closing of both [redacted] at the same time. A similar condition exists in these fire zones for spurious opening of both [redacted] at the same time.

Refer to Section 7 for further evaluation of extent of condition. No extension of this condition was found to currently exist beyond Fire Zones [redacted]

Interim Mitigating Strategy

Upon discovery of this condition, [redacted] was immediately revised to take preemptive control room operator action for a fire in Fire Zones [redacted] These actions are:

a) to verify [redacted] are closed, and
b) to verify the [redacted] is not an operating pump

Closure of Block Valves [redacted] ensures that an open RCS vent path does not initially exist upon concurrent spurious operation (opening) of both Pressurizer PORVs and with a loss of offsite power.

Verification that the [redacted] is not an operating pump mitigates damage to the pump, maintains the pump water solid and enables the pump to remain available to be used for RCS inventory makeup as needed.

3. Investigation Summary

Summary

The methodology applied in this investigation is consistent with the requirements of CAP-NGGC-0205. However, due to the nature of the condition, existing techniques are supplemented with a design review of the condition. This design review first determined the Appendix R functional and operating design criteria and requirements, followed by a determination of whether the present design meets these requirements. It was determined that a design deficiency exists between the present design and the design bases requirements. A Barrier Analysis and Cause and Effect Analysis were conducted to determine cause of failure (See Attachments 2 and 3).

This condition was discovered during the development of [redacted] The purpose of the Engineering Change is to perform a feasibility analysis of credited manual actions taken outside the control room. The activity was being performed by experienced engineering staff on site, in conjunction with experienced engineering staff of Framatome-ANP. Framatome-ANP was contracted by Progress Energy to perform the feasibility study and to assemble the engineering change. The original Appendix R analysis was performed by outside Vendors knowledgeable in Appendix R and assisted by CP&L personnel knowledgeable in plant systems.

As a part of the engineering change, certain postulated fire induced hydraulic cases were developed to confirm the engineering requirements. The two cases identified above are examples of some of the cases postulated. This engineering basis is needed in order to prioritize operator actions, ensuring Safe Shutdown Performance goals and objectives are met.

During the latter stages of the development of these cases, it became evident that the two postulated cases above would be problematic. Specifically, that the operator actions may not be achievable in the required time frame to prevent unrecoverable conditions.

Due to the historical nature of this issue, no environmental conditions and potential error precursors could be established.

Appendix R Chronological Time Line

1975 - Browns Ferry Fire
1981 - Appendix R Rule Promulgated
1981 - Generic Letter 81-12, Fire Protection Rule, Issued. First letter providing guidance on circuit analysis
1983 -1985 - RNP SER Submittals / NRC Approval of the Appendix R SER
1986 - Generic Letter 86-10, Implementation of Fire Protection Requirements, Issued. Provides additional guidance on Appendix R Fire Induced Circuit Failures. This letter was issued after NRC approval of the Appendix R Program at RNP.
2003 - Discovery of Unanalyzed Condition at RNP.

Detailed Review Methodology and Results

The design engineering review includes three distinct elements. They are as follows:

1) Review the Appendix R Design and Licensing Basis requirements,
2) Review the current Design and Licensing basis to insure appropriate design considerations are factored into the Safe Shutdown Analysis, and
3) Results / Conclusions of the Design Review.

(1) Review of Design and Licensing Basis to determine requirements:

The Appendix R Safe Shutdown Performance Goals and requirements are described in [redacted] The requirements embodied in this document are directly derived from 10CFR50 Appendix R, Section III.L. The Appendix R Safe Shutdown performance goal that is not met as a result of the two postulated fires is as follows:

Performance Goal and Definition

Reactor Coolant Makeup - Maintain the reactor coolant inventory within the indicating range of the pressurizer level instrumentation, and control reactor cooling system pressure.

(2) Design Review:

For a postulated fire in Fire Zones [redacted] the Licensing and Design basis for achieving Safe Shutdown conditions are embodied in 10CFR50, Appendix R, Section III.G.3. This section requires Alternate or Dedicated Shutdown capability due to the inherent damage to both trains of safety related equipment in these fire zones. A Dedicated Shutdown System is essentially a minimum capability safe shutdown train independent of normal shutdown trains. This is commonly referred to as the [redacted]

[redacted] is the operating procedure that provides the necessary operating instructions for achieving Hot Shutdown conditions, for this postulated fire event. For purposes of maintaining reactor coolant inventory, credit is taken for starting the [redacted] and isolating the [redacted] subsequent to the initiation of the postulated fire.

In this postulated fire event,

Loss of reactor coolant inventory is to be limited to only reactor coolant pump seal leakage. This is accomplished by removing power from the [redacted] thereby causing their closure. The [redacted] are deactivated (currently within 10 minutes of entry into [redacted] to the closed position and only the mechanically-operated relief valves to the [redacted] will be available for primary system pressure relief. The [redacted] is also blocked by the deenergization of the isolation valve, thereby causing it to close. Additional [redacted] are blocked closed by de-energizing the system isolation valves. E4

Following reactor trip, the secondary system will be used to remove decay heat, causing shrinkage of the RCS inventory during cool down. As mentioned above, [redacted] will cause a further reduction in the primary system inventory. Additional borated water from the [redacted] is added to the system by means of [redacted] Reactor coolant makeup by use of [redacted] In addition, some of the [redacted] water is utilized to maintain the [redacted]

These functional requirements must be maintained independent of the fire induced circuit failure(s) resulting from the postulated fire. In the [redacted] are identified as spurious components. Likewise, the [redacted] are also identified as spurious operations concerns.

A review of the safe shutdown supporting mechanical calculations determined that a hydraulic analysis was performed for the potential loss of [redacted] due to spurious actuations of the [redacted]

[redacted] This calculation determined the impact to the [redacted] assuming spurious actuation of the appropriate combination of valves. The results and conclusions of this calculation indicate that the operator actions taken to mitigate the event are performed in an acceptable time frame. The time critical (10 minutes) manual operator action taken outside the control room to [redacted] terminates the event, prior to undesirable conditions existing.

For both scenarios, the original analysis assumed that appropriate operator actions could be taken prior to the postulated fire induced circuit failures that would result in operation beyond the allowable operating limit(s). Therefore, no hydraulic analyses were performed or required for some cases where two concurrent spurious operations could be postulated. Review of the original safe shutdown analysis and supporting calculations support this fact. No prior hydraulic analysis could be found to establish the technical basis for [redacted] This is contrary to other cases as identified above, where two concurrent spurious operations were considered and hydraulic analyses were performed. Shifting regulatory guidance added to the confusions surrounding the history behind the licensing basis. This resulted in unclear guidance that was not evenly applied.

This apparent assumption in the design was unsubstantiated. It assumed that no fire induced circuit failure(s) would render safe shutdown equipment inoperable, as long as manual action could be taken early in the event. The need to perform hydraulic analyses to back up this assumption was not evenly applied to all cases. This is classified as an "Apparent Assumption", because it is not documented, either in the Safe Shutdown Analysis or supporting licensing correspondence.

Mechanical Engineering thermal hydraulic analyses described in [redacted] have determined the potential exists to lose the [redacted] assuming the pump is running during normal operation. Based on this analysis, loss of suction to the pump would occur in less than one minute following closure of [redacted] As later discussed in the Safety Significance Section, catastrophic failure of the pump is not expected to occur for at least 15 minutes following loss of suction. The pump would be able to function when later called upon, but at a reduced efficiency due to air entrainment. Since the [redacted] during this postulated fire, the potential exists that the plant would be in an unrecoverable condition. As later discussed, the postulated failures result in minimal damage to the [redacted] This would not preclude the [redacted] from performing its intended design function during the event. Securing the [redacted] at the onset of fire in the areas provides a preventative measure to mitigate pump damage, maintain the pump water solid and enable the [redacted] as needed.

Additionally, the hydraulic case for the excess and normal letdown valves have also been determined in [redacted] Based on the results and conclusions of this analysis, operator actions taken to terminate spurious actuation of the excess and normal letdown valves are accomplished in the required time frame.

A calculation has been prepared to address the potential for [redacted]o be open. This calculation concluded that the reactor core would remain covered within the time it would take for operator actions to remove power to the [redacted]causing them to go closed. This calculation assumed a two phase flow through the [redacted] The calculation used a simplified model of only the reactor vessel and pressurizer. It ignored the large volume of fluid in [redacted] The calculation started with approximately [redacted] while the [redacted] Additionally, a simulator run mimicking the event was performed and showed the event was even less of a concern (See Attachment 5). The simulator run revealed that only steam flow would result throug[redacted]at less than half the amount of mass loss assumed in the calculation. It also showed the [redacted]during the event swung from a starting point of [redacted] in [redacted] The simulator run resulted in a [redacted] Both the calculation and simulator run both accounted for reactor head voiding.

All spurious actuation cases that could result in a loss of RCS inventory have now been analyzed in [redacted]

(3) Results of the Design Review:

Guidance for performance of the original fire induced circuit failures in the Safe Shutdown Analysis is unclear. This has a direct effect on the number and type of fire induced circuit failures assumed during a fire event. This in turn, influences the mechanical hydraulic cases which may be required to support Appendix R Performance goals and objectives. For purposes of the hydraulic cases considered, time equals zero at the onset of the postulated fire induced circuit failures. This design deficiency in how spurious operations are applied has existed since the original analysis. Since no prior revalidation effort of the entire original analysis has been undertaken until recently, this deficiency was never discovered.

The current Safe Shutdown Analysis references Generic Letters 81-12, Fire Protection Rule, and 86-10, Implementation of Fire Protection Requirements, in the Reference Section, which specified different criteria. The Safe Shutdown Analysis requires that Fire Induced Circuit Failures consider "any and all one at a time". It is not known whether this was intended to be sequential with time to recover from one before proceeding to the next, or if the events were to be postulated concurrently. Contrary to this guidance, examples exists which clearly consider two hot shorts concurrently at the system level. The following is a partial listing: (Note: Each of these cases has been evaluated and is acceptable.)

However, some cases appear to only consider one fire induced failure. An example would be the de-energizing of the [redacted] during a postulated [redacted] fire, to preclude the possibility of a [redacted]

The root cause of this event is the unclear guidance provided in the Appendix R Safe Shutdown Analysis on postulated fire induced circuit failures. The corrective action to prevent reoccurrence of the event is to establish clear guidance on the performance of circuit analysis for Safe Shutdown purposes and ensure our program is in alignment with this guidance.

Ex4

Progress Energy recently completed a position paper on Fire Induced Circuit Failures for Appendix R purposes to be considered at all Progress Energy Nuclear Operating Facilities. This paper clearly requires two postulated fire induced circuit failures to be considered at the system level in the Appendix R Revalidation Project at each site. This position paper clearly defines the number and type of circuit failures to consider. RNP will need to complete reanalysis of the Appendix R Program utilizing the criteria specified in the Progress Energy position paper.

4. **Inappropriate Acts / Equipment Failures**

The inappropriate act is an incomplete design analysis. The inappropriate act involved the original Appendix R analysis team for RNP.

5. **Causal Factor Associated with each Inappropriate Act / Equipment Malfunction**

1. Causal Factor: Unclear design criteria/guidance at the time of the original design analysis. This is historical as the original analysis was performed in the 1980s.
   Cause Code: K1
   Type: Root Cause

2. Causal Factor: Lack of technical justification to support criteria/guidance. This is historical as the original analysis was performed in the 1980s.
   Cause Code: K1
   Type: Contributing

6. **Previous Operating Experience (Internal and External)**

<u>Internal OE</u>

CR3 reported in October of 1997 that a design error resulted in inability to provide reactor coolant system inventory makeup during an Appendix R event. A reanalysis of Appendix R Fire Study determined that the power supplies for the high pressure injection valves and the normal inventory makeup valves were not protected from the postulated Appendix R fire in the control room or cable spreading room. This resulted from a deficient fire study previously performed. The event was determined to be not significant.

RNP Response: This event occurred before CR3 joined the Progress Energy nuclear fleet. This event was not released as OE by the utility, and therefore, was not previously evaluated by RNP. As part of the RNP long term plan for continued upgrade and evaluation of its Appendix R analysis, projects were begun in 2003 to address manual action feasibility and those portions of the analysis that would uncover similar problems.

In December of 2002, HNP identified that postulated fires in three fire areas could cause spurious closure of certain valves. Spurious closure of valves in the flow path for the protected [redacted] could result in loss of the protected [redacted] if it was in service at the time of the postulated fire. Similarly, simultaneous multiple spurious closures of valves in the flow paths of water to the [redacted] could result in loss of [redacted] credited in the SSA and subsequent [redacted] In January of 2003, it was identified that simultaneous multiple spurious opening of certain valves could result in transferring of [redacted] The cause of these conditions is inadequate original Safe Shutdown Analysis of certain conductor-to-conductor interactions.

RNP Response: As part of the RNP long term plan for continued upgrade and evaluation of its Appendix R analysis, projects were begun in 2003 to address manual action feasibility and those portions of the analysis that would uncover similar problems.

OE

A search was conducted of the Nuclear Network for Operating Experience on the subject of this NCR. Only one item could be found that had been posted as an OE item.

In February of 2002, during revalidation of the Appendix R compliance strategy for Indian Point Unit 2 it was discovered that the analysis lacked sufficient detail and/or support documentation to justify the adequacy of separation of the original and current design configuration of the [redacted] control cables. Panels for control and local/remote breaker control for all three pump controllers are located in a common hallway immediately outside the [redacted] cubicles. This configuration leaves all control functions (i.e. both breaker and speed control) for [redacted] vulnerable to damage by a single fire event in the area. This issue was determined to be not safety significant.

RNP Response: RNP has had a long term plan for continued upgrade and evaluation of its Appendix R analysis. In 2001 evaluation of manual actions for III.G.3 areas was completed. Work on manual actions for III.G.2 areas was to begin in 2002, but was postponed until 2003 due to the power up-rate project. Work was begun in 2003 to address the remaining manual actions and those portions of the analysis that would uncover similar problems.

LERs

A total of four events concerning [redacted] were found in the LER database.

1. In September of 1998 at St. Lucie Unit 2, it was determined that the cables providing control signals to the [redacted] were not adequately isolated from adjoining cables and could cause the [redacted] to spuriously open in the event of a control room fire. A fire isolation switch was provided for this circuit; however, it did not adequately isolate all portions of the [redacted] control circuit. The station attributed the [redacted] cable issue to misapplication or misinterpretation of NRC requirements for circuit failure analyses. This event was determined to be not significant.

2. In October of 1999 at Salem Unit 1 a concern was identified with the cable routing of the [redacted] during a review of the post fire safe shutdown analysis. The cable for each [redacted] is routed in the same cable tray inside the containment. In the event of a postulated fire inside containment [redacted] could lose power and can not be closed. The fire could also cause a hot short to occur that would cause the associated [redacted] to spuriously open. These two occurrences together would result in the [redacted] The cause of the event was the failure to properly evaluate the interface function of the [redacted] during the development of the Appendix R safe shutdown analysis. This event was considered to be not significant.

3. In May of 2000, Prairie Island Unit 2 determined that the [redacted] in containment do not meet the Appendix R 20-feet separation criteria. The scenario of concern is a fire in containment causing a sustained external short circuit in the [redacted] circuitry that would result in the [redacted] concurrent with the same fire causing a ground or open circuit in the [redacted] circuitry that would prevent [redacted] With these two valves opened, a [redacted] would occur that could not be isolated. The cause of the event was an oversight with considering the [redacted] when the safe shutdown analysis was updated to implement the guidance of NRC Generic Letter 86-10. This event was considered to be not significant.

4. In April of 2002, Millstone Unit 3 determined that the emergency operating procedure (EOP) did not provide adequate assurance that the [redacted] would be disabled within a timeframe that would prevent inadvertent actuation from a fire-induced short circuit and [redacted] It had been assumed that 15 minutes would provide adequate time to isolate the [redacted] and establish positive control of [redacted] in the event of a fire in [redacted] However, reanalysis of operator actions and response times could not assure isolation of the [redacted] Assumptions to support the fire safe shutdown analysis were not properly validated. This event was considered to be not significant.

RNP Response to each: These LERs were not released by the utilities as Operating Experience; therefore, they were not evaluated by RNP. These events are being addressed within this NCR.

7. **Extent of Condition**

The loss of [redacted] operation (spurious closing of [redacted] has been addressed in [redacted] Review of cable routing for [redacted] found no other plant fire zones where a similar problem exists. On the discharge side of the [redacted] only one electrical motor operated valve is in the flow path. Motor operated valve [redacted] is the [redacted] There is no impact to [redacted] or component operation should this valve spuriously close. Therefore, [redacted] does not impact the ability to achieve safe shutdown conditions.

The spurious actuation hydraulic cases associated with a loss of [redacted] have been completed. These cases were evaluated in [redacted] These analyses address the following [redacted]

[redacted]

Review of cable routings for [redacted] found that they are also routed in other fire zones; however, in these cases other mitigating factors, such as the availability of SI, preclude them from being a concern. Ex4

Several other fluid systems function to support Appendix R safe shutdown. They are Auxiliary Feedwater, Component Cooling Water, Service Water and the Residual Heat Removal Systems. **These systems were evaluated in the original analysis for fire induced circuit failures under the same apparent assumption that manual actions could be taken early in the event prior to circuit failures resulting in unrecoverable conditions. However, these systems / components need to be reevaluated to determine if there are postulated fire induced circuit failures that could result in unrecoverable conditions.** The extent of condition cannot be fully determined until such an analysis is complete. This is an extensive analysis, which will require significant engineering effort to complete.

This engineering evaluation is currently part of the overall Appendix R Safe Shutdown Analysis Revalidation Project, which is being completed by Sargent and Lundy for RNP. The task is currently scheduled for completion by July, 2004 at RNP. This task will be relied upon to complete the extent of condition for the nuclear condition report.

Appendix R Safe Shutdown Analysis Revalidation Project - Treatment of Spurious Operation of Equipment

The Appendix R Safe Shutdown Analysis Revalidation Project is currently an ongoing project. Project Instructions for Task 5 of this effort, specifically addresses the methodology and treatment of spurious operation of equipment. These instructions state that two spurious concurrent mal-operations of equipment must be considered in the circuit analysis for cables and equipment being credited for shutdown of the plant. Project Instructions for Task 6 will identify all hydraulic analyses that must be considered. Plant modifications are anticipated to be required following completion of the revalidation project.

8. Safety Significance

Summary

[redacted]

This issue deals with the possibility that fires in certain locations in Fire Zones [redacted] could cause spurious closure o[redacted] This would result in loss of suction to [redacted] A concern was raised that this could potentially result in rapid damage to and loss of the two pumps. There are [redacted] but approximately two-thirds of the time, the [redacted] will be in service and thus it could potentially be subject to damage. The [redacted] is important in the safe shutdown analysis because it is powered from the dedicated shutdown bus.

It is important to note that there has been no actual failure associated with the issues identified in NCR 111308. In addition, no actual fire initiating event is being reported by the NCR that challenges the operability of the charging pumps. The only question examined in this assessment is whether there was a significantly higher likelihood of core damage at some time in the past due to the external events / fire issues identified in this NCR than had previously been understood. The following provides this historical review of the event prior to the establishment of the compensatory action to take preemptive control room action to verify the [redacted] This compensatory action maintains the pump water solid.

Vendor information (See Attachment 4) and an event at St. Lucie (described below) support the ability of positive displacement charging pumps to run for a limited period of time without suction and not cause sufficient damage to the operating pumps that would prevent them from being restarted. The head of water developed from

This head will help to push air from the pumps. Local control in the [redacted] is available to the operators to start and control the pumps as needed. Since only two of the three pumps are operating at the start of the event, the non-running pump remains full of water and not entrained with air. Once the supply is restored to the pump(s), they will be capable of supplying water into the system. Should the non-running pump be available to be started, normal flow into the system is expected since the pump remained full of water. If one of the previously operating pumps is started, then a forward flow of water is still expected. Dedicated shutdown (fire response) procedure [redacted] already directs a prompt realignment of [redacted] Therefore, on a qualitative basis this potential concern would not result in any significant increase in risk in comparison with prior estimates.

[redacted]

This issue identified concerned the possibility that fires in certain locations in Fire Zones [redacted] could cause concurrent spurious opening of both [redacted] resulting in an [redacted] before operators could take mitigating actions.

It is again important to note that there has been no actual failure associated with the issues identified in NCR 111308. In addition, no actual fire initiating event is being reported by this NCR that challenges the ability of the PORVs to operate or be isolated as required. The only question examined in this assessment is whether there was a significantly higher likelihood of core damage at some time in the past due to the external events / fire issues identified in this NCR than had previously been understood. Ex 4

It has been determined through calculation and a simulator run that mitigating actions currently proceduralized in the dedicated shutdown procedure [redacted] to isolate [redacted] are adequate to prevent core damage, whether one or two PORVs spuriously open. Therefore, this new potential concern would not result in any significant increase in estimates of risk in comparison with prior estimates.

The issue o[redacted] spurious operation was previously addressed by the NRC and Progress Energy. In letter NLS-85-0732, dated 11/21/85, the NRC approved the methodology to close [redacted] early in the fire event. The NRC stated they found this method of "ensuring prevention of fire induced spurious operations of these applicable high/low pressure interface valves acceptable." As such, the dedicated safe shutdown procedures provide a means by which this is accomplished. Additionally, Operators are routinely trained on this procedure.

Maintaining th[redacted] in the closed position has been considered, but has been determined to be not preferable at this time. Maintaining the [redacted] in the closed position during normal operation would prevent the [redacted] from relieving pressure during an [redacted] This could result in unnecessary actuation of the [redacted] during a transient condition. By maintaining the [redacted] in automatic control and unblocked condition, it is less likely that th[redacted] will be actuated. This is considered to be preferable, because the availability of the both the [redacted] and the [redacted] provides additional mitigation capability for an [redacted] and reduces the likelihood of malfunction of the [redacted] valves.

Initial mitigating action to close [redacted] from the control room is not a concern if during the event should they spuriously operate to the open position. First, the valves are closed to prevent a loss of power event from preventing their closure. Once closed, a spurious operation would constitute a third and fourth spurious operation. This is beyond our current and redefined (Appendix R revalidation effort) design basis. Additionally, it has been shown that even with bo[redacted] after manual actions are taken to remove power from the [redacted] are in series, so closure of either one removes the leakage path.

Impact of Loss of Suction to Charging Pumps

A scenario has been postulated which would result in the [redacted] running for approximately 15 minutes while experiencing a loss of suction. This would be due to spurious closure o[redacted] The concern with this scenario is a catastrophic failure of the operating pump(s). In addition, after a period of approximately 36 minutes the [redacted] would be called upon to provide [redacted]

Ex4

When [redacted] suction is lost, air entrainment and associated cavitation in the pump will be experienced from both dissolved gases in the liquid as well as air residing in the [redacted] suction stabilizer. RNP actual experience has shown that such air entrainment would cause cavitation within the pump resulting in pitting and increased wear on the [redacted] alve train components. This observed wear was over an extended period of time; on the order of two to three months. The wear was also seen to accelerate based on the operating speed of the pump. At that time RNP was operating with only one [redacted], which thereby increased the speed of the pump, the cavitation, and subsequently the wear. Operating two pumps at lower speeds decreased this phenomenon significantly and eliminated the cavitation type wear completely. RNP currently practices dual pump operation for the [redacted] o reduce maintenance costs and wear. However, only [redacted] is required to meet system needs.

In this scenario, with the continued operation of the pumps, cavitation would peak as more and more air is introduced into the pump. Eventually, the hydraulic forces acting on the internal valve components would begin to decrease due to a reduction in hydraulic forces caused by the replacement of water with air. There would be an increase in associated pump operating noise accompanying this timeline, as well as associated increased wear on the power end components due to unbalanced forces within the fluid cylinders of the pump. This would reach the same threshold as the internal valve components, followed by a reduction as more and more air enters the pump. The other obvious correlation is the loss of pumping efficiency as more air enters the pump. It should be noted that the pumps do not rely on the pumped fluid for lubrication of power end or motive force components other than for some cooling of the packing which again would result in some accelerated wear. This wear is not expected to be significant as the primary lubrication and cooling for the packing is provided by the [redacted] lubrication tank supplying primary water.

Operating experience from IN 83-77 discusses some events at nuclear power plants involving pumps failing to function due to gas entrainment. One of those events involved positive displacement [redacted] and the discussion of the event supports the conclusion that positive displacement charging pumps can withstand a period of operation without a suction supply:

> *St. Lucie*
>
> *On October 23, 1982, with St. Lucie Unit 1 in hot standby during recovery from a reactor trip, the three operating positive displacement charging pumps stopped injecting coolant to the reactor coolant system because the volume control tank (VCT) was pumped dry. The reactor had tripped on a low steam generator water level signal after a loss of feedwater flow to the steam generator. The VCT was empty although its two liquid level sensors indicated an acceptable liquid inventory and hence an apparently acceptable inflow/outflow balance from the VCT. The hydrogen cover-gas blanket of the VCT entered the suction of each pump. The false liquid level indication was caused by an empty reference leg that was shared by both liquid level sensors. The pumps were restored to operation by repeated venting after filling the VCT to a high level.*

Based on RNP experience in internal valve train and packing wear, characteristics and principles of operation of the pumps, and previous operating experience, a catastrophic failure of the [redacted]s not expected to occur while operating with a loss of suction for approximately 15 minutes. Ten minutes is considered a reasonable time period for the operators to recognize the situation and stop the operating [redacted] The vendor, [redacted]vas contacted to provide their insights into this scenario as well. They came to the same conclusion; the pumps would not be expected to experience a catastrophic failure during this time period. Their reply is provided in Attachment 4.

Impact of Fire Protection

Fire Zones [redacted]re protected by a full area fire detection system and automatic Halon suppression system. The detection system for each fire zone is provided with two trains of detection. Actuation of both trains of detection will cause the Halon system to automatically discharge. The Halon system is a total flooding suppression system consisting of a main and reserve bank of cylinders. This redundancy in suppression capability also minimizes system out of service time. Detection system design information identifies that for each fire zone, the number of detectors actually installed exceeds the required minimum number of detectors. Upon actuation of a fire alarm by one of the detection trains, the Control Room will initiate an investigation and appropriate fire brigade response.

Procedural guidance already in place requires that upon the loss of either the fire detection/actuation system or the fire suppression system for the affected fire zones, a continuous fire watch will be put in plac[redacted]

The permanent fire loading in Fire Zone [redacted] is considered "high", while the fire loading in Fire Zon[redacted]s considered "moderate". Existing plant procedures contribute to the fire safety of the plant by controlling the use and storage of combustibles, maintaining housekeeping standards and controlling sources of ignition. In addition, non-qualified IEEE-383 cables in Fire Zones [redacted]re coated with a fire retardant that will slow down the propagation of fire between circuits.

Fire Zones [redacted] are adjacent to each other. Access into Fire Zone[redacted]s from Fire Zone [redacted] Four unannounced fire drills have been conducted in these fire zones in the last two years. Fire drill response times for each fire zone show an operator on the scene between 1 and 7 minutes. This response time starts when the initial alarm is received in the control room. In each of these drills, the fire brigade was on the scene between 10 and 13 minutes from the sounding of the plant fire alarm.

Cable Testing – Times to Failure and Spurious Operation

EPRI document 1003326, Characterization of Fire-Induced Circuit Faults - Results of Cable Fire Testing, discusses spurious actuation of devices in electrical circuits due to fire induced damage to electrical cables. This document includes recent fire testing of circuits. Section 12.2.5 gives results of the time to cable failure and Section 12.2.6 provides information on spurious actuation. For the types of cables originally installed at RNP (thermoplastic), the test results give an average time to cable failure in 15 minutes. The average time to spurious actuation is 25 minutes, with an average spurious duration of less than 3 minutes. These values support the fact that on average, sufficient time exists for the execution of manual actions prior to initiation of spurious operations and that when spurious operations occur, they are short in duration.

Time Lines

Generic Time Line Assumptions

1. Automatic fire suppression system does not operate or extinguish the fire.
2. No Operator or fire brigade actions are taken in the fire zone to control or extinguish the fire.
3. A maximum of two spurious operations of components occur at the onset of the event.
4. Entry into the dedicated shutdown procedures (DSP) begins with the first spurious signal.
5. First and second spurious signals occur concurrently, followed by subsequent failures. Subsequent failures are taken one at a time.
6. Spurious operation of equipment has no specific end time.
7. Loss of off-site power is required to be taken when it can do the most harm and cannot be used to benefit the fire scenario.
8. Credit cannot be taken for cables or components that have not been analyzed for Appendix R.

[redacted]

Time from Start of Scenario (Minutes)	Description of Action
0	Fire starts in FZ[redacted]
X	• First and second spurious operations clos[redacted]

Mitigating Factors Not Taken Credit For In Charging Pump LCV Scenario

1. First and second train fire detection signals being received in Control Room.
2. Automatic Halon system actuation following detection of fire by the second train of detectors.
3. Built-in redundancy of detection and suppression systems: two detection trains, two Halon actuation circuits, and main and reserve banks of Halon cylinders.
4. Operator investigation initiated with first fire alarm received in Control Room. Four recent unannounced fire drills reported investigator on the scene between 1 and 7 minutes.
5. Fire Brigade on the scene between 10 and 13 minutes as recorded in the four recent unannounced fire drills.
6. No large single fire source exists in either Fire Zone [redacted]
7. Non-IEEE-383 qualified cables in Fire Zones [redacted] are coated with a fire retardant that will slow down the propagation of fire between circuits.
8. Average duration for spurious signal operation as determined by fire testing is three minutes.
9. Loss of off-site power is not taken in this event. If taken, [redacted] would stop running, further minimizing any damage to the operating pumps.
10. The CVC System design. The head of water developed from the [redacted] above the elevation of the pumps, all provide for a positive suction supply to the pumps. This head will help to push air from the pumps. Local control in the [redacted] is available to the operators to start and control the pumps as needed. Since only two of the three pumps are operating at the start of the event, the non-running pump remains full of water and not entrained with air. Piping to each pump can be vented locally at its suction stabilizer upstream of the pump. If off-site power has not been lost and the non-running pump is not affected by the initial consequences of the fire, it could be started.
11. If SI is not affected by the initial consequences of the fire, and if is needed, it could be started.

Mitigating Factors Not Taken Credit For In [redacted] Scenario

1. Same as the items 1 through 8 above for the [redacted] scenario.
2. Scenario is analogous to Station Blackout Event.

Ex

Conclusion

Based on the above, it is highly unlikely that these events would have lead to unrecoverable conditions. Loss of both [redacted] would have resulted in minimal damage to the operating [redacted] prior to manual actions taken to restore the flow path. Therefore, there would be no significant increase in risk from this event.

In the case of [redacted], it has been shown by calculation and a simulator run that the manual actions to remove power and close the valves can be achieved prior to core uncovery with no resulting core damaged. The simulator run shows the conservative nature of the calculation with respect to water remaining above the fuel. Therefore, there would be no significant increase in risk from this event.

Cable testing shows that on average, sufficient time exists for the execution of manual actions prior to initiation of spurious operations and that when spurious operations occur, they are short in duration.

The design of the fire detection and Halon suppression systems, lack of a significant fire source in either fire zone, fire retardant cable coatings and fire brigade performance make it highly unlikely that a fire would not be extinguished or at least controlled to its place of origin. Thereby, limiting fire spread and cable damage to only those initially involved.

With the existence of the detection and suppression system limiting fire spread, it is also unlikely that fire damage would prevent automatic SI initiation immediately following [redacted] SI operation will stabilize the event.

The compensatory changes made i[redacted]o add preemptive control room operator actions for a fire in Fire Zones [redacted] provide the plant with the ability to cope with these postulated fire events both now and as an interim step. These preemptive actions provide sufficient protection until a cohesive plan is in place to deal with these and any future issues identified by the ongoing Appendix R Safe Shutdown Analysis revalidation.

In conclusion, based on current plant physical configuration (and not accounting for the interim compensatory measures), both scenarios are outside the required Appendix R design requirements. However, it has been shown that based on actual plant responses to these events (both procedurally and in non-Appendix R credited equipment/responses) that there should have been no significant increase in risk from either of these events.

9. Corrective Action Plan

Causal Factor #	Planned/Completed Actions (Annotate Committed Assignments as Committed)	Assignment Type	Assignee / Concurred By	Initial Due Date
--		CORR	--	Complete 11/19/03
--	Operations Night Order 03-024 was released 11/19/03 directing the review of the changes made t[redacted] Fire Emergency, by each Operating Shift.	CORR	--	Complete 12/04/03
--	To reduce exposure to the potential effects of a fire from transient combustible materials, the administrative available limits for the affected fire zones were reduced to 50 percent of the normal allowed loadings.	CORR	--	Complete 11/19/03

--	Personnel responsible for Appendix R Program and circuit analysis (F. Modlin, R. Hightower and B. Gerwe) are cognizant of NCR findings and requirement that two concurrent spurious mal-operations are to be considered in Appendix R analyses.	CORR	--	Complete. All were NCR Team Members. 12/23/03
1	Confirmation that Task 5 of the current Appendix R Analysis Revalidation process includes the assumption that two spurious and concurrent mal-operations are to be considered in the analysis.	CAPR	Frank Modlin	Complete 12/12/03
1	Provide written guidance in appropriate design documents for performing Appendix R Analyses that address circuit analysis failures and manual action feasibility. Guidance to include direction on how to address spurious operation issues and the feasibility to perform manual actions.	CAPR	Frank Modlin	3/14/04
1	Revise NGGC "Fire Protection Technical Position Paper on Fire Induced Circuit Failure – Circuit Analysis" to reference this NCR and link this NCR with the appropriate steps in position paper requiring that two concurrent spurious mal-operations are to be considered in Appendix R analyses.	CAPR	Jeff Ertman	4/19/04
--	Confirm and include the results of this NCR investigation into an Engineering Document	CORR	Frank Modlin	4/16/04
2	Task 6 of the current Appendix R Analysis Revalidation process is to evaluate the Reactor Coolant System, Auxiliary Feedwater System, Component Cooling Water System, Service Water System, Residual Heat Removal System and their components to determine if there are postulated fire induced circuit failures that could result in unrecoverable conditions.	CORR	Frank Modlin	7/1/04 *
2	Complete necessary plant modifications (as appropriate) t [redacted] to ensure spurious operations do not lead to unrecoverable events and confirm the extent of condition for this event has been adequately addressed.	CORR	Frank Modlin	12/1/05 (RO-23F) * +

--	Perform an effectiveness review of the completed corrective actions (if effectiveness review is waived, provide basis below).	EREV	Bruce Gerwe	4/1/06 * +

* The corrective actions will not be completed in the required 120 days due to the complexity and scope of the engineering involved in determining the existence of other unrecoverable hydraulic conditions and proposed resolution(s) to any problems found. The design activities to correct problems found must be completed in a logical sequence which will also impact the ability to complete the corrective actions in the 120 days specified limit.

+ RO-23 Modifications are anticipated to be required.

10. Basis, If Effectiveness Review is waived:

11. PNSC/CSERB Review Required? YES X ☐ NO ☐

- Refer to applicable Implementing procedure

ATTACHMENT 1
REFERENCE LISTING
AR 111308

The following are the primary references reviewed in the investigation of this Nuclear Condition Report. This listing does not contain all of the documents, drawings, licensing correspondence reviewed in the course of this investigation.

1. Code of Federal Regulations, Title 10, Part 50, Appendix R: "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979.
2. H. B. Robinson Steam Electric Plant, Unit No. 2, Appendix R, Section III.G Supplemental Submittal; CP&L Letter No. NLS-84-030 dated February 6, 1984.
3. H. B. Robinson Steam Electric Plant, Unit No. 2, Follow-up Clarifications: CP&L Letter No. NLS-84-220, Dated June 6, 1984.
4. H. B. Robinson Steam Electric Plant, Unit No. 2, Appendix R - Alternate Shutdown Capability: Open Item Resolution and Additional Clarification: CP&L Letter No. NLS-85-140, dated June 18, 1985.
5. H. B. Robinson Steam Electric Plant, Unit No. 2, Supplemental Safety Evaluation Report for Appendix R to 10CFR50, Items III.G.3 and III.L, dated August 8, 1984.
6. H. B. Robinson Steam Electric Plant, Unit No. 2, Supplemental Safety Evaluation Report for Appendix R to 10CFR50, Items III.G.3 and III.L, dated November 21, 1985
7. H. B. Robinson Steam Electric Plant, Unit No. 2, Appendix R, Alternate Shutdown Capability, CP&L Letter to NRC, Serial: NLS-84-434, November 30, 1984.
8. H. B. Robinson Steam Electric Plant, Unit No. 2, Appendix R Exemption Request, CP&L Letter to NRC, Serial: NLS 85-026. February 13, 1985.

19. GL 81-12, Fire Protection Rule, dated 2/20/1981
20. GL 86-10, Implementation of Fire Protection Requirements, dated 4/24/1986
21. H. B. Robinson Steam Electric Plant, Unit No. 2, Fire Protection Modifications – Additional Information, CP&L Letter to NRC, Serial: GD-79-871, April 2, 1979.

ATTACHMENT 2
Barrier Analysis
AR 111308

BARRIER IDENTIFICATION HELP SHEET				
BARRIER CATEGORY • Were any physical barriers not functioning as designed? • Were there any barriers that did not perform their functions?	**Identify the barriers that will be assessed**	**If a barrier category contributed to the event then assess the specific barrier as follows:**		
		Barrier is deficient or failed	**No barrier in place**	**Barrier was circumvented or incorrectly applied**
SYSTEM/COMPONENT DESIGN CONTROL				
Design Codes/Standards	X			Unsubstantiated Assumption caused barrier to be circumvented.
Drawing/Dimensions				
Other				
PHYSICAL BARRIERS				
Engineered Safety Features				
Safety and relief devices				
Conservative design allowances	X			Unsubstantiated Assumption caused barrier to be circumvented. Hydraulic analyses were not prepared to support assumption time line.
Redundant equipment				
Alarms and annunciators				
Fire barriers and seals				
Other				
PROGRAM CONTROL/MONITORING BARRIERS				
Training Program				
Engineering System Monitoring				
Human Performance				
Procedure & Document Management				
Maintenance Rule				
Lessons Learned Programs				
Self Evaluation & Assessment				
Corrective Action				
Other – Performance of Appendix R Safe Shutdown Analysis	X	X		Unclear criteria/guidance at the time of original analysis.
ADMINISTRATIVE BARRIERS				
Plant Policies & procedures				
Training and education				
Equipment Clearances				
Radiation Work permits				
Qualification of welders				
Methods of communication				
Certification of engineers				
Regulations				
Supervisory practices				
ALARA				
Other				
Table is NOT intended to be ALL inclusive				

Attachment 4
AR 111308

From: Peck, Larry [mailto:lpeck@dbup.textron.com]
Sent: Wednesday, December 17, 2003 3:16 PM
To: Little, John
Cc: Woods, Paul
Subject: FW: [redacted]

John Little
Per our phone conversation there is a scenario of complete loss of suction pressure for 15 Minutes. During the loss of suction the pump would experience cavitation and the accompanying slamming of plungers into pockets of fluid. At some point the pumping chambers would gas bind and the slamming and vibration would cease. We do not expect to see catastrophic failure of the pumps or components due to the incident. There may be additional wear on the load carrying components, i.e., gears, bearings, crank and crossheads. Packing, stuffing box bushings, valves, seats, and springs may also see damage.

Lawrence A. Peck
Nuclear Project Engineer

8of4

[redacted] T=0

MPS: Monitored Parameter Summary

MP #	Variable Name	Current Value	Limits Low	High	Units	Type	Description
		53.241	0	100	pct	none	
		53.241	0	100	pct	none	
		53.241	0	100	pct	none	
		38.552	0	100	pct	none	
		53.2411	0	100	pct	none	
		-24.0563	0	120	pct	none	
		-4.99607	66	120	pct	none	
		-24.0563	0	120	pct	none	
		-4.99607	66	120	pct	none	
		2235.12	800	2300	psig	none	
		2235.12	800	2300	psig	none	
		2235.12	800	2300	psig	none	
		75.0588	0	100	pct	none	
		75.0588	0	100	pct	none	
15	THPCELL[24]	2257.41	800	2300	psia	none	CELL PRESSURE
16	THPCELL[21]	2273.07	800	2300	psia	none	CELL PRESSURE
17	THPCELL[54]	2252.47	800	2300	psia	none	CELL PRESSURE
18	THWCELL[54]	1.53891	-200	200	lbm/s	none	CELL MIXTURE FLOW RATE
20	PRTFL1LIQ[4]	0	0	100	lb/s	none	LIQUID (V)
21	PRTFL1LIQ[5]	0	0	100	lb/s	none	LIQUID (V)
22	PRTFL1GAS[4]	0	0	100	lb/s	none	GAS (V)
23	PRTFL1GAS[5]	0	0	100	lb/s	none	GAS (V)
24	THALFCR[1]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
25	THALFCR[2]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
26	THALFCR[3]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
27	THALFCR[4]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
28	THMSTMRCS	3987.2	4000	4001	lbm	none	PRIMARY RCS STEAM MASS
29	THMLIQRCS	384750	0	385000	lbm	none	PRIMARY RCS LIQUID MASS

[redacted]
ATT. 5 Pg 1/26

[redacted] T= 8 sec [redacted]

MPS: Monitored Parameter Summary

MP #	Variable Name	Current Value	Limits Low	High	Units	Type	Description
		0	0	100	pct	none	
		53.0927	0	100	pct	none	
		53.0927	0	100	pct	none	
		0	0	100	pct	none	
		53.1297	0	100	pct	none	
		-21.779	0	120	pct	none	
		-4.99649	66	120	pct	none	
		-21.779	0	120	pct	none	
		-4.99647	66	120	pct	none	
		1700	800	2300	psig	none	
		2231.89	800	2300	psig	none	
		2231.89	800	2300	psig	none	
		0	0	100	pct	none	
		0	0	100	pct	none	
15	THPCELL[24]	2252.53	800	2300	psia	none	CELL PRESSURE
16	THPCELL[21]	2265.69	800	2300	psia	none	CELL PRESSURE
17	THPCELL[54]	2247.59	800	2300	psia	none	CELL PRESSURE
18	THWCELL[54]	150.002	-200	200	lbm/s	none	CELL MIXTURE FLOW RATE
20	PRTFL1LIQ[4]	0	0	100	lb/s	none	LIQUID (V)
21	PRTFL1LIQ[5]	0	0	100	lb/s	none	LIQUID (V)
22	PRTFL1GAS[4]	0	0	100	lb/s	none	GAS (V)
23	PRTFL1GAS[5]	0	0	100	lb/s	none	GAS (V)
24	THALFCR[1]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
25	THALFCR[2]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
26	THALFCR[3]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
27	THALFCR[4]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
28	THMSTMRCS	3988.11	4000	4001	lbm	none	PRIMARY RCS STEAM MASS
29	THMLIQRCS	384756	0	385000	lbm	none	PRIMARY RCS LIQUID MASS

Ex 4

[redacted]
ATT. 5 pg 2/24

MPS: Monitored Parameter Summary

MP #	Variable Name	Current Value	Limits Low	High	Units	Type	Description
15	THPCELL[24]	2177.68	800	2300	psia	none	CELL PRESSURE
16	THPCELL[21]	2187.91	800	2300	psia	none	CELL PRESSURE
17	THPCELL[54]	2172.9	800	2300	psia	none	CELL PRESSURE
18	THWCELL[54]	436.788	-200	200	lbm/s	none	CELL MIXTURE FLOW RATE
20	PRTFL1LIQ[4]	0	0	100	lb/s	none	LIQUID (V)
21	PRTFL1LIQ[5]	0	0	100	lb/s	none	LIQUID (V)
22	PRTFL1GAS[4]	53.5694	0	100	lb/s	none	GAS (V)
23	PRTFL1GAS[5]	53.5692	0	100	lb/s	none	GAS (V)
24	THALFCR[1]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
25	THALFCR[2]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
26	THALFCR[3]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
27	THALFCR[4]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
28	THMSTMRCS	4013.02	4000	4001	lbm	none	PRIMARY RCS STEAM MASS
29	THMLIQRCS	384603	0	385000	lbm	none	PRIMARY RCS LIQUID MASS

[redacted]
ATT. 5 Pg 3/26

T= 1 min 25 sec

MPS: Monitored Parameter Summary

MFW Iso Lvl

MP #	Variable Name	Current Value	Limits Low	High	Units	Type	Description
15	THPCELL[24]	1460.97	800	2300	psia	none	CELL PRESSURE
16	THPCELL[21]	1466.24	800	2300	psia	none	CELL PRESSURE
17	THPCELL[54]	1456.86	800	2300	psia	none	CELL PRESSURE
18	THWCELL[54]	-254.237	-200	200	lbm/s	none	CELL MIXTURE FLOW RATE
20	PRTFL1LIQ[4]	0	0	100	lb/s	none	LIQUID (V)
21	PRTFL1LIQ[5]	0	0	100	lb/s	none	LIQUID (V)
22	PRTFL1GAS[4]	33.1897	0	100	lb/s	none	GAS (V)
23	PRTFL1GAS[5]	33.1897	0	100	lb/s	none	GAS (V)
24	THALFCR[1]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
25	THALFCR[2]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
26	THALFCR[3]	0	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
27	THALFCR[4]	0.000123295	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
28	THMSTMRCS	3014.3	4000	4001	lbm	none	PRIMARY RCS STEAM MASS
29	THMLIQRCS	379641	0	385000	lbm	none	PRIMARY RCS LIQUID MASS

[redacted]
ATT. 5 PG 4/26

T=10min 10sec

MPS: Monitored Parameter Summary

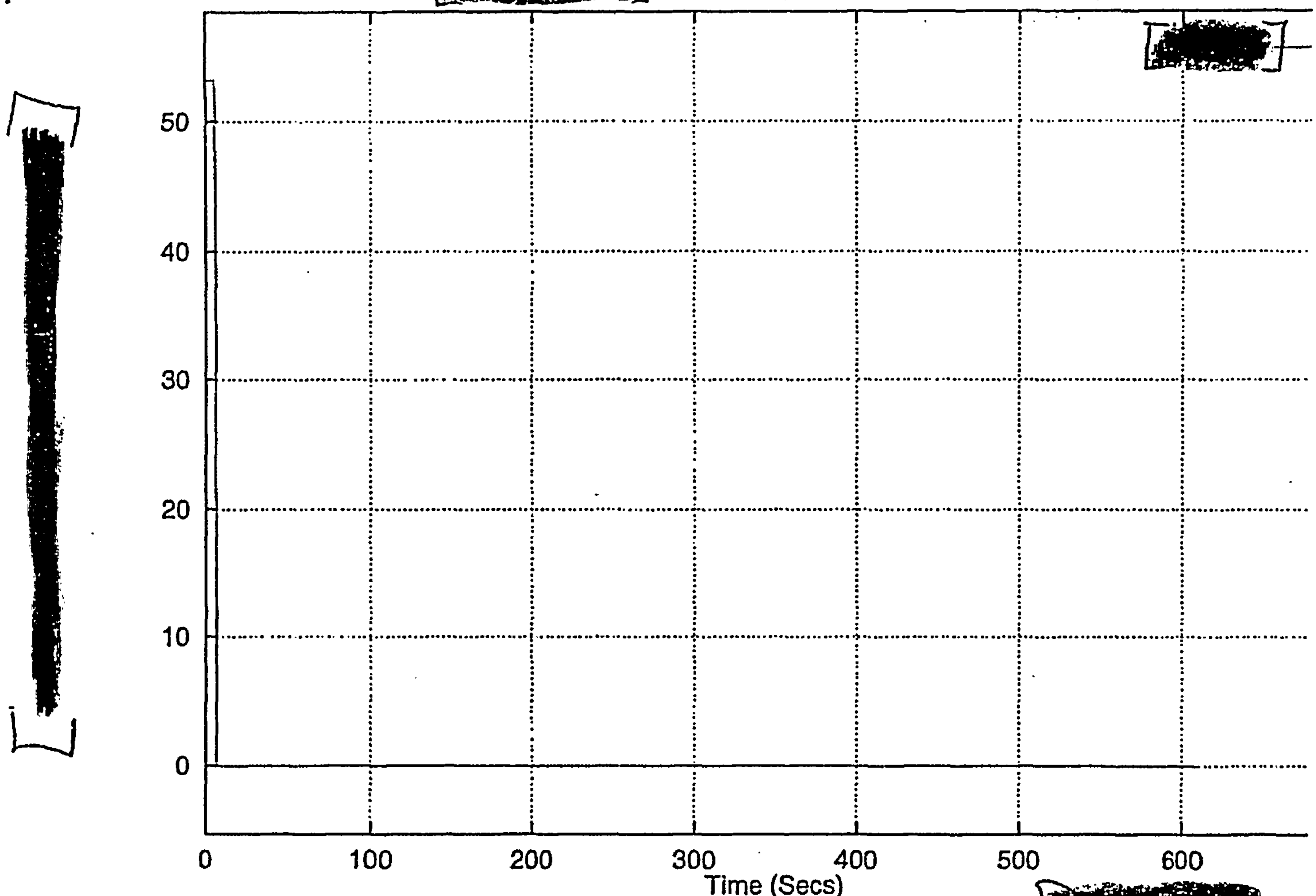
MP #	Variable Name	Current Value	Limits Low	High	Units	Type	Description
15	THPCELL[24]	1062.72	800	2300	psia	none	CELL PRESSURE
16	THPCELL[21]	1067.83	800	2300	psia	none	CELL PRESSURE
17	THPCELL[54]	1057.02	800	2300	psia	none	CELL PRESSURE
18	THWCELL[54]	-34.5073	-200	200	lbm/s	none	CELL MIXTURE FLOW RATE
20	PRTFL1LIQ[4]	0	0	100	lb/s	none	LIQUID (V)
21	PRTFL1LIQ[5]	0	0	100	lb/s	none	LIQUID (V)
22	PRTFL1GAS[4]	23.2207	0	100	lb/s	none	GAS (V)
23	PRTFL1GAS[5]	23.2207	0	100	lb/s	none	GAS (V)
24	THALFCR[1]	1.24186e-07	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
25	THALFCR[2]	0.0524183	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
26	THALFCR[3]	0.0785172	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
27	THALFCR[4]	0.0648001	0	1	dmls	none	REACTOR CORE VOID FRACTION PASSE
28	THMSTHRCS	3880.8	4000	4001	lbm	none	PRIMARY RCS STEAM MASS
29	THMLIQRCS	351309	0	385000	lbm	none	PRIMARY RCS LIQUID MASS

EX4

[redacted]
ATT. 5 5/26

CX7

[redacted] SJAPPR2(Mon Dec 8 16:28:59 2003)

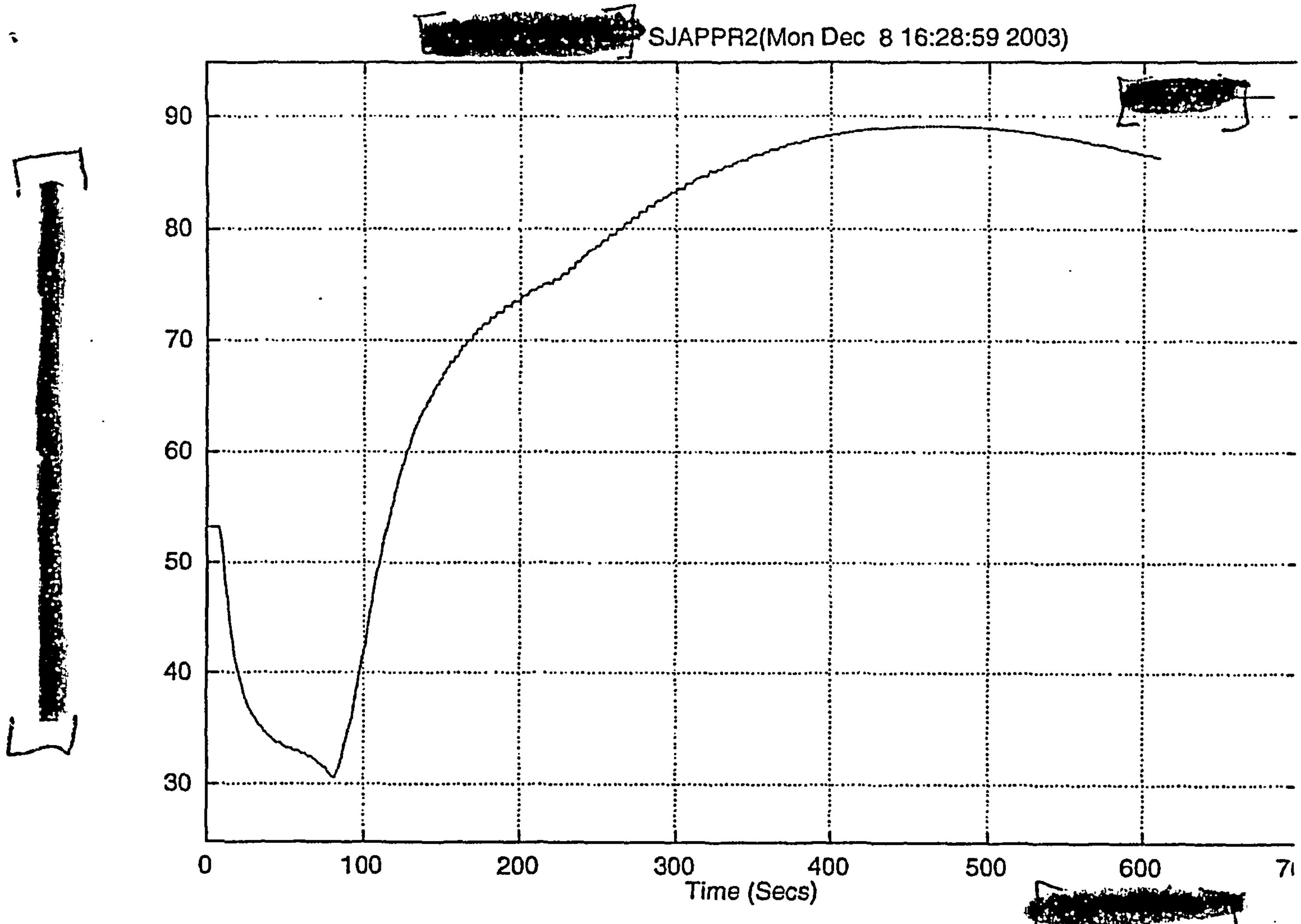


[redacted]

Fails to 0% due to LOOP/SEO

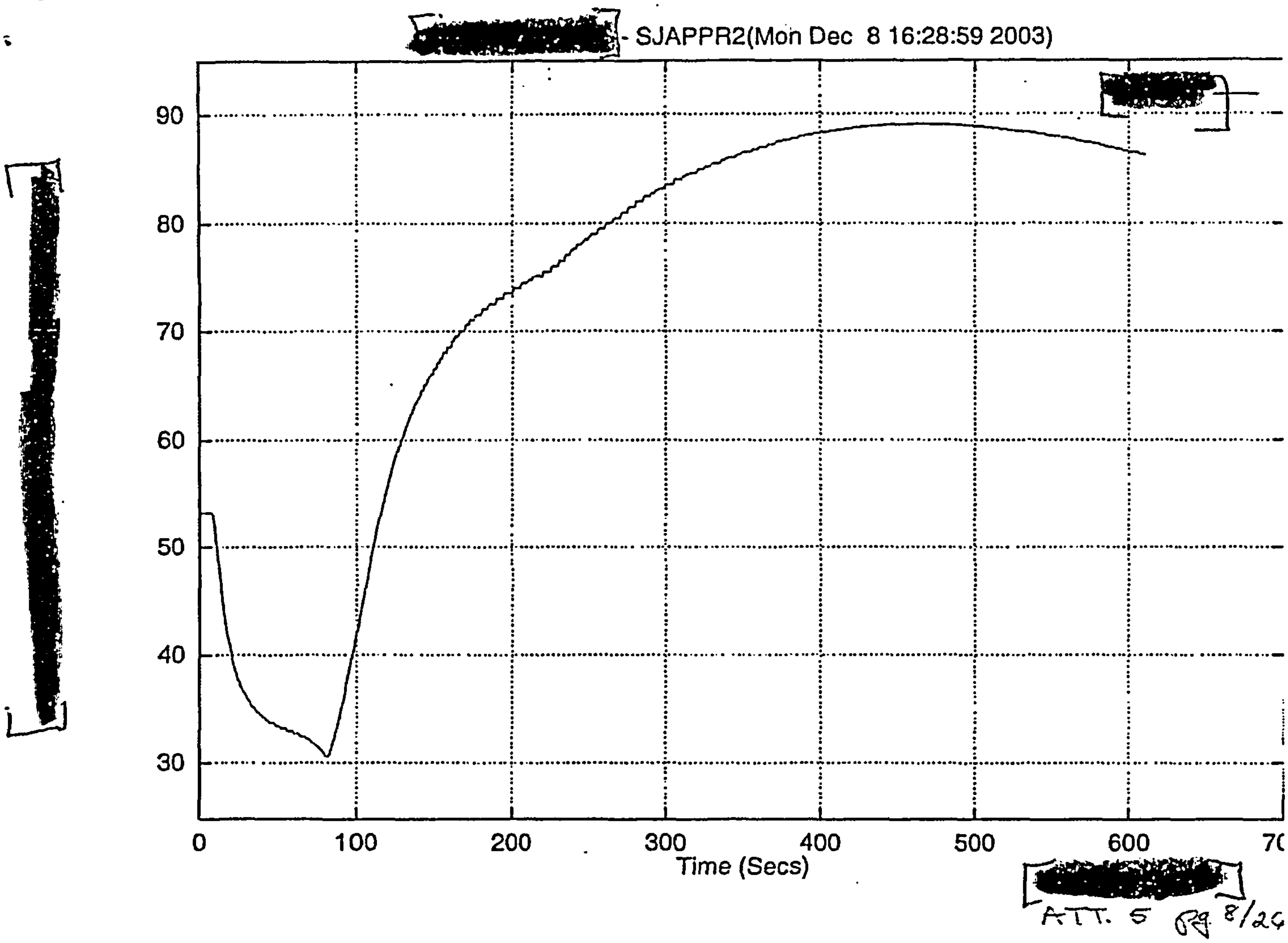
ATT. 5 pg 6/2

Ex 4



ATT. 5 pg ?/26

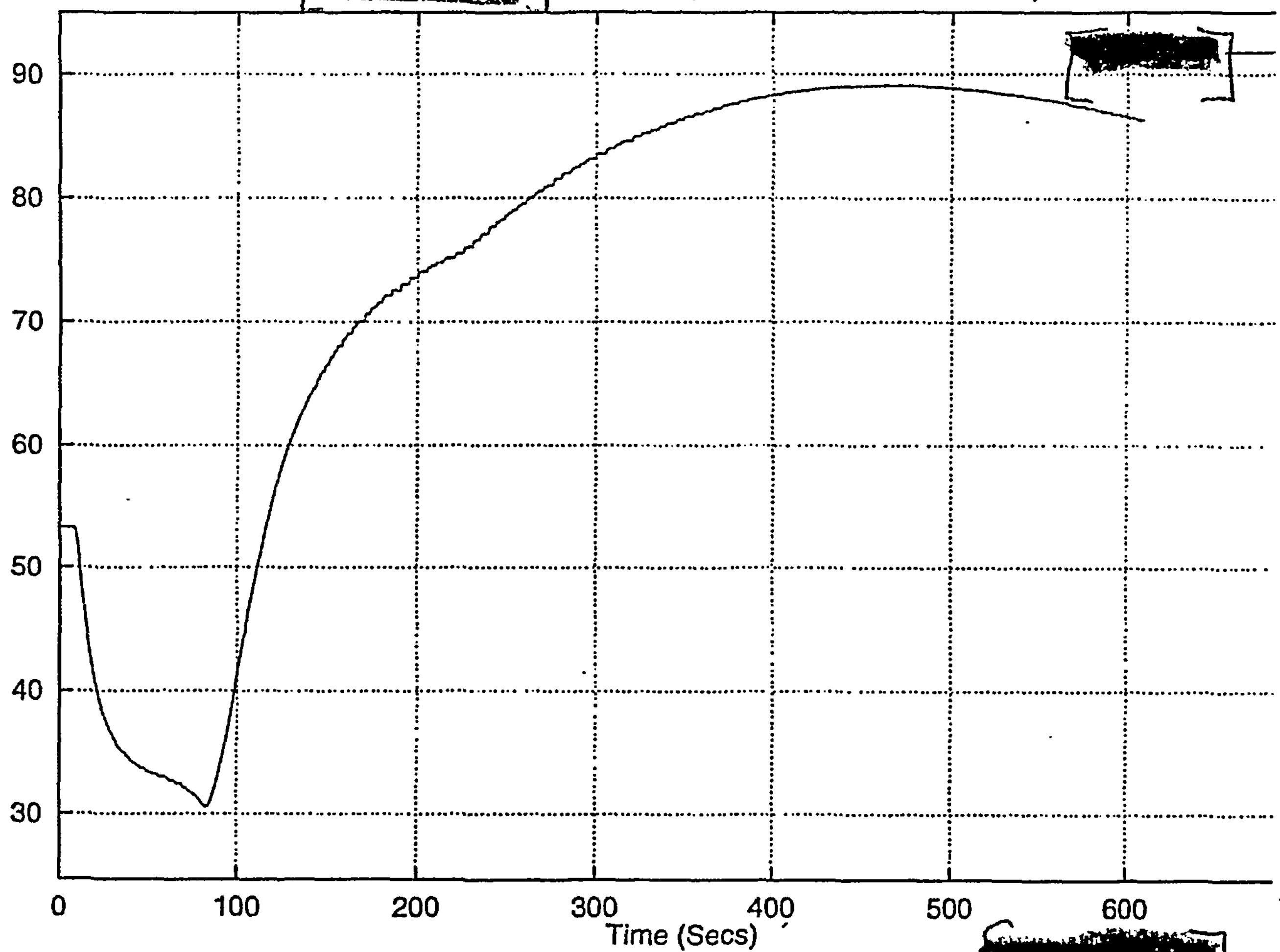
Ex4


[redacted] - SJAPPR2(Mon Dec 8 16:28:59 2003)
[redacted]
[redacted]
90
80
70
60
50
40
30
0
100
200
300
400
500
600
70
Time (Secs)
[redacted]
ATT. 5 Pg 8/24

64

[redacted] - SJAPPR2(Mon Dec 8 16:28:59 2003)

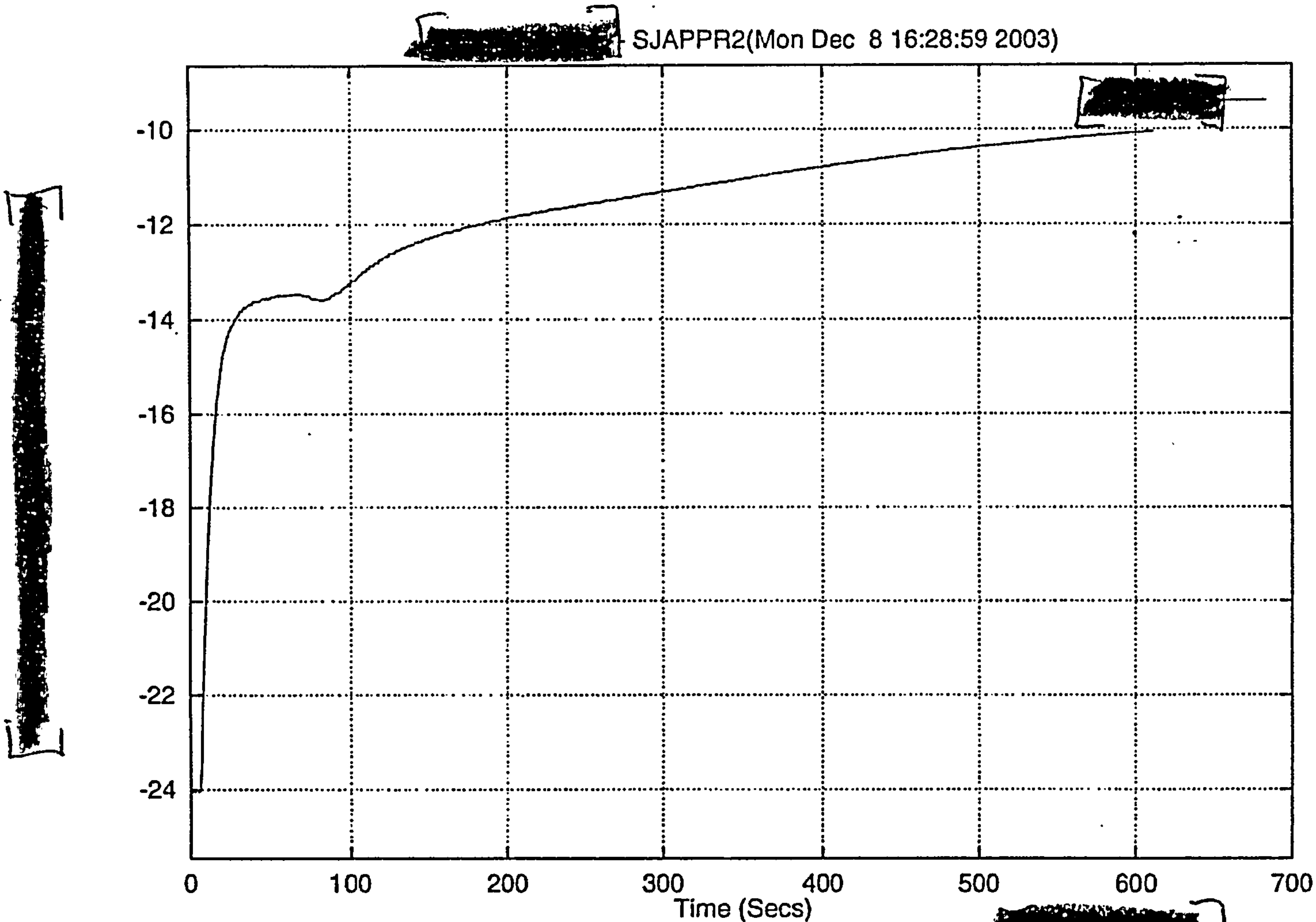
[redacted]



[redacted]

ATT. 5 pg 4/29

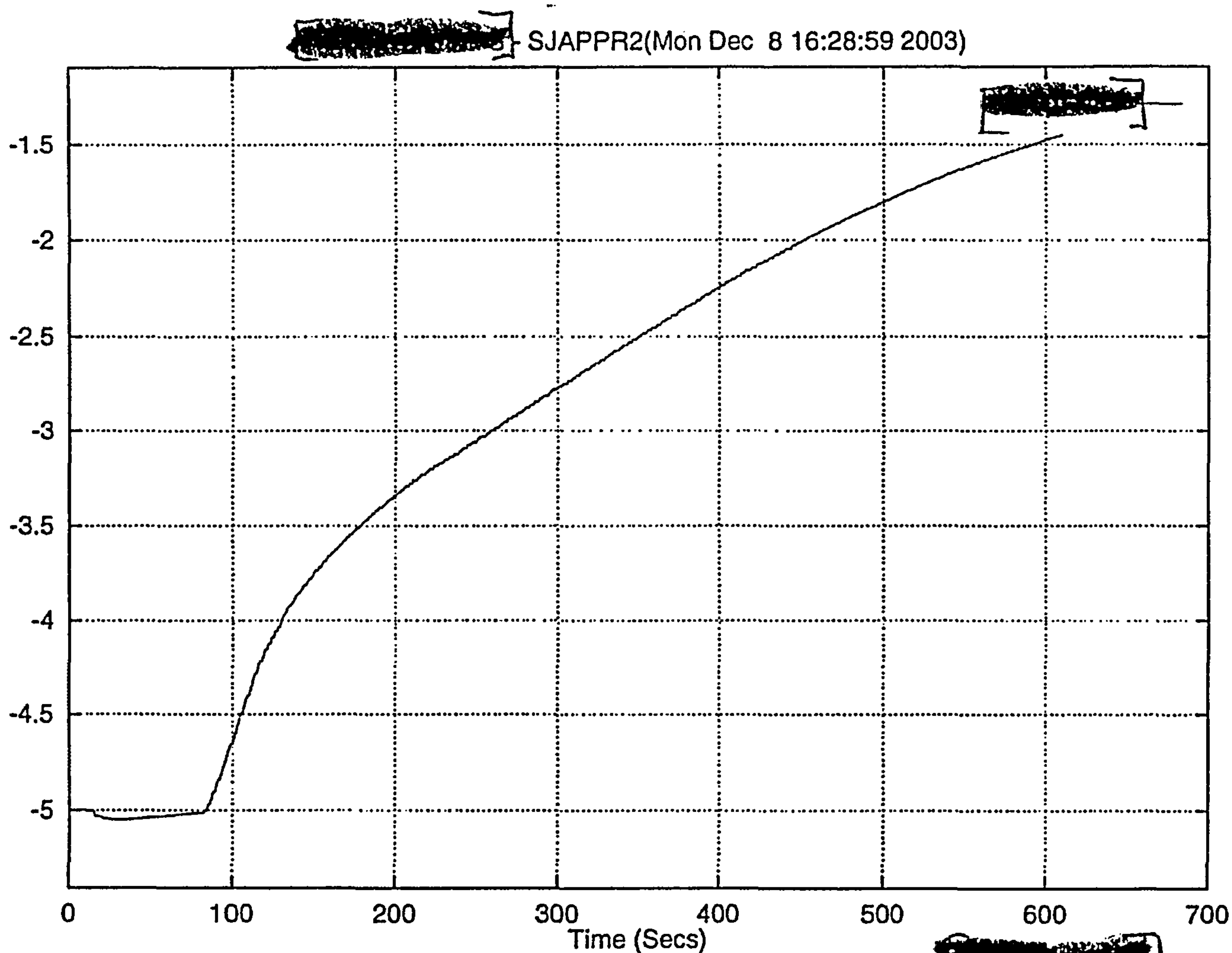
E44



[redacted]

ATT. 5 OJ 10/26

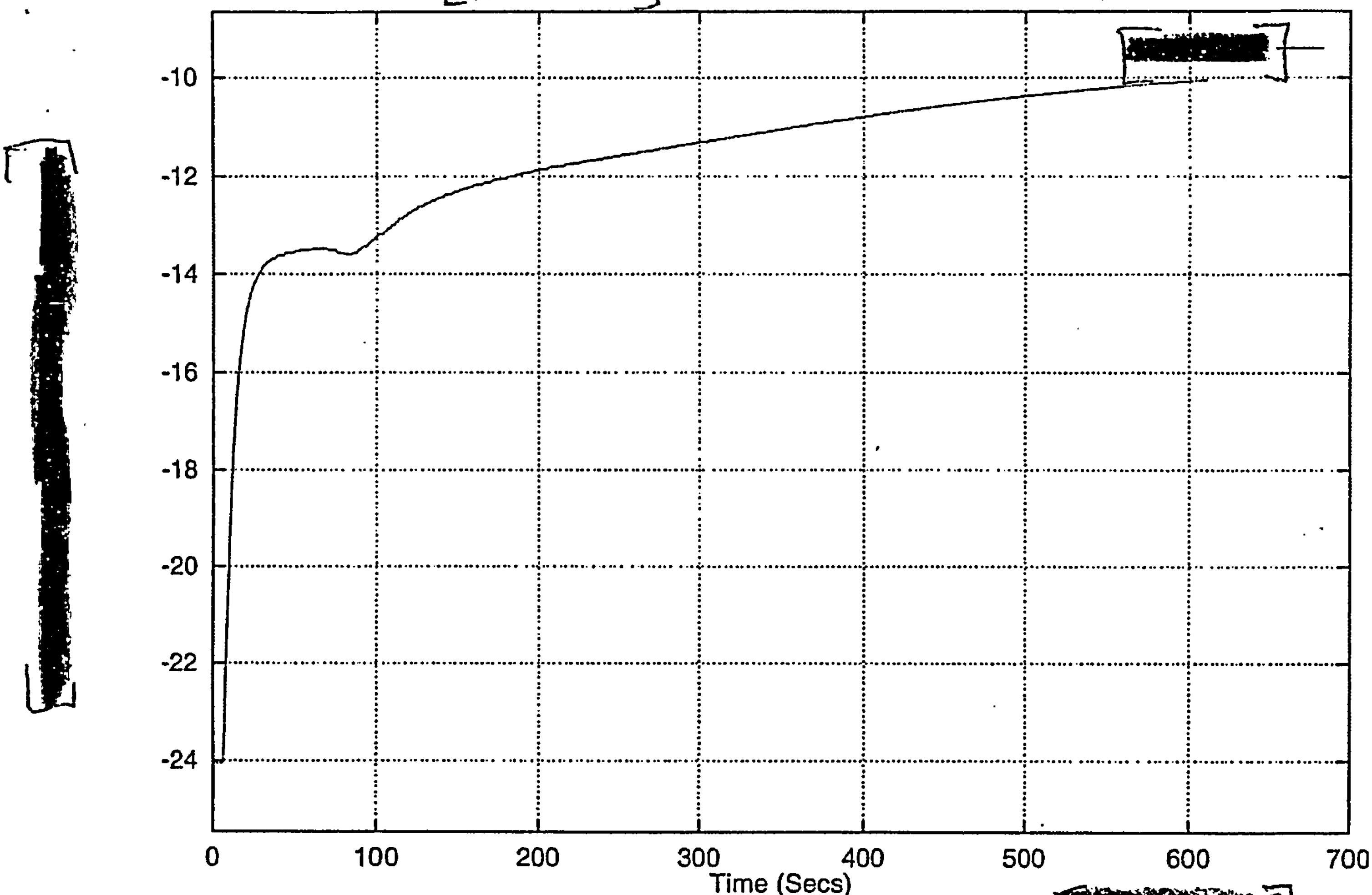
Ex 4



[redacted]
ATT. 5 Pg 71/24

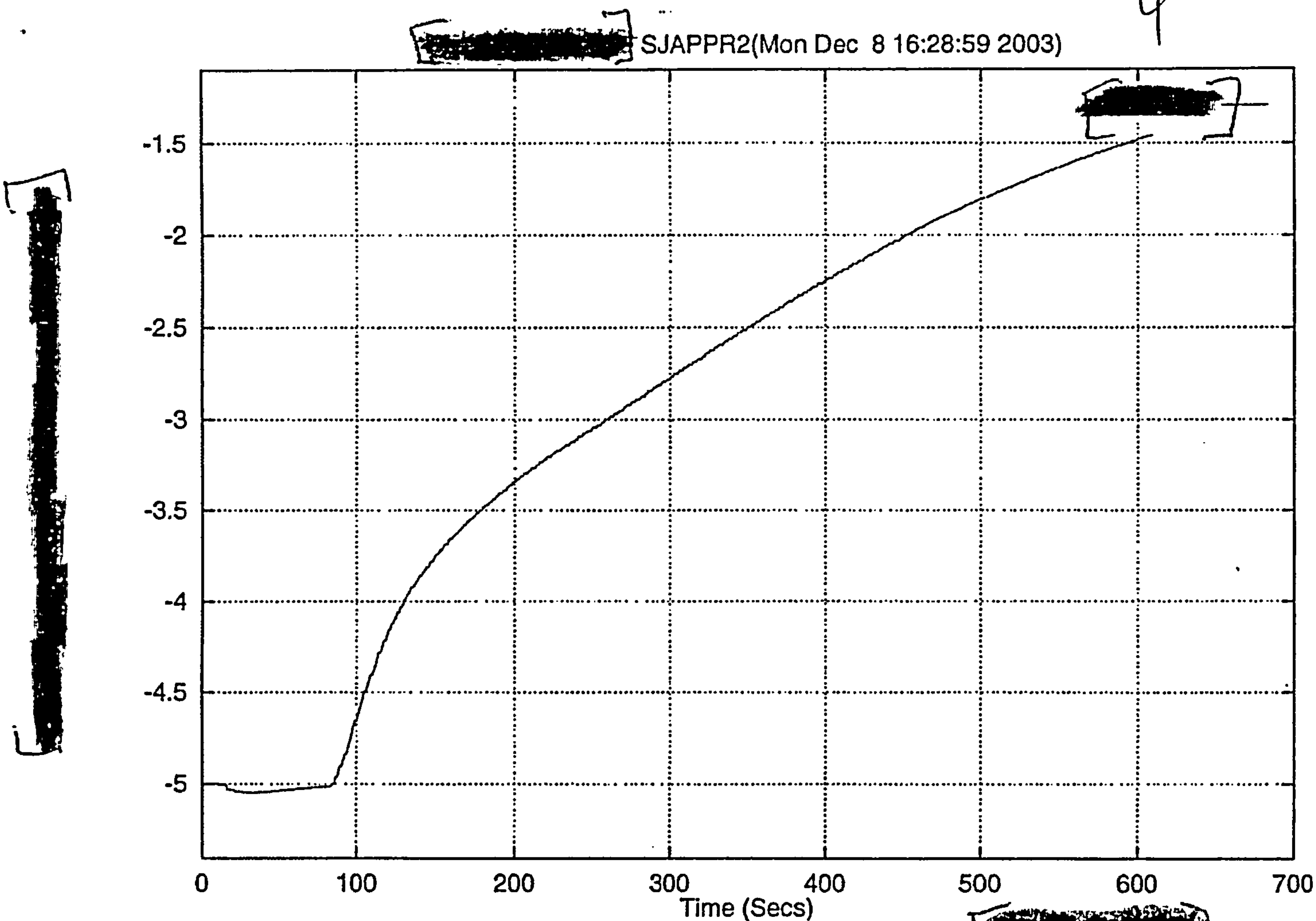
Ex 4

[redacted] SJAPPR2(Mon Dec 8 16:28:59 2003)



[redacted]
ATT. 5 OB 12/26

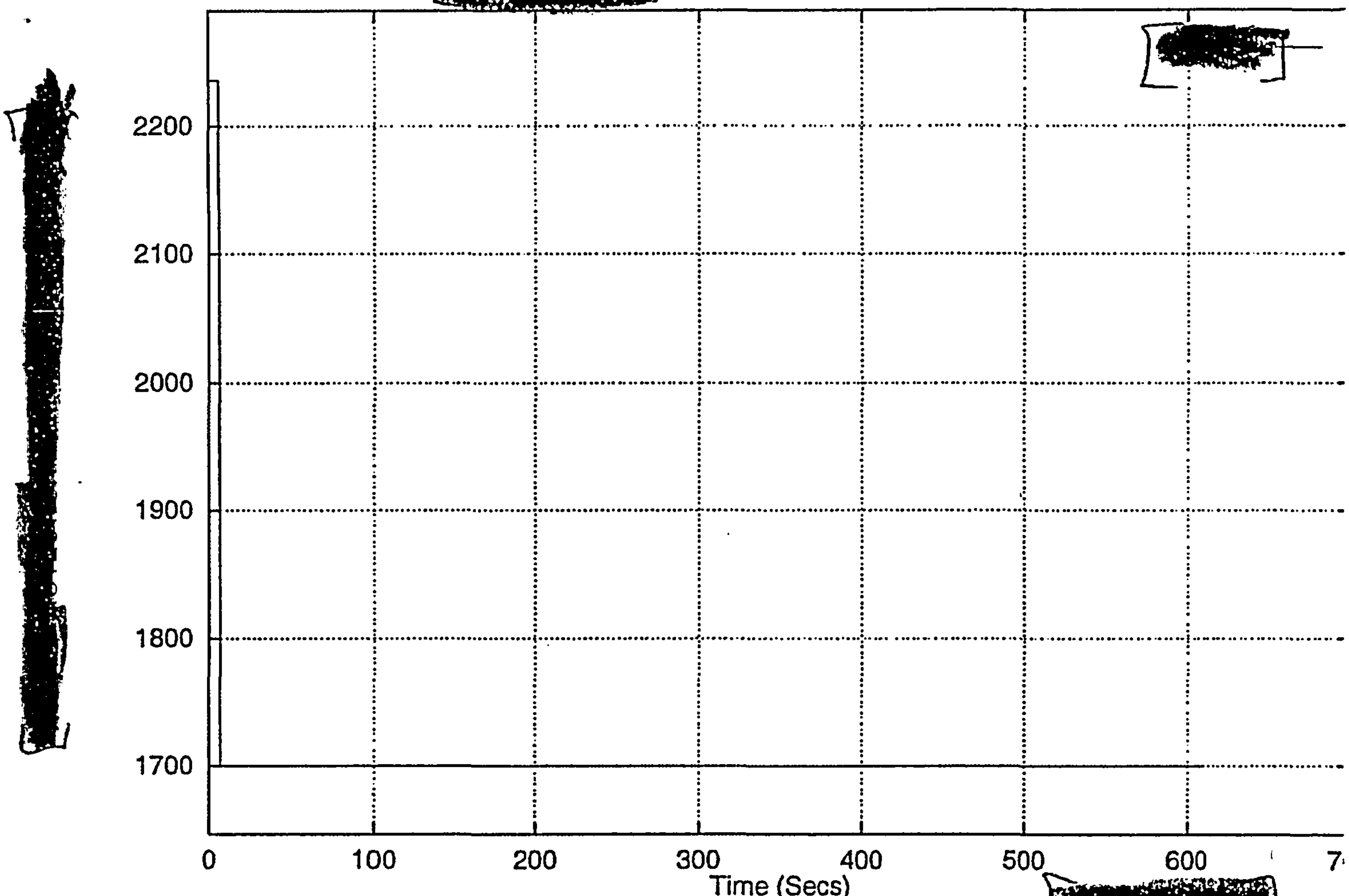
Ex 4



[redacted]
ATT. 5. Pg 13/26

EH4

[redacted] SJAPPR2(Mon Dec 8 16:28:59 2003)

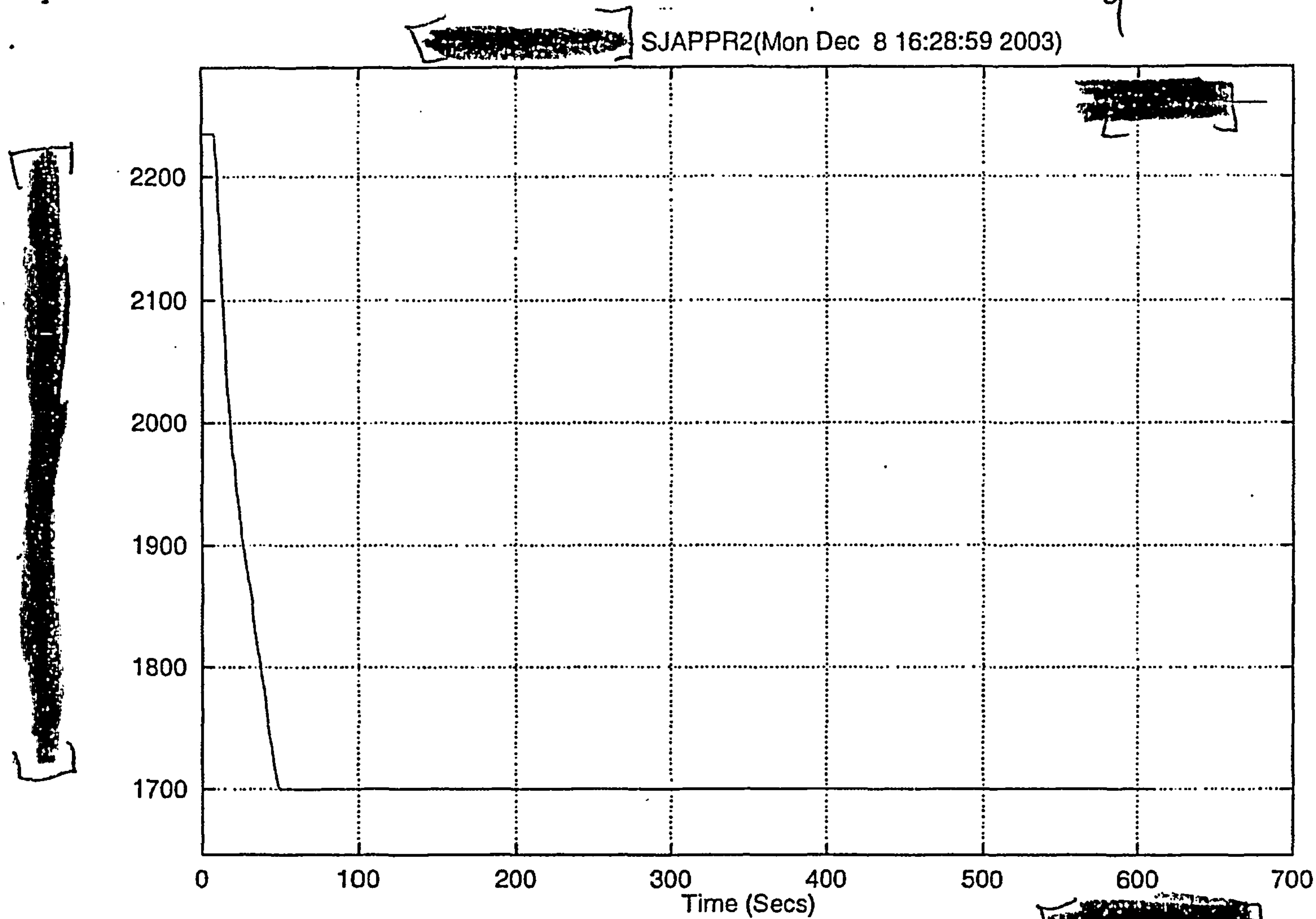


[redacted]

Fails offscale low due to LOOP/SBO

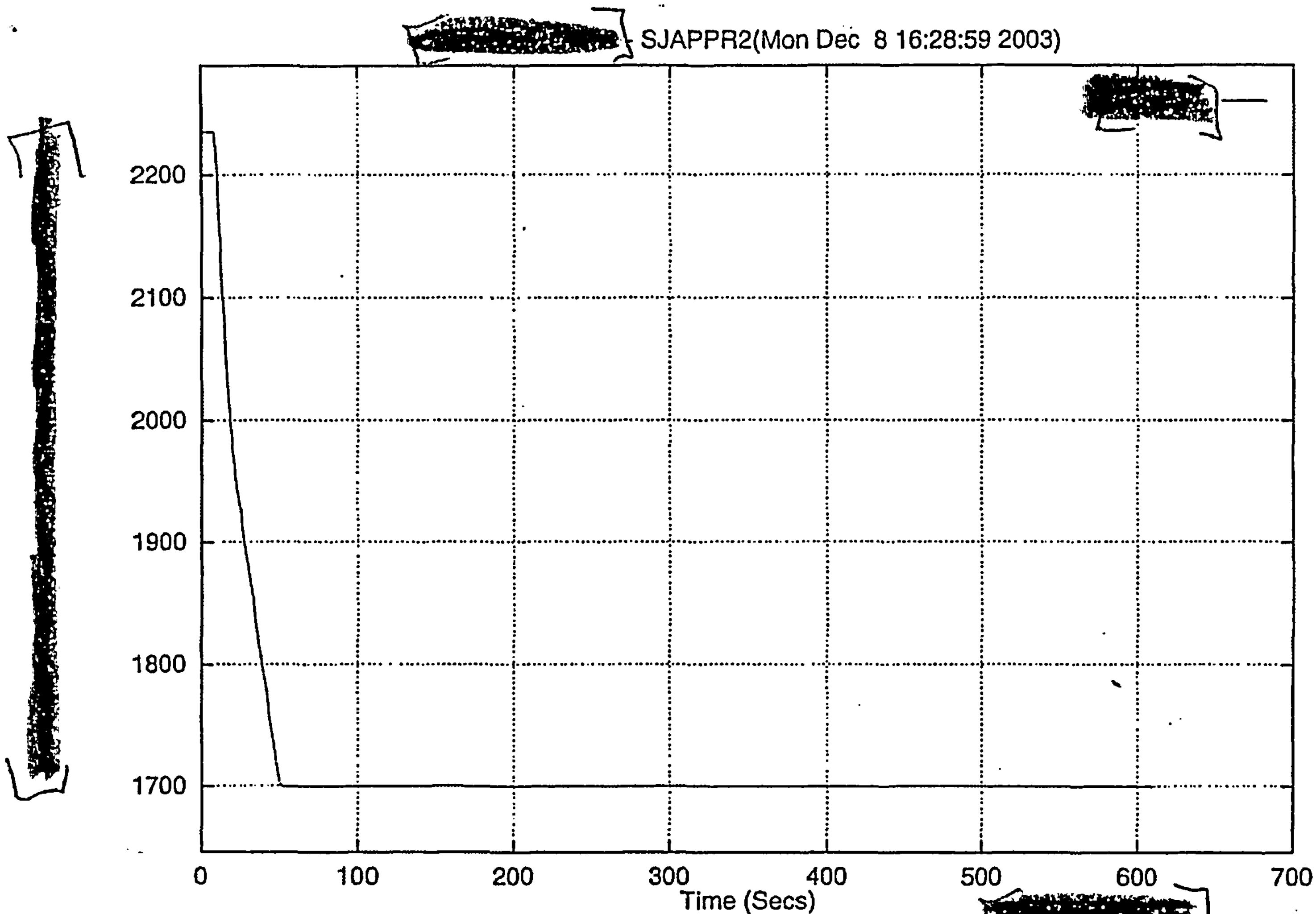
ATT. 5 Pg 14/26

Ex 4



OFFSCALE LOW AT 1700 psig

Ex 4

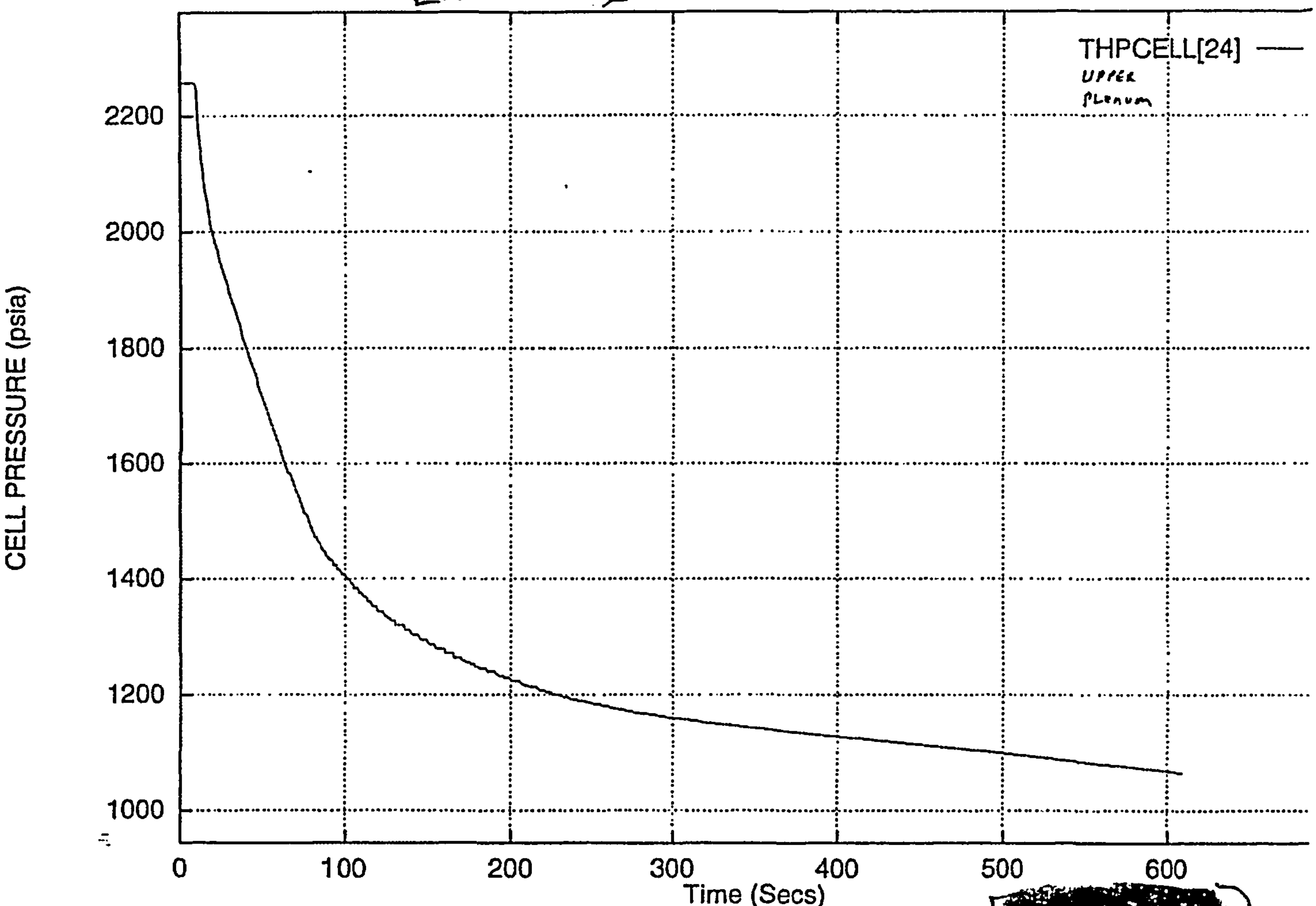


OFFSCALE LOW AT 1700 psig

[redacted] ATT. 5 RG 10/24

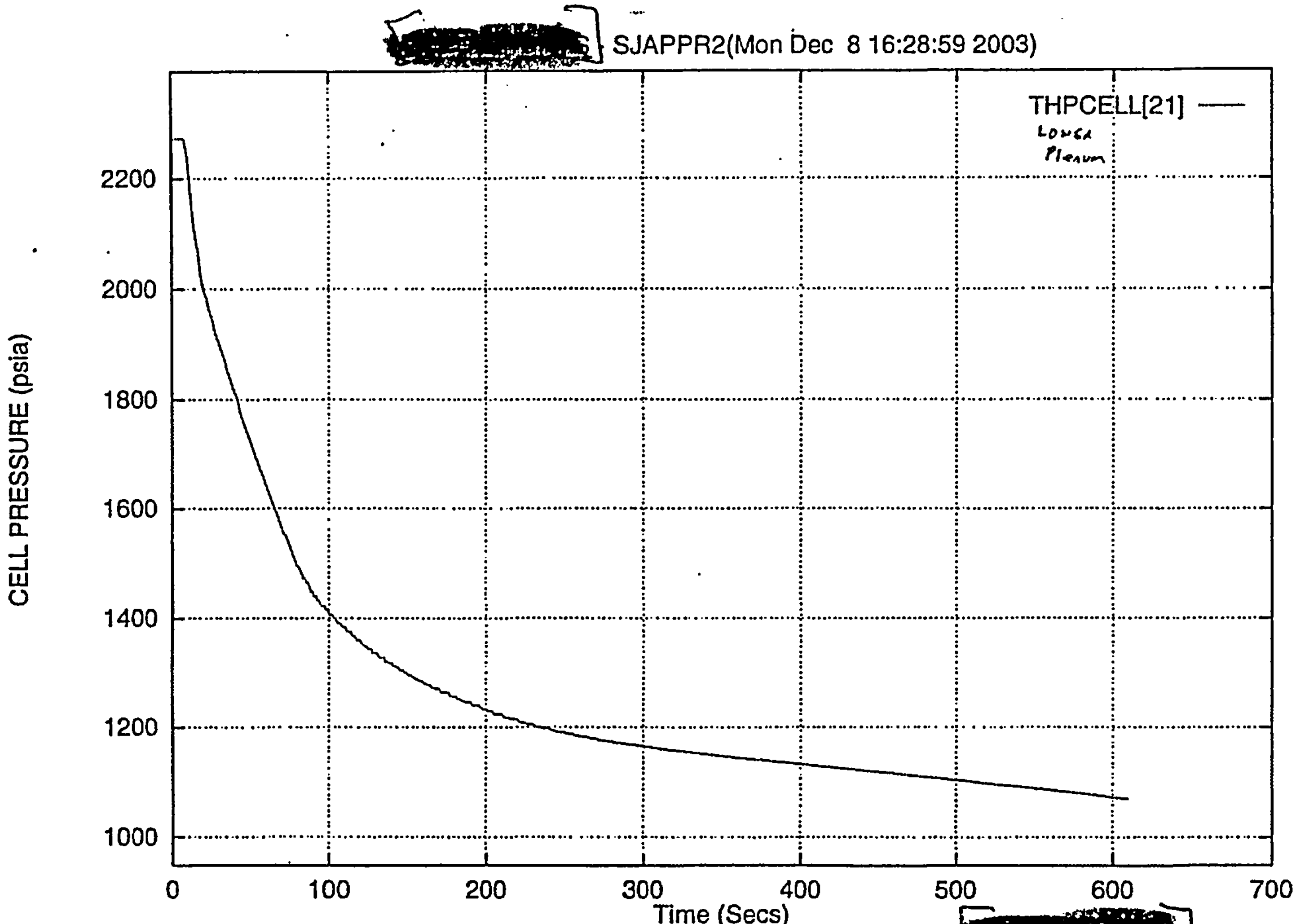
44

[redacted] SJAPPR2(Mon Dec 8 16:28:59 2003)



[redacted]
ATT. 5 Pg 17/26

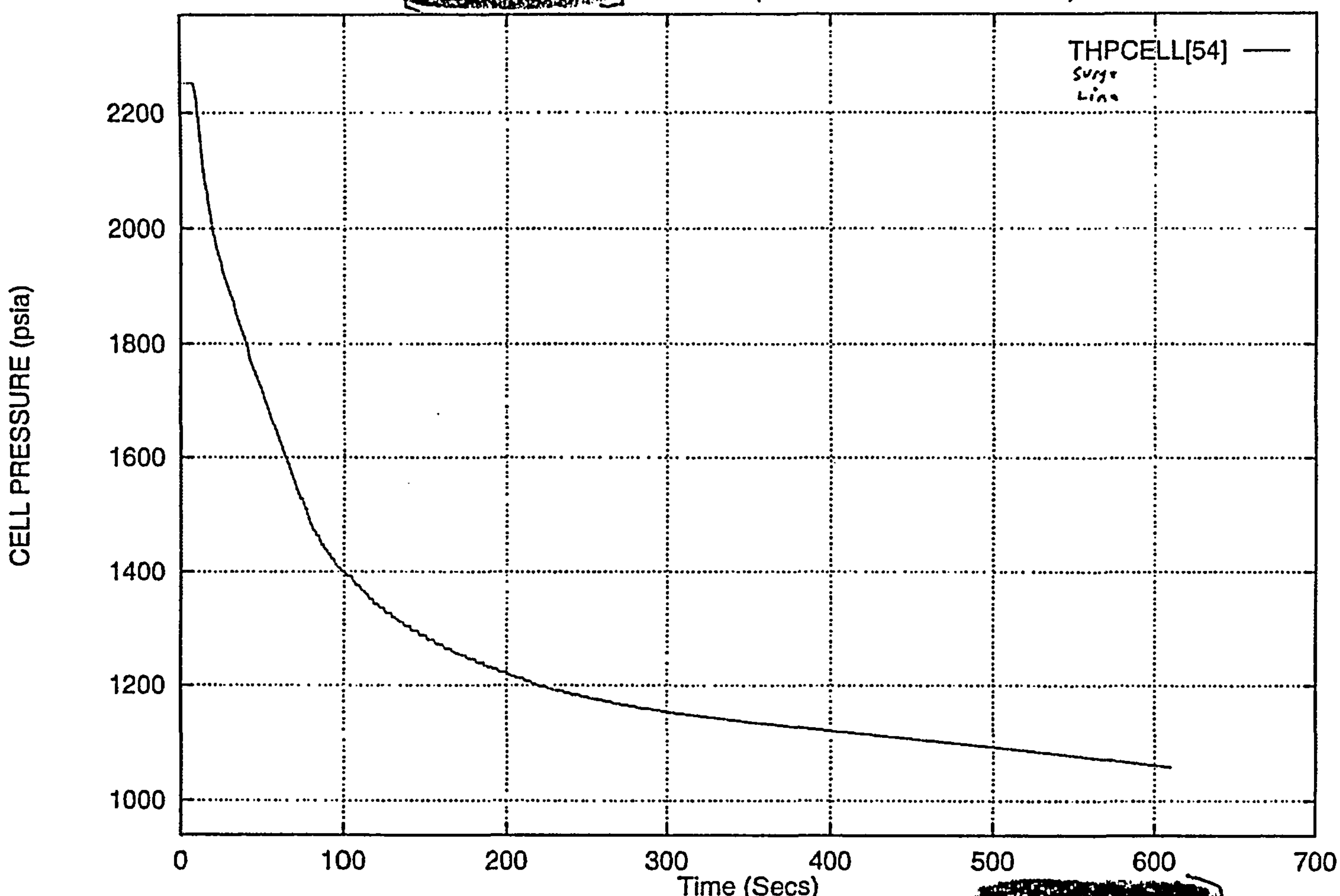
EX4



[redacted]
ATT. 5 Pg 18/26

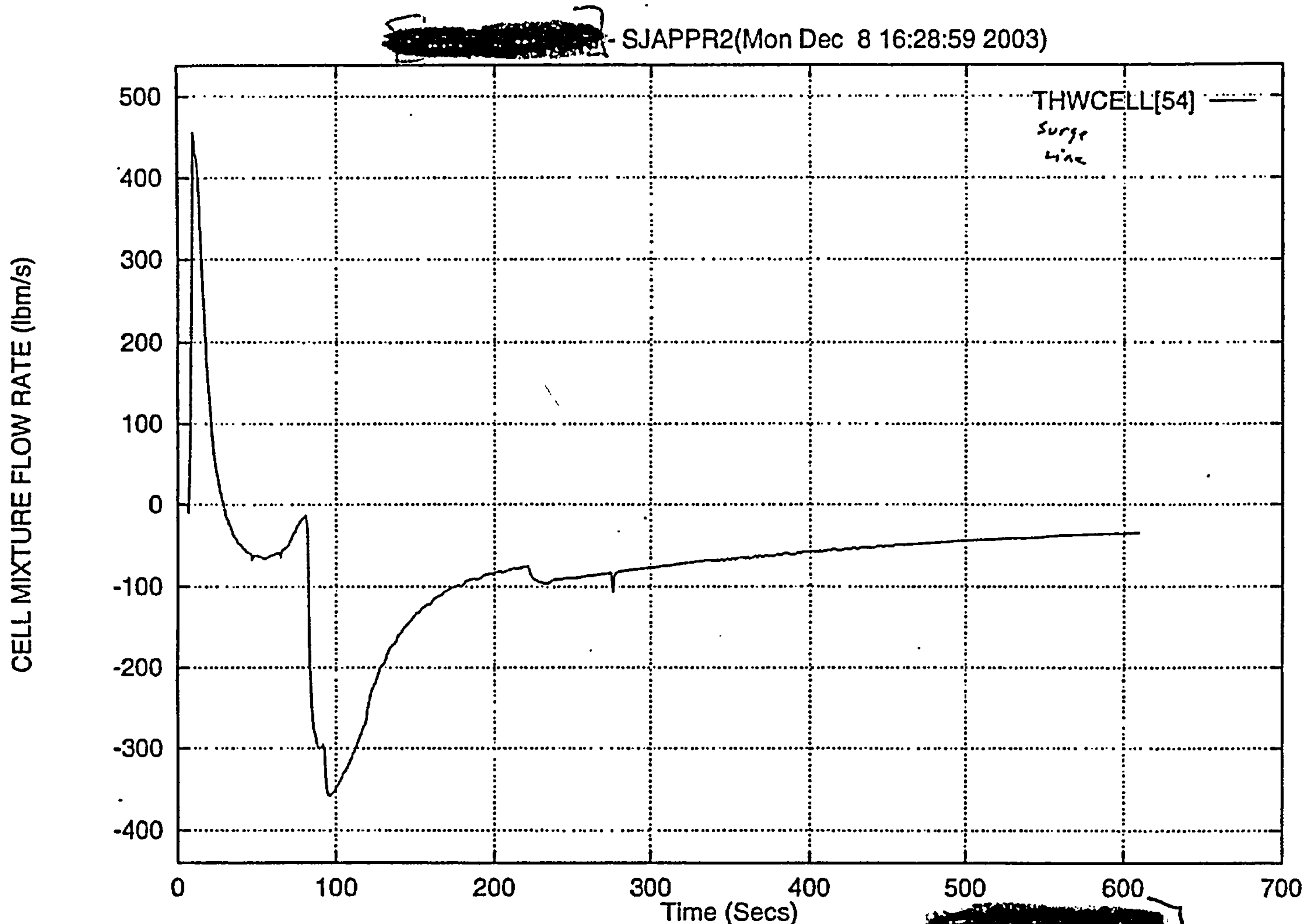
EX4

[redacted] - SJAPPR2(Mon Dec 8 16:28:59 2003)



[redacted]
ATT. 5 pg 19/24

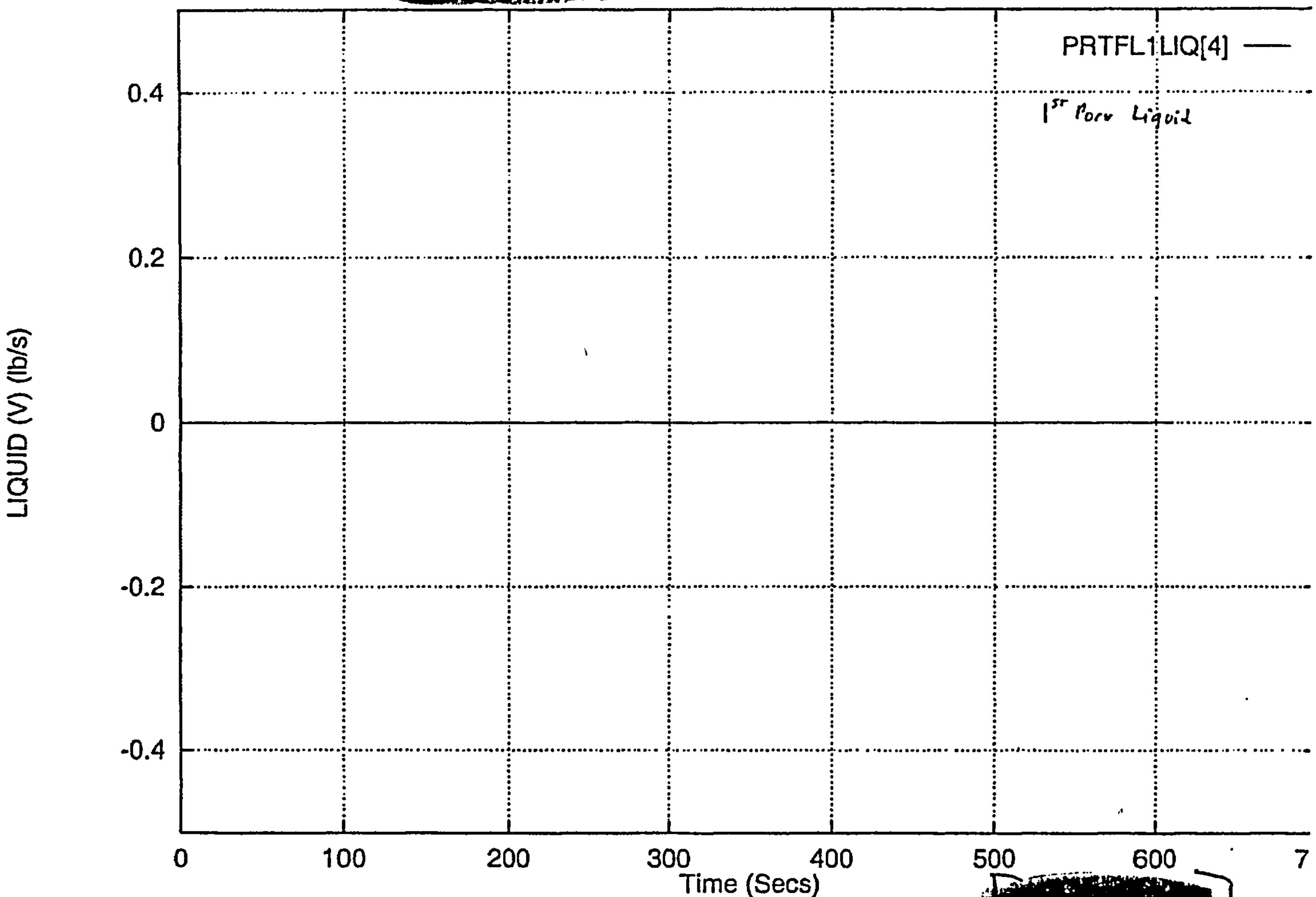
Ex 4



[redacted]
ATT. 5 Pg 20/26

E44

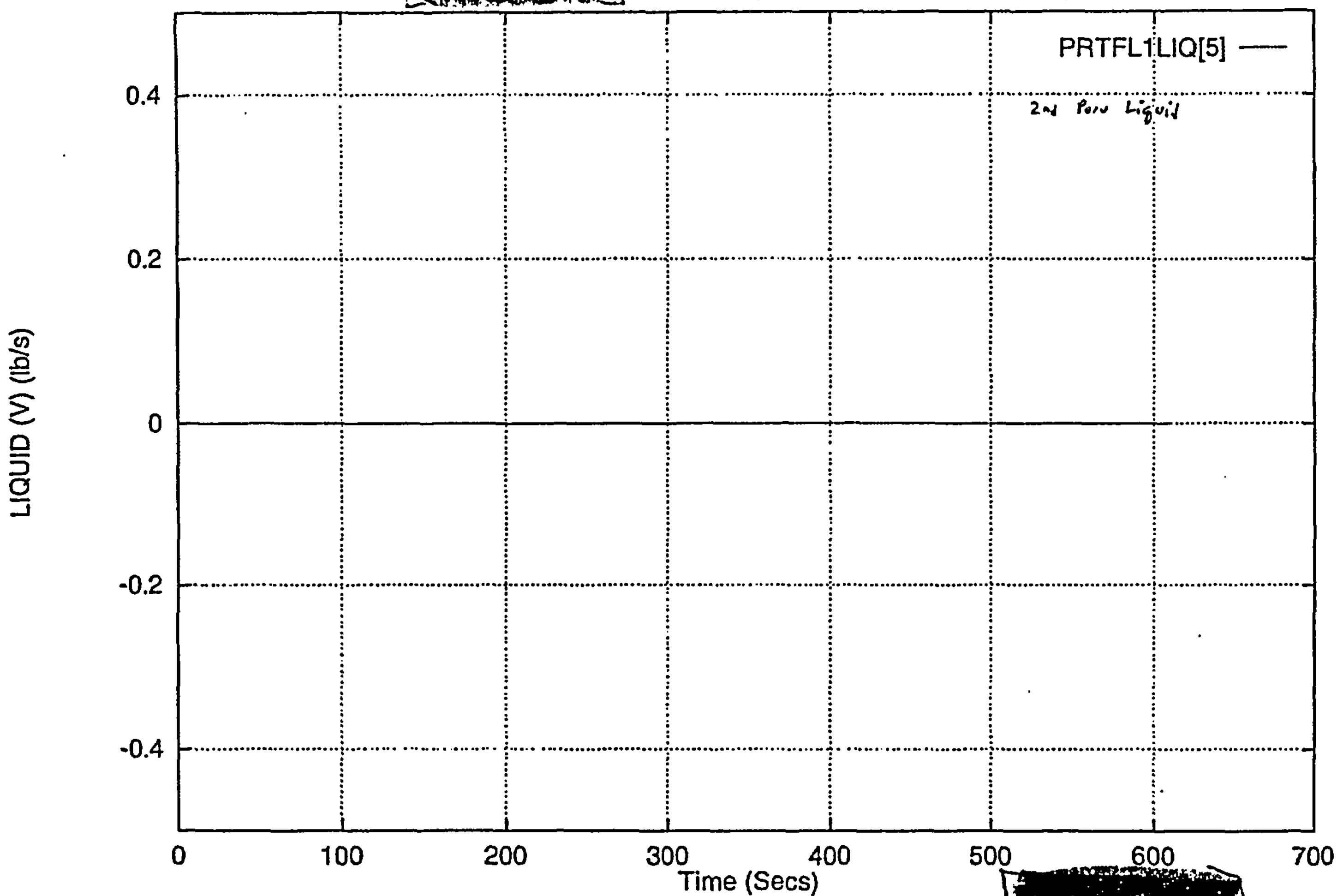
[redacted] SJAPPR2(Mon Dec 8 16:28:59 2003)



[redacted]
ATT. 5 OF 21/26

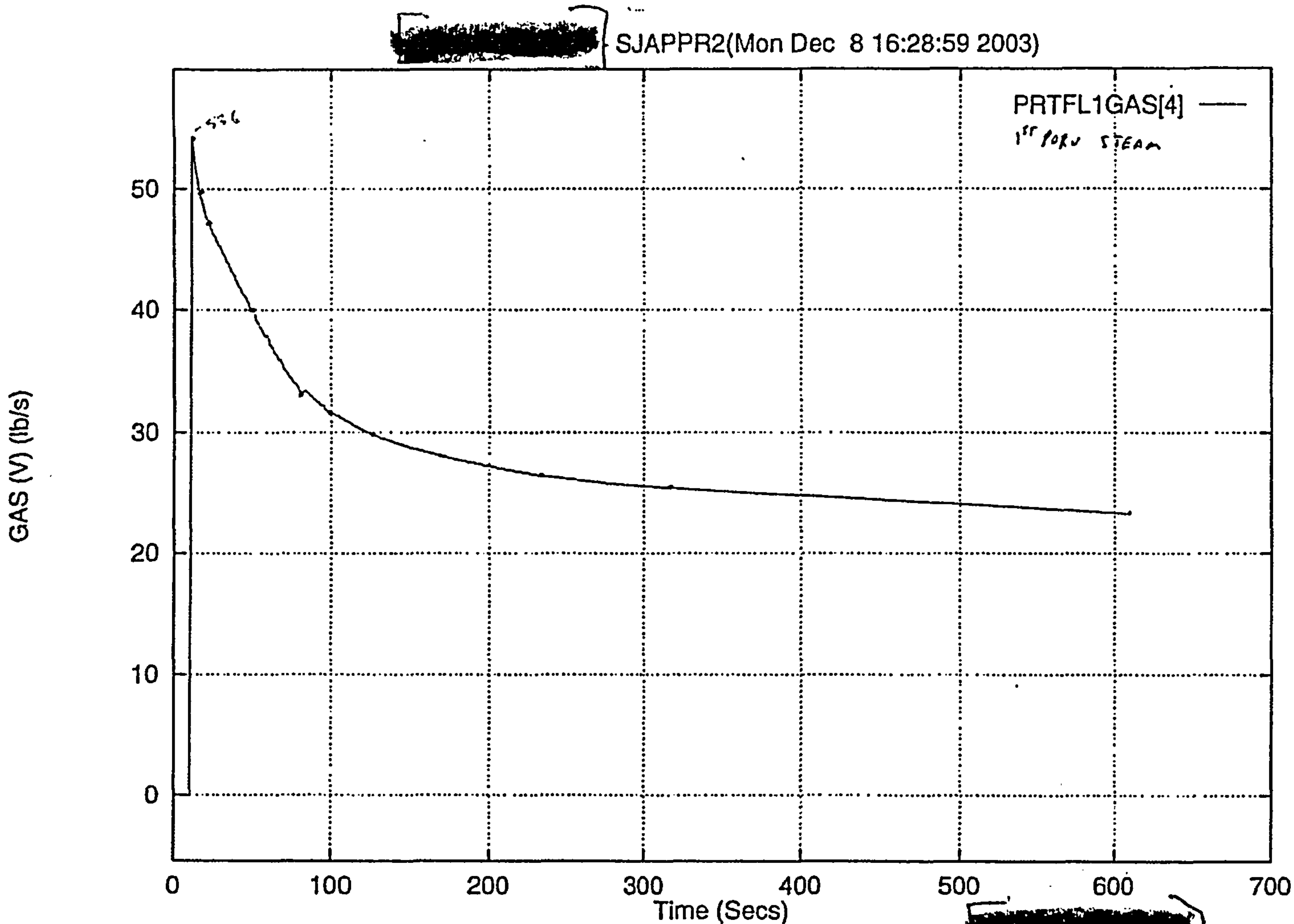
E44

[redacted] - SJAPPR2(Mon Dec 8 16:28:59 2003)



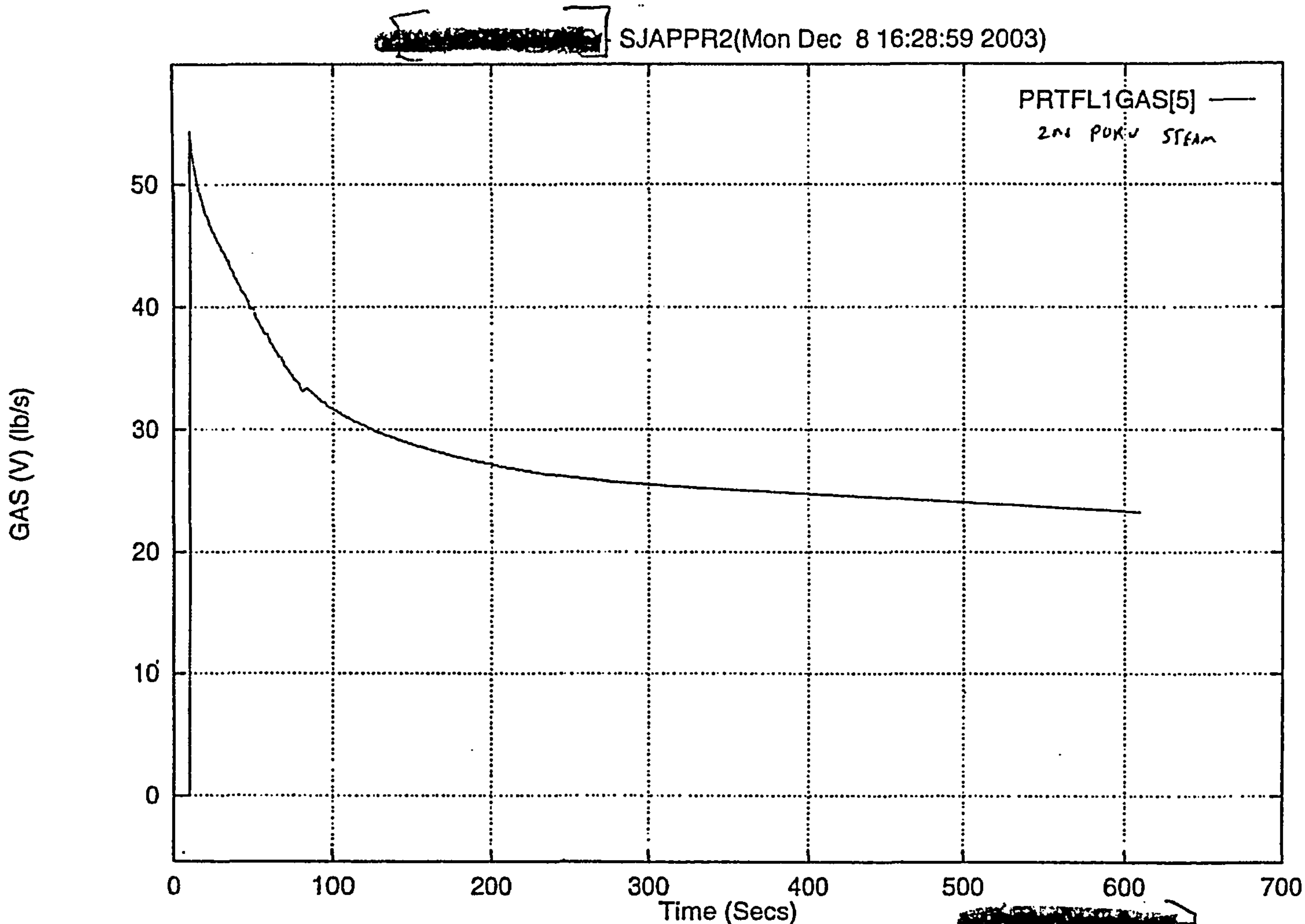
[redacted]
ATT. 5 PS 22/26

EX4



[redacted]
ATT. 5 Sg 23/26

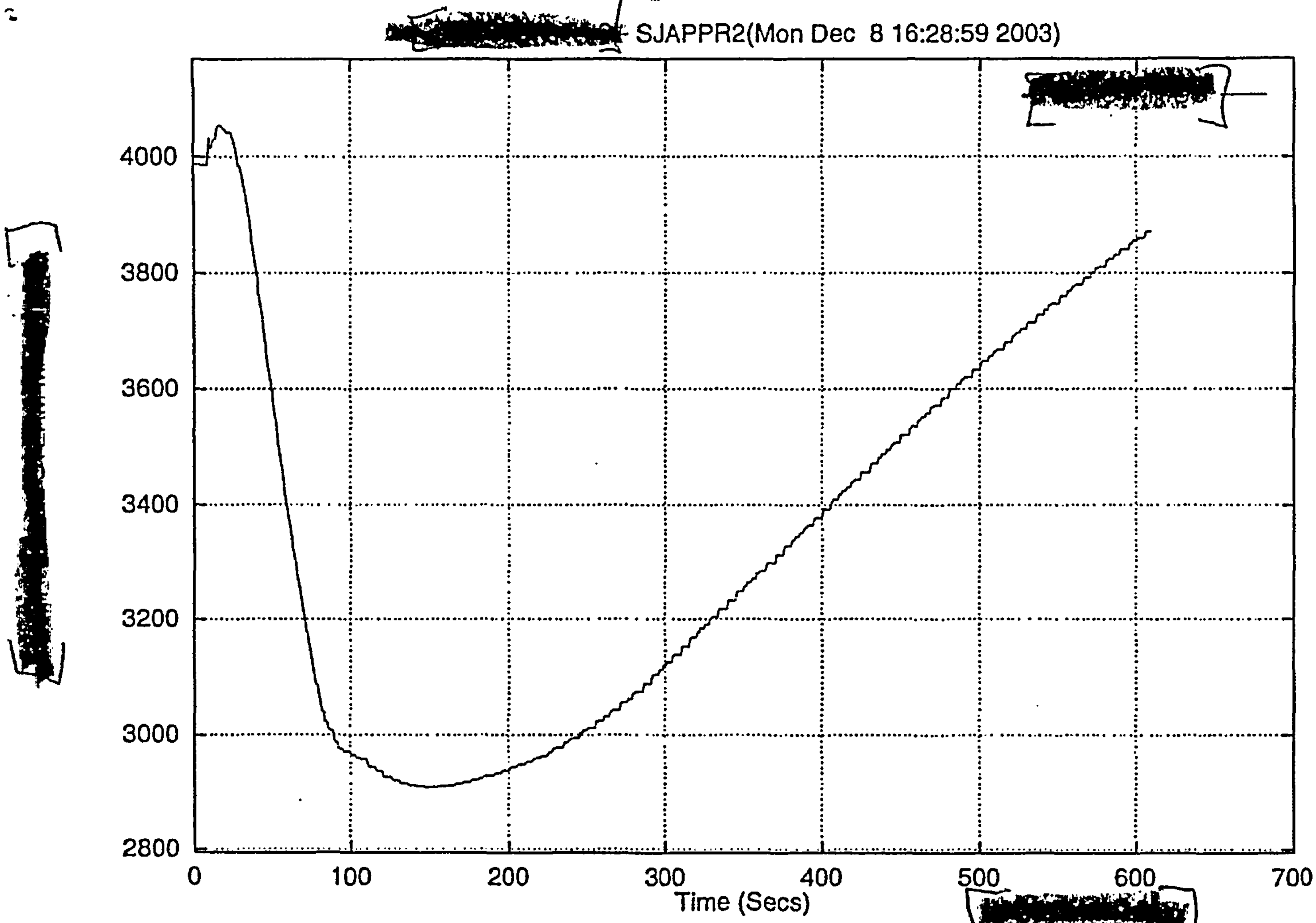
E44



[redacted]

ATT. 5 24/26

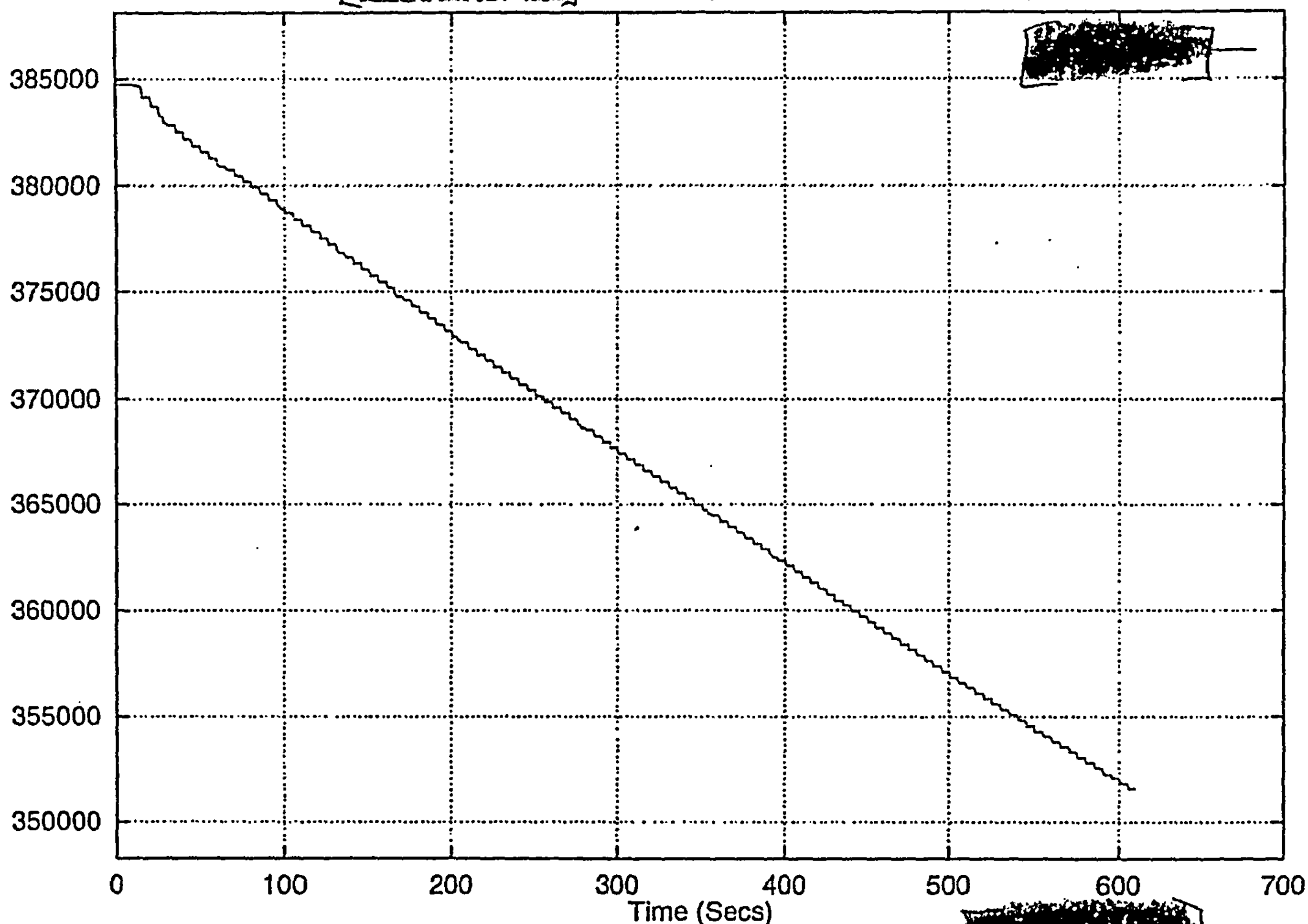
Ex4



ATT. 5 Of 25/26

EX4

[redacted] SJAPPR2(Mon Dec 8 16:28:59 2003)



[redacted]

ATT. 5 Pg 26/26