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June 30, 1997

U.S. Nuclear Regulatory Commission
Mail Station P1-37
Washington, D.C. 20555

Attention: Document Control Desk

Subject: Grand Gulf Nuclear Station
Docket No. 50-416
License No. NPF-29
Response to Generic Letter (GL) 95-07
Request for Additional Information

GNRO-97/00056

Gentlemen:

Regarding GL 95-07, Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves, Grand Gulf Nuclear Station (GGNS) has submitted responses dated October 11, 1995 (GNRO-95/00113), February 13, 1996 (GNRO-96/00011), and June 28, 1996 (GNRO-96/00078). The information requested in your May 1, 1997 Request for Additional Information is attached for your use to complete the review of GGNS's response to GL 95-07.

Please contact Rita Jackson at (601) 437-2149 if you have questions regarding this submittal.

Yours truly,

JJH/RRJ
attachment: Response to NRC RAI w/ Appendices
cc: (See Next Page)

A056

cc: GGNS NRC Senior Resident Inspector (w/a)
Mr. L. J. Smith (Wise Carter) (w/a)
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Response to NRC Request for Additional Information
Generic Letter 95-07

1. "The NRC staff reviewed the test report (14-inch William Powell Gate Valve) but the information necessary to independently verify the pressure locking test results was not in the report. Discuss the schedule when the test data can be provided to the staff."

Response:
The test data on the 14 inch William Powell gate valve is provided as Appendix 1 to this package.

2. "EOI stated that it intended to perform more testing to validate the model but a test schedule has not been developed to accomplish this testing. Discuss these additional tests and the schedule to complete the tests."

Response:
EOI's draft test plan is provided in this response as Appendix 2. EOI currently anticipates the completion of testing by December 1997.

3a. "Discuss how the use of a 0.4 friction factor in the EOI pressure locking prediction equation accurately validates the EOI pressure locking prediction methodology in cases when the actual friction factor was significantly less than 0.4?"

Response:
During the April 9, 1997 meeting, EOI's presentation reflected use of a 0.4 friction factor because they did not have access to the friction factors from the Commonwealth Edison test data. When validating the EOI methodology against actual test data, EOI uses the actual measured friction factor when it is available. If no friction factor is available, EOI uses a 0.4 friction factor. This conservatively envelopes the actual test conditions, because the higher the friction factor, the higher the calculated required pullout thrust.

From a design standpoint, EOI uses a 0.4 friction factor when the actual friction factor is less than 0.4. This will provide conservative or higher calculated thrust values. This accounts for some of the variances shown in testing. Appendix 3 provides some comparisons of 0.4 and 0.2 friction factors.

3b. "Explain the basis for the applicability of the EOI pressure locking prediction methodology to all flexible wedge gate valves or for the use of the methodology to specific types of flexible wedge gate valves."

Response:
The EOI calculation methodology is based on "first principle" analysis. EOI evaluates valves susceptible to pressure locking by calculating required pullout thrust at design conditions. There are few if any actual design conditions where upstream and downstream side pressures equals zero; however, where conditions dictated, these values were used. EOI believes that our method conservatively calculates thrust in the ranges where it is applied (i.e. design conditions). The EOI pressure locking analysis method establishes the disk pullout thrust by determining the forces imposed by the disk on the seat rings of the valve. This models the valve disk as two flat plates connected by a hub. The behavior of the plates under pressure is approximated by the application of flat plate formulas from Roark's formulas for stress and strain. EOI's method assumes that the differential pressure force from the side of the valve with the higher pressure is transmitted through the disk hub and imposed on the opposite seating surface. The EOI method calculates that the maximum required pullout force will occur when the valve's high side pressure equals the bonnet pressure and the low side's pressure equals zero.

3c. "Why do the EOI pressure locking thrust methodology prediction results conflict with the Walworth valve test results? Discuss if there are any differential pressure restrictions or other conditions associated with the use of the EOI pressure locking methodology."

Response:
EOI can not determine why the EOI pressure locking methodology conflicts with the Walworth test results. Additional testing should help address various differential pressure conditions.

3d. "Discuss how differential flow test results can be used to validate EOI's pressure locking prediction methodology."

Response:
Differential flow test provides additional data for valve loading conditions. EOI believes that DP loads approximate hydraulic locking. We utilize this data in our calculation methodology to compare measured and calculated thrust under comparable DP loads. This provides additional assurance of the application of EOI's pressure locking methodology.

3e. "Discuss why it is not necessary to address these parameters (disk shear forces, vertical downward force on the disk, compression of the disk hub and flexibility of the body and disk) in the EOI pressure locking prediction methodology."

Response:
EOI does not consider disk shear forces, vertical downward force on the disk, compression of the disk hub and flexibility of the body and disk to be significant parameters based on our simplified conservative pressure locking model. EOI's methodology is intended to determine a bounding pullout thrust, and we believe that our method conservatively calculates thrust in the ranges where it is applied (i.e. design conditions). We feel that consideration of these parameters would result in a more precise approximation of required thrust and therefore a reduction of conservative margin as established by our current method.

3f. "Discuss how this variance in unwedging force is accounted for in the EOI pressure locking prediction methodology."

Response:
Variance in unwedging forces is not considered in the EOI pressure locking methodology. The unwedging force used in the EOI pressure locking method is the same unwedging force used in the Generic Letter 89-10 program.

4. Provide the pressure locking thrust and actuator capability calculations for the nine valves that EOI said (in 180 day submittal) would operate during a pressure locking scenario. E12F028A & B, E12F064C, P41F064A & B, P41F081A & B, P41F237, and P41F238.

Response:
The pressure locking thrust and actuator capability calculation results are summarized and provided as Appendix 4 to this response. EOI would be willing to provide a detailed review and discussion of these calculations on-site, if necessary, to enhance NRC's understanding of the use and validity of our design-condition based methodology.

5. Discuss the basis for deciding not to evaluate shutdown cooling line suction valves (E12F006A, E12F008, & E12F009) for pressure locking and thermal binding.

Response:
GL 95-07 specifies that valves with a safety function to open be evaluated for pressure locking. The shutdown cooling line suction valves have no safety function to open. E12F006A has active function to close manually for isolation of shutdown cooling suction for safety related modes of RHR. Valves E12F008 and E12F009 have an active function to close automatically for containment isolation, and to close automatically on a RHR isolation signal to prevent loss of reactor coolant inventory and to isolate the low pressure portion of RHR from the RCPB.

The shutdown cooling mode of the RHR system used during a normal reactor shutdown and cooldown is often referred to as the non-safety portion of the RHR system. The shutdown cooling mode utilizes most of the safety classified portions of the RHR system although this mode of operation is not so classified.

The system can accomplish its design objectives by a preferred means by directly extracting reactor vessel water from the vessel via the recirculation loop suction line and routing it to a heat exchanger and back to the vessel, or by an alternate means by indirectly extracting the water via relief valve discharge lines to the suppression pool and routing pool water to the heat exchanger and back to the vessel.

6. EOI evaluated eleven valves for pressure locking/thermal binding and determined that these valves were acceptable. "Are these eleven valves in systems that would be declared inoperable per Technical Specifications when surveillances are performed on the system? If not, explain why these valves are not susceptible to pressure locking/thermal binding."

Response:
During surveillance testing these eleven valves are considered inoperable. This response was also provided in GGNS's June 28, 1996 transmittal to the NRC.

Attachment 1 to:
GNRO-97/00056

APPENDIX 1

TEST DATA FOR 14-INCH WILLIAM POWELL GATE VALVE

"INSTRUMENTATION CHANNEL PARAMETER PLOTS
Attachment II to Test Report No. 43008-01 for Entergy Operations"

INSTRUMENTATION CHANNEL PARAMETER PLOTS

ATTACHMENT II

TO TEST REPORT NO. 43008-01
FOR
ENTERGY OPERATIONS

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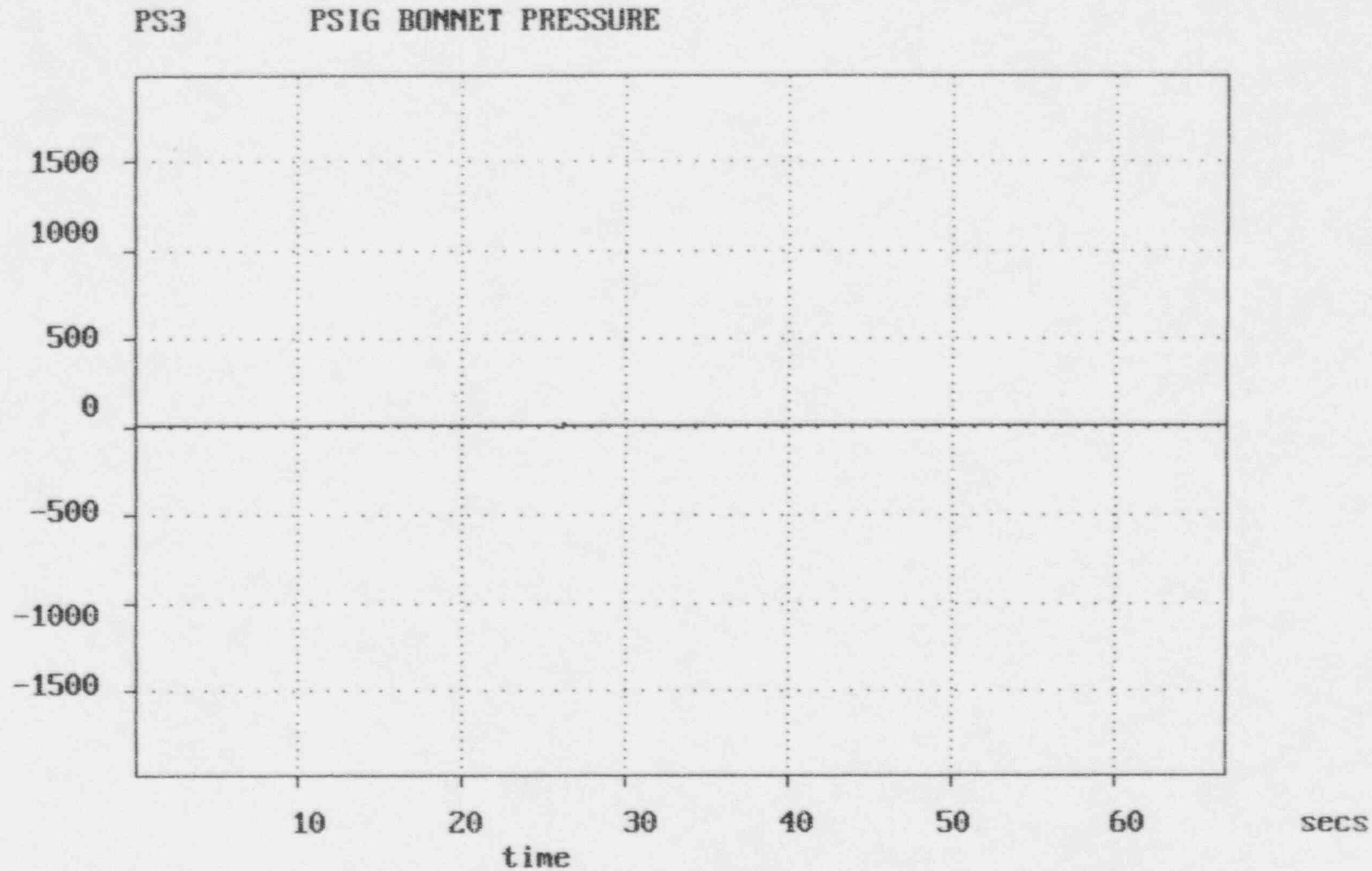
6.3.3 PRESSURE LOCK TEST TEST#1 a,b,c.



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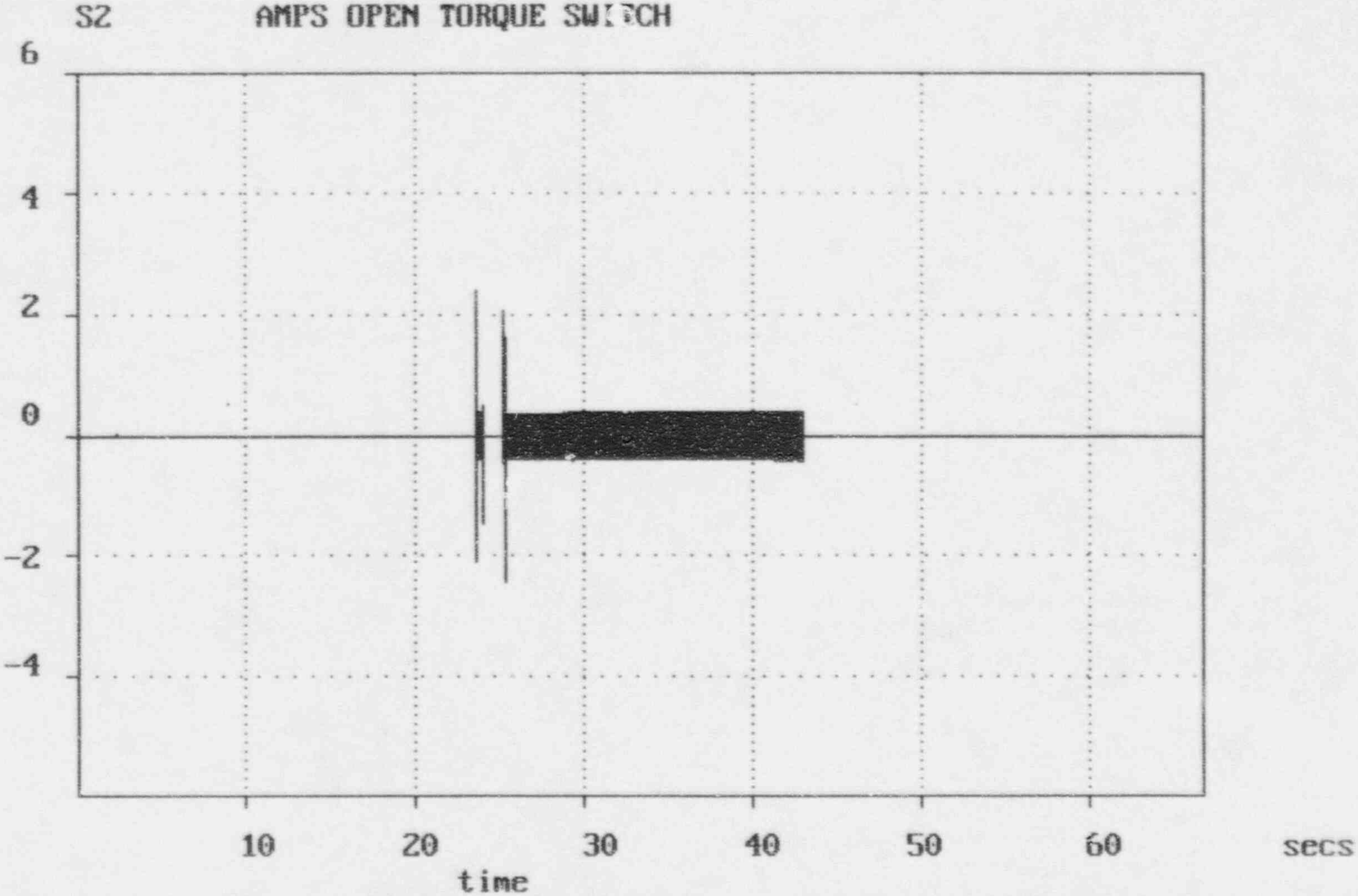

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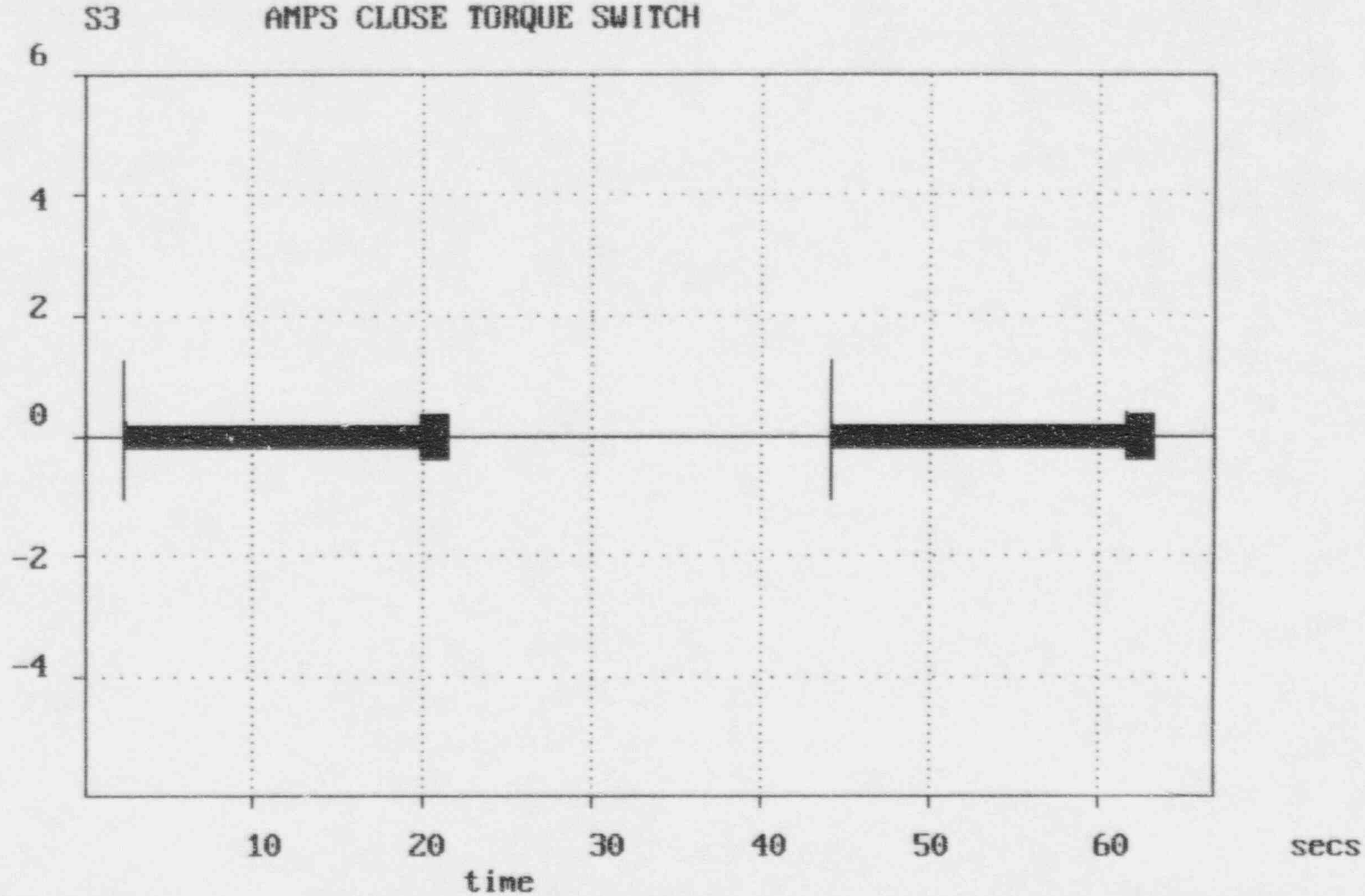

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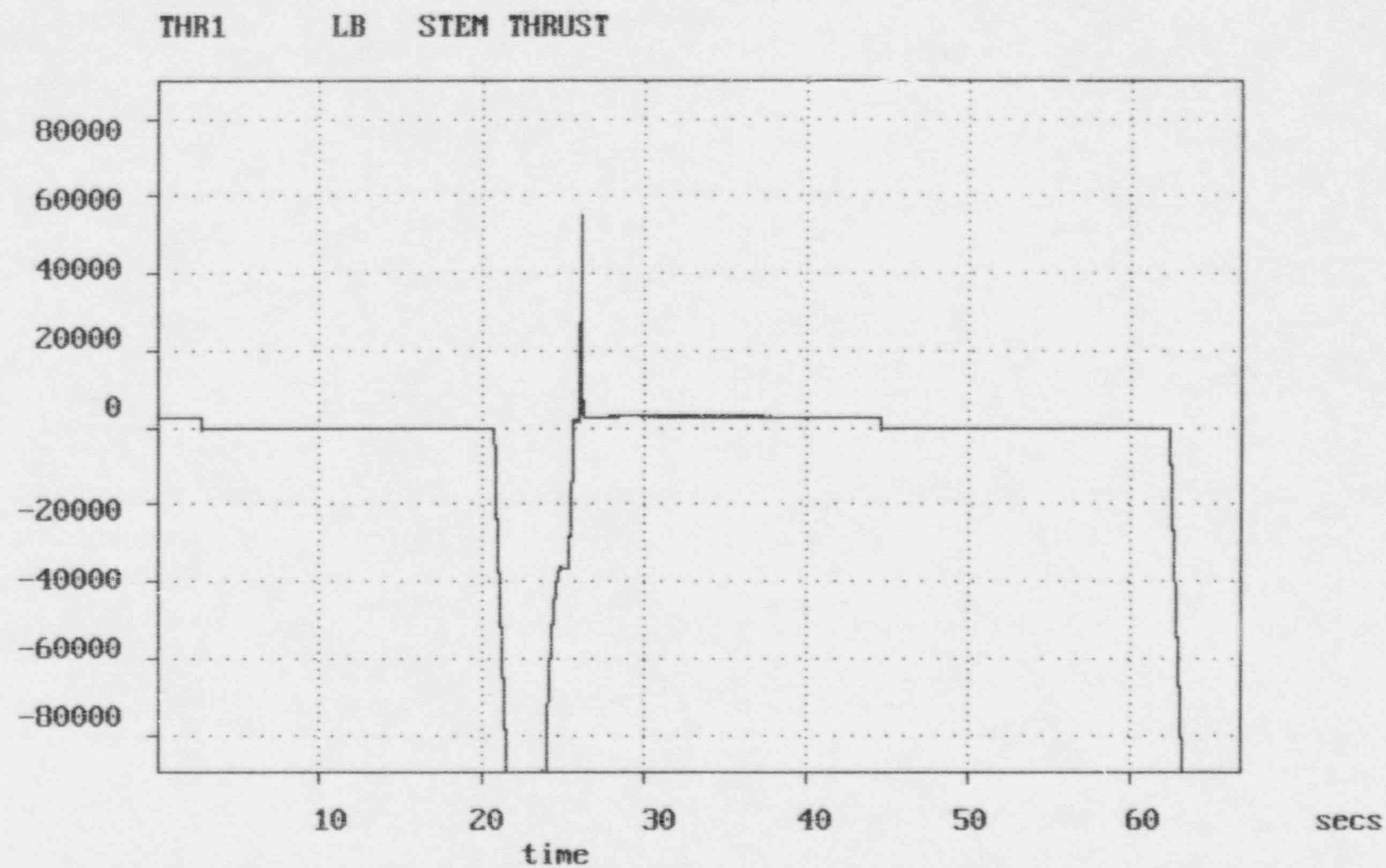

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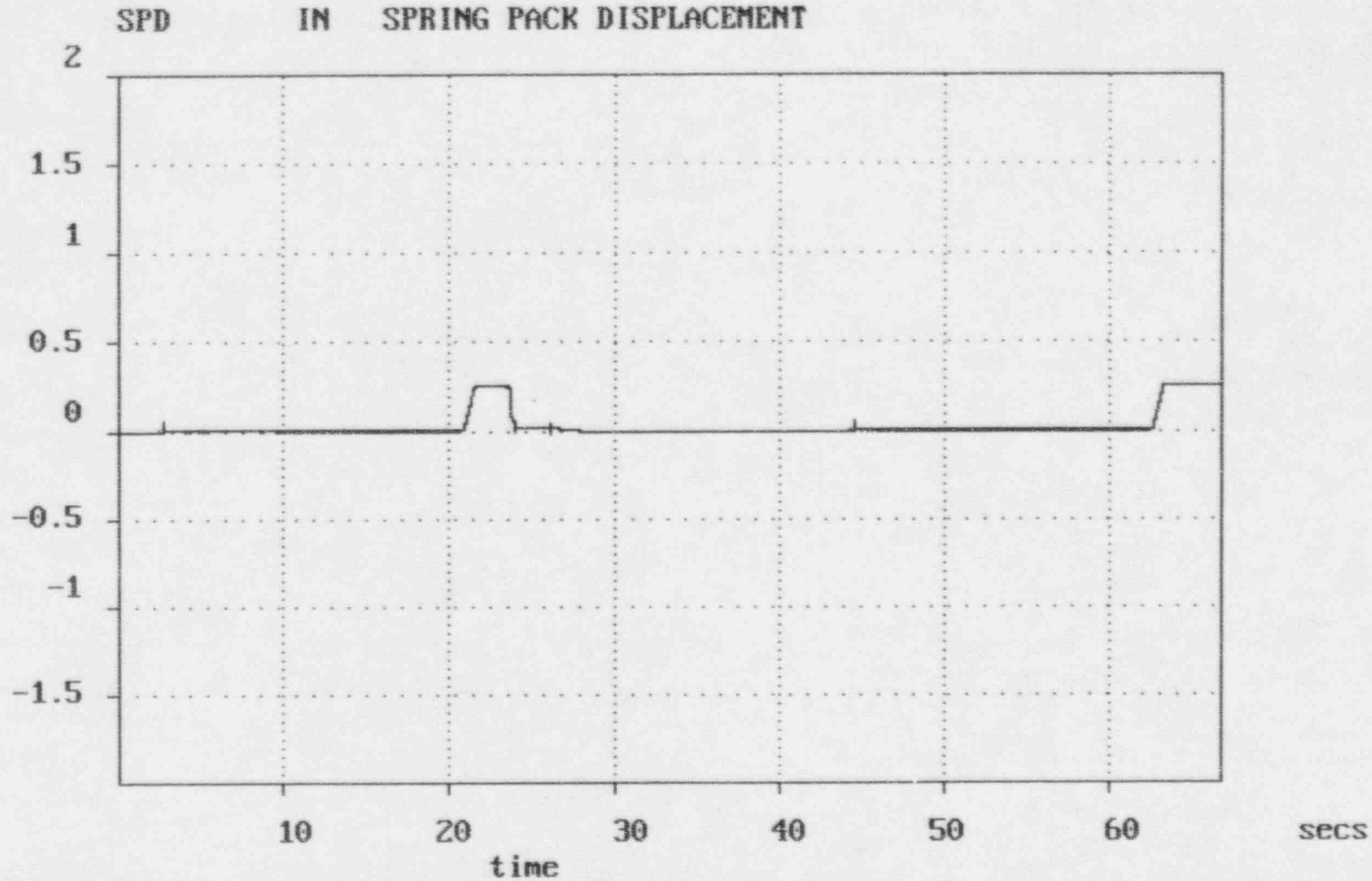

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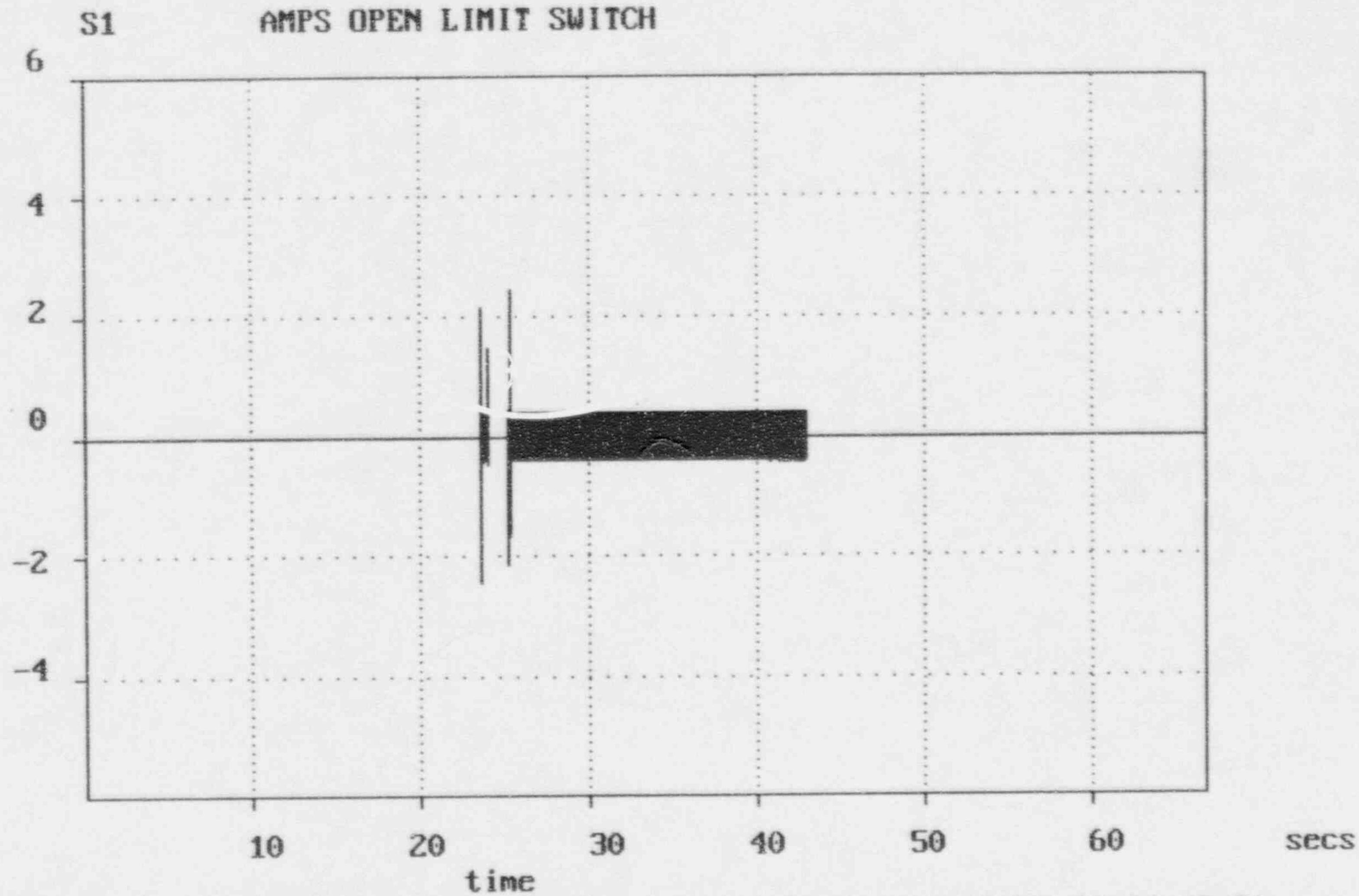

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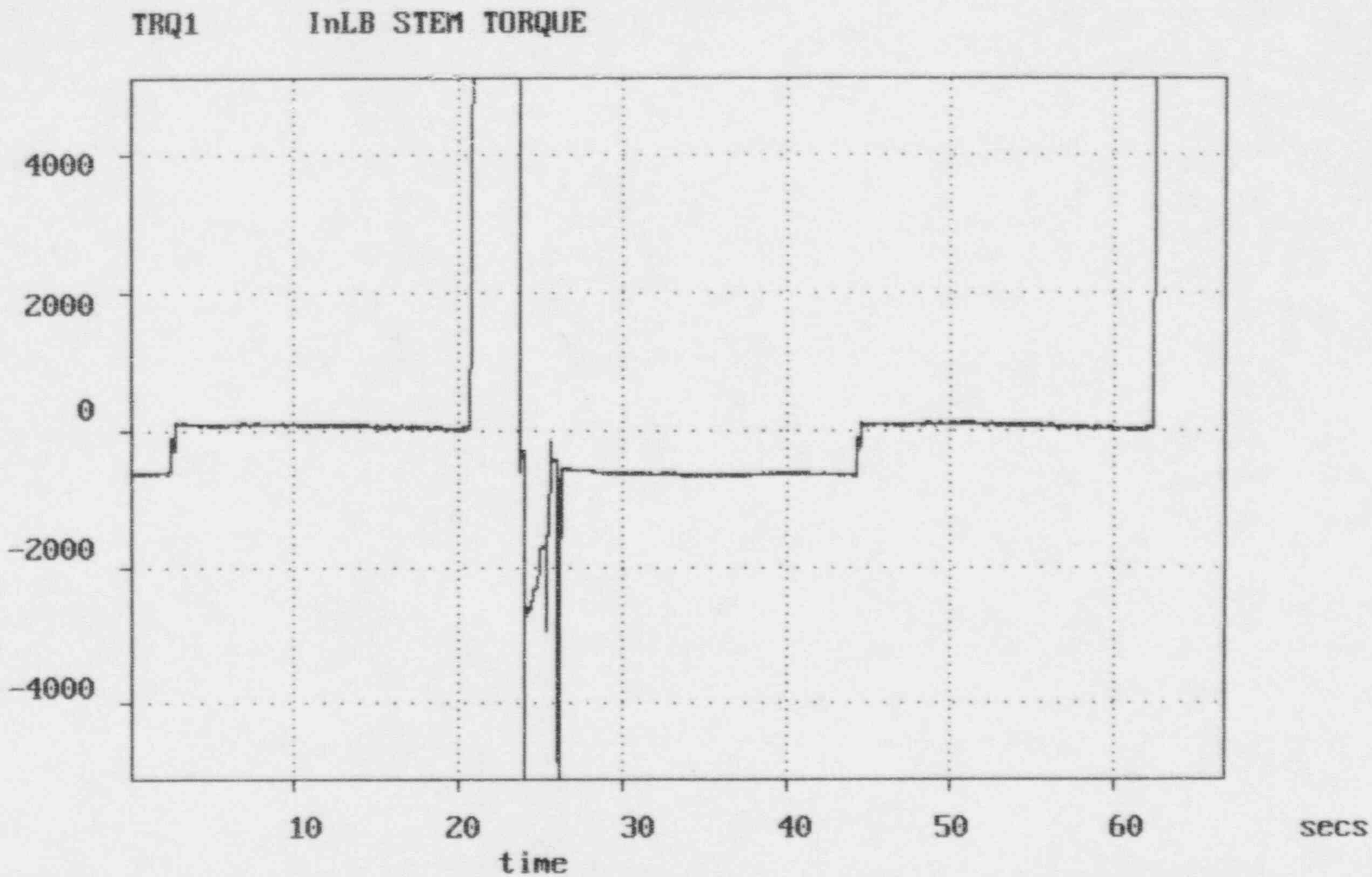

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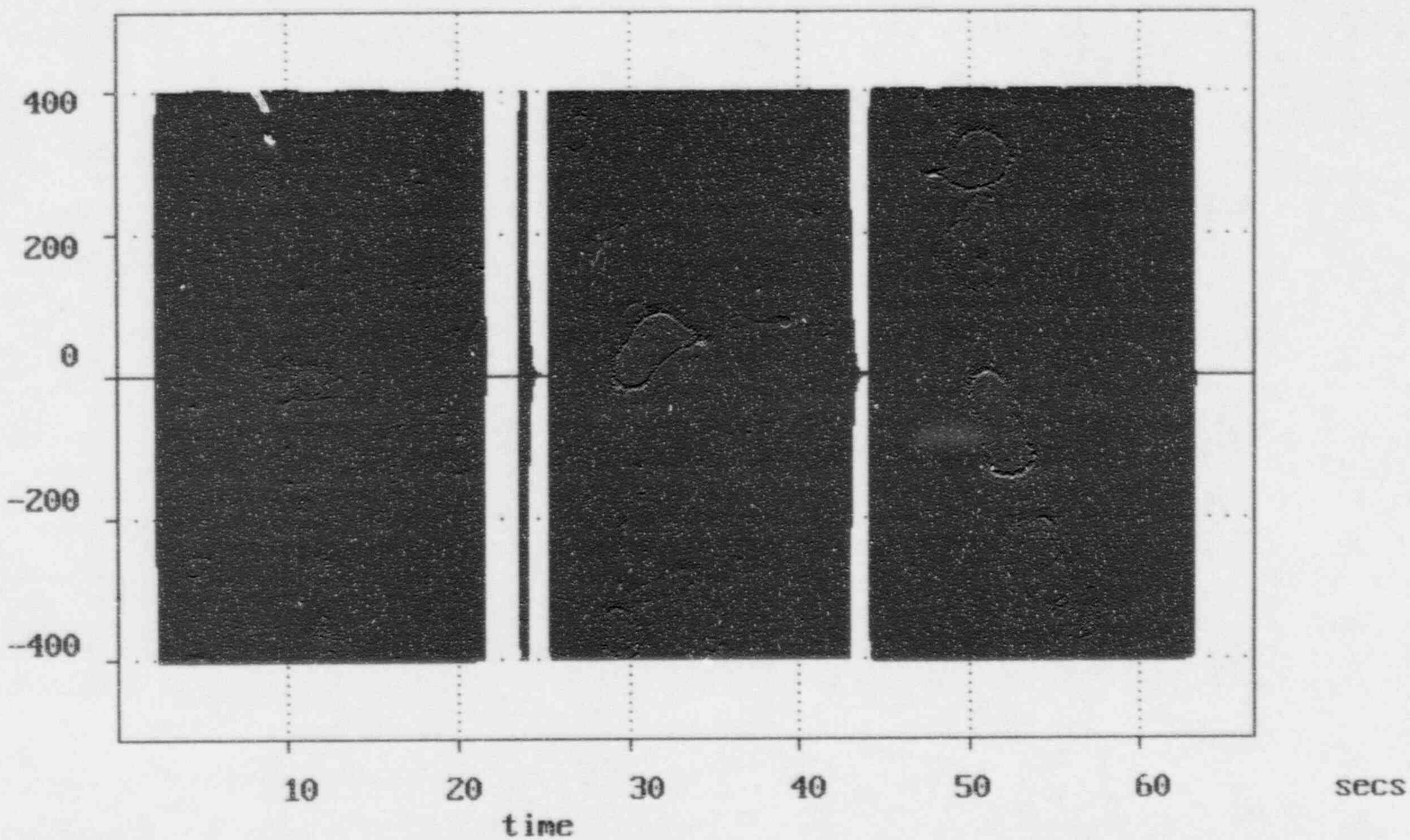
6.3.3 PRESSURE LOCK TEST TEST#1 a,b,c.

MV1 VAC L1 to NEUTRAL VOLTAGE



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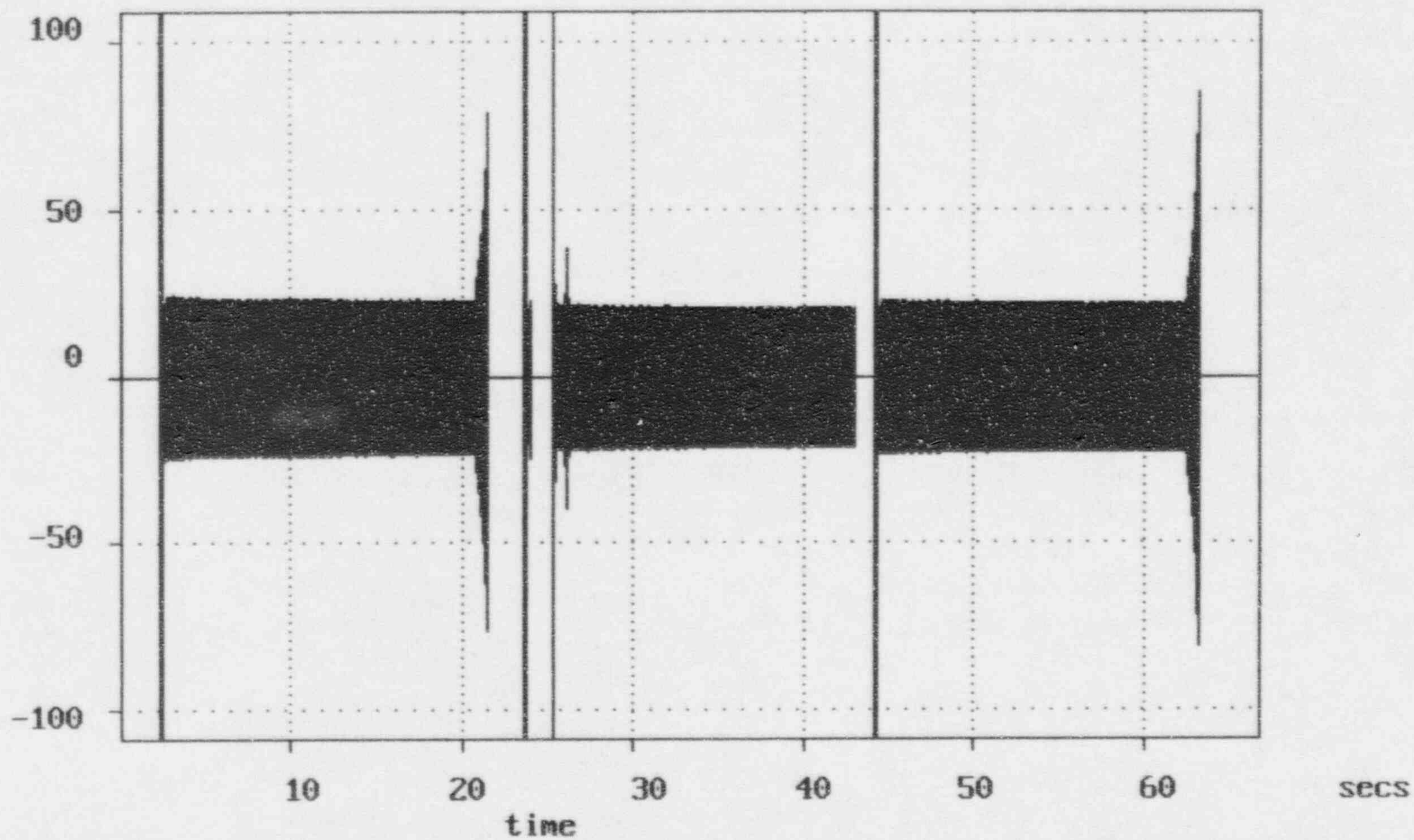
6.3.3 PRESSURE LOCK TEST   TEST #1 a,b,c.

MC1   AMPS L1 CURRENT



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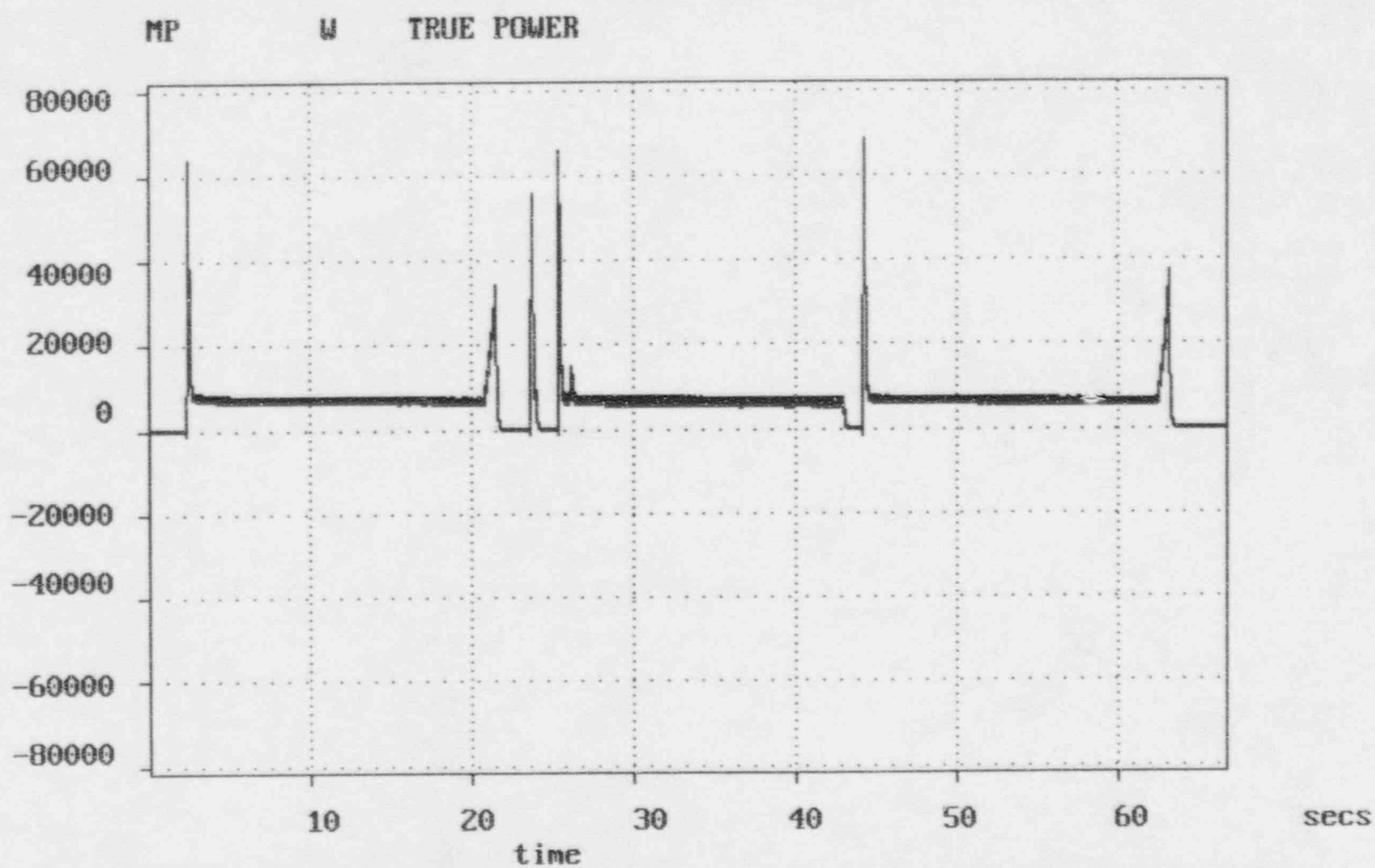
6.3.3 PRESSURE LOCK TEST TEST#1 a,b,c.



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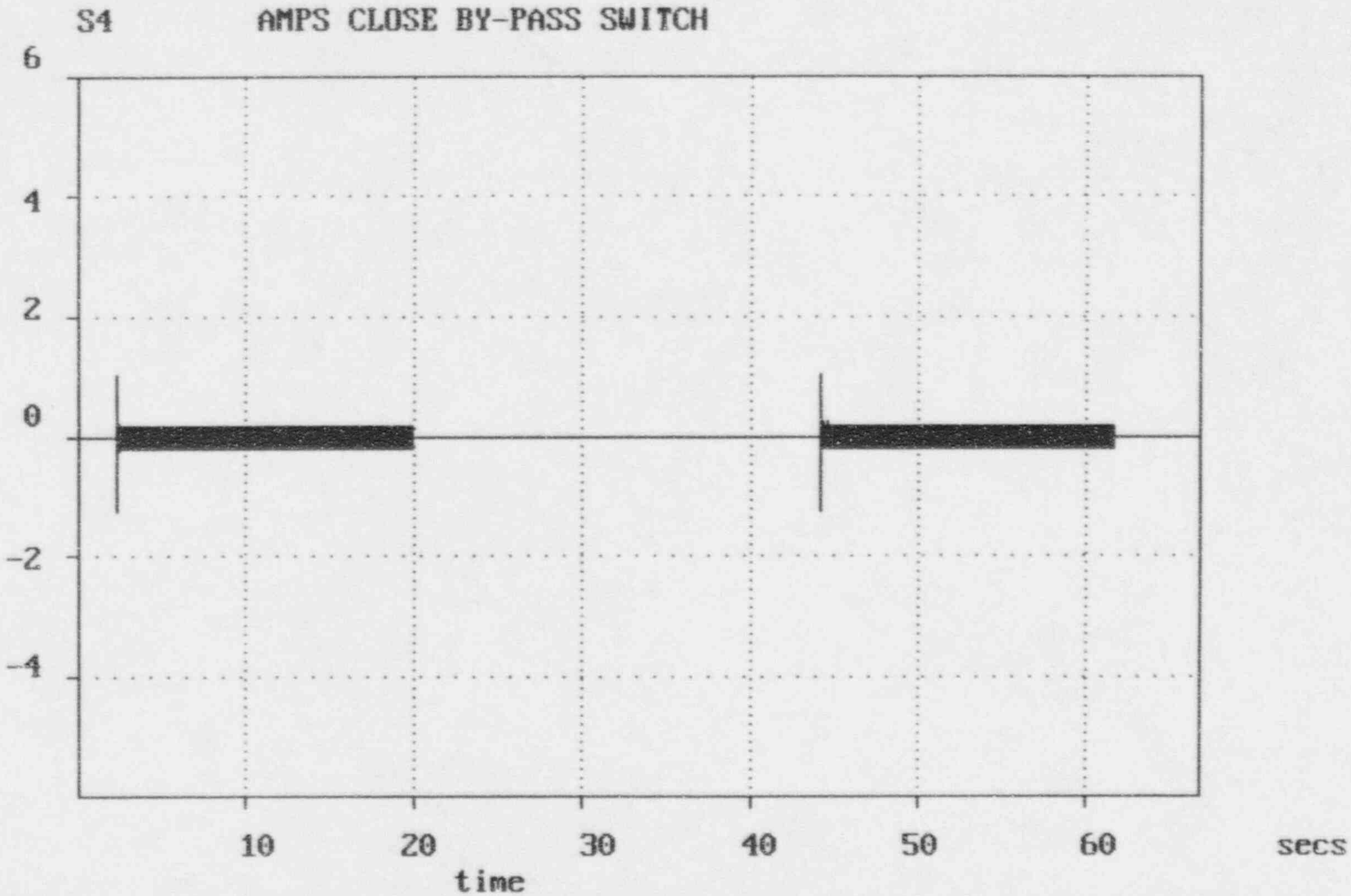

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6.3.3 PRESSURE LOCK TEST TEST#1 a,b,c.

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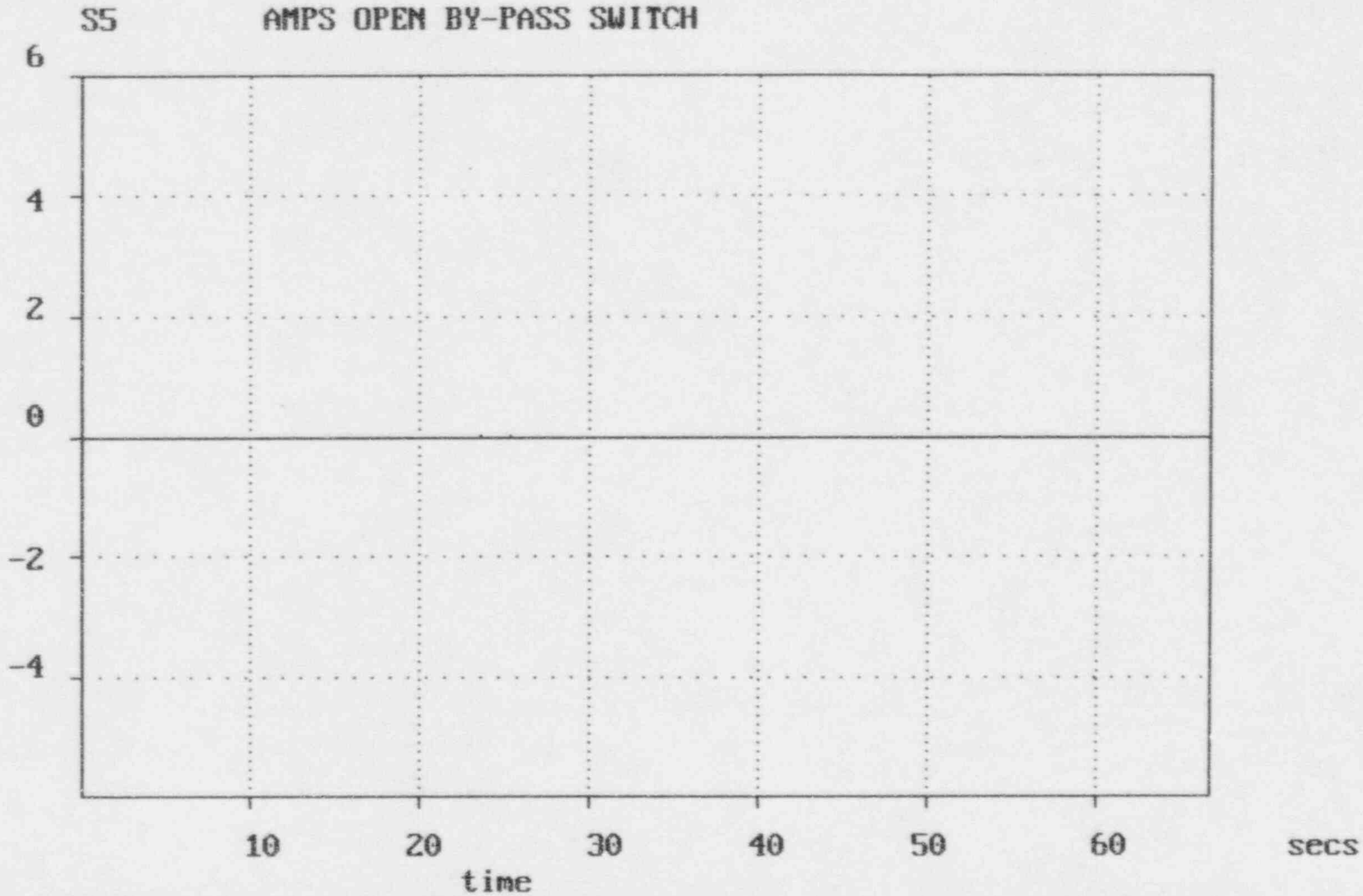
6.3.3 PRESSURE LOCK TEST TEST#1 a,b,c.



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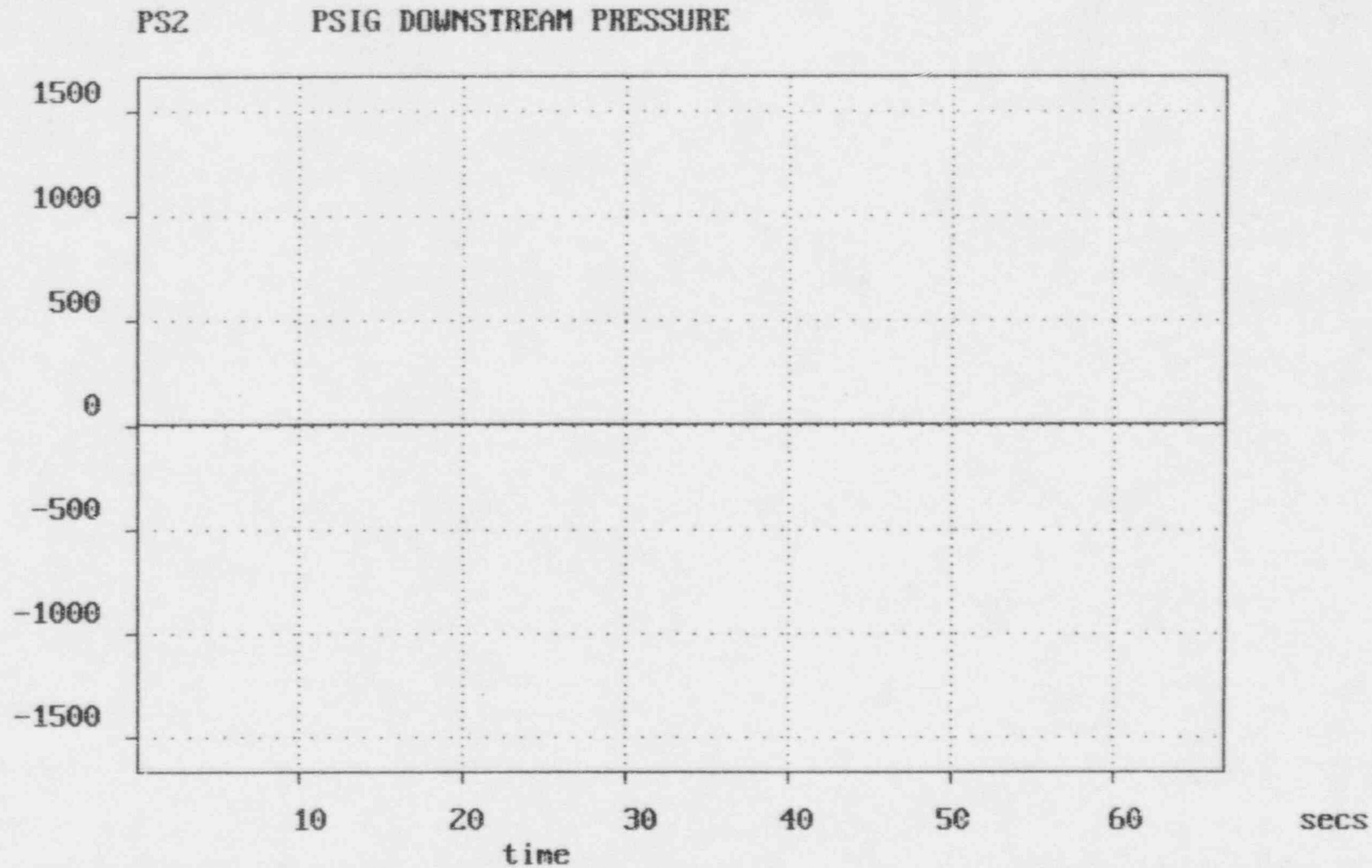

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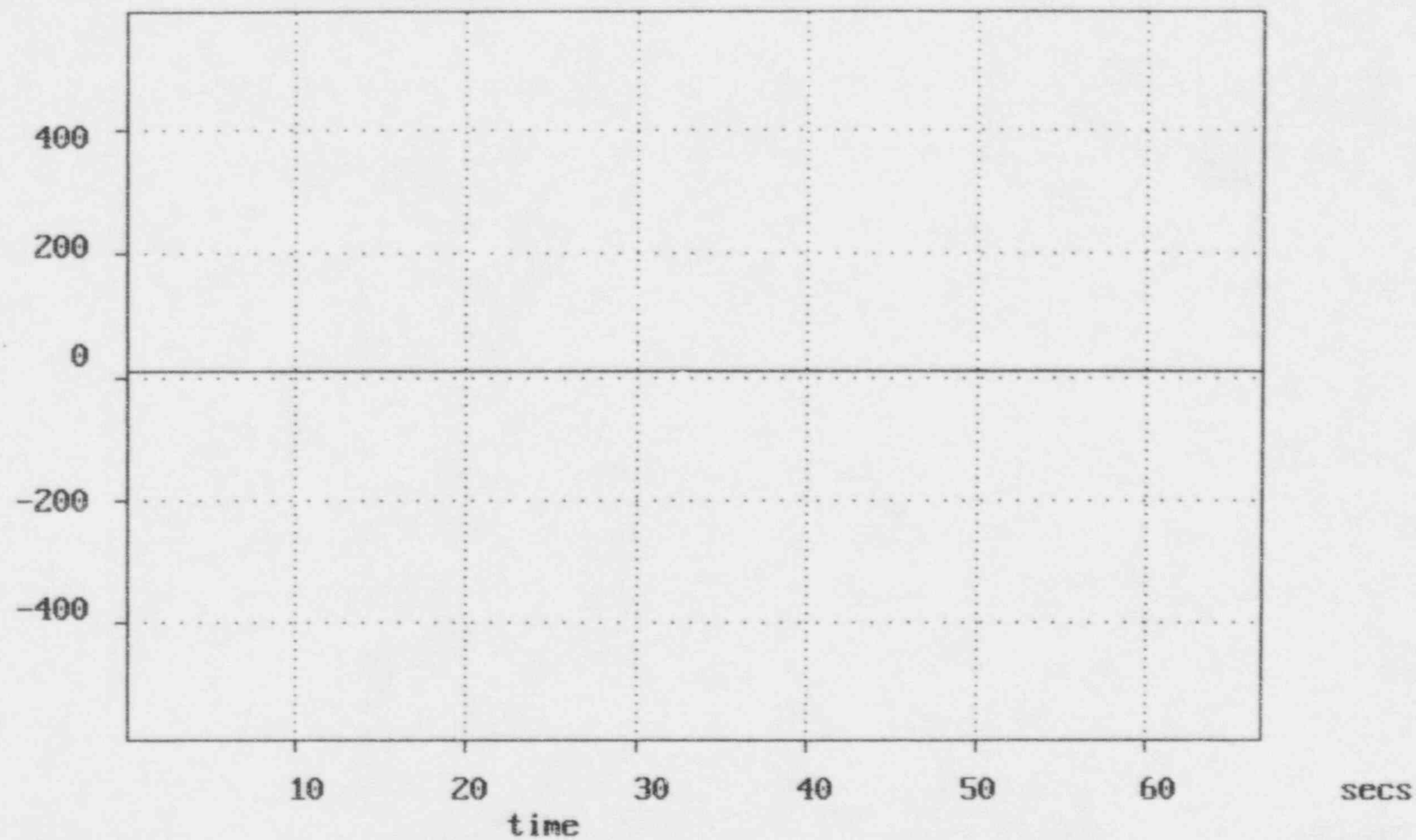
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#1 a,b,c.

PS1 PSIG UPSTREAM PRESSURE



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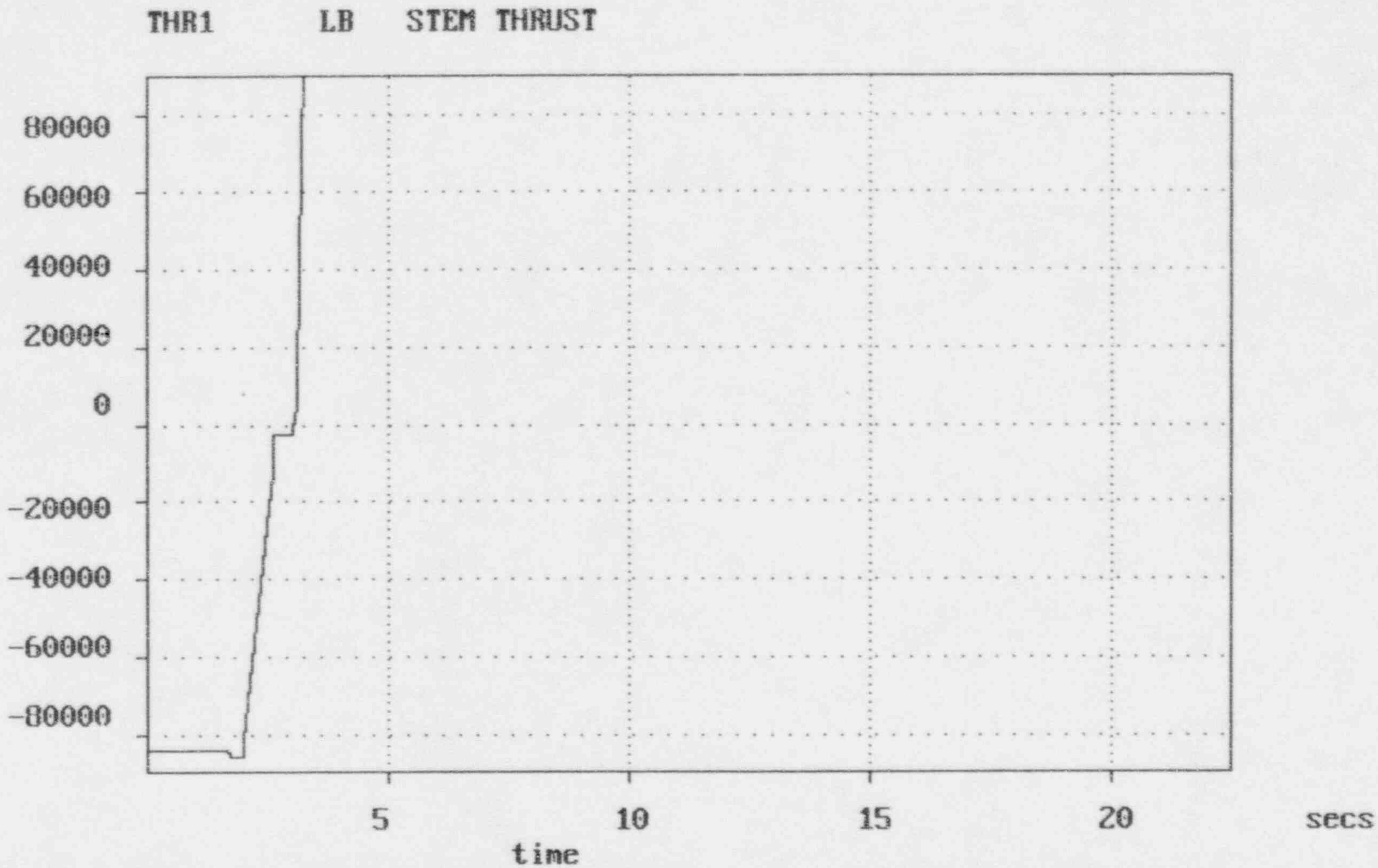

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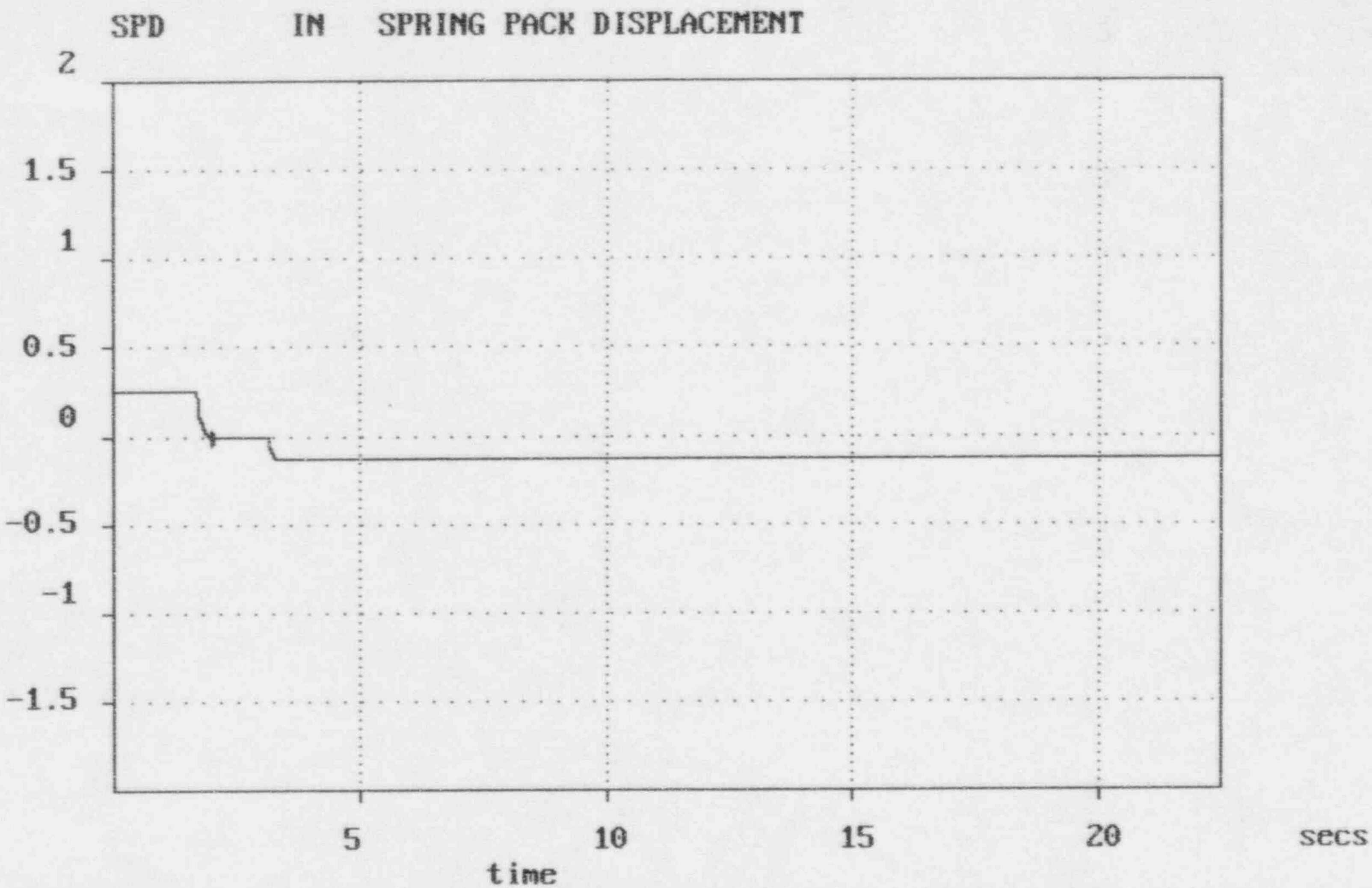

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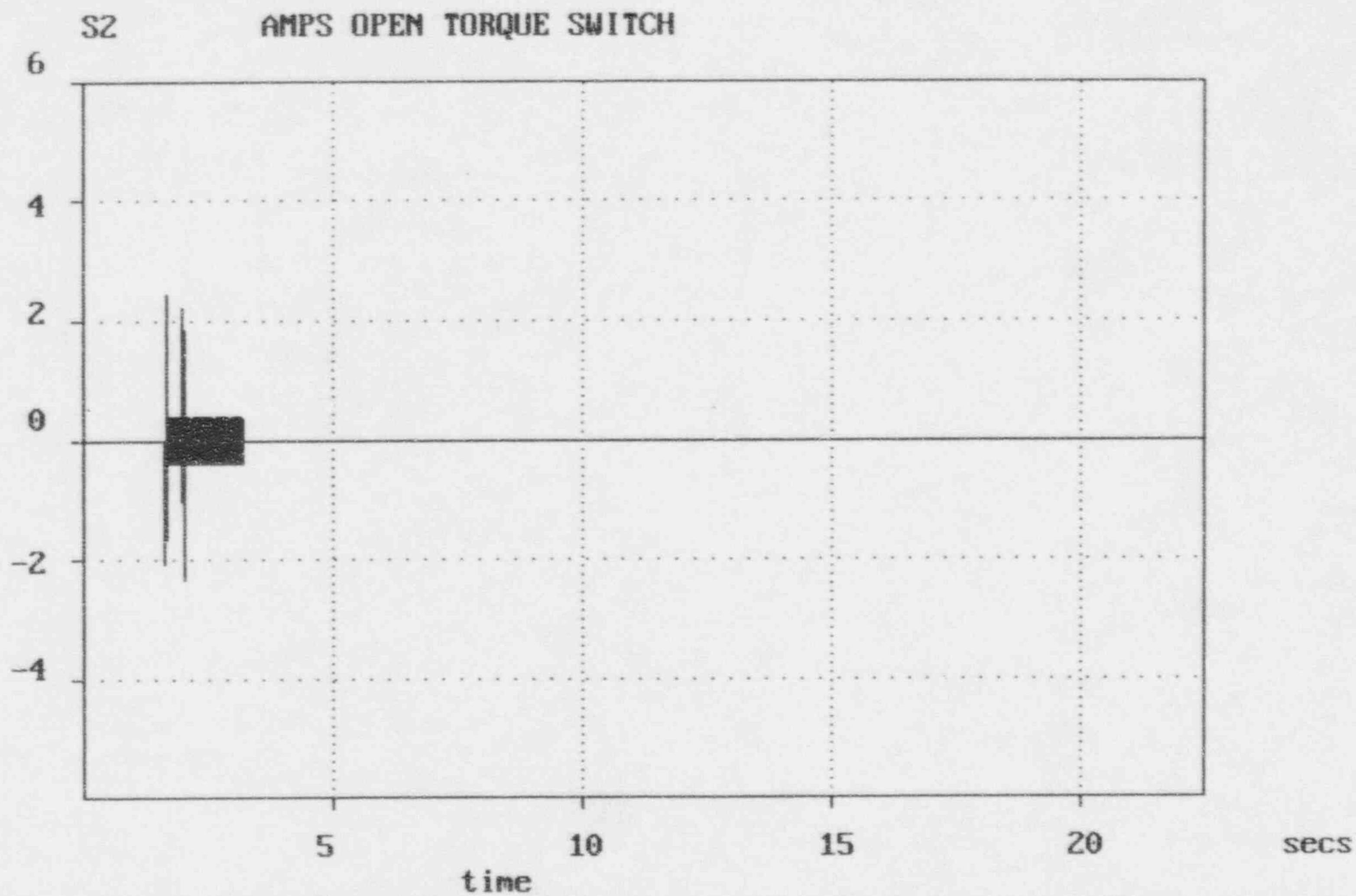

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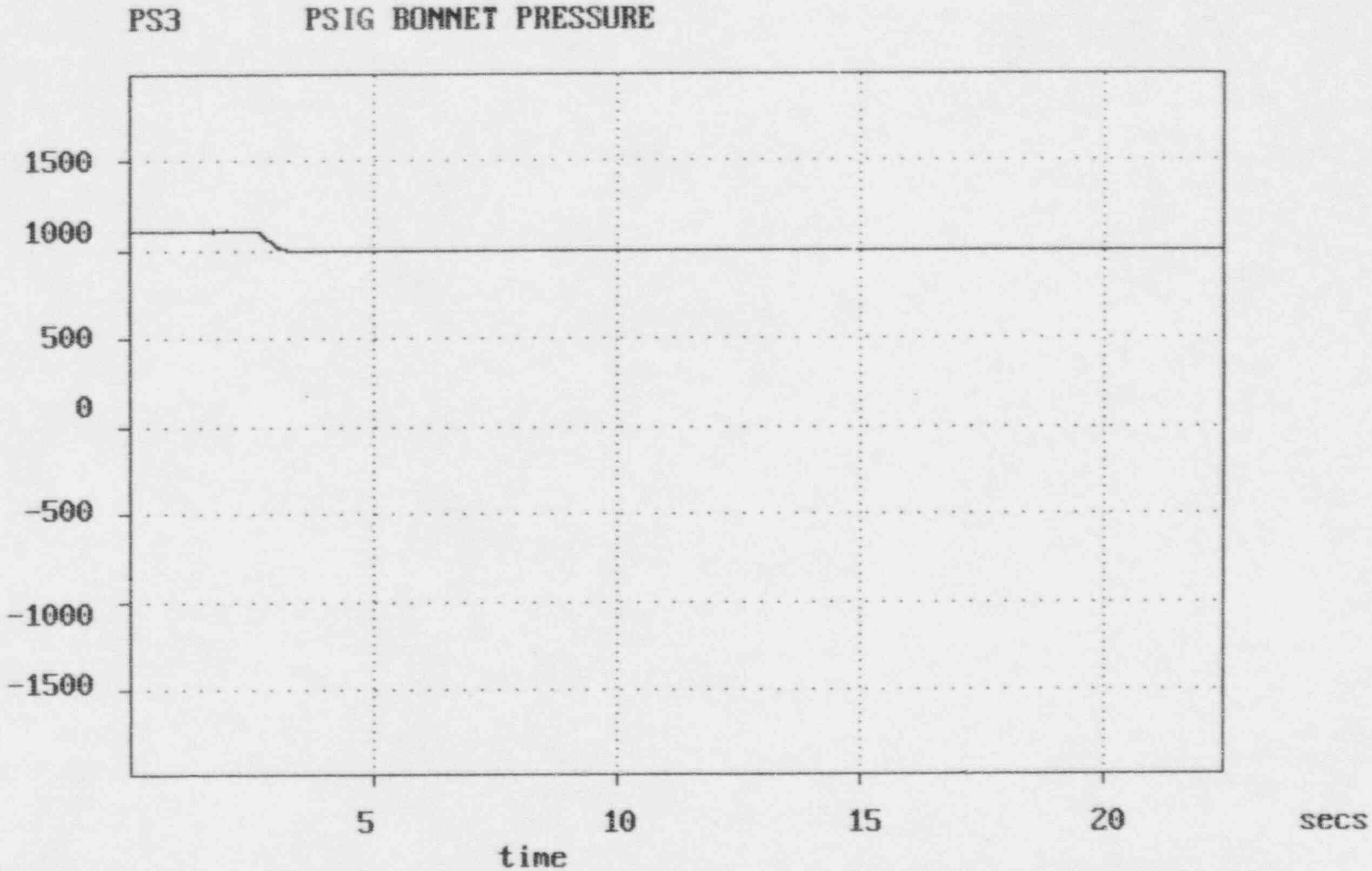

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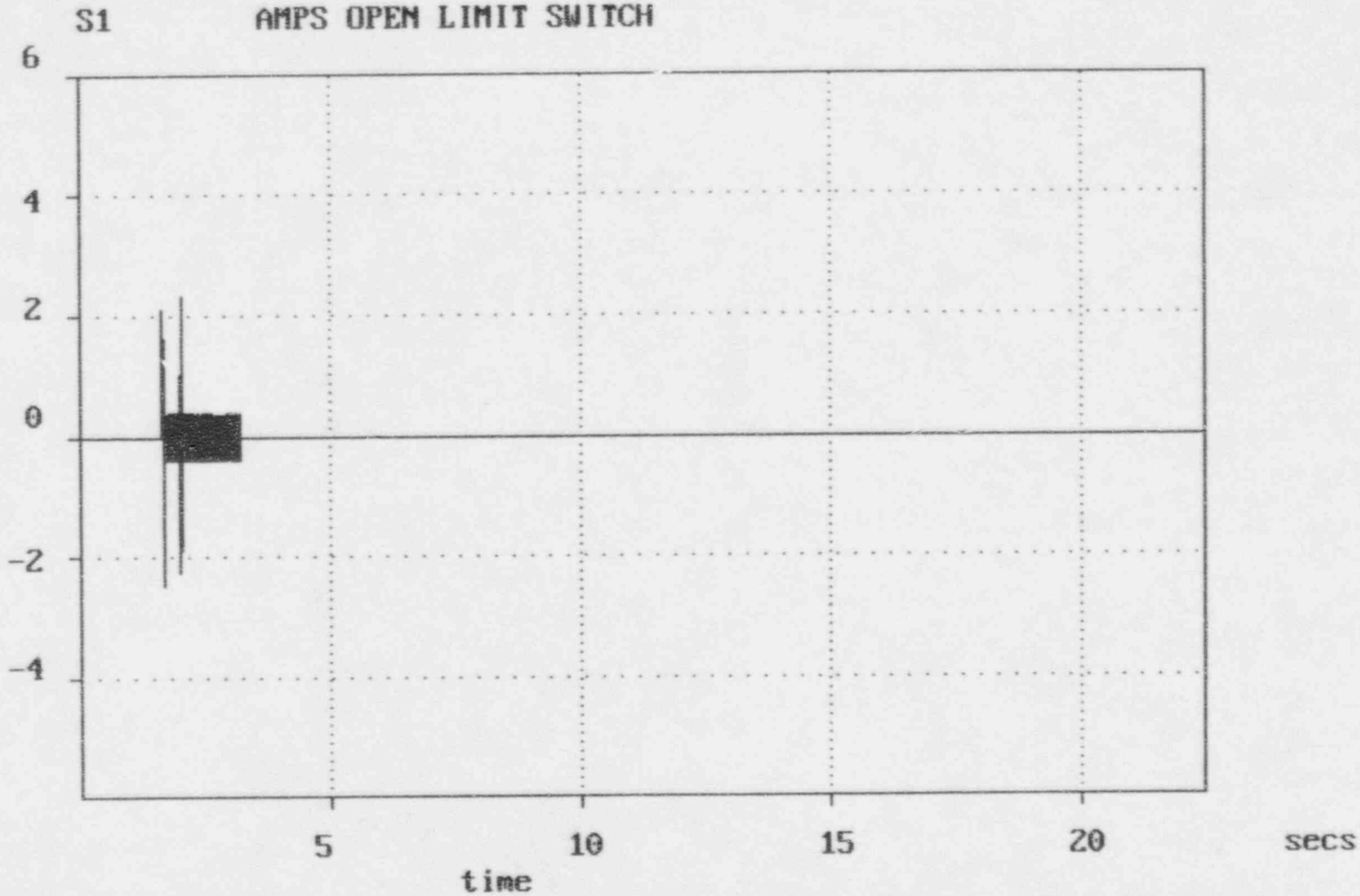

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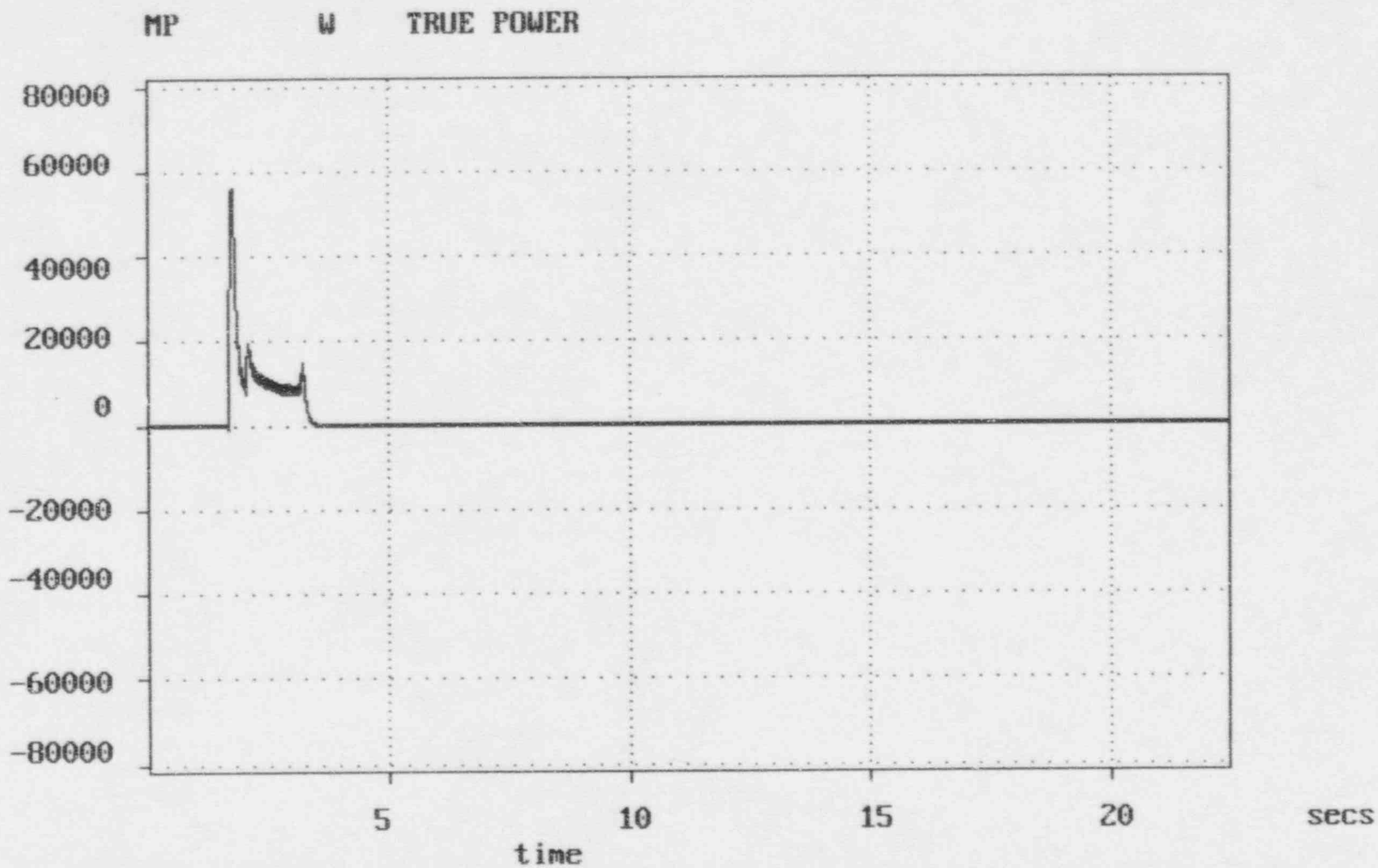

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6.3.3 PRESSURE LOCK TEST   TEST#3 a

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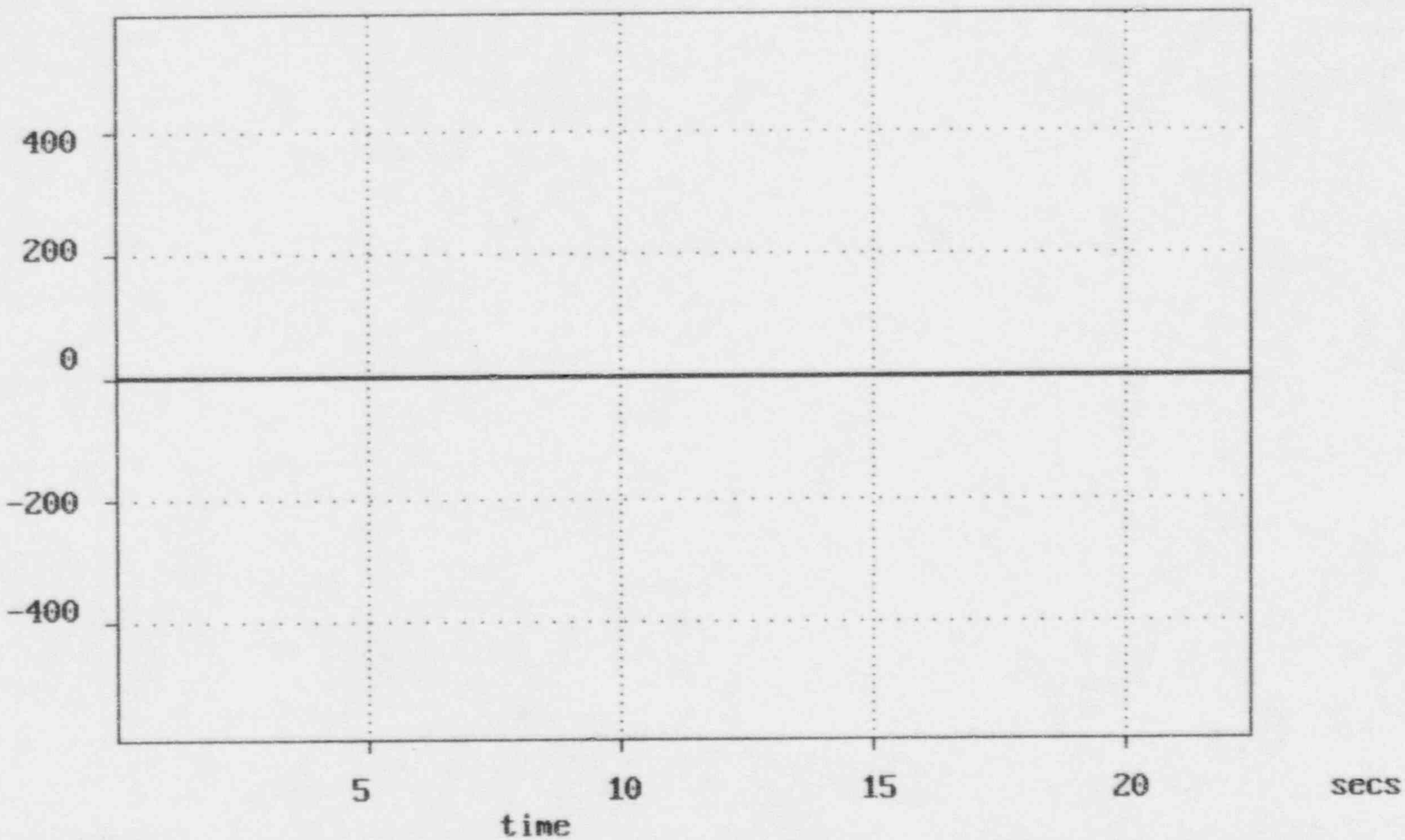

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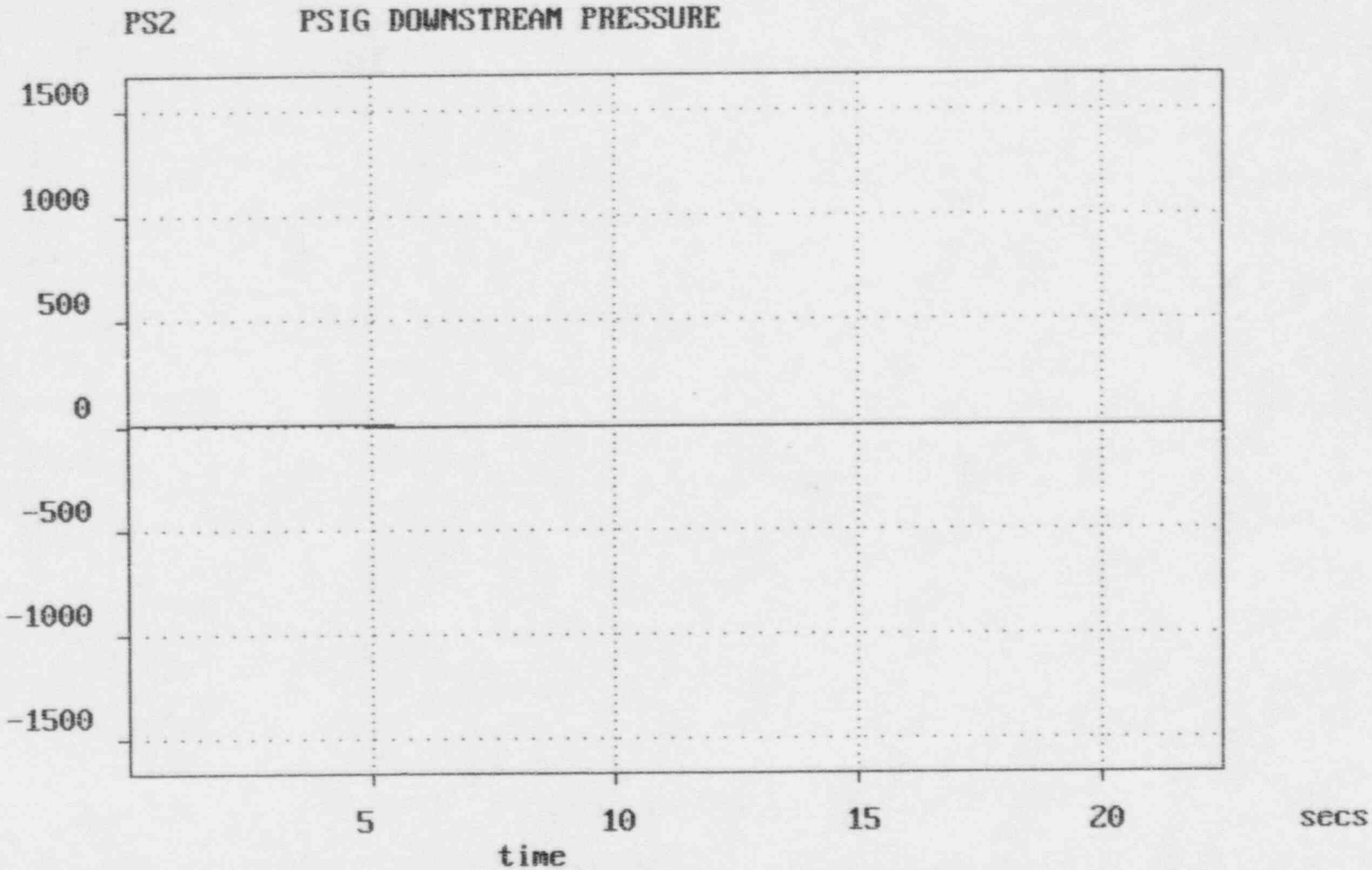

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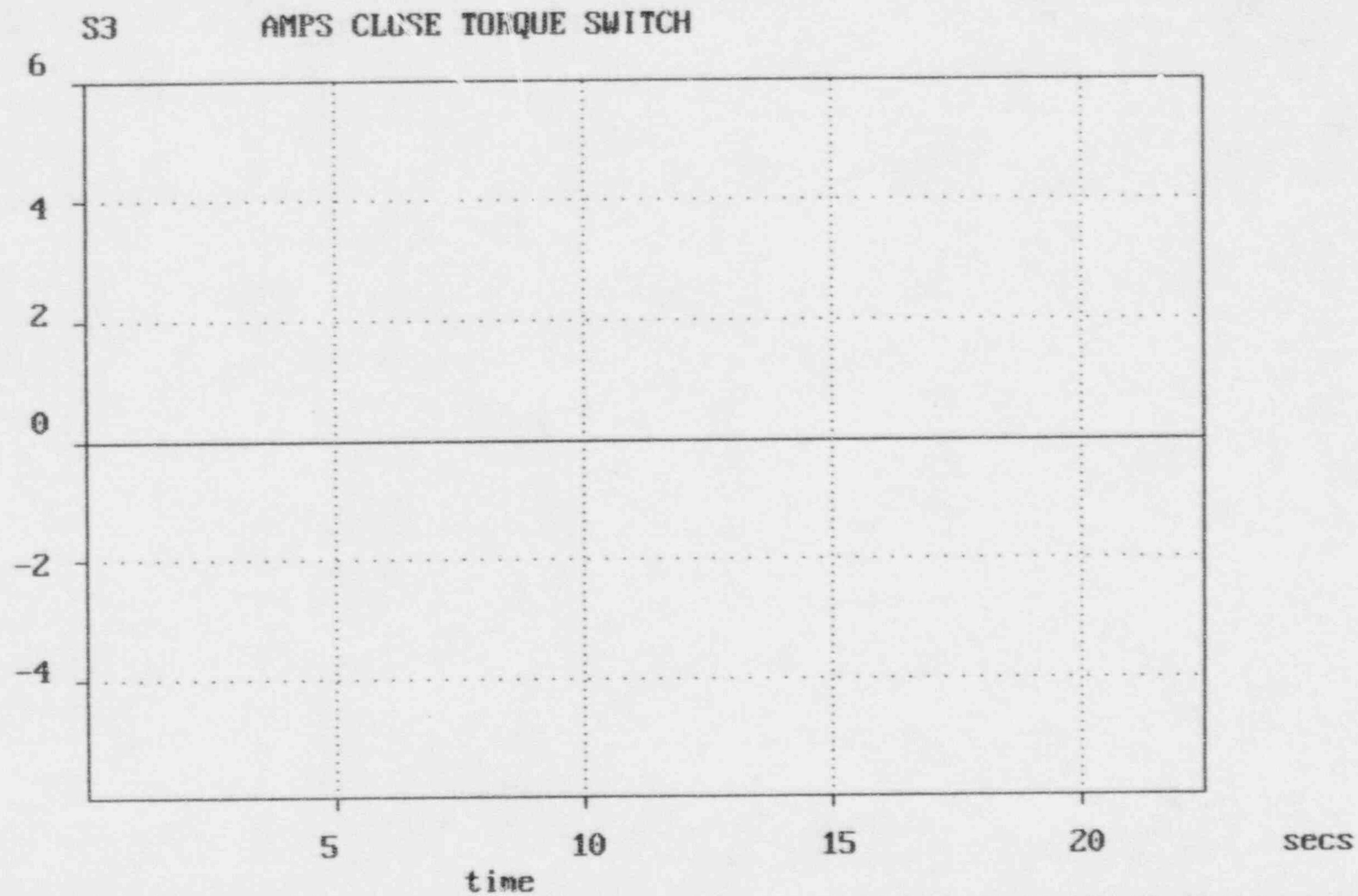

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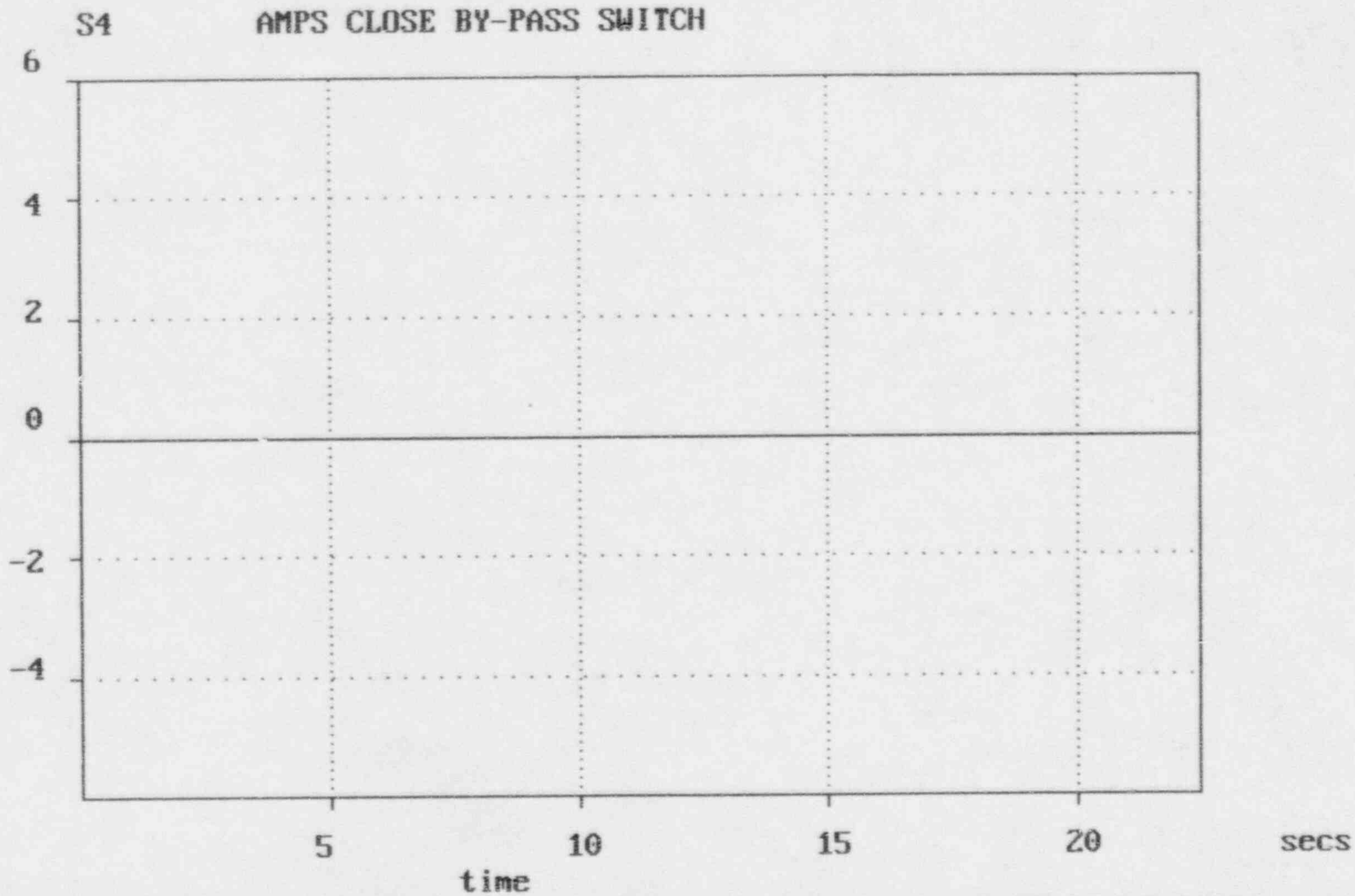

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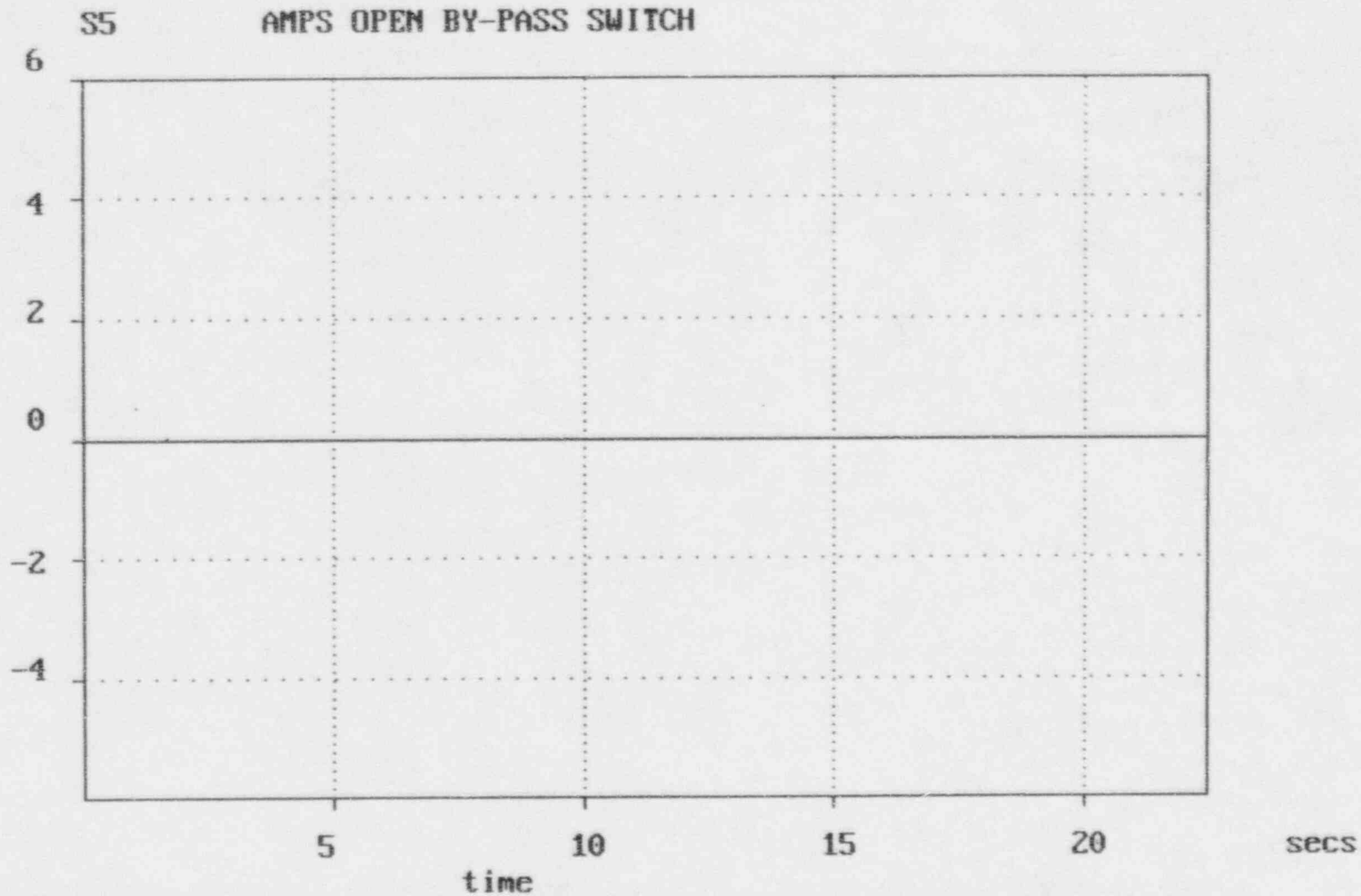

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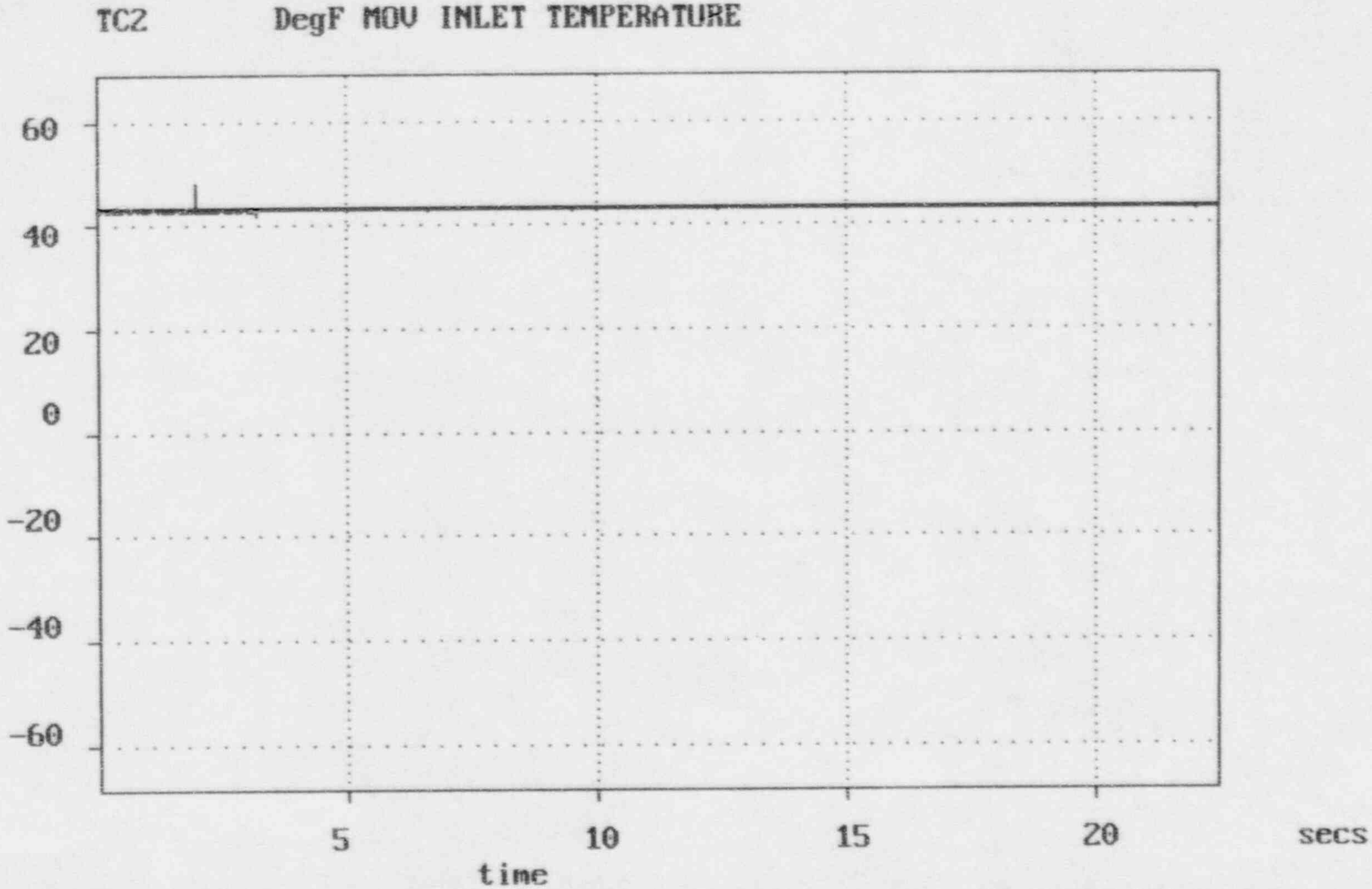

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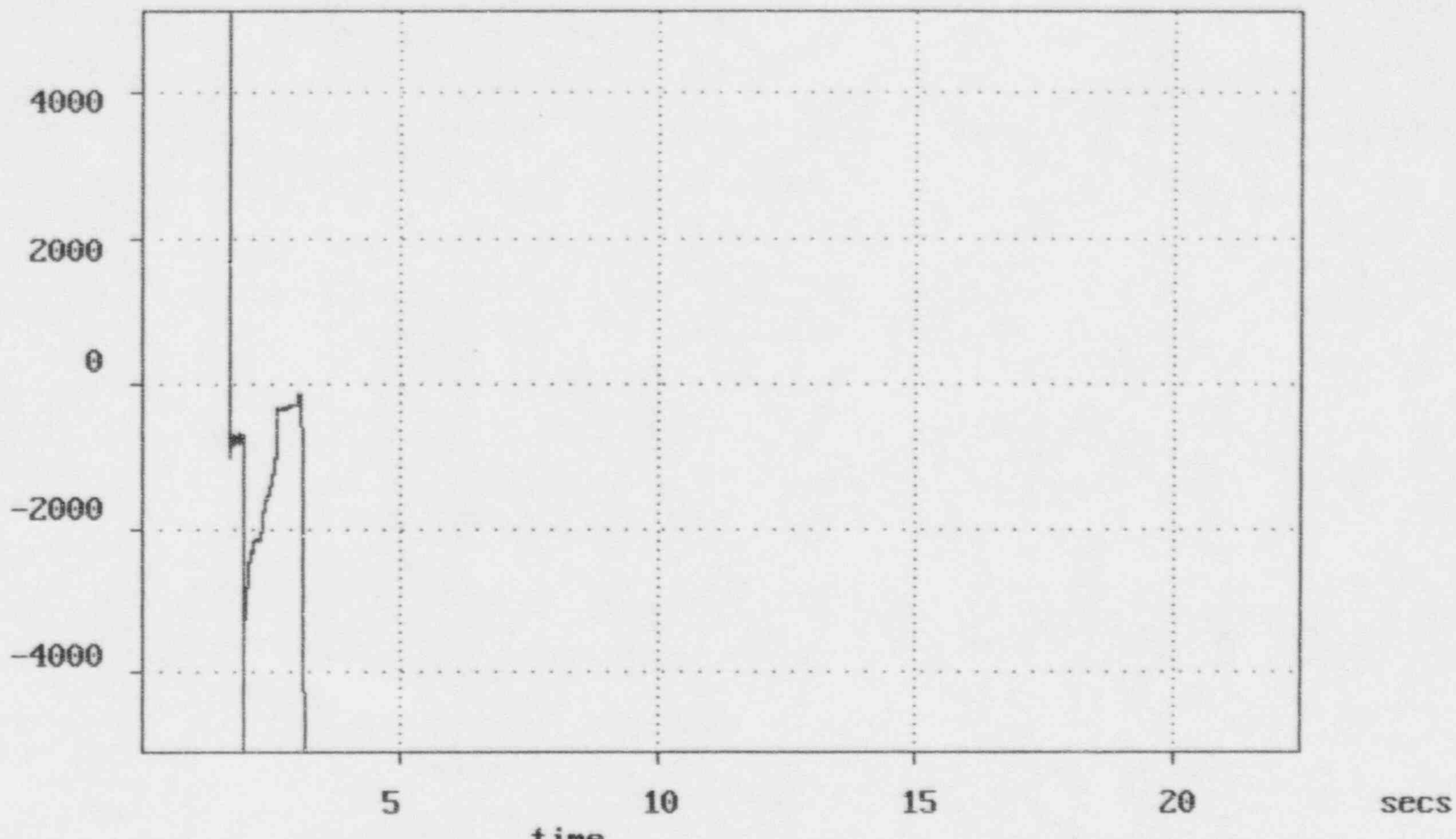
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#3 a

TRQ1   InLB STEM TORQUE



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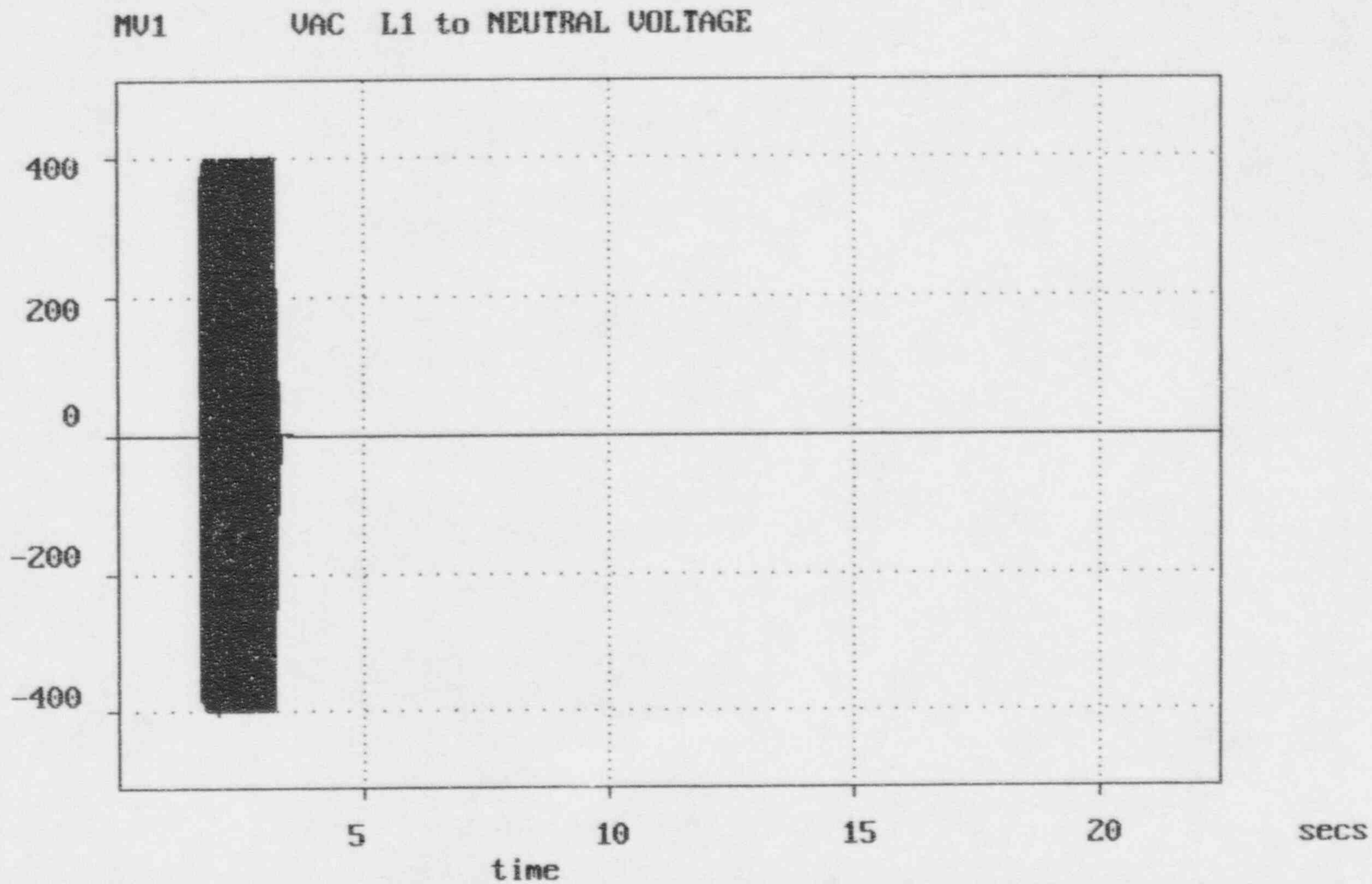

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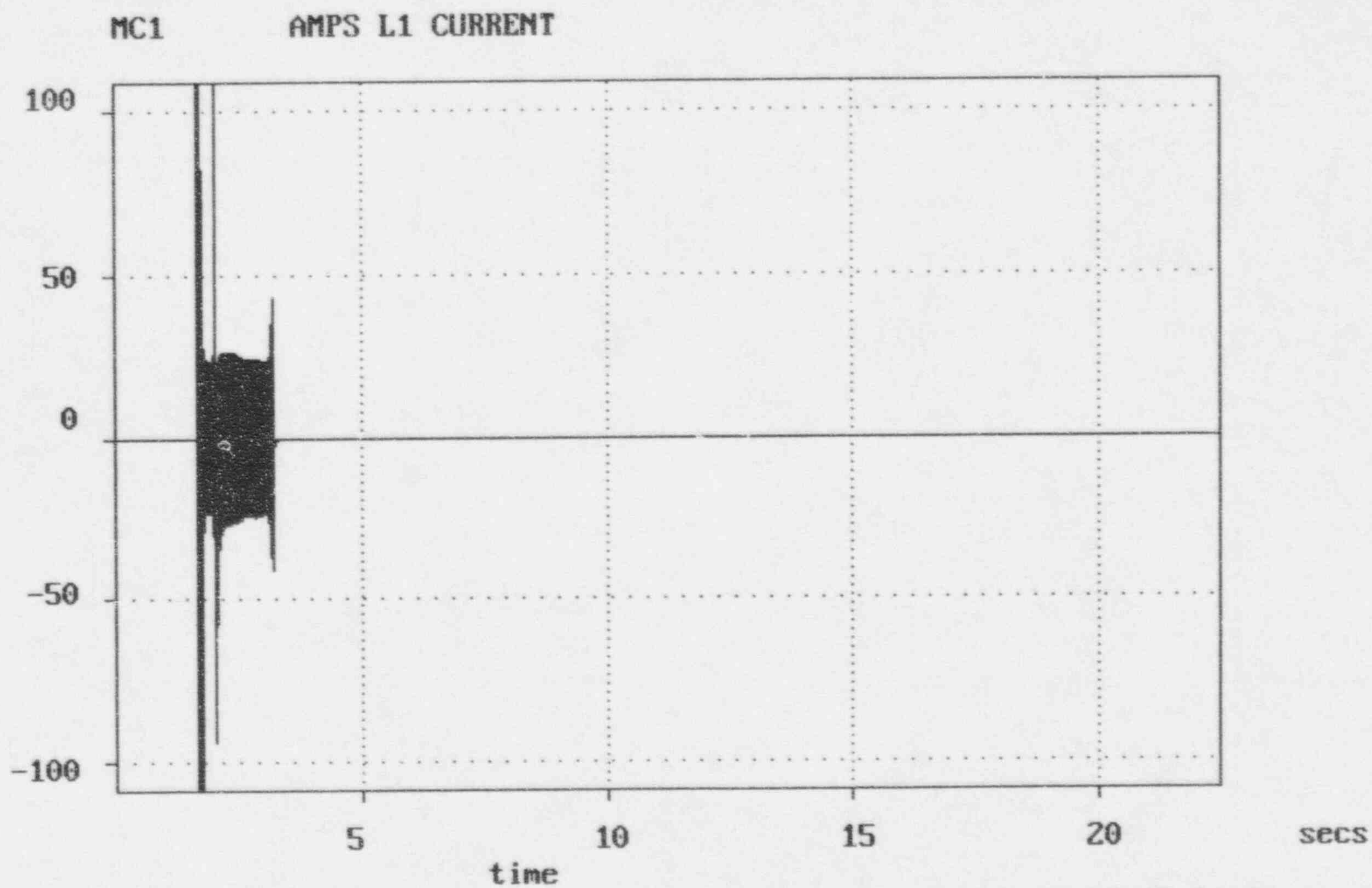
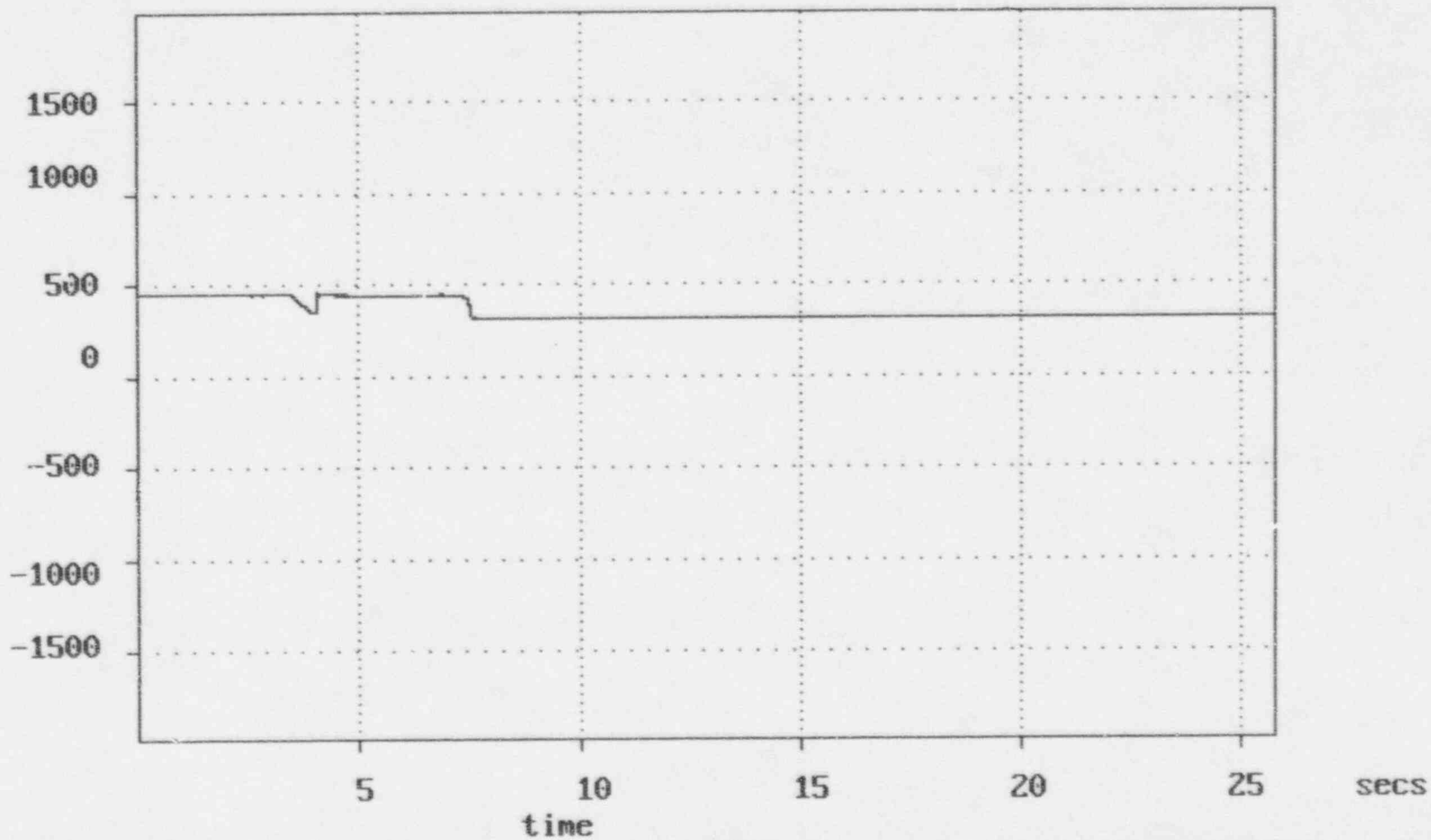


B430081 DataSet 003 Duration 00:00:22:458 Recorded On 12/28/92 15:34:04

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)

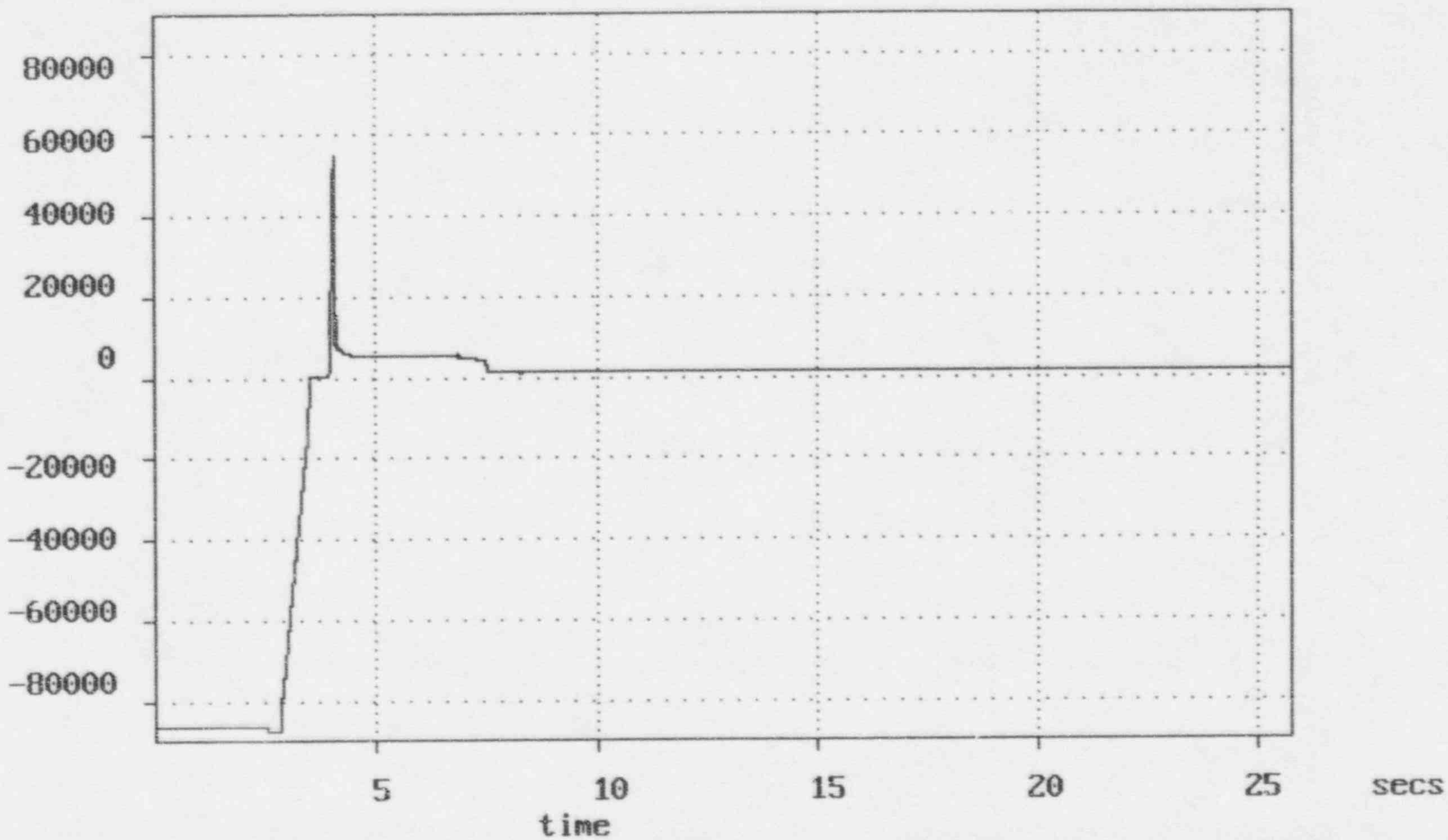
PS3 PSIG BONNET PRESSURE



B430081 DataSet 006 Duration 00:00:25:759 Recorded On 12/29/92 09:02:04

TEST COMPLET
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)

THR1 LB STEM THRUST



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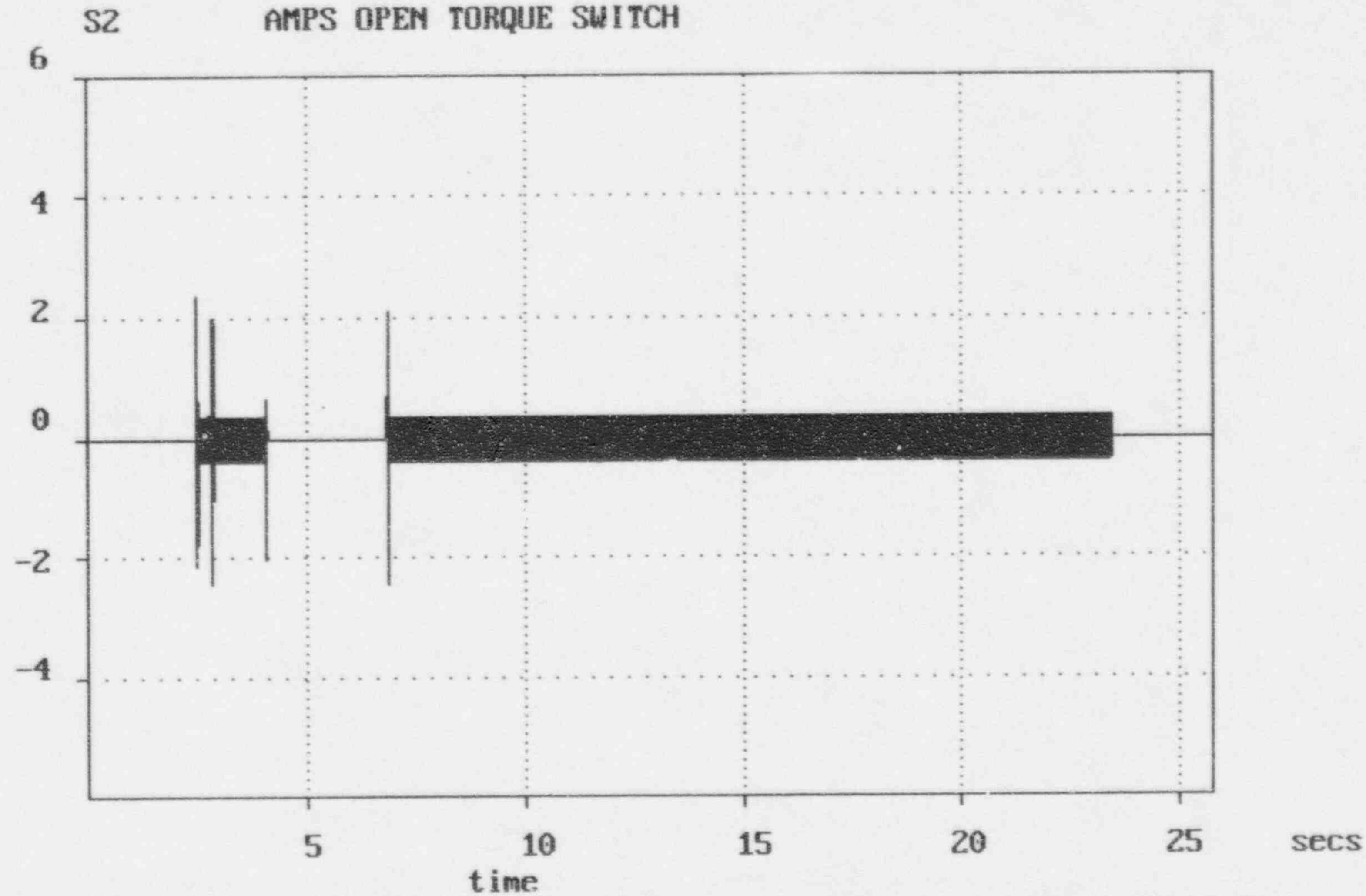

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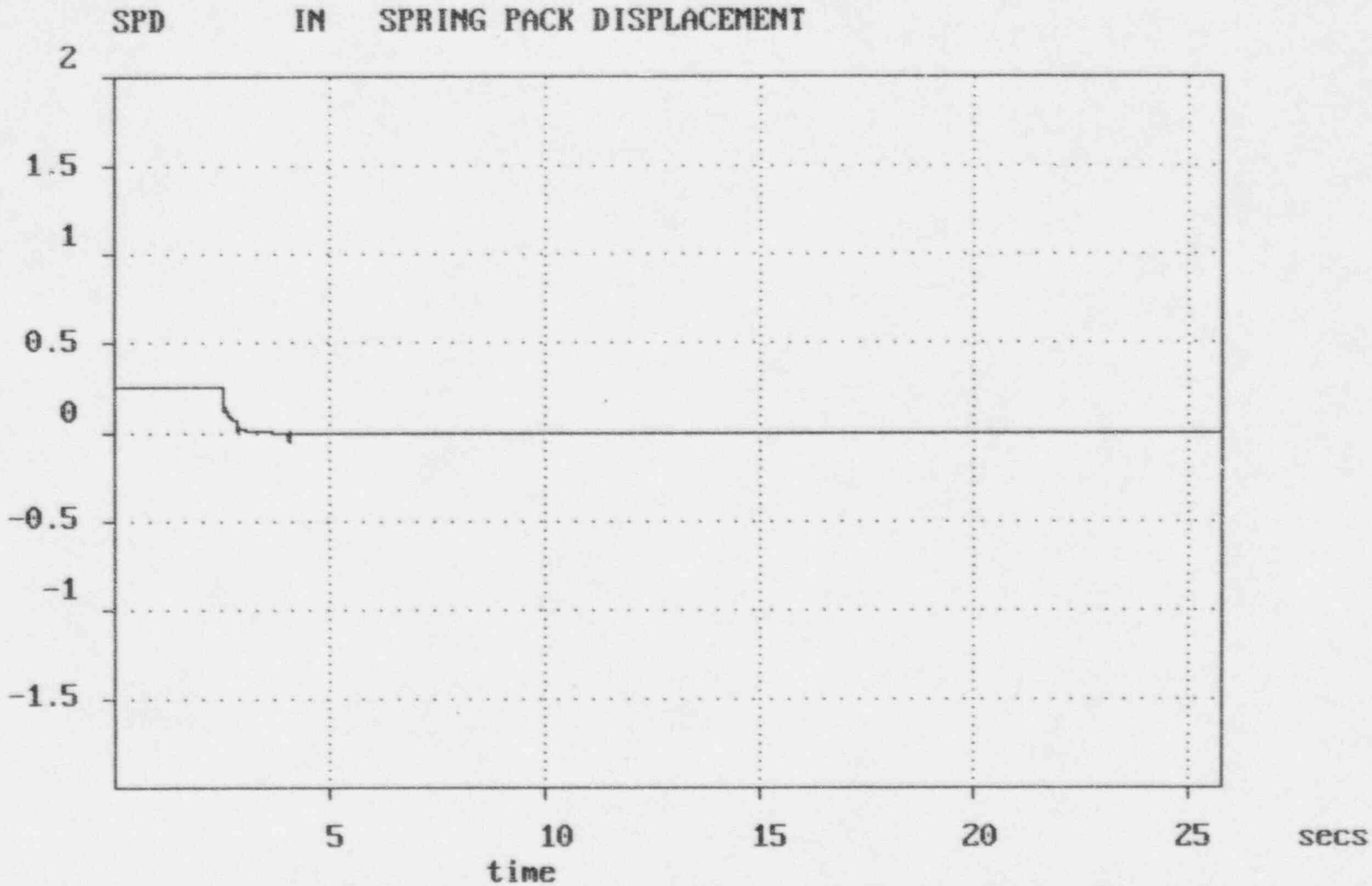

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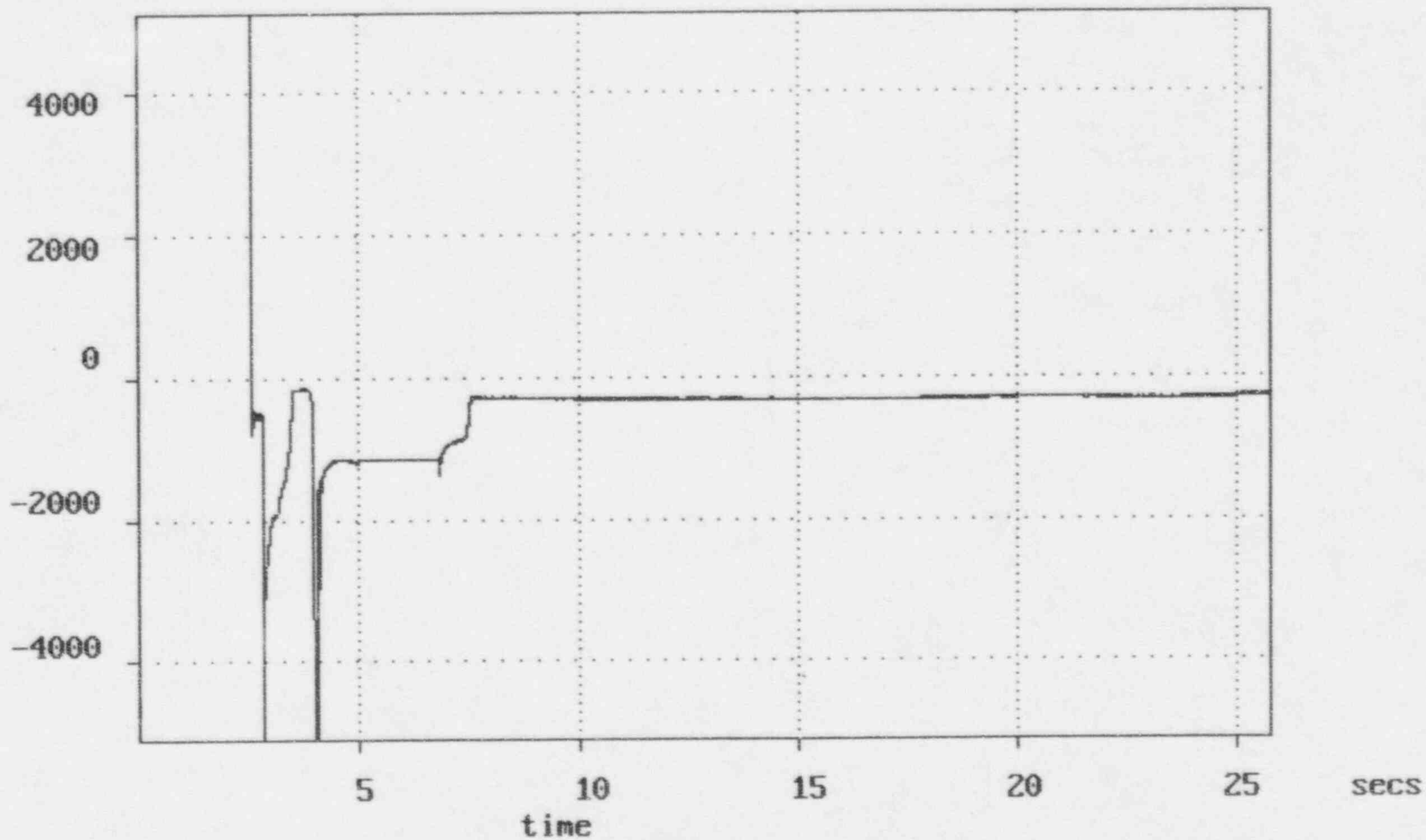
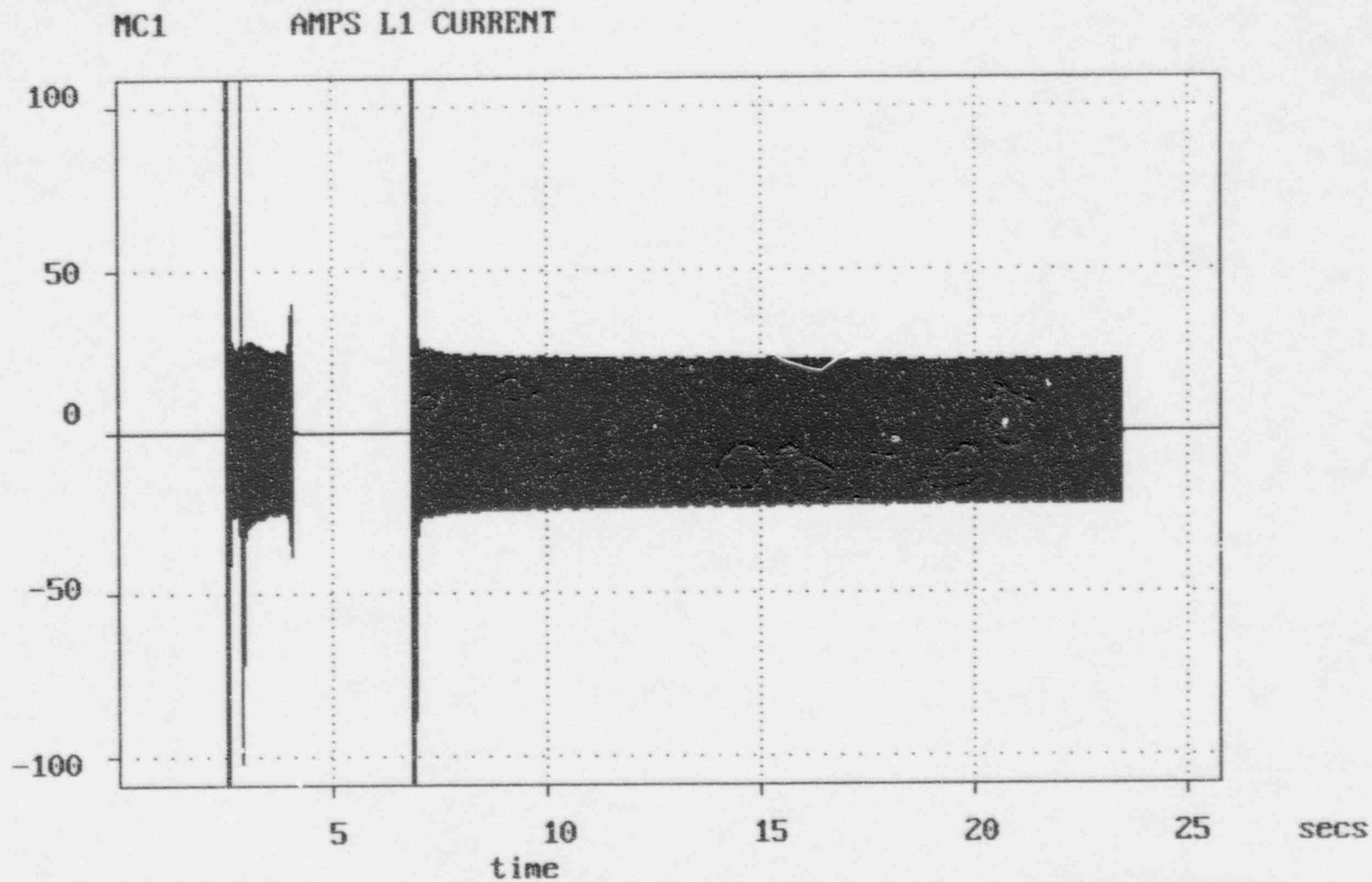
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)

TRQ1 InLB STEM TORQUE



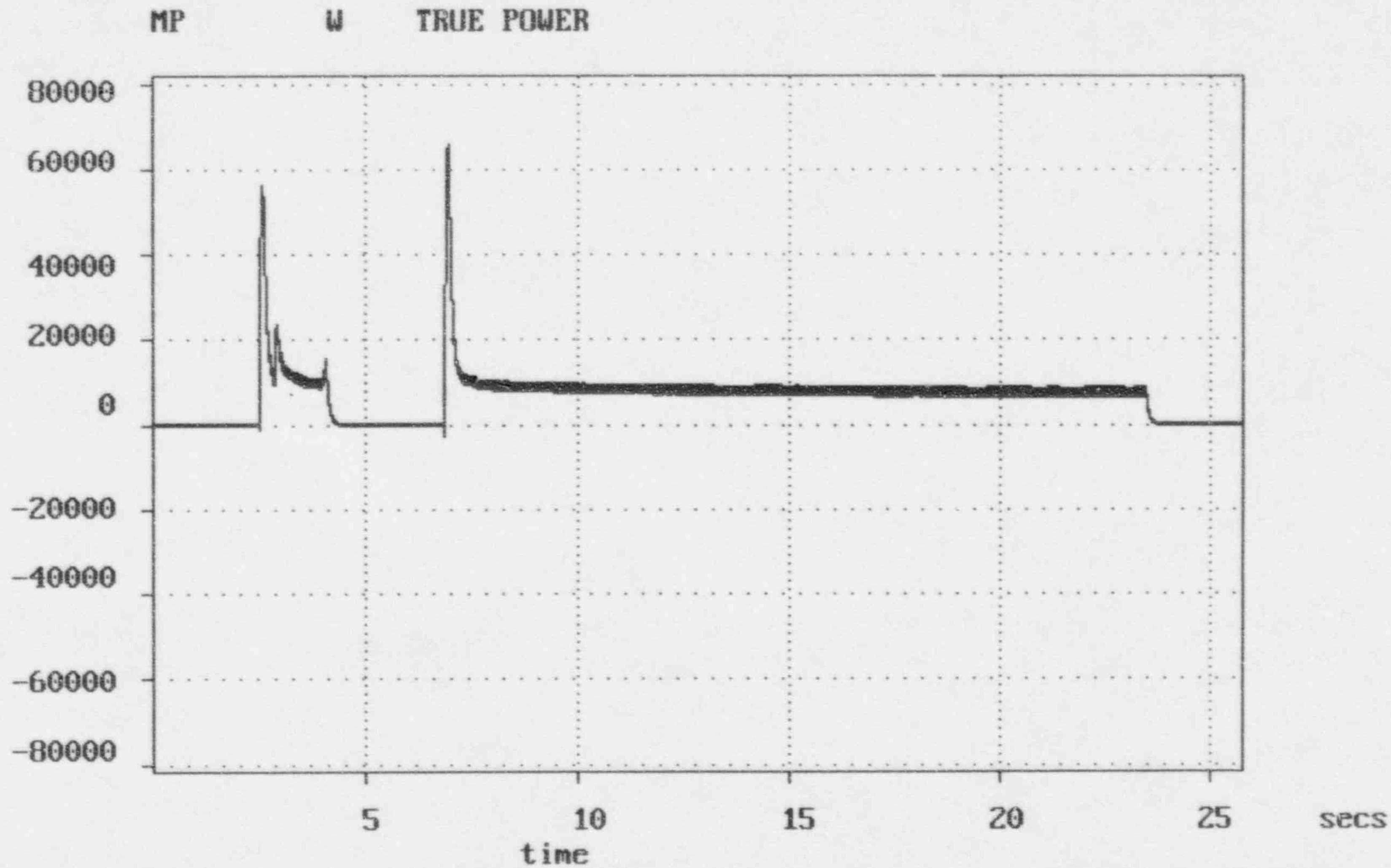
B430081 DataSet 006 Duration 00:00:25:759 Recorded On 12/29/92 09:02:04

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST #5 a (TORQUE SWITCH TRIPPED)



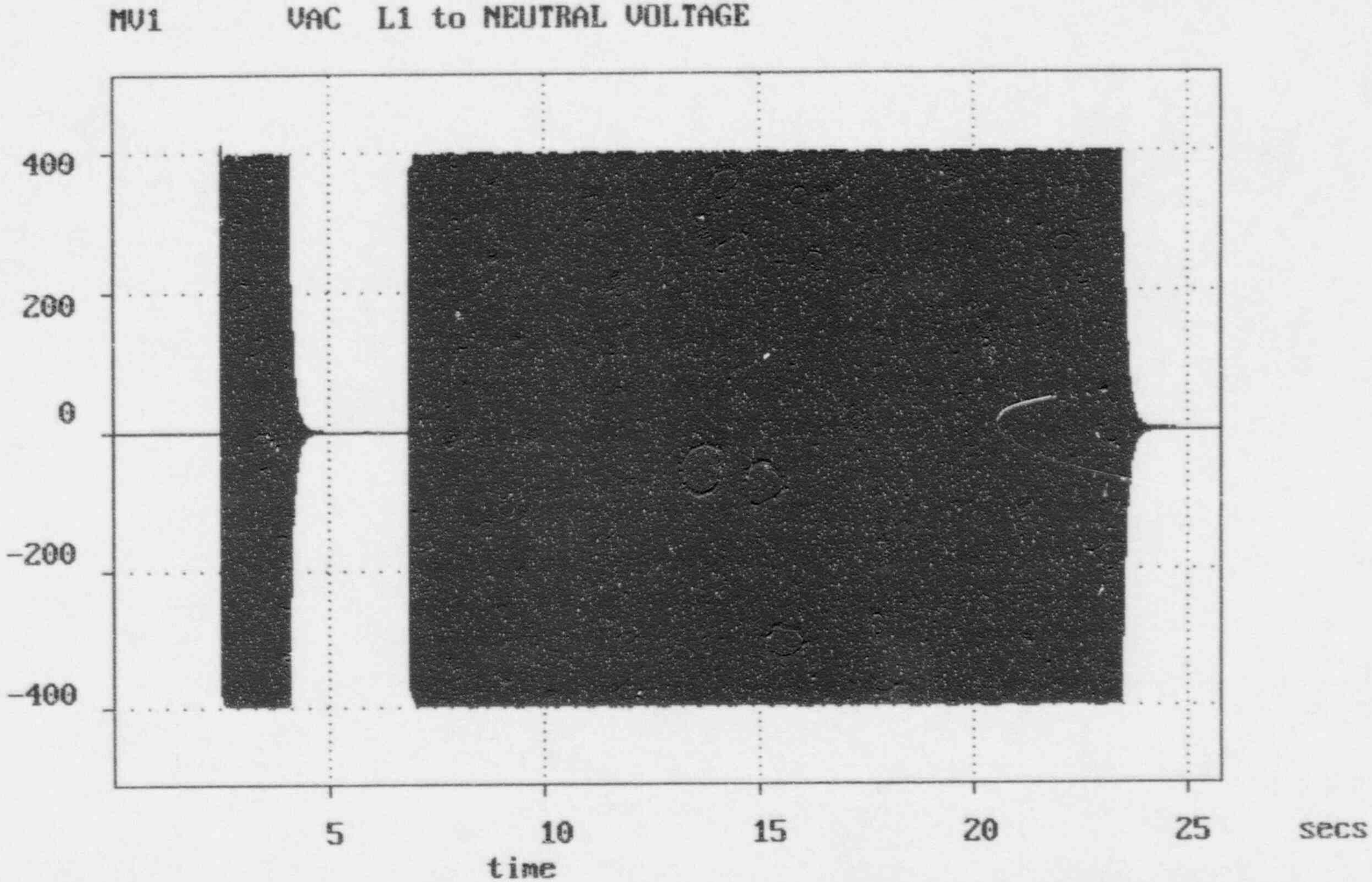
B430081 DataSet 006 Duration 00:00:25:759 Recorded On 12/29/92 09:02:04

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)



B430081 DataSet 006 Duration 00:00:25:759 Recorded On 12/29/92 09:02:04

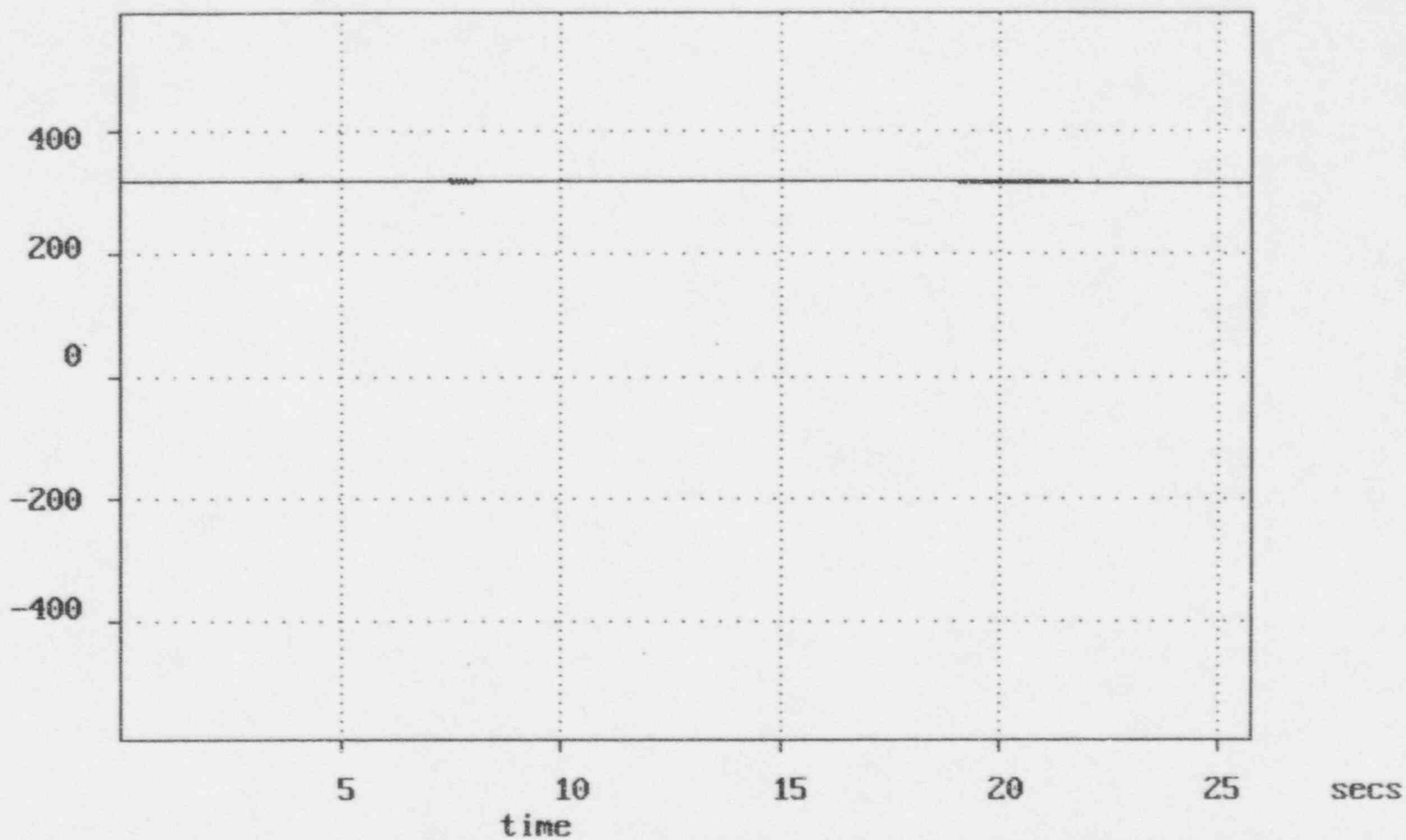
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST   TEST#5 a   (TORQUE SWITCH TRIPPED)



B430081 DataSet 006 Duration 00:00:25:759 Recorded On 12/29/92 09:02:04

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)

PS1 PSIG UPSTREAM PRESSURE



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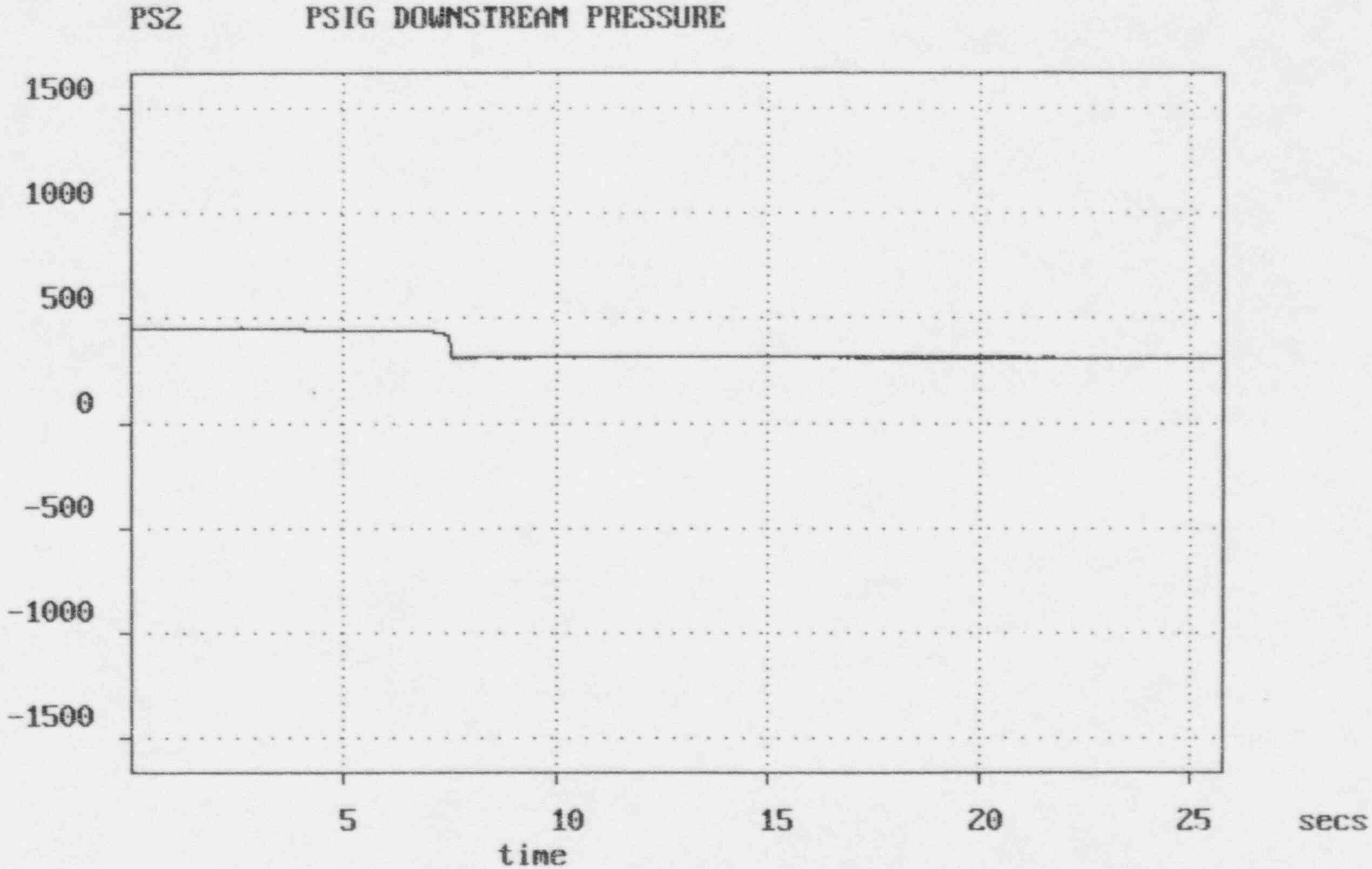
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)



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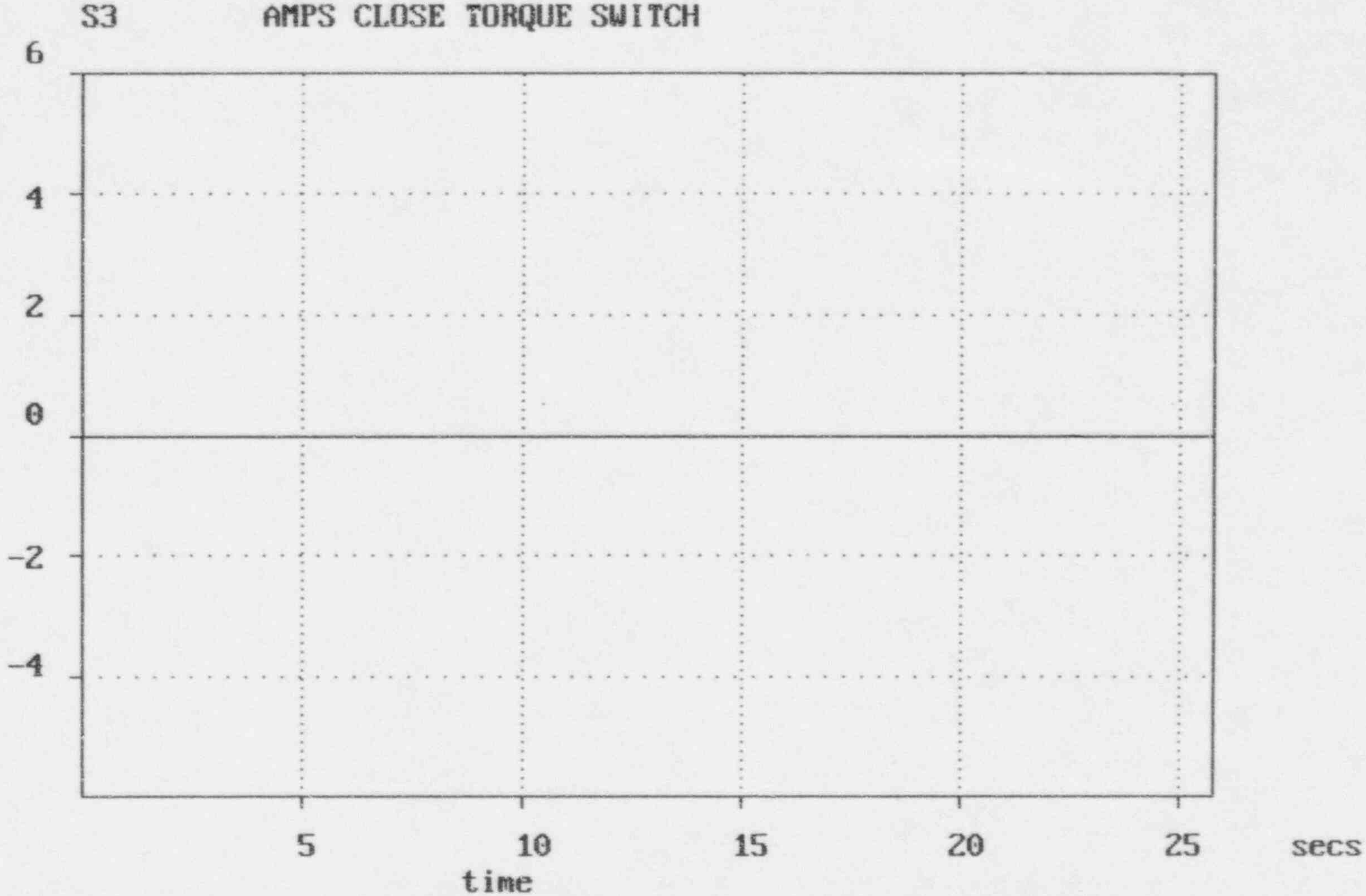
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)



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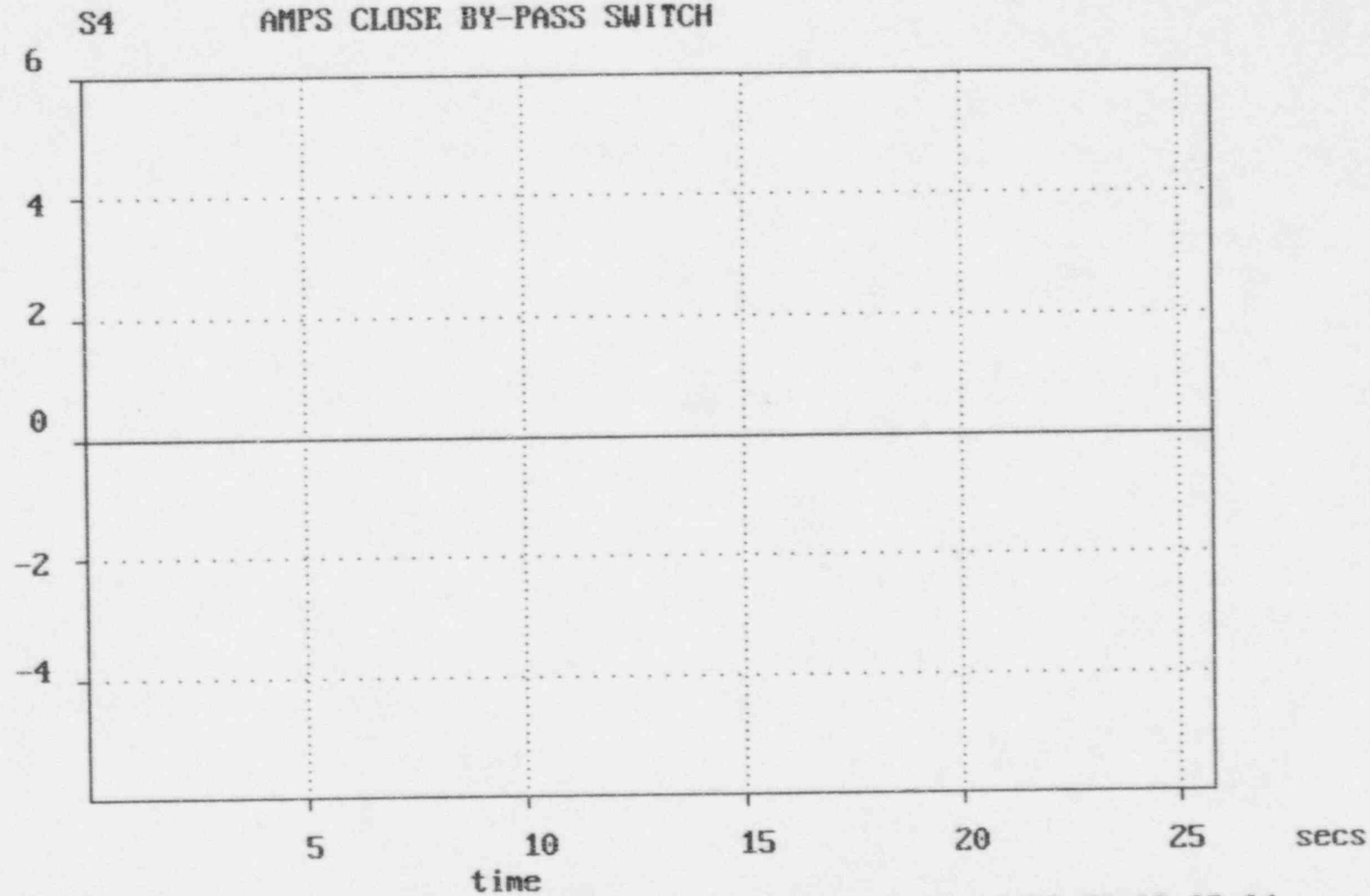
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)



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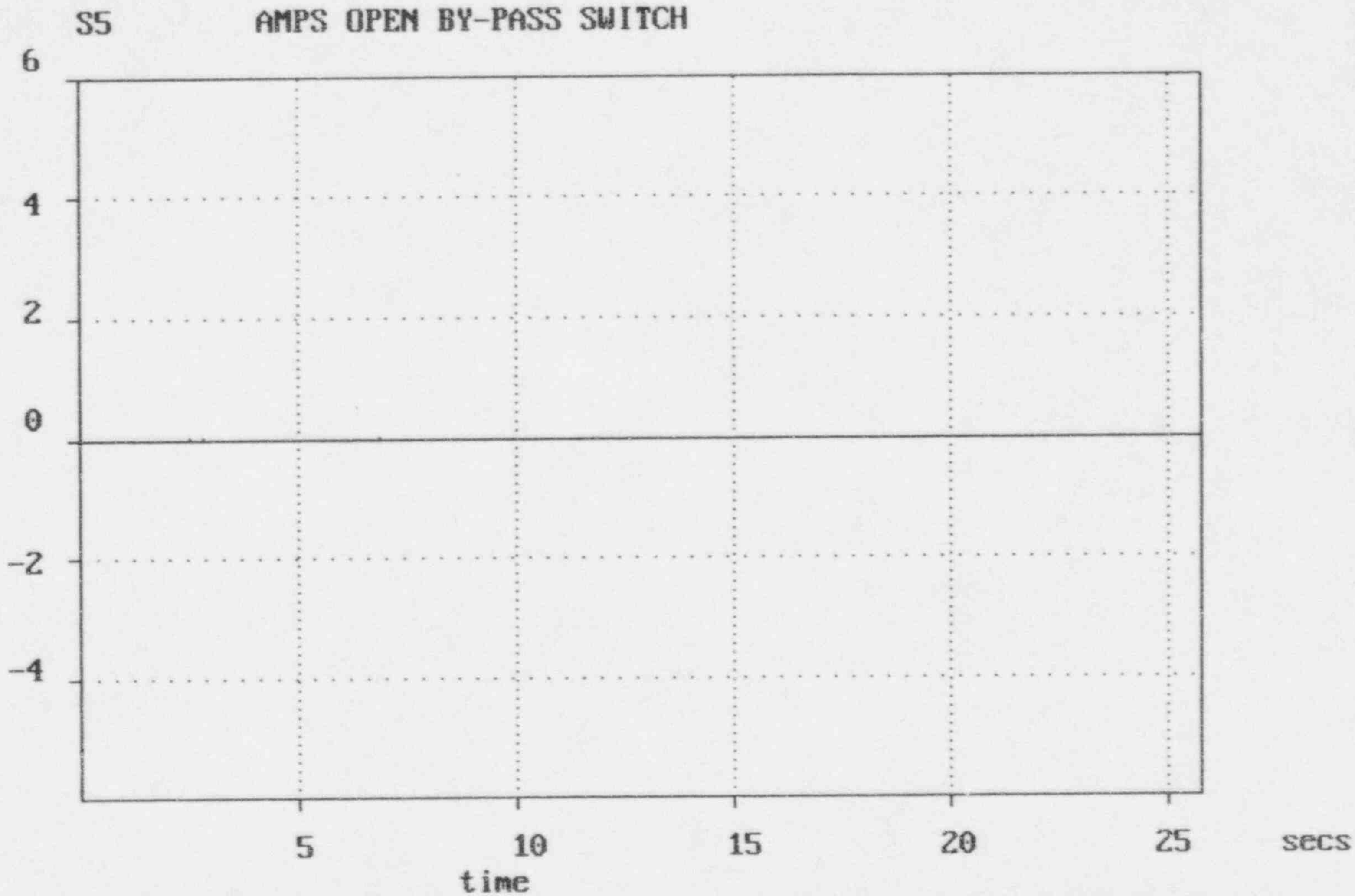
TEST COMPL¯TE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)



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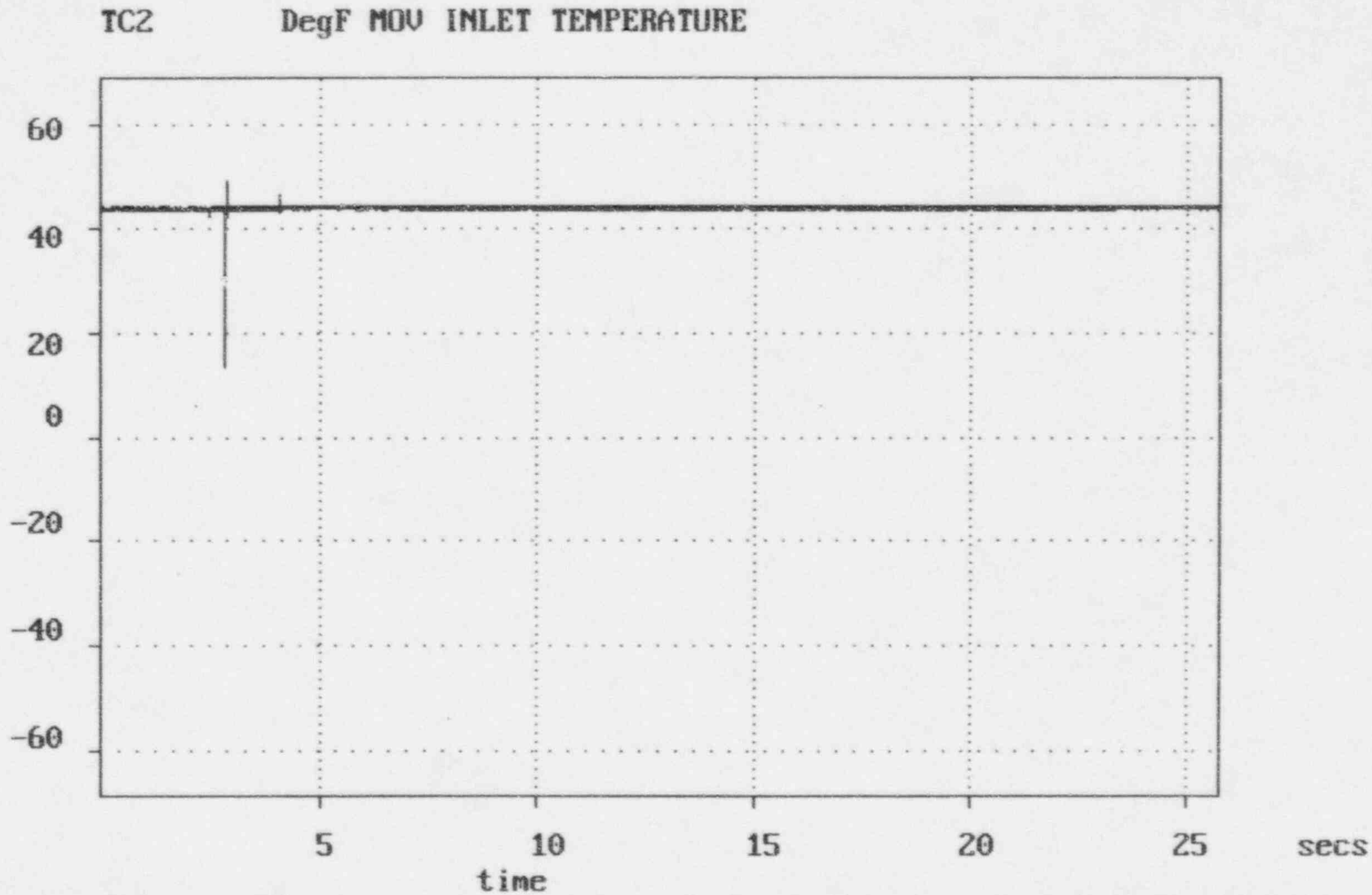
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)



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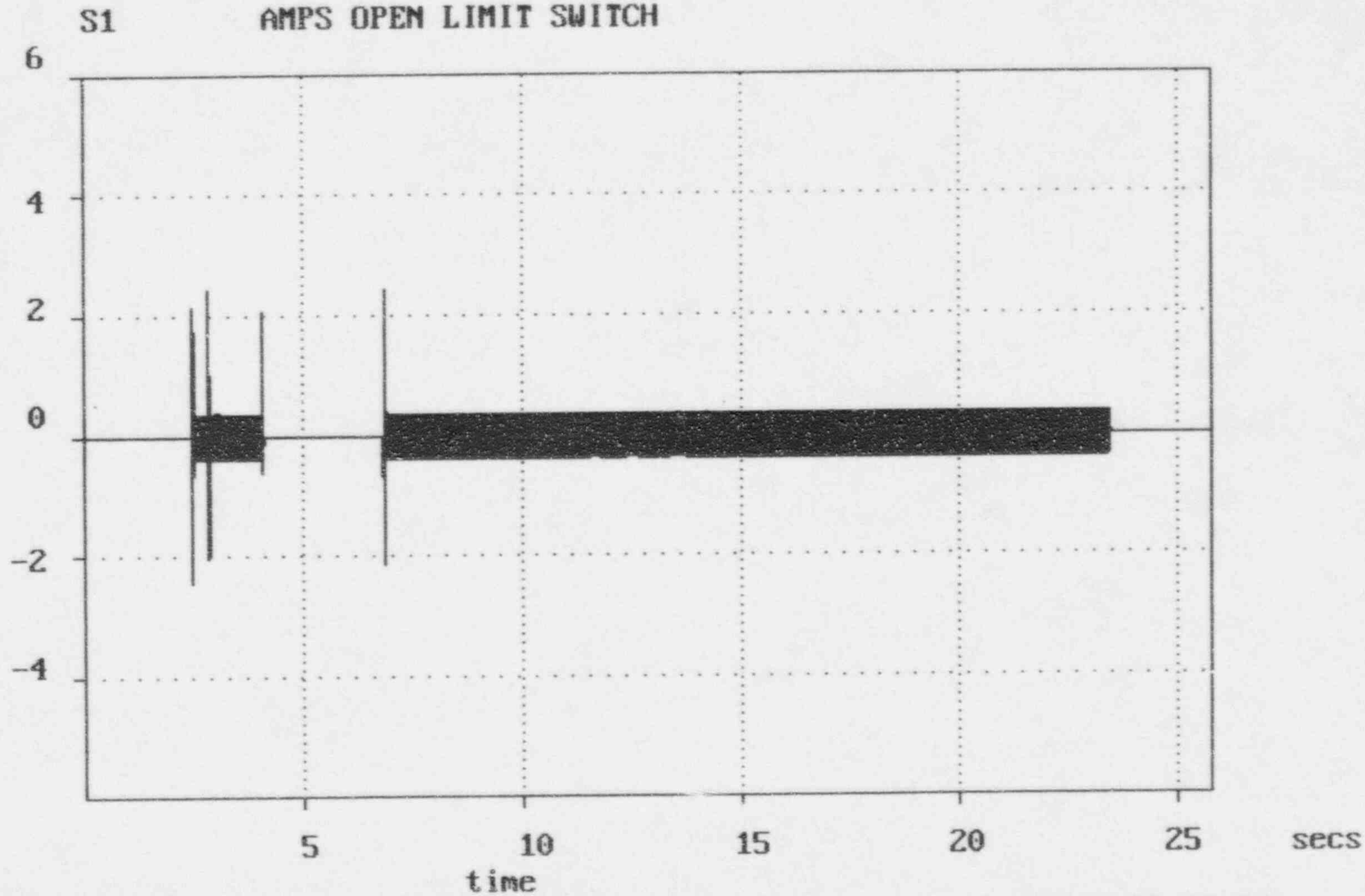
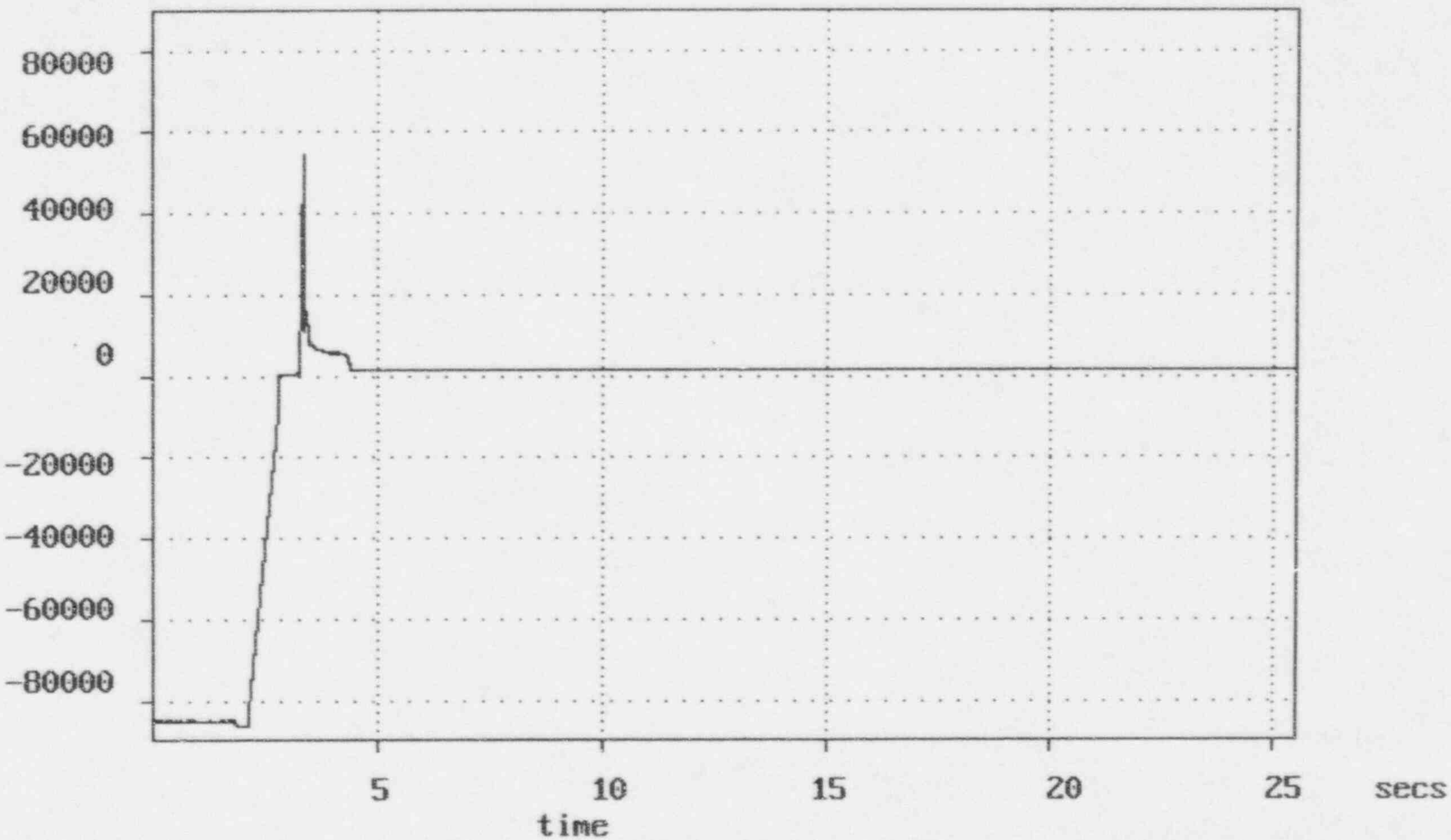
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH TRIPPED)



B430081 DataSet 006 Duration 00:00:25:759 Recorded On 12/29/92 09:02:04

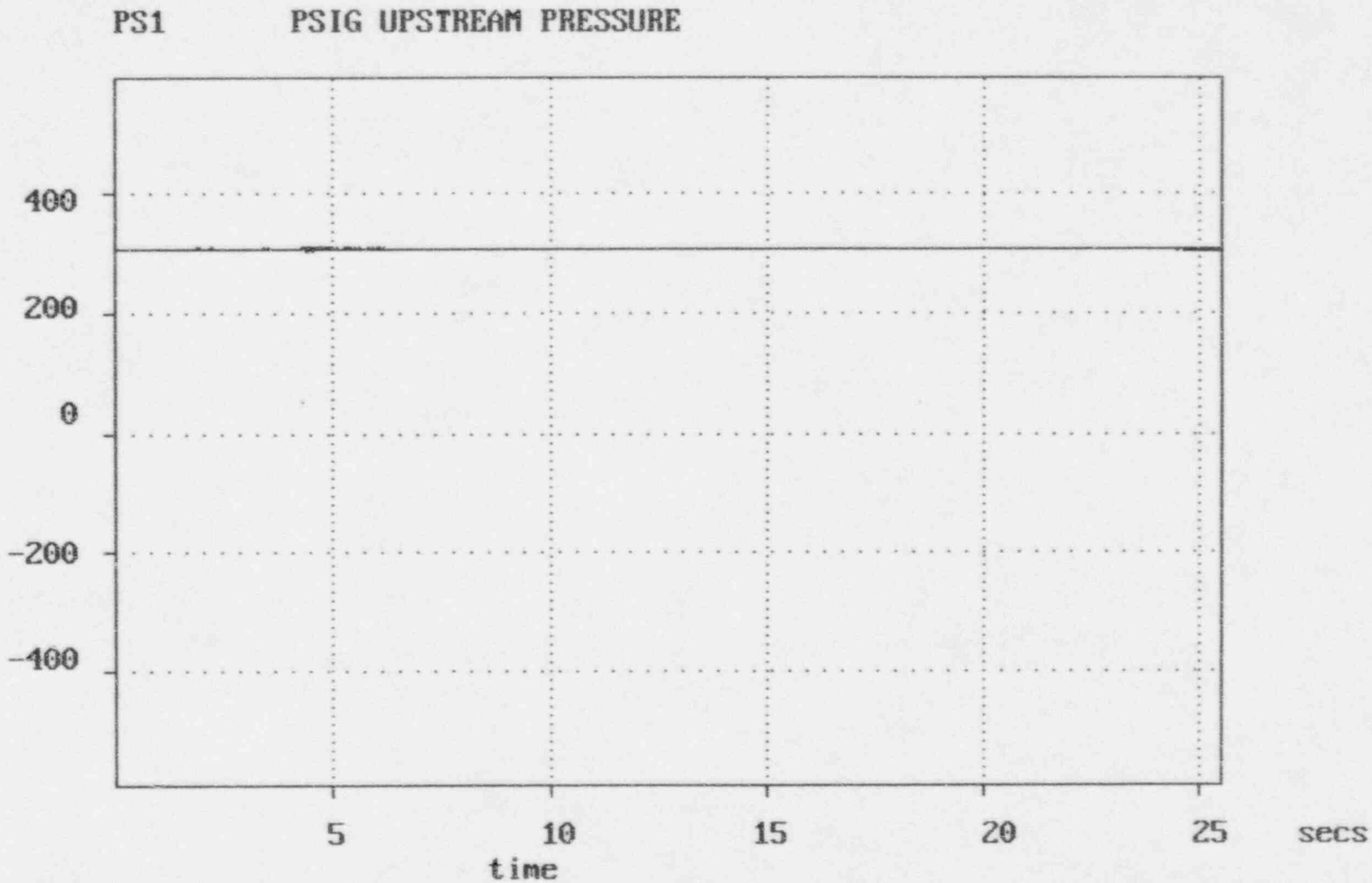
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)

THR1 LB STEM THRUST



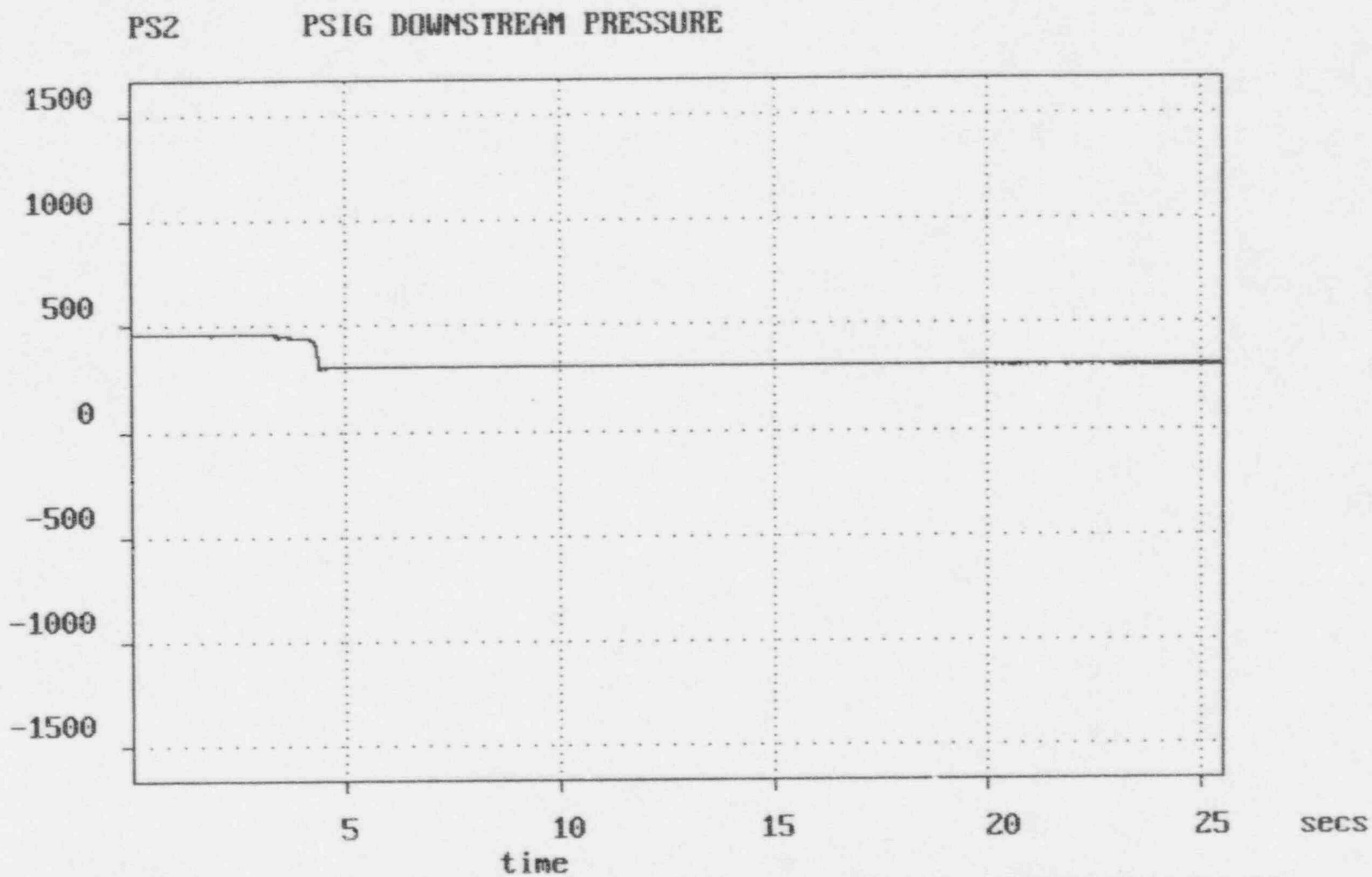
B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)



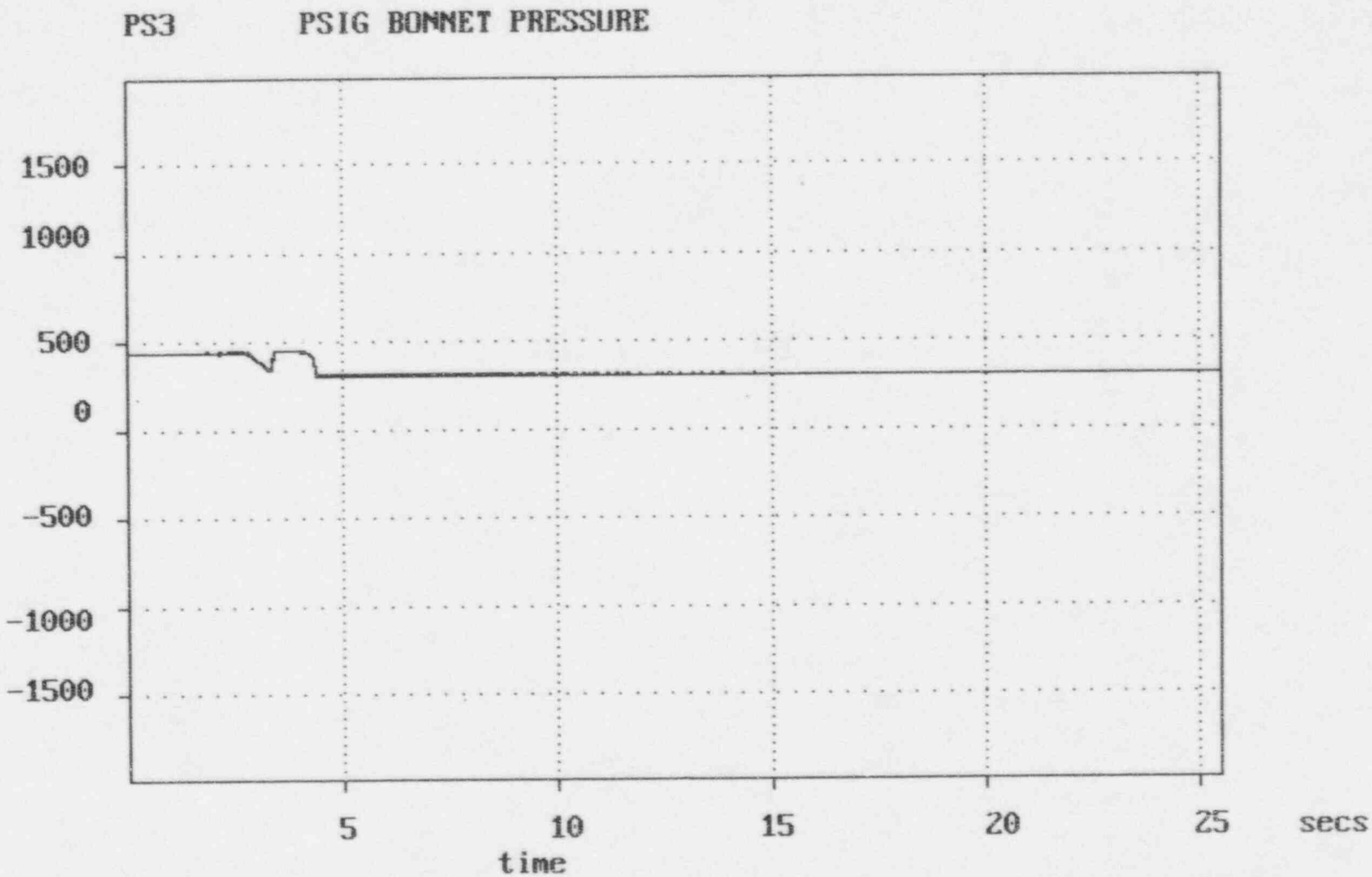
B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)



B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)

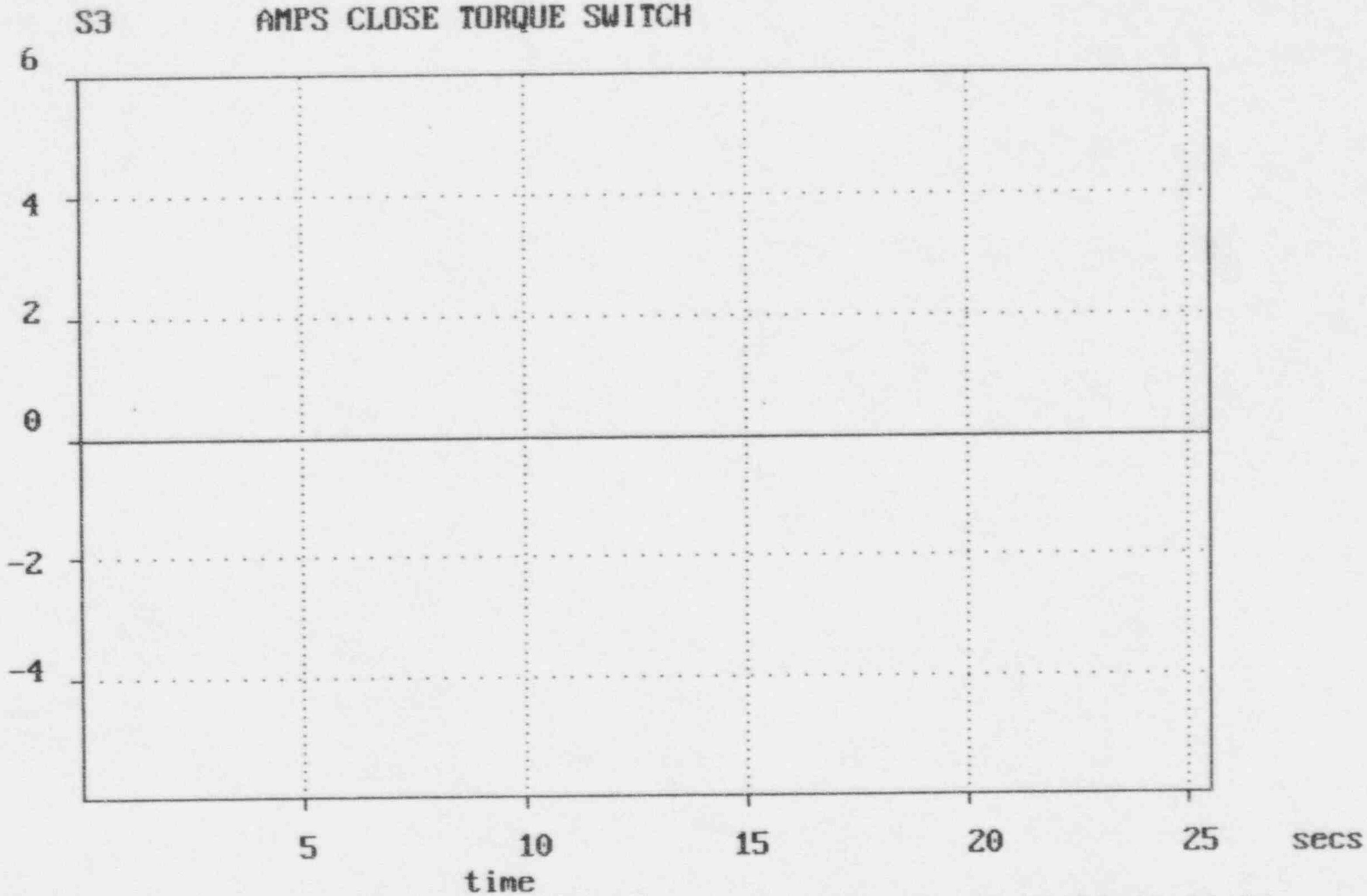


B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)

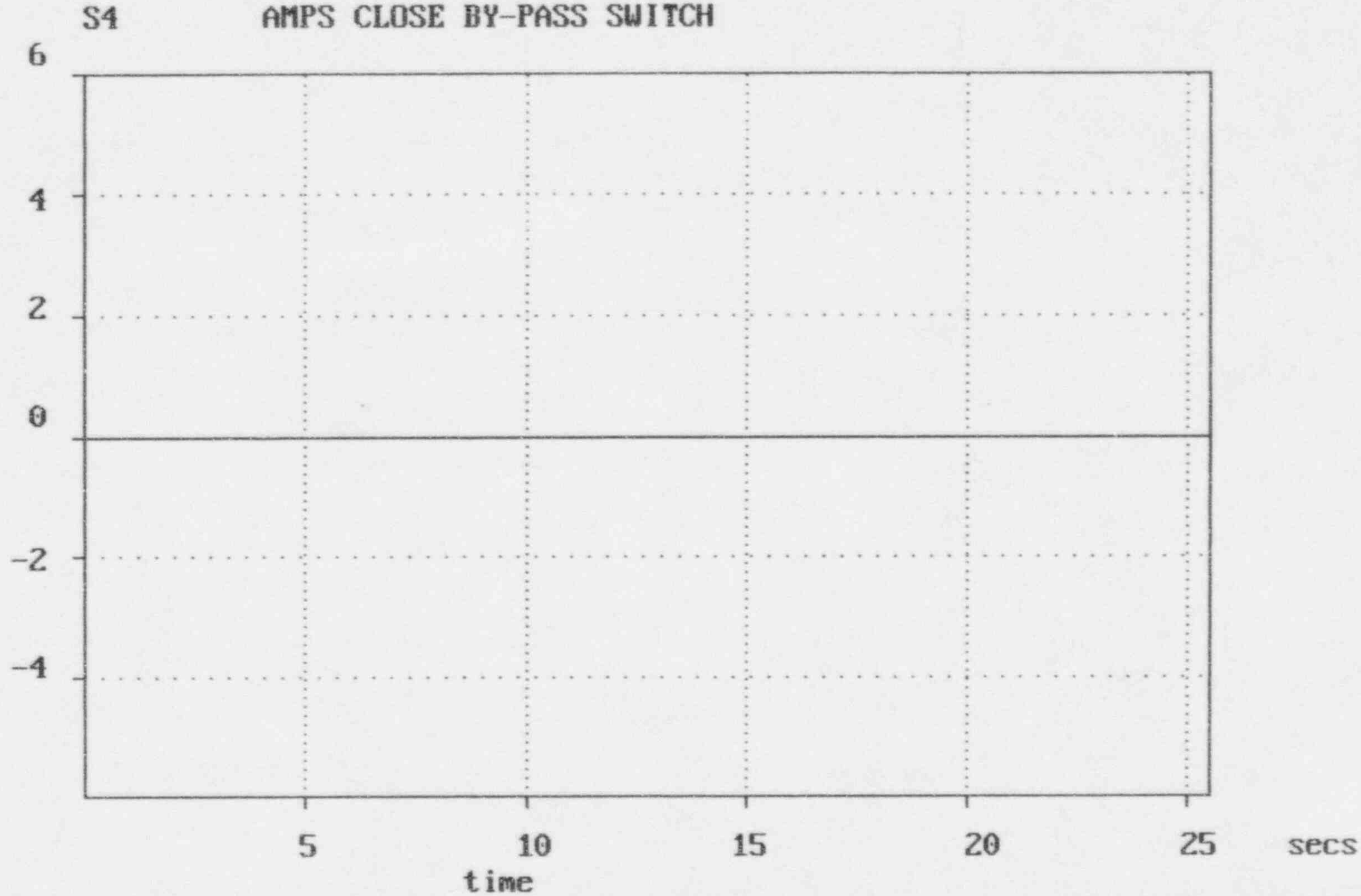
B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)



B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

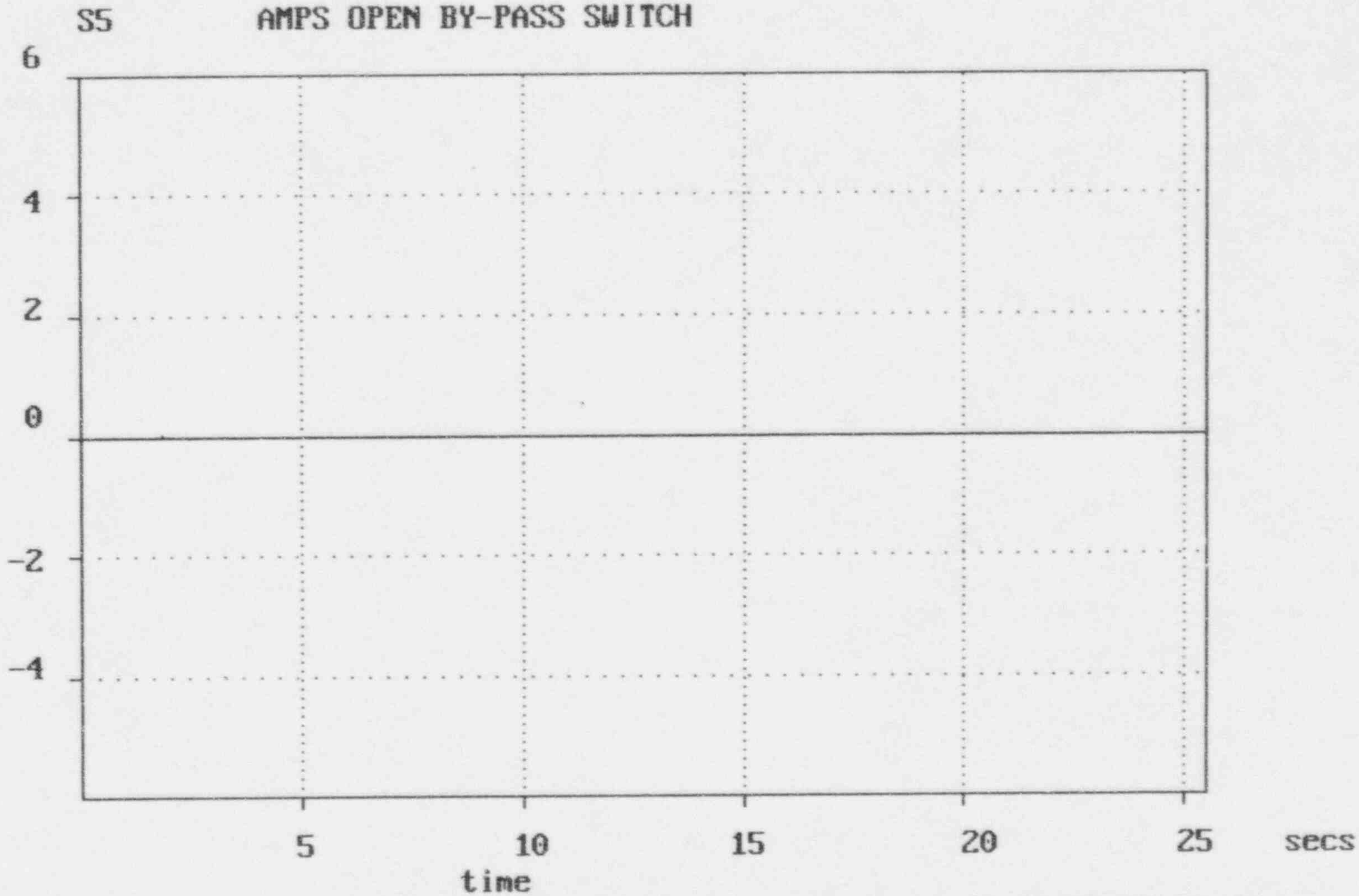
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)



B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

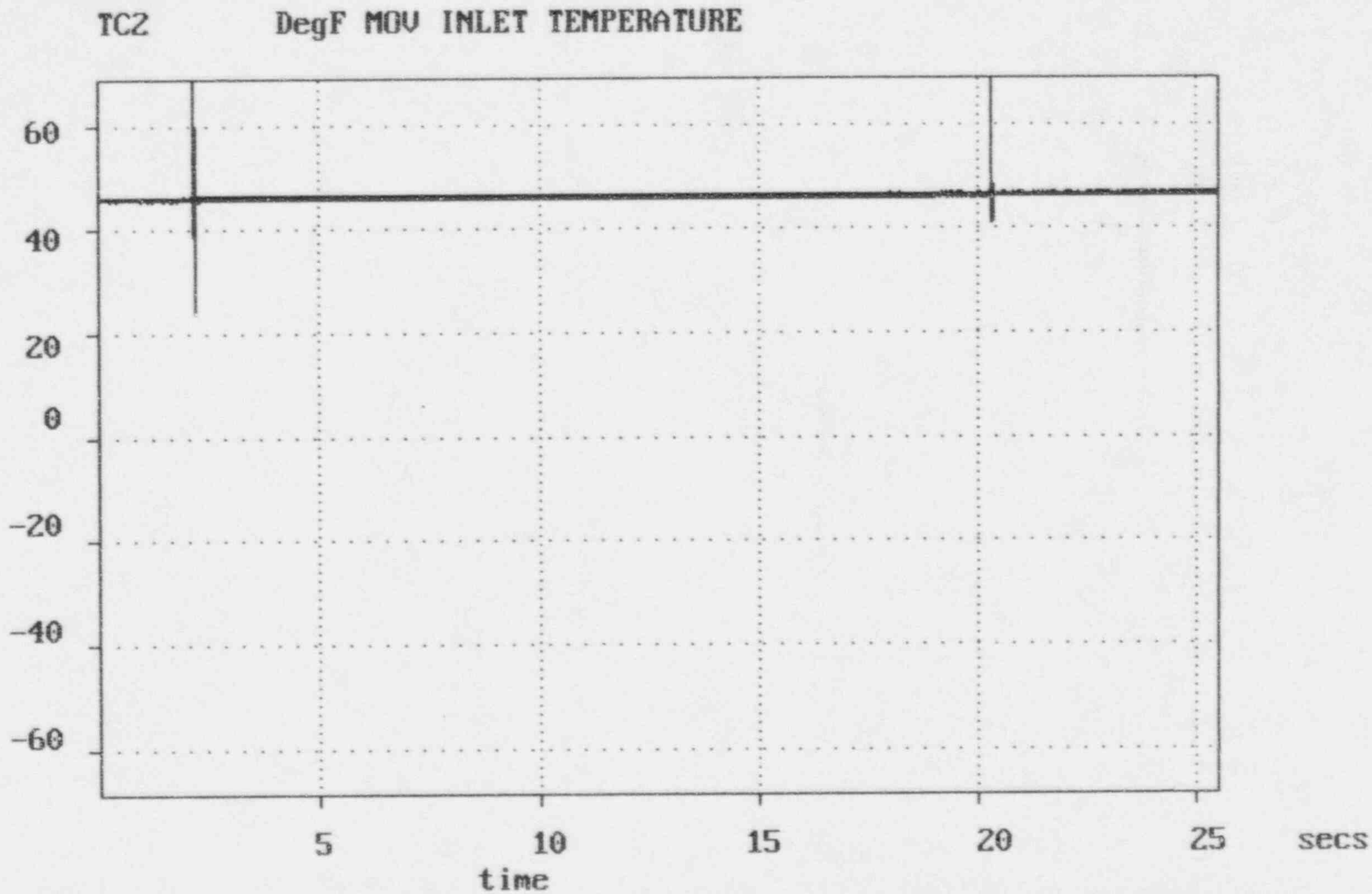
TEST COMPLETE

6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)



B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)

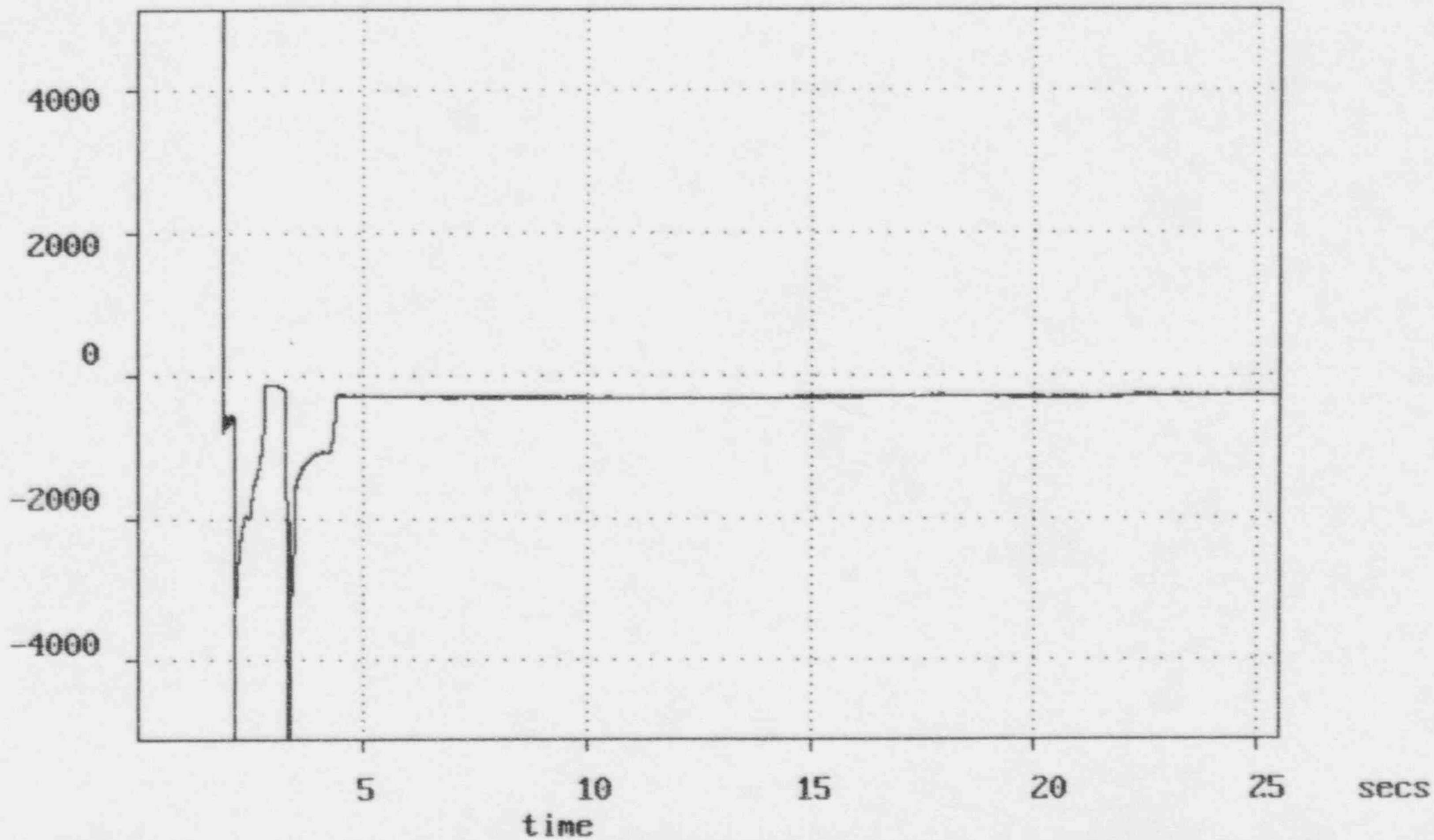


B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

TEST COMPLETE

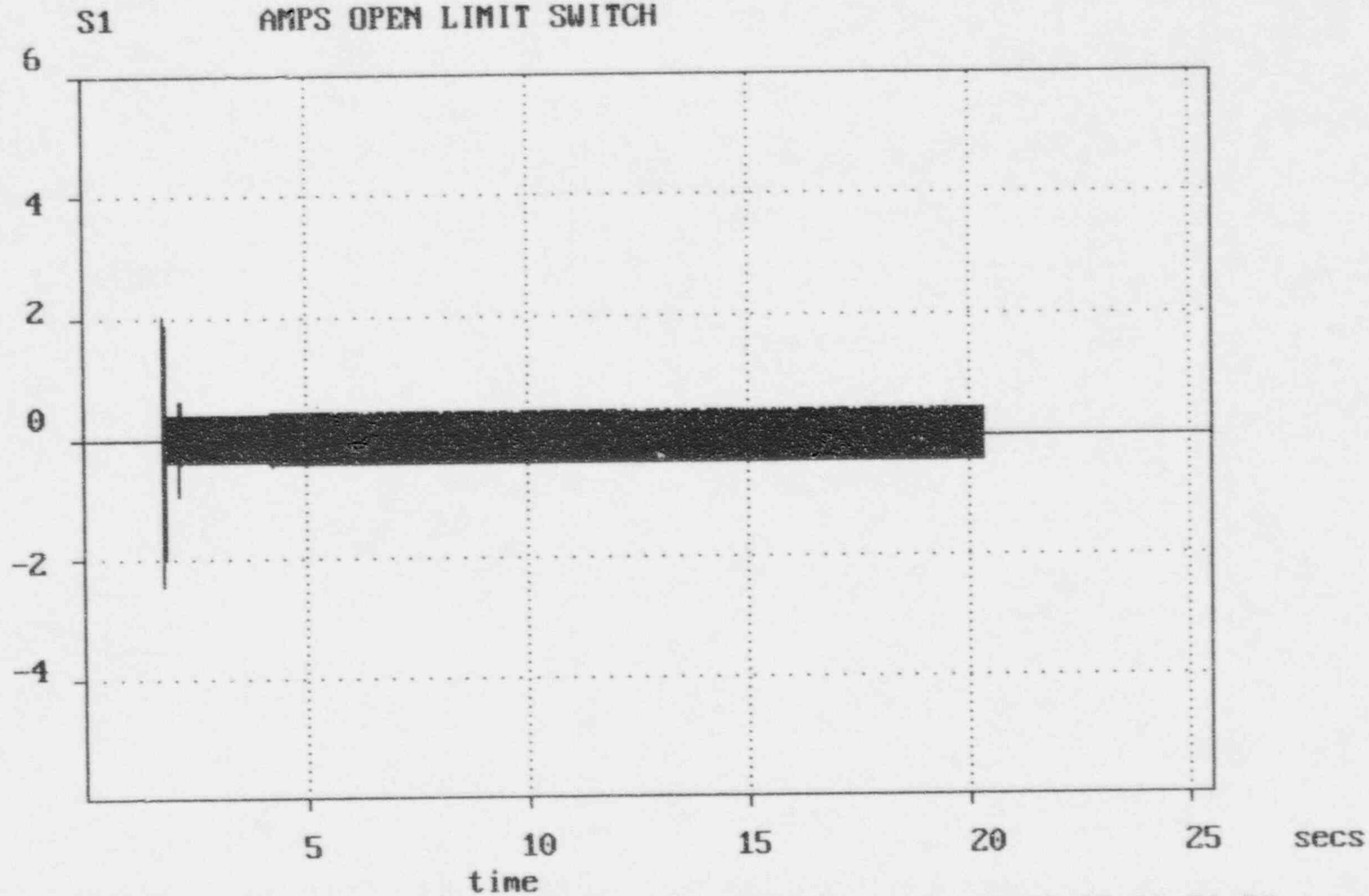
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)

TRQ1 InLB STEM TORQUE



B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

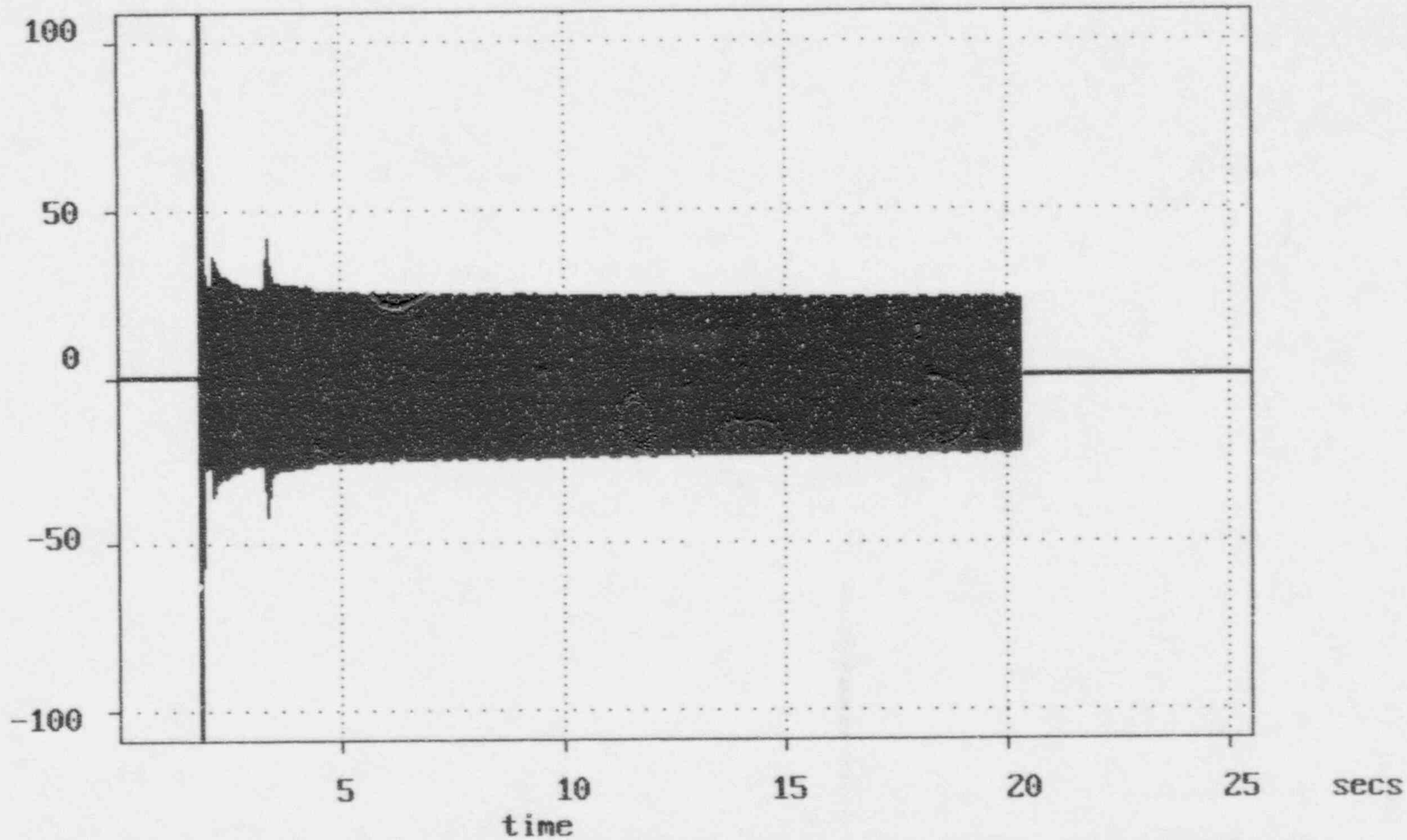
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST   TEST#5 a   (TORQUE SWITCH SET TO APROX. 1.5)



B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

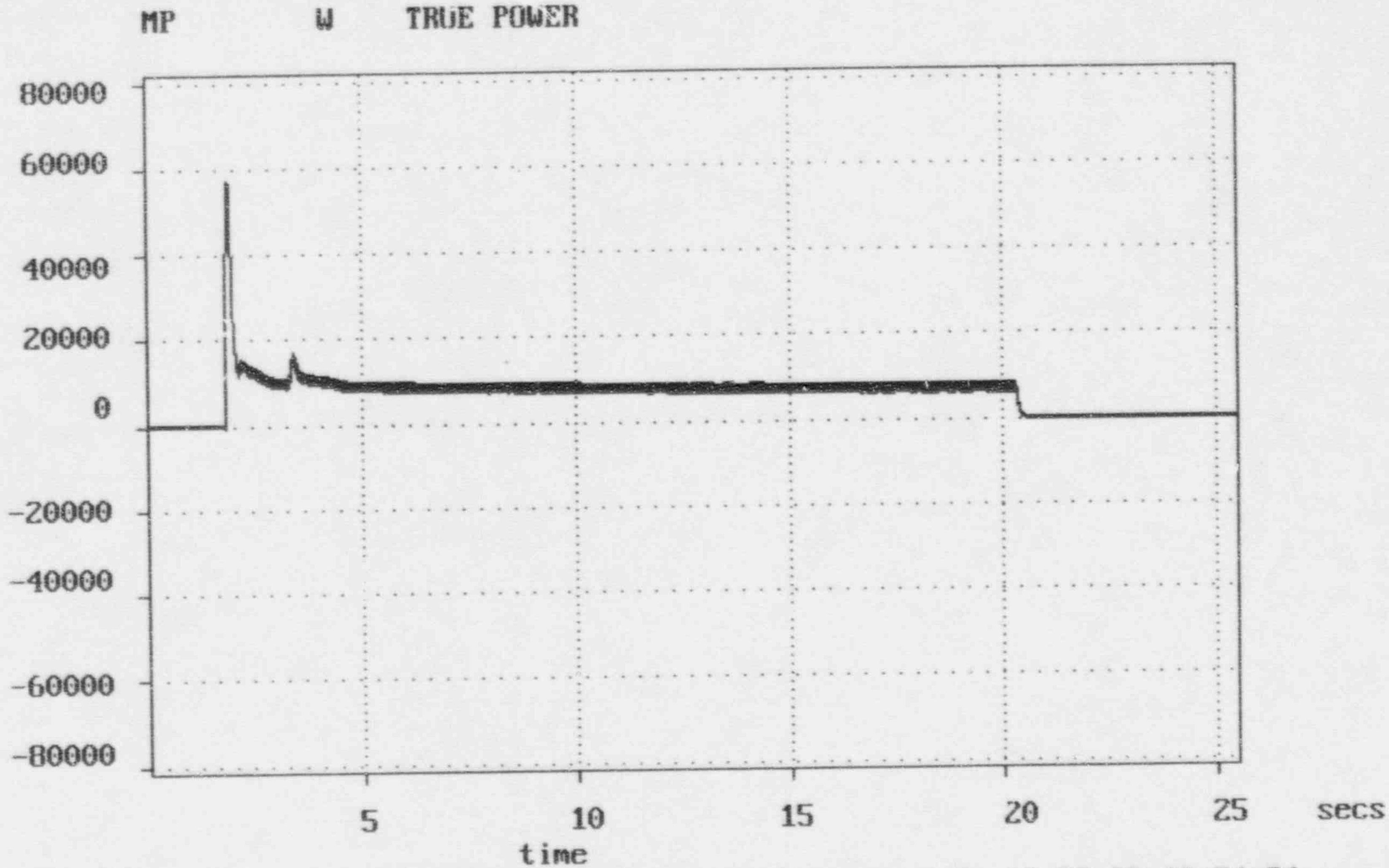
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST #5 a (TORQUE SWITCH SET TO APROX. 1.5)

MC1 AMPS L1 CURRENT



B430081 DataSet 007 Duration 00:00:25:470 Recorded On 12/29/92 10:34:34

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)



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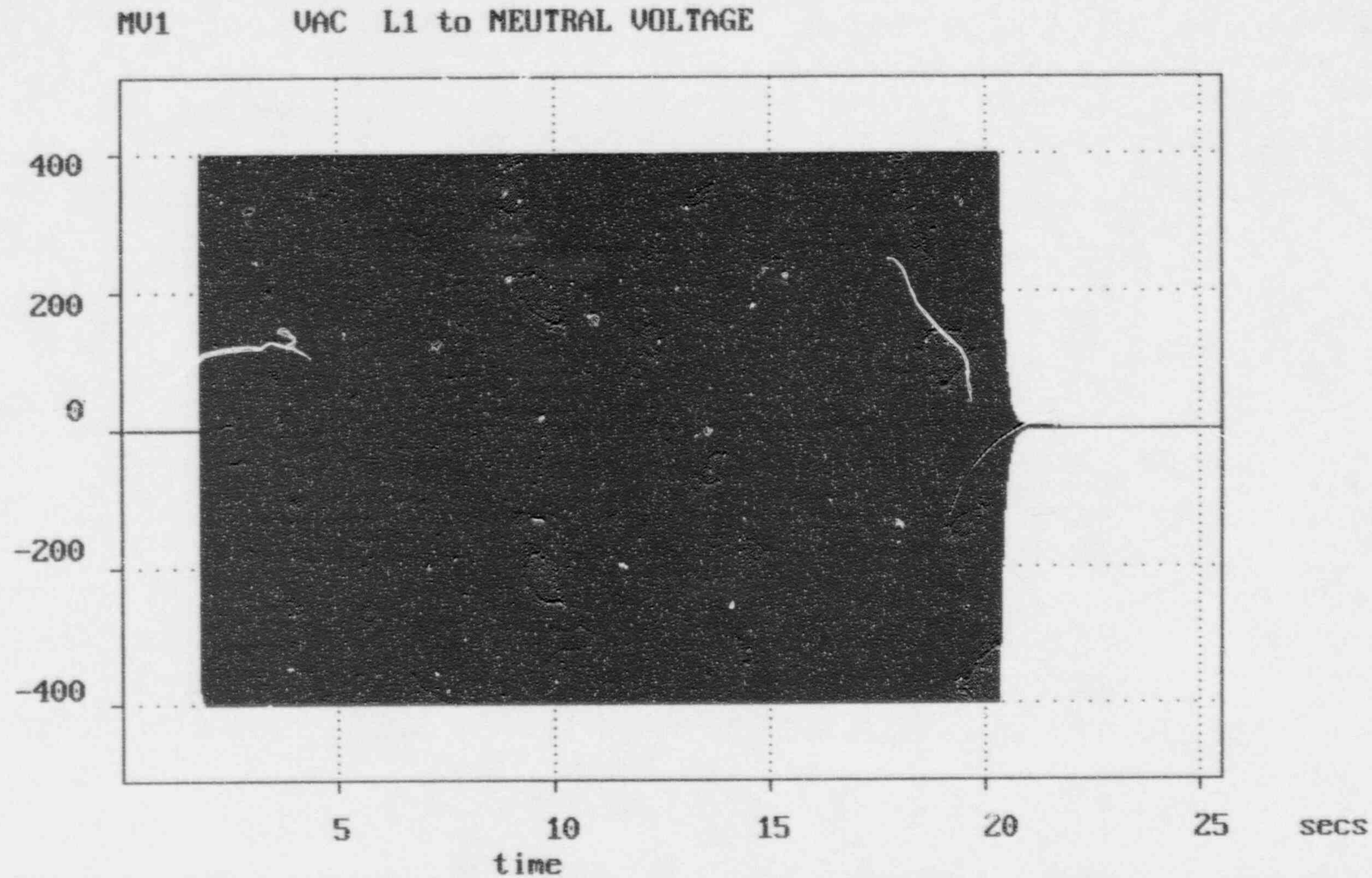
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.5)



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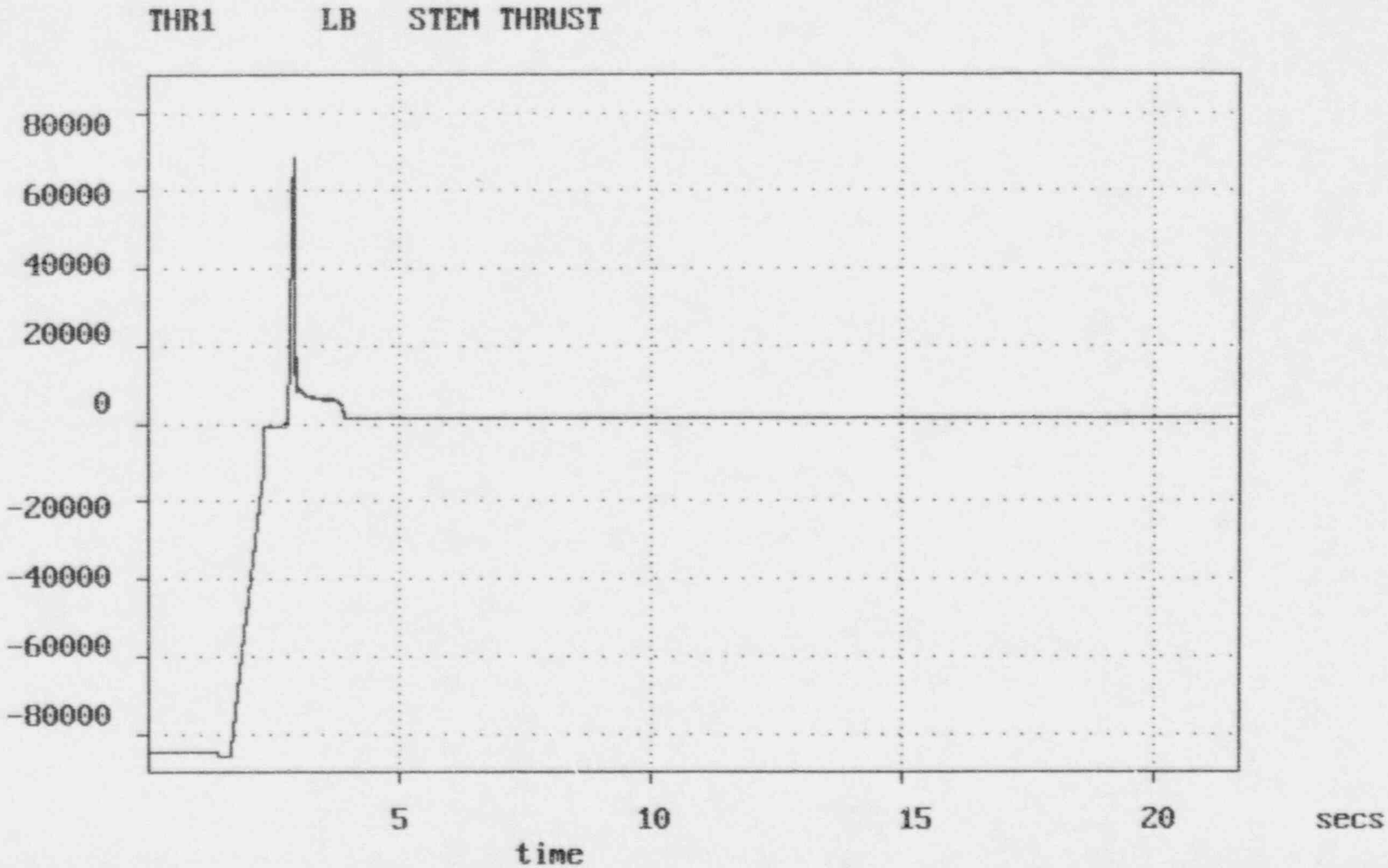
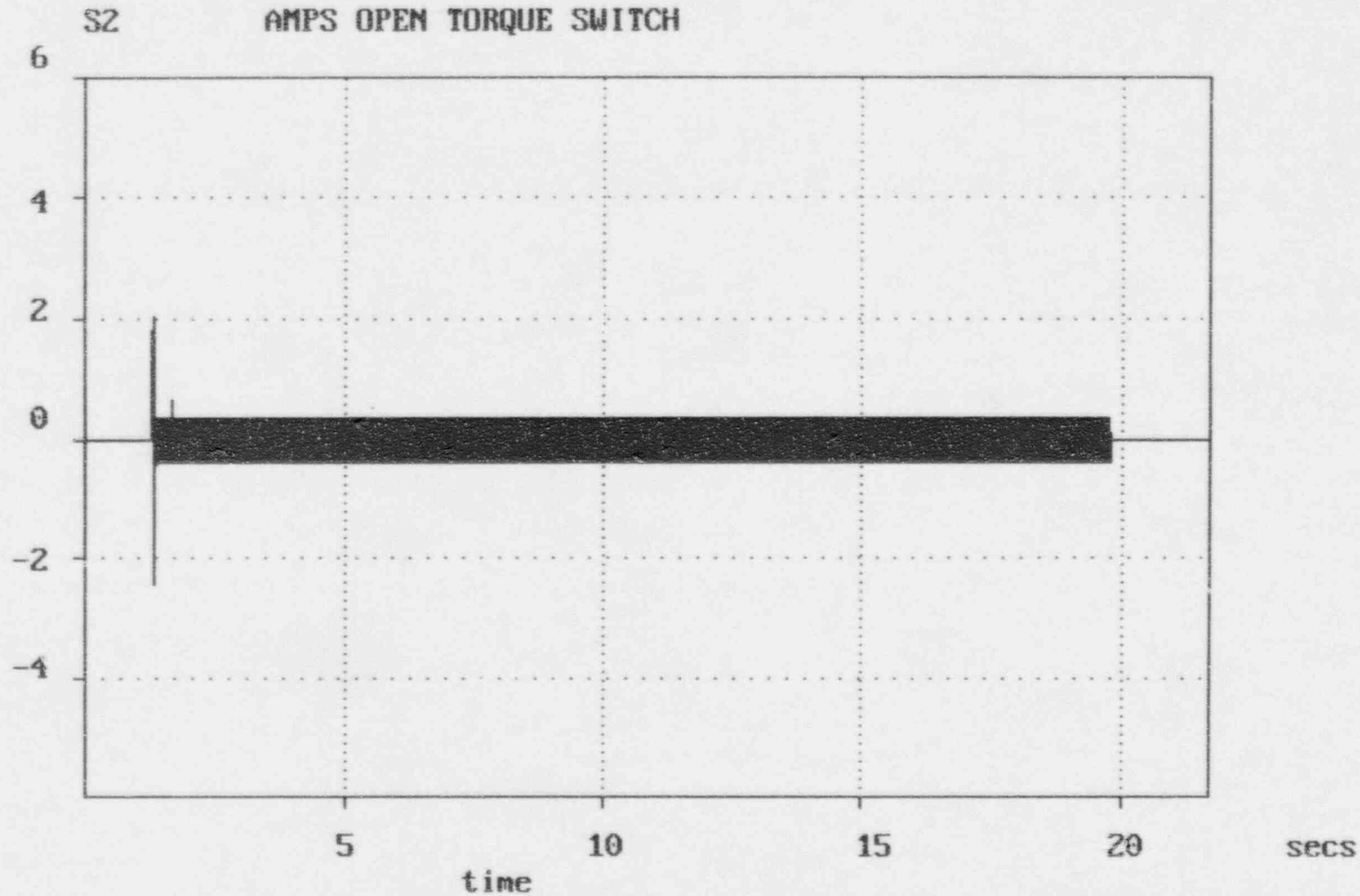
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

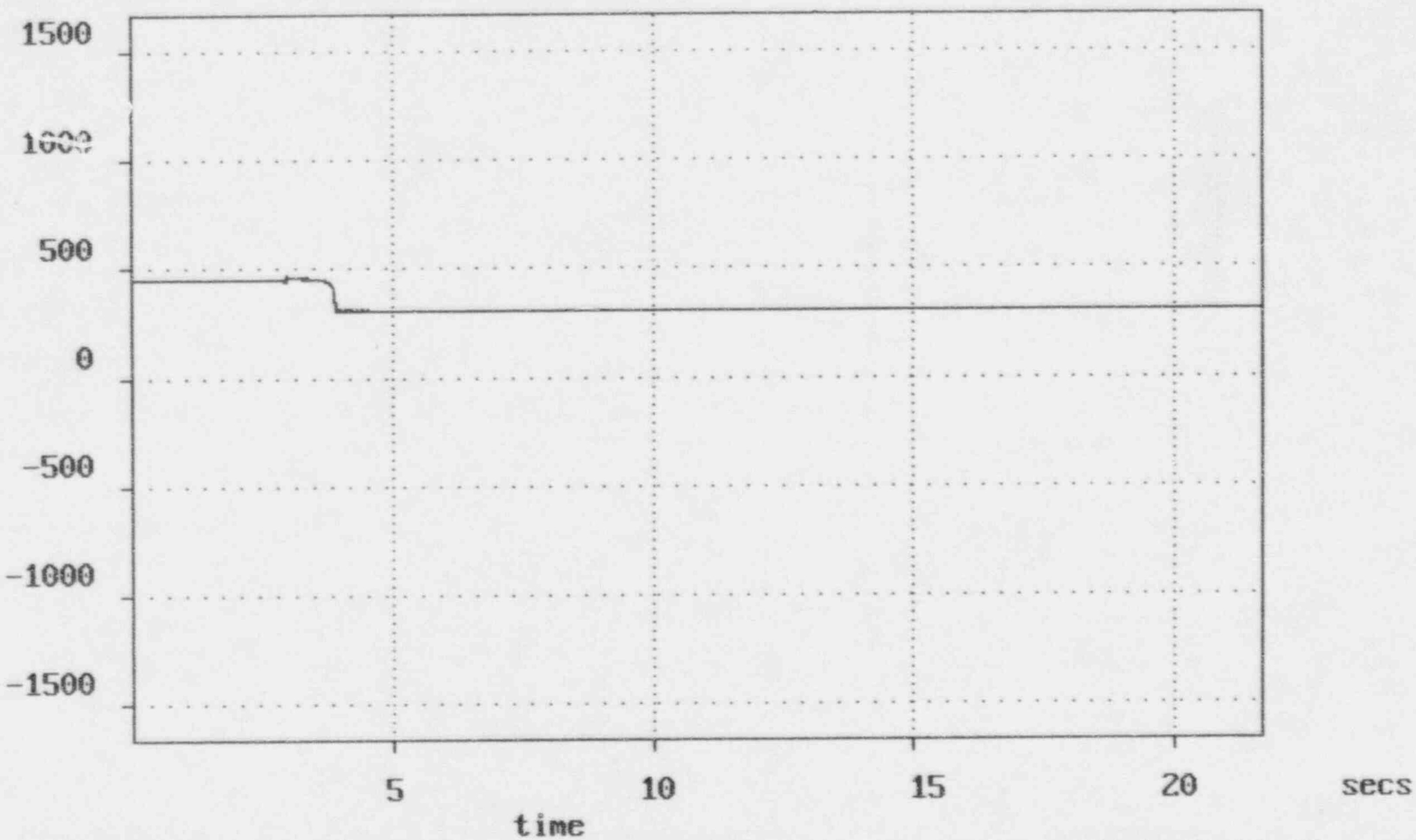
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)

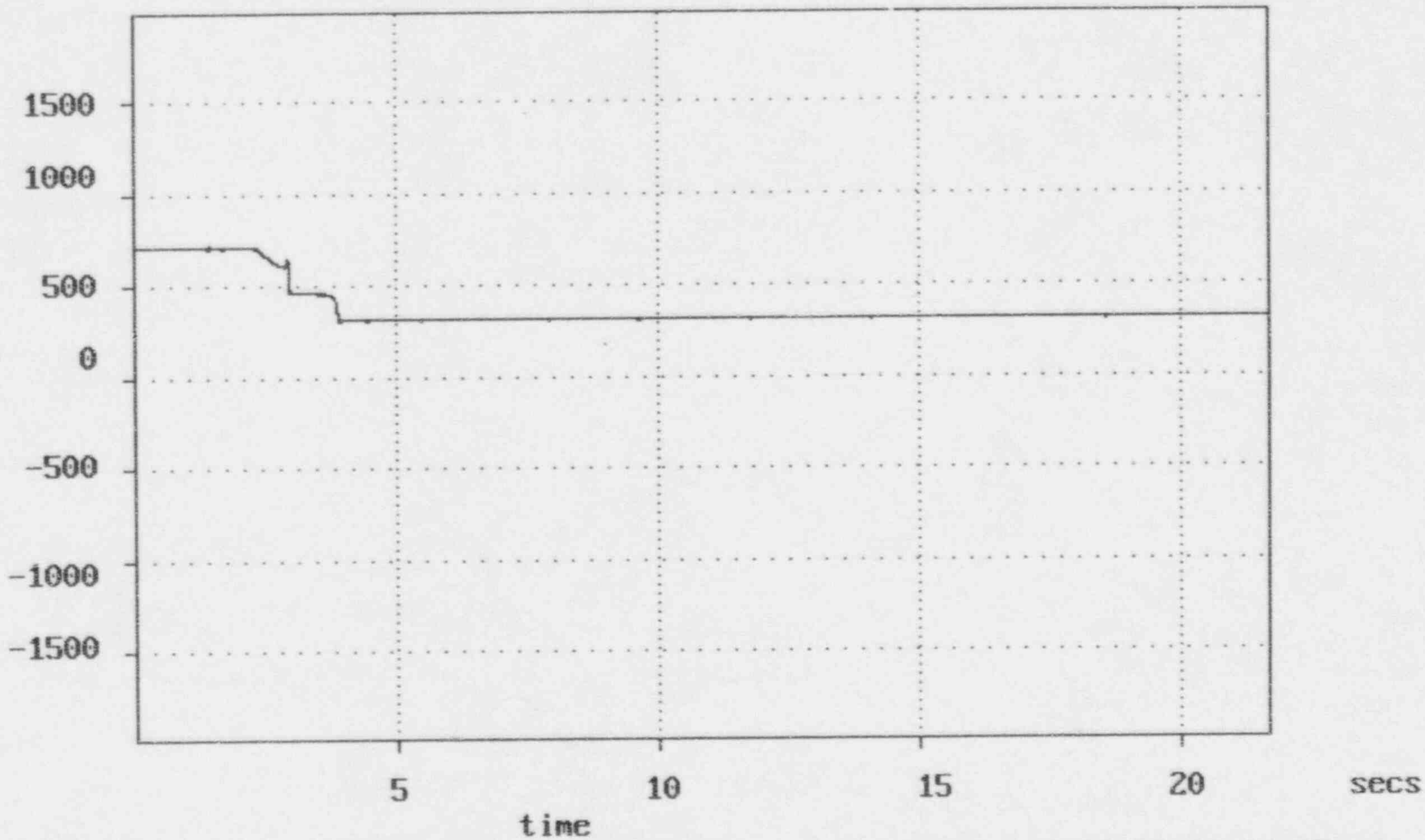
PS2 PSIG DOWNSTREAM PRESSURE



B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

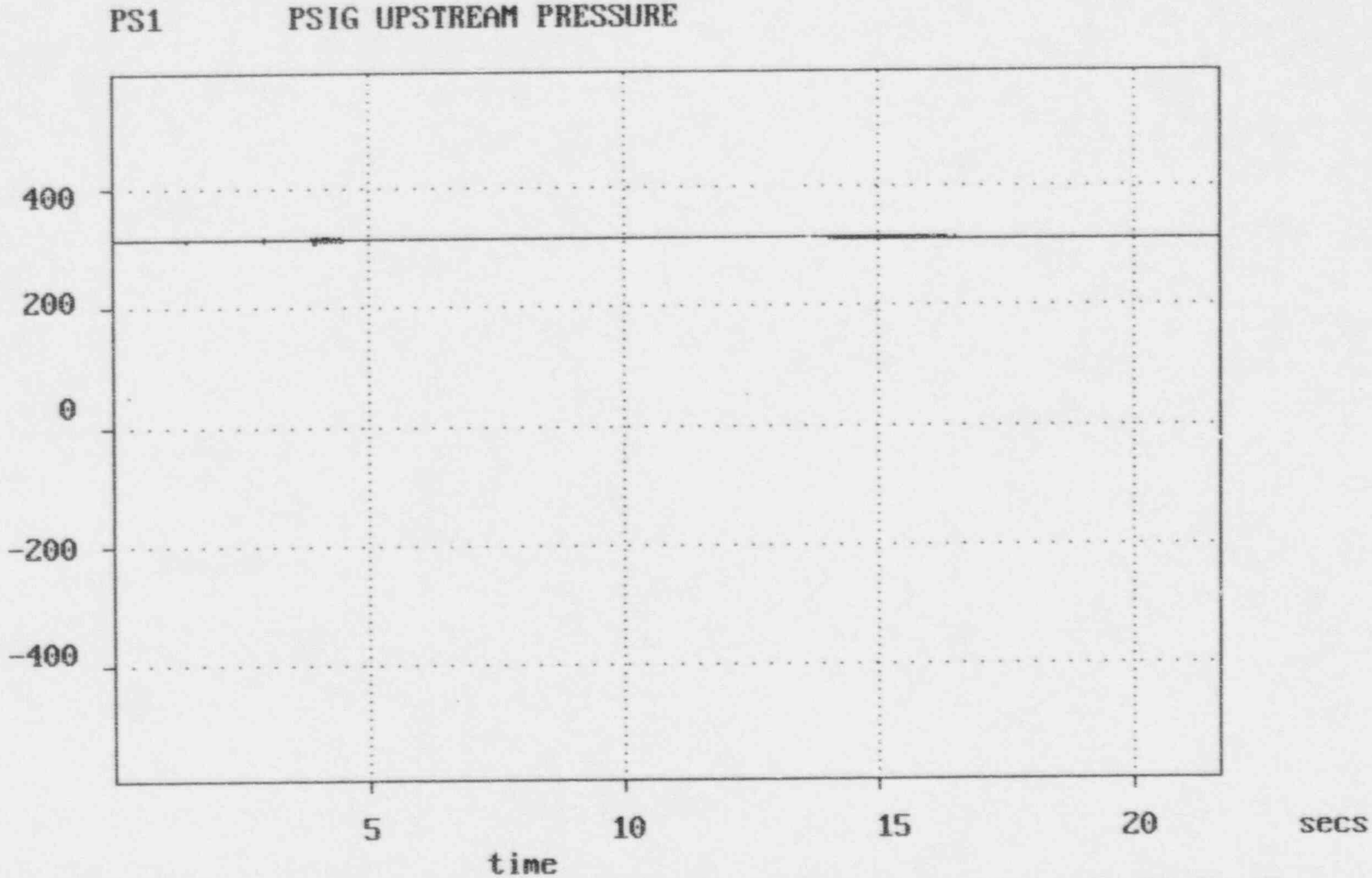
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)

PS3 PSIG BONNET PRESSURE



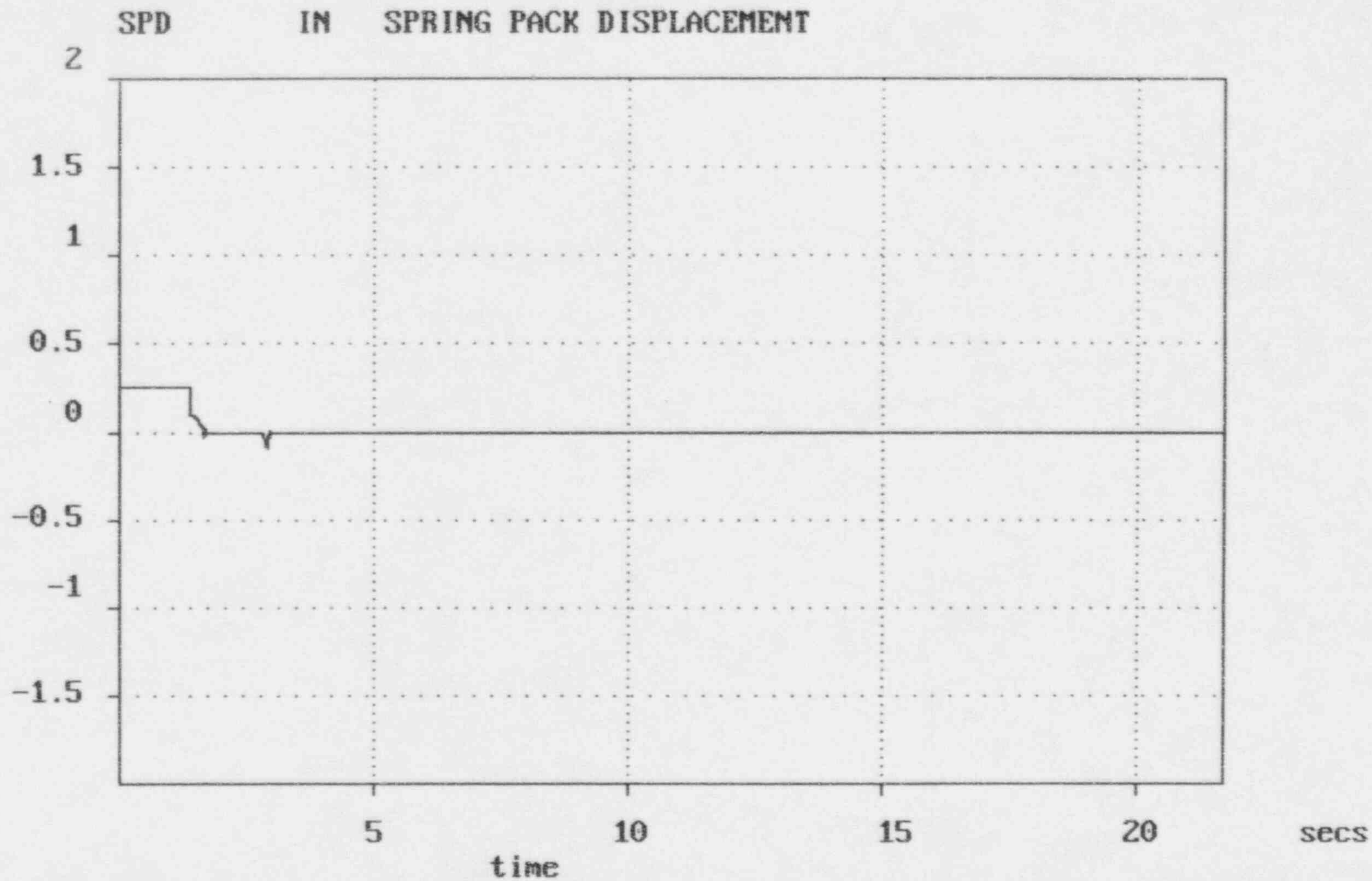
B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



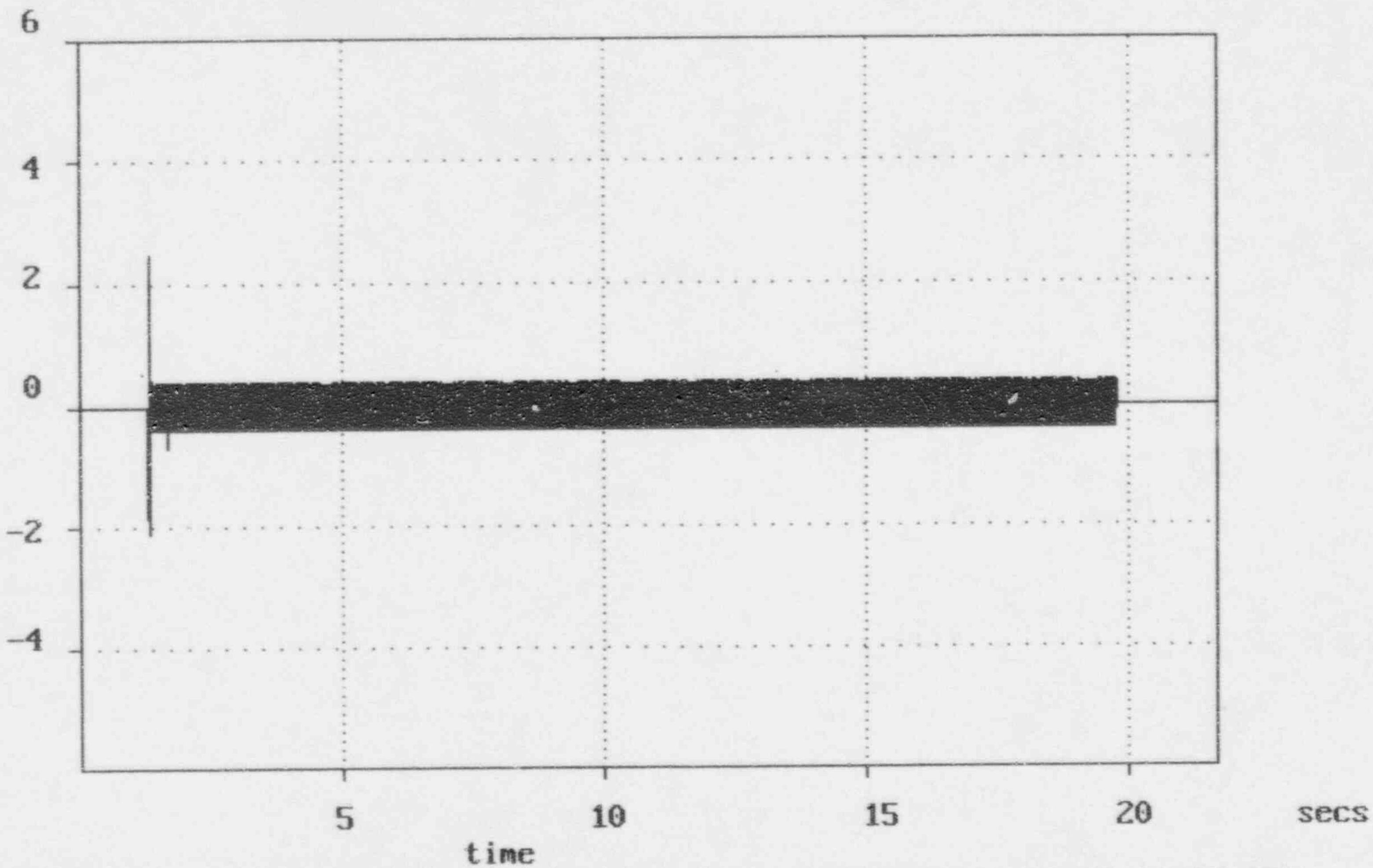
B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



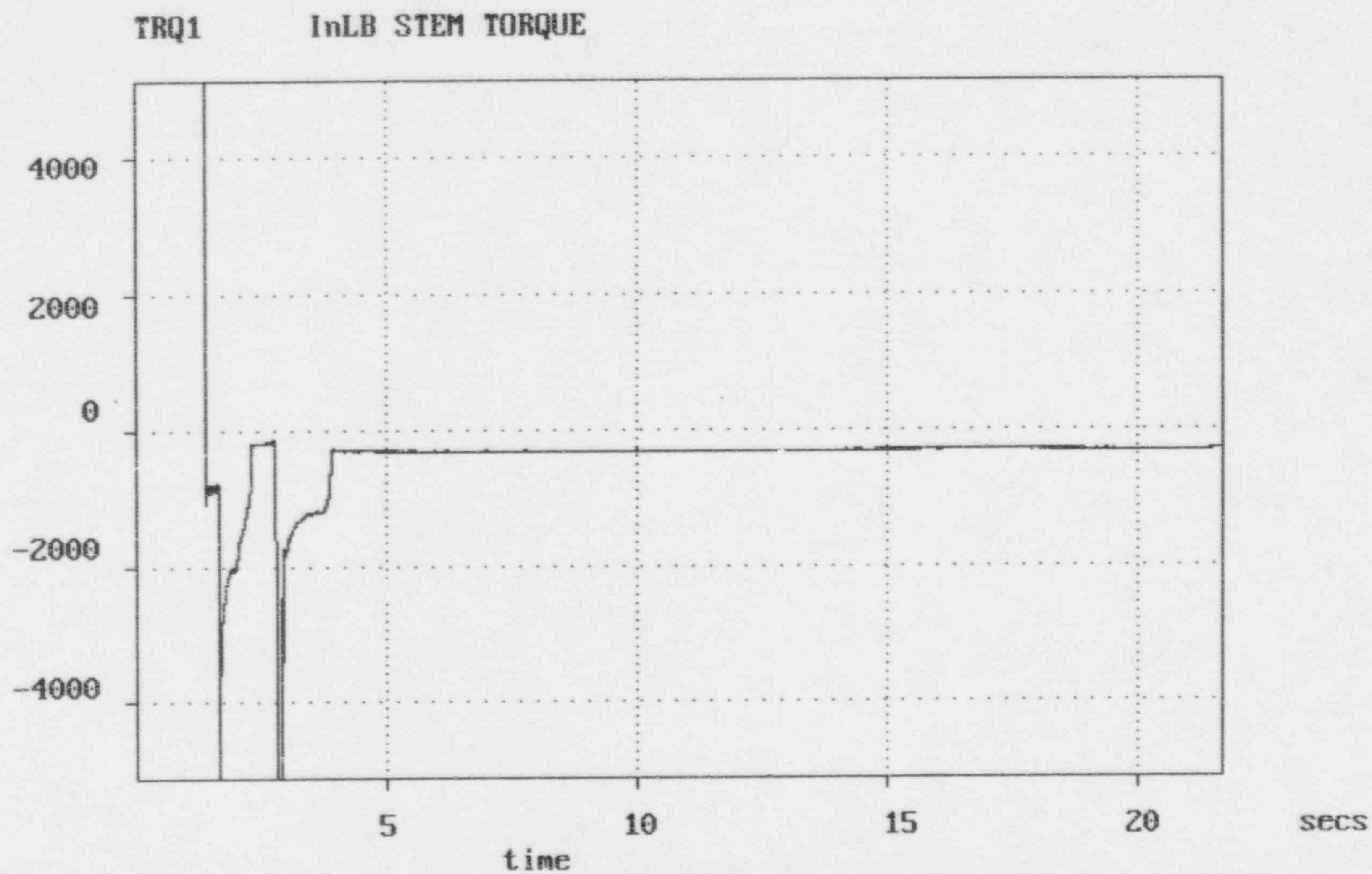
B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



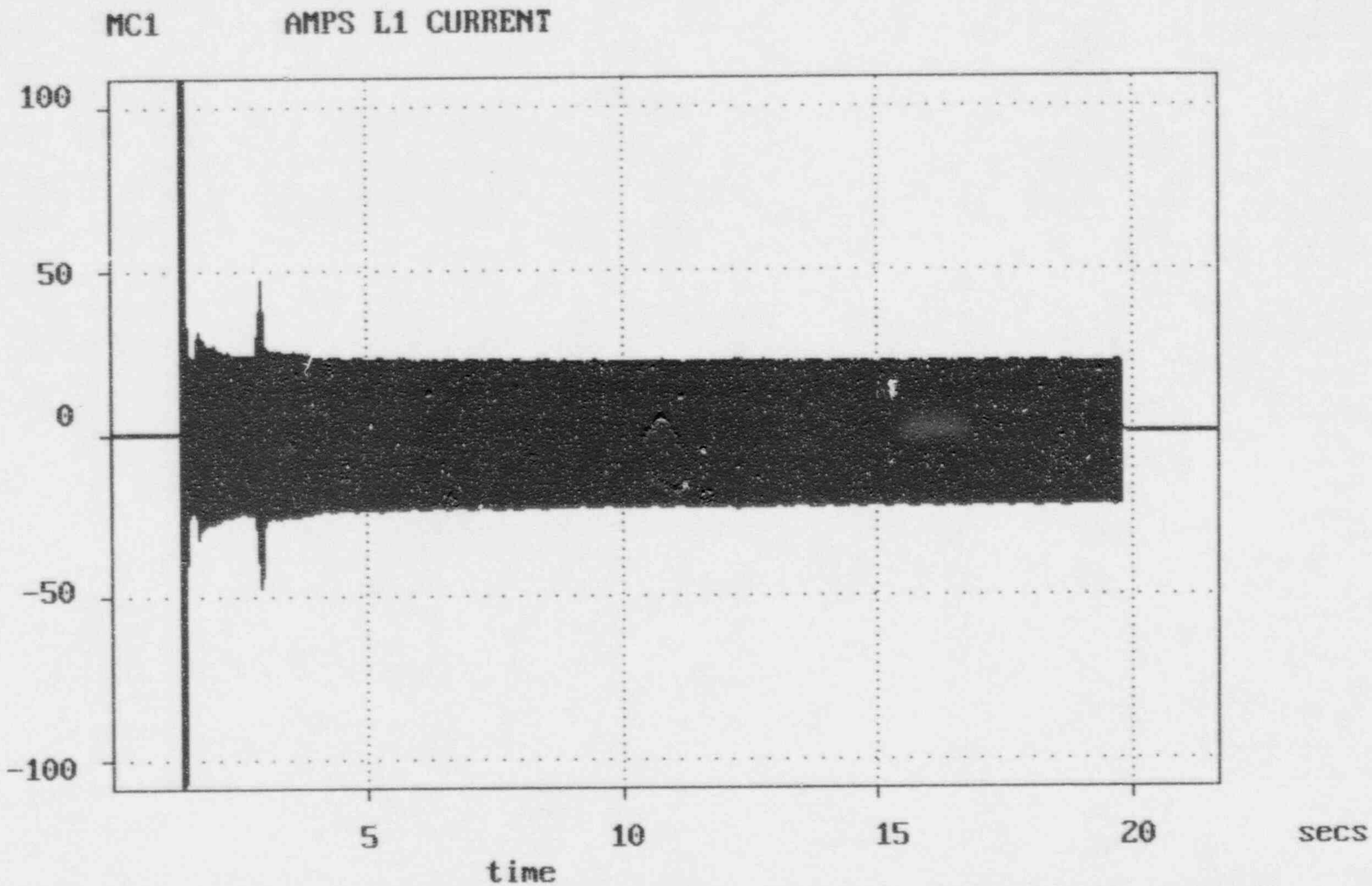
B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



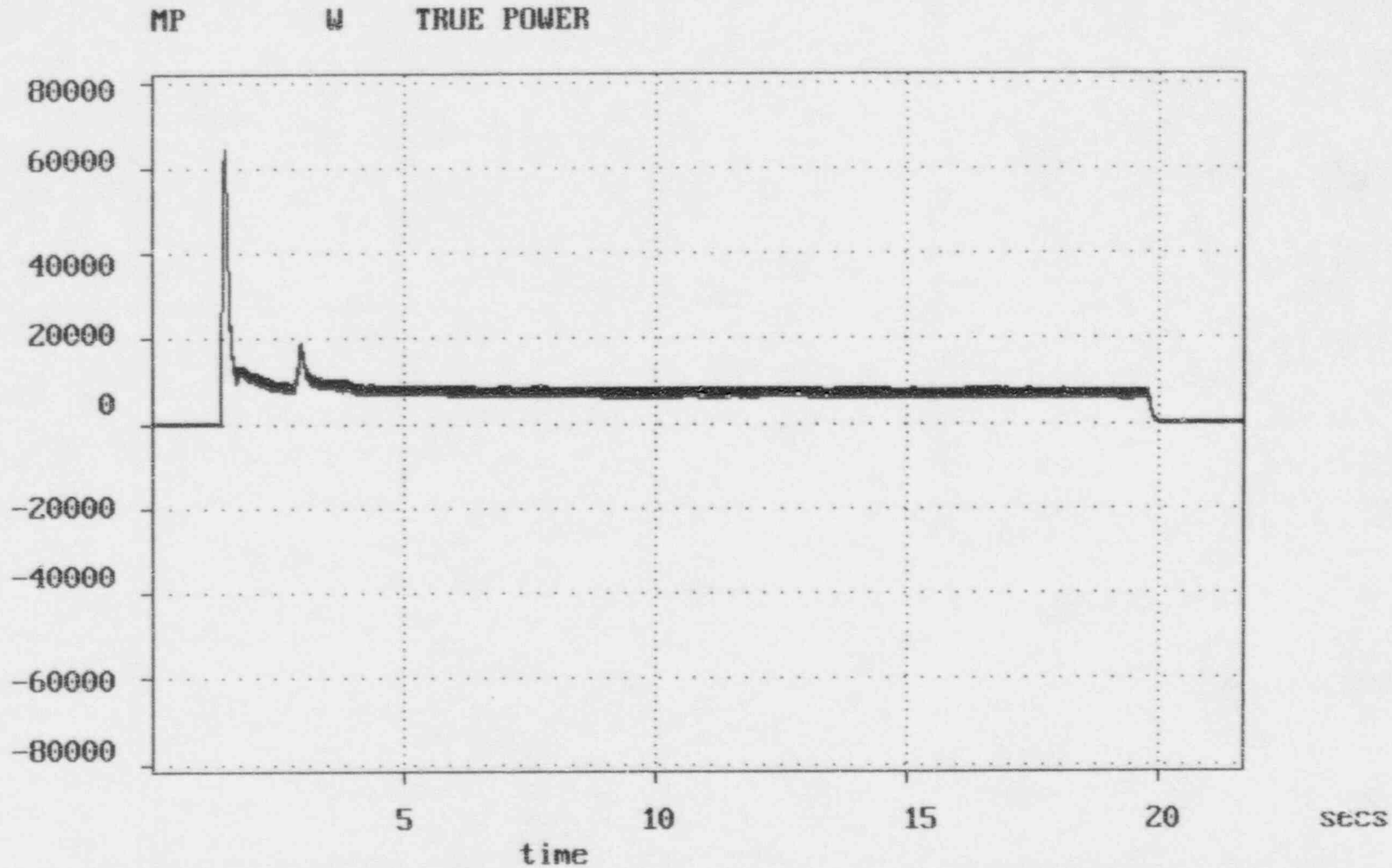
B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST #5 a (TORQUE SWITCH SET TO APROX. 1.65)



B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

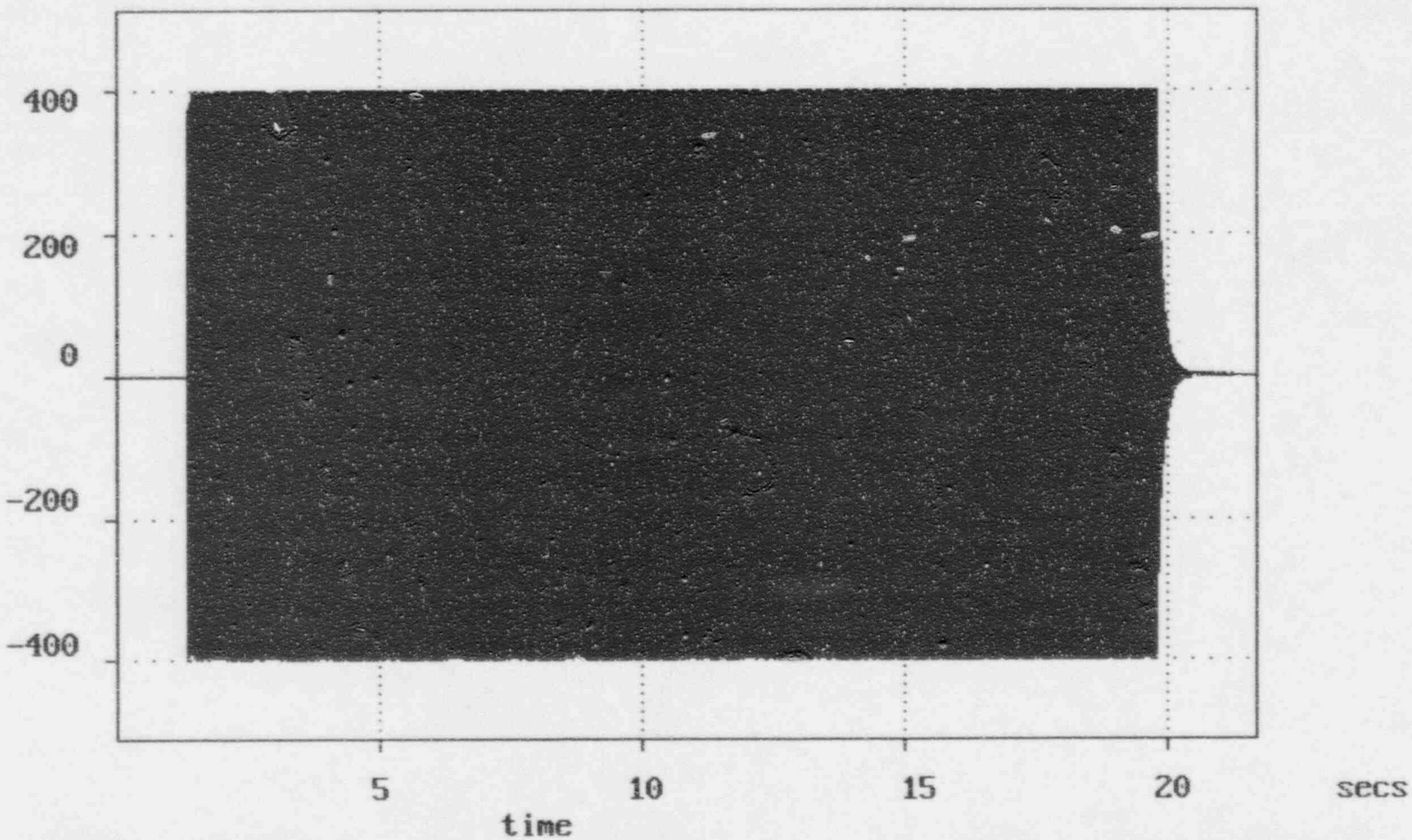
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

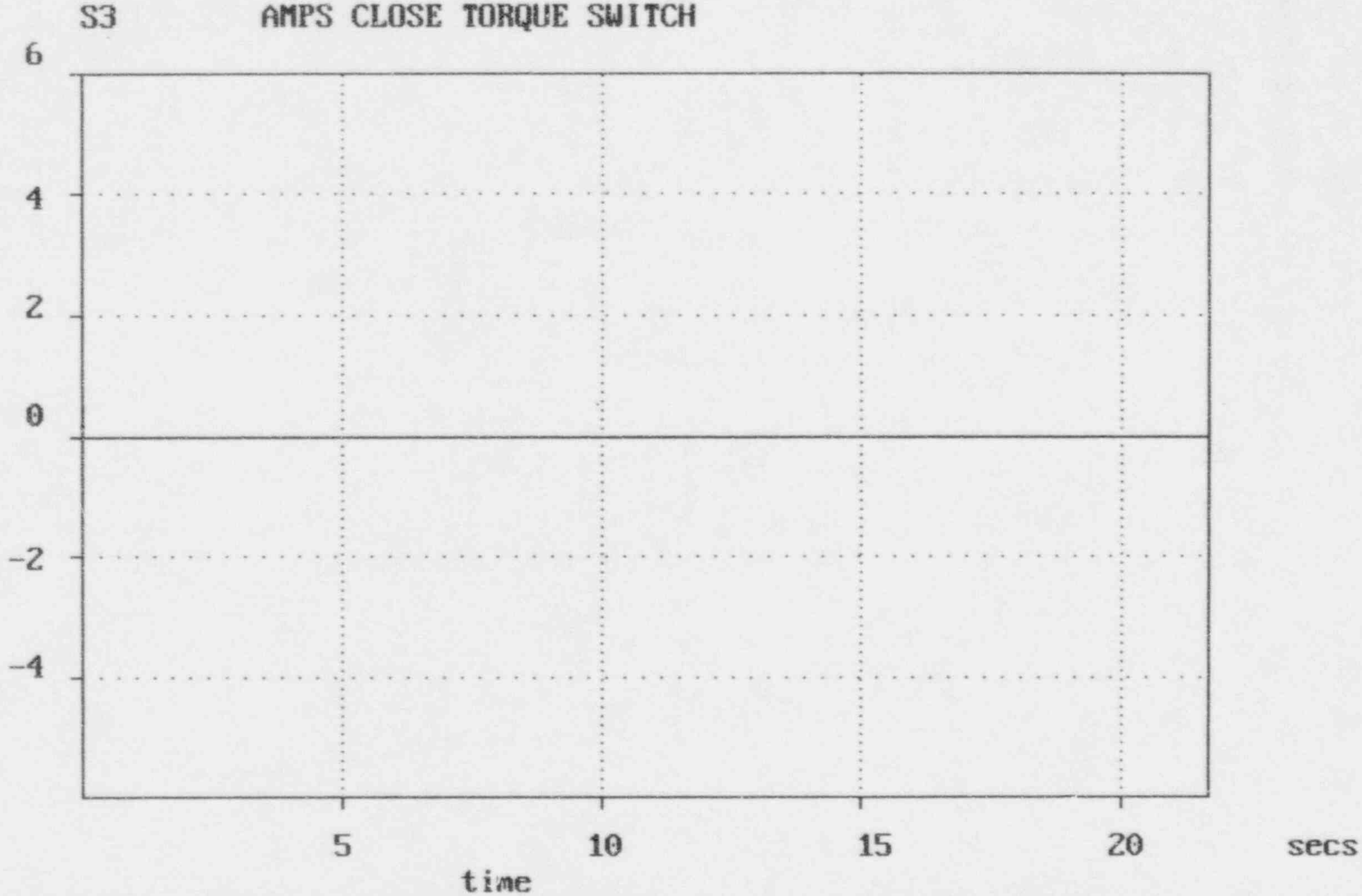
TEST COM LETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)

MV1 VAC L1 to NEUTRAL VOLTAGE



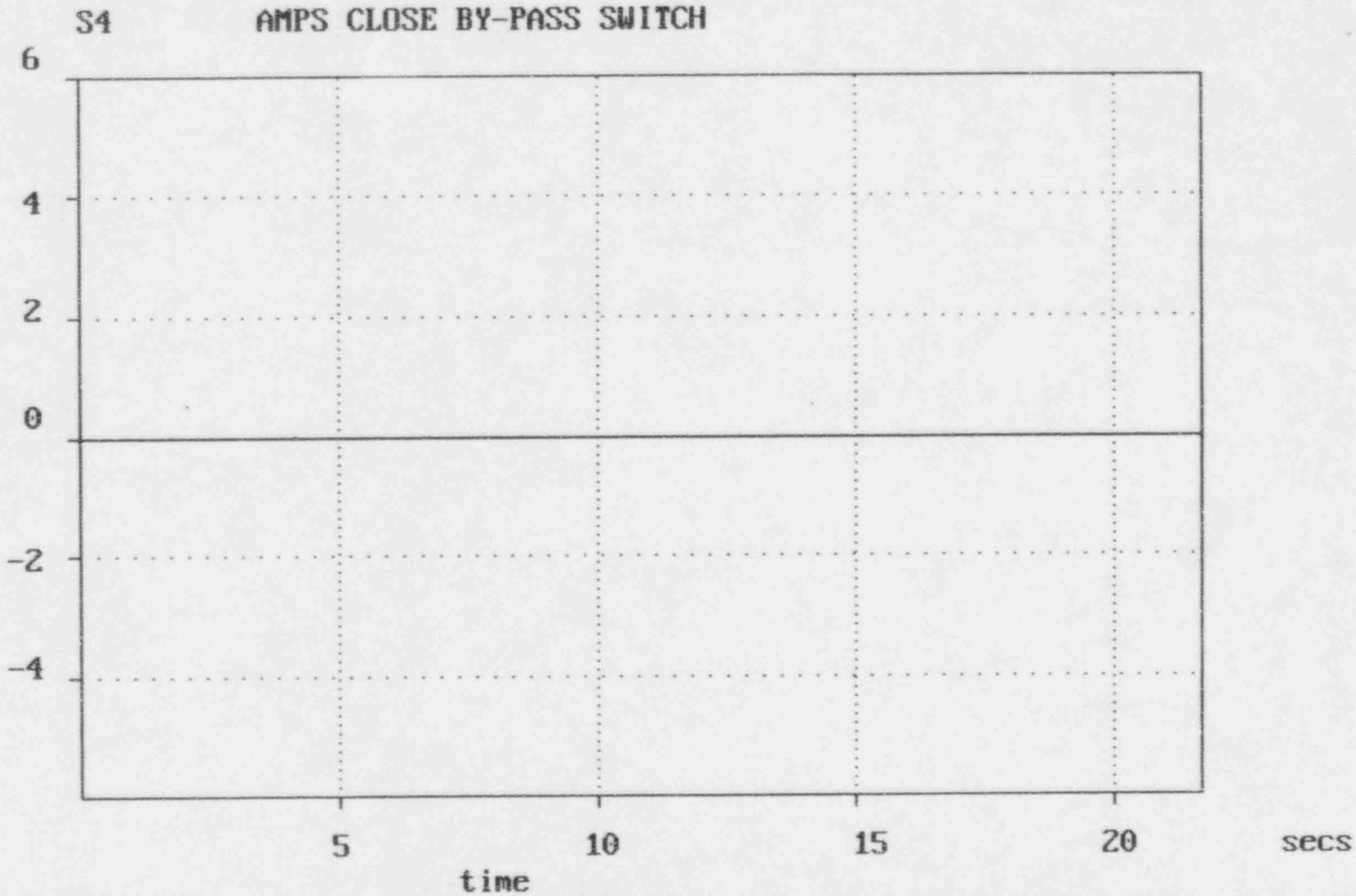
B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



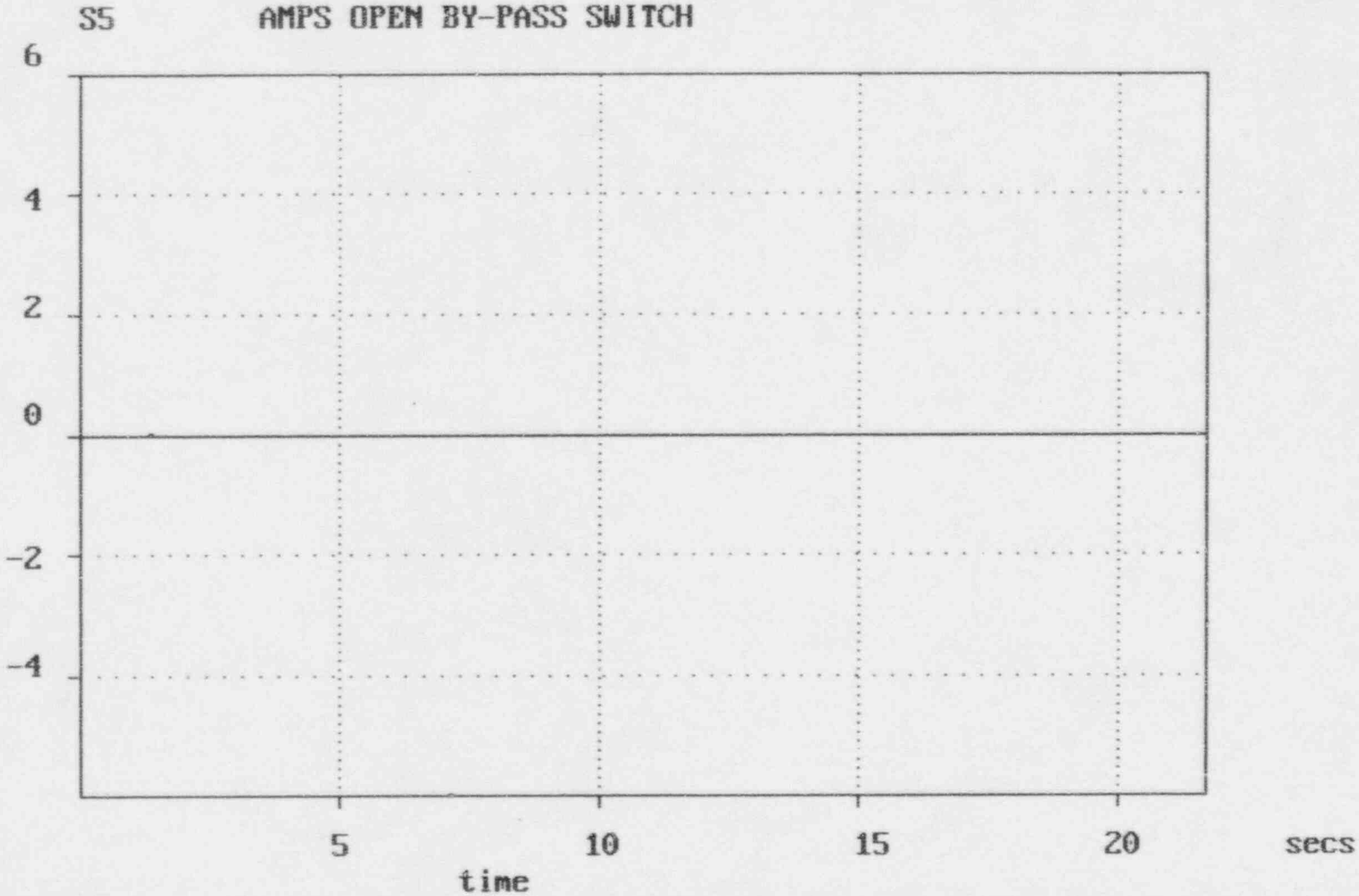
B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

T¯ST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

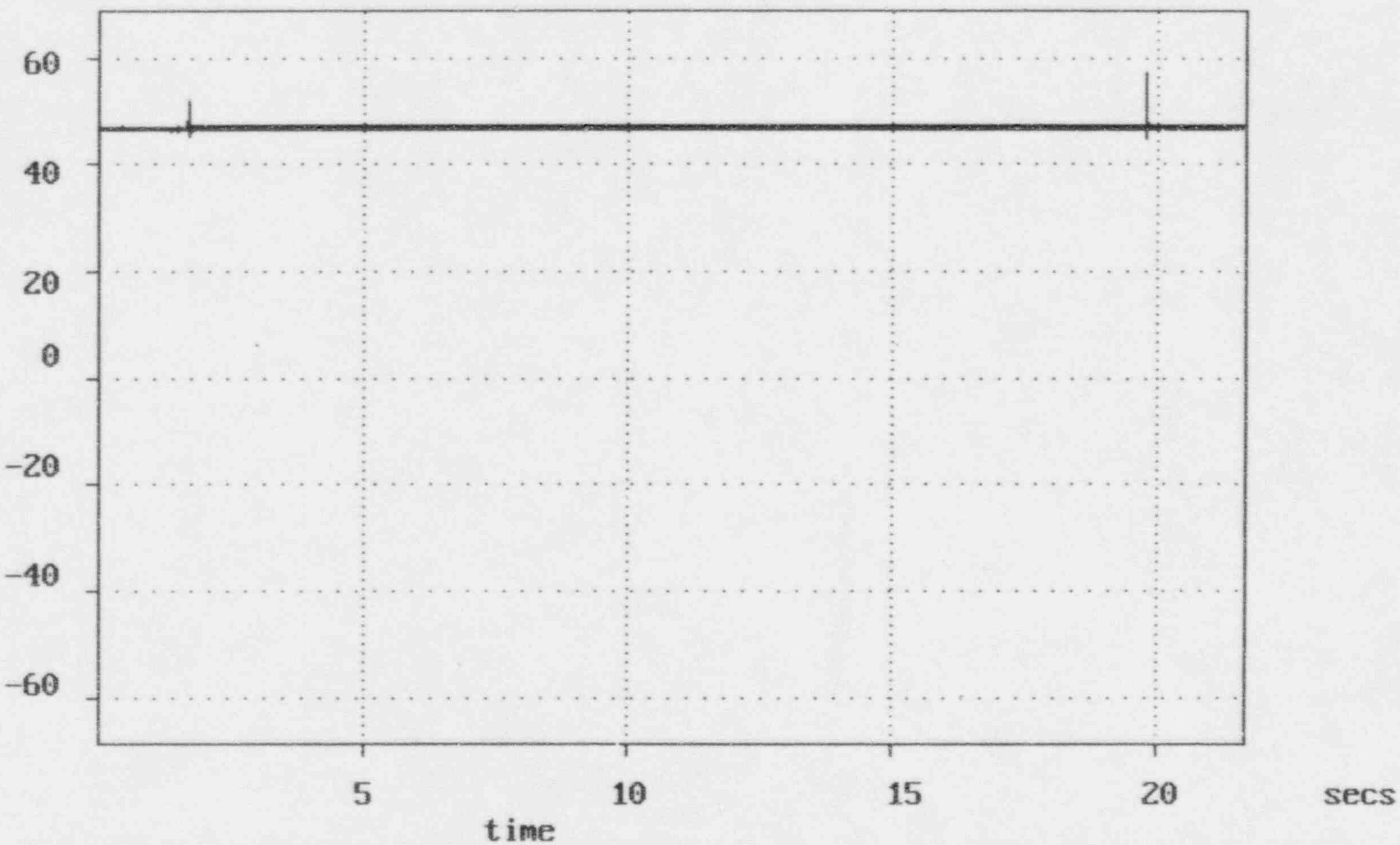
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)



B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.65)

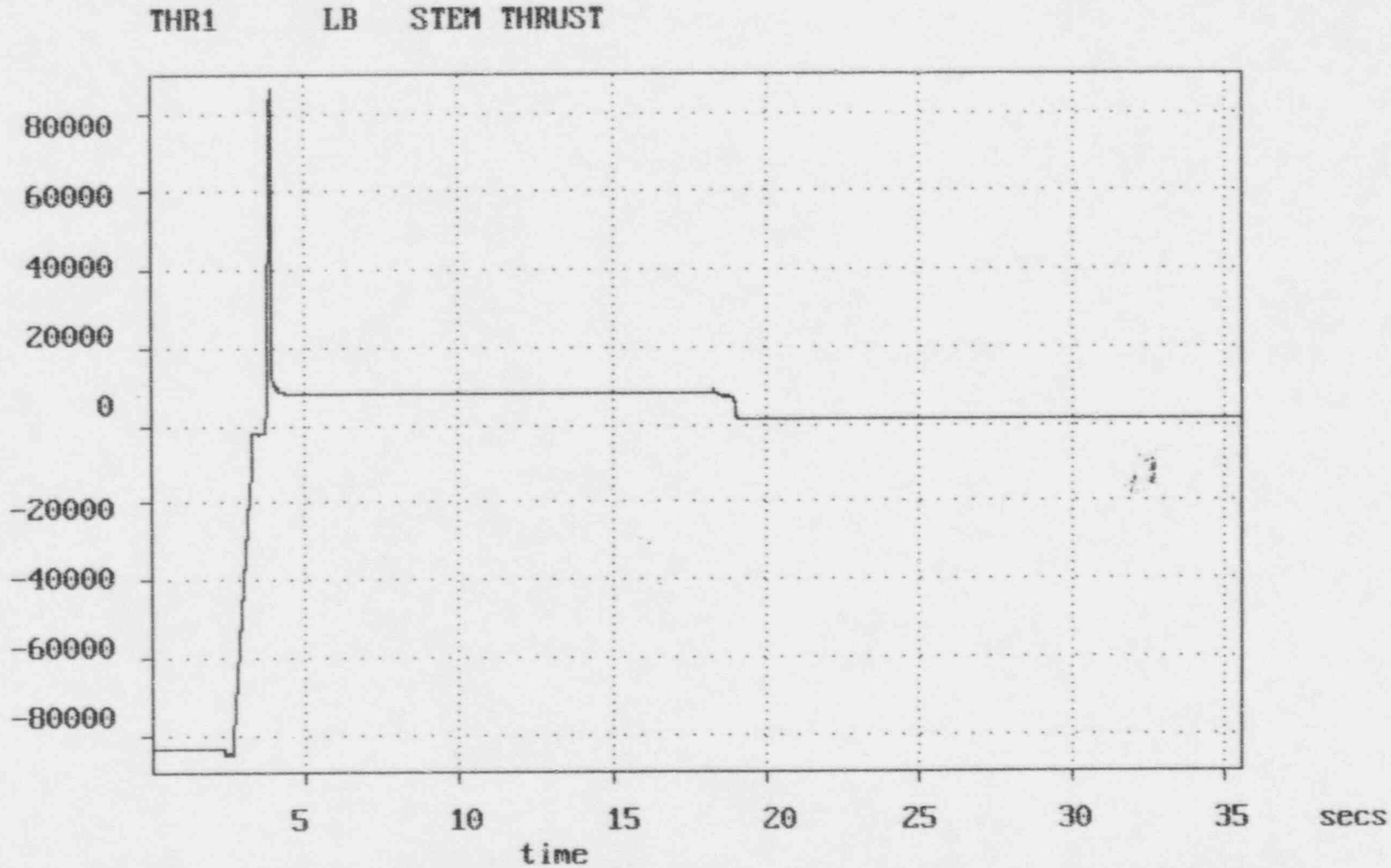
TC2 DegF MOV INLET TEMPERATURE



B430081 DataSet 008 Duration 00:00:21:683 Recorded On 12/29/92 11:04:17

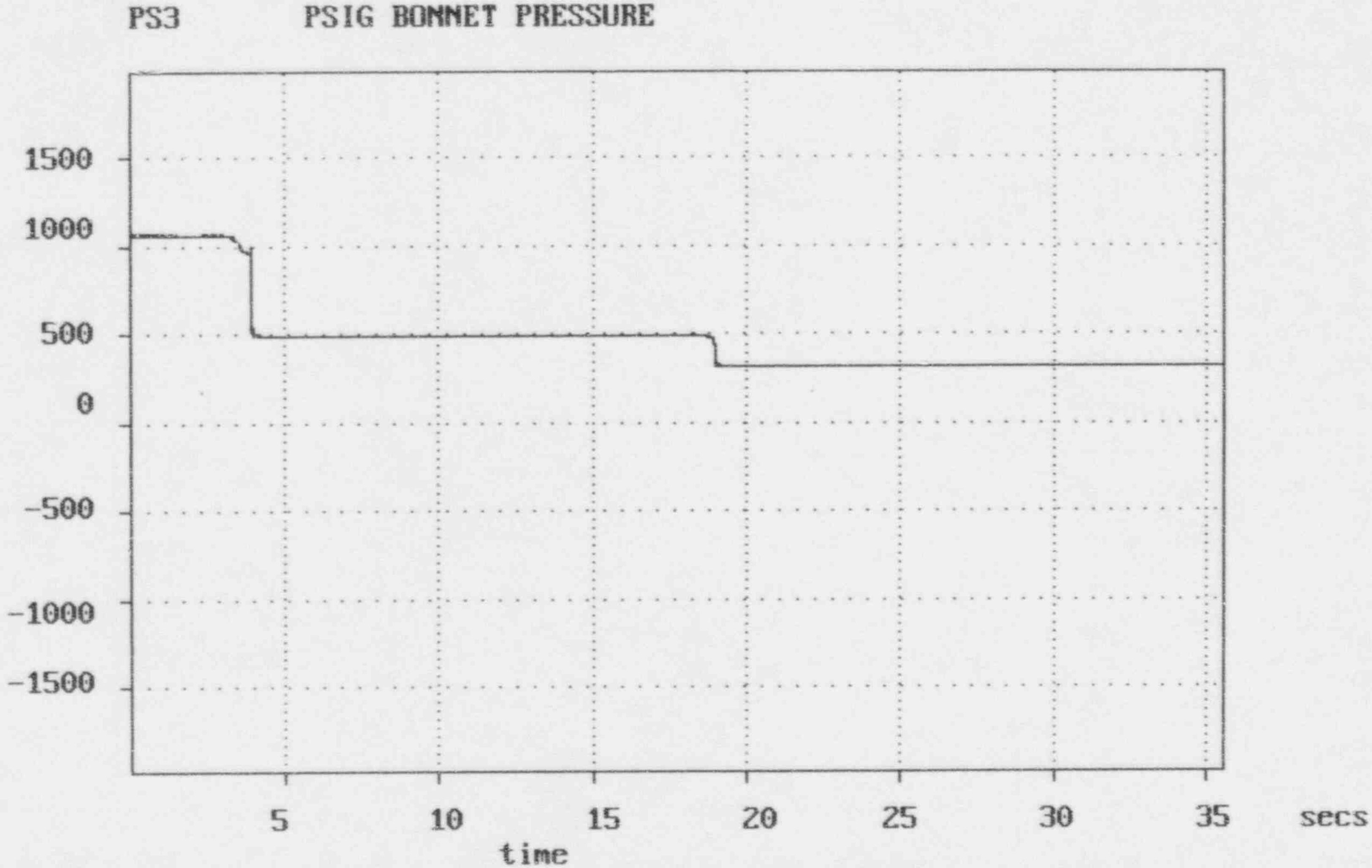
TEST COMPLETE

6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)



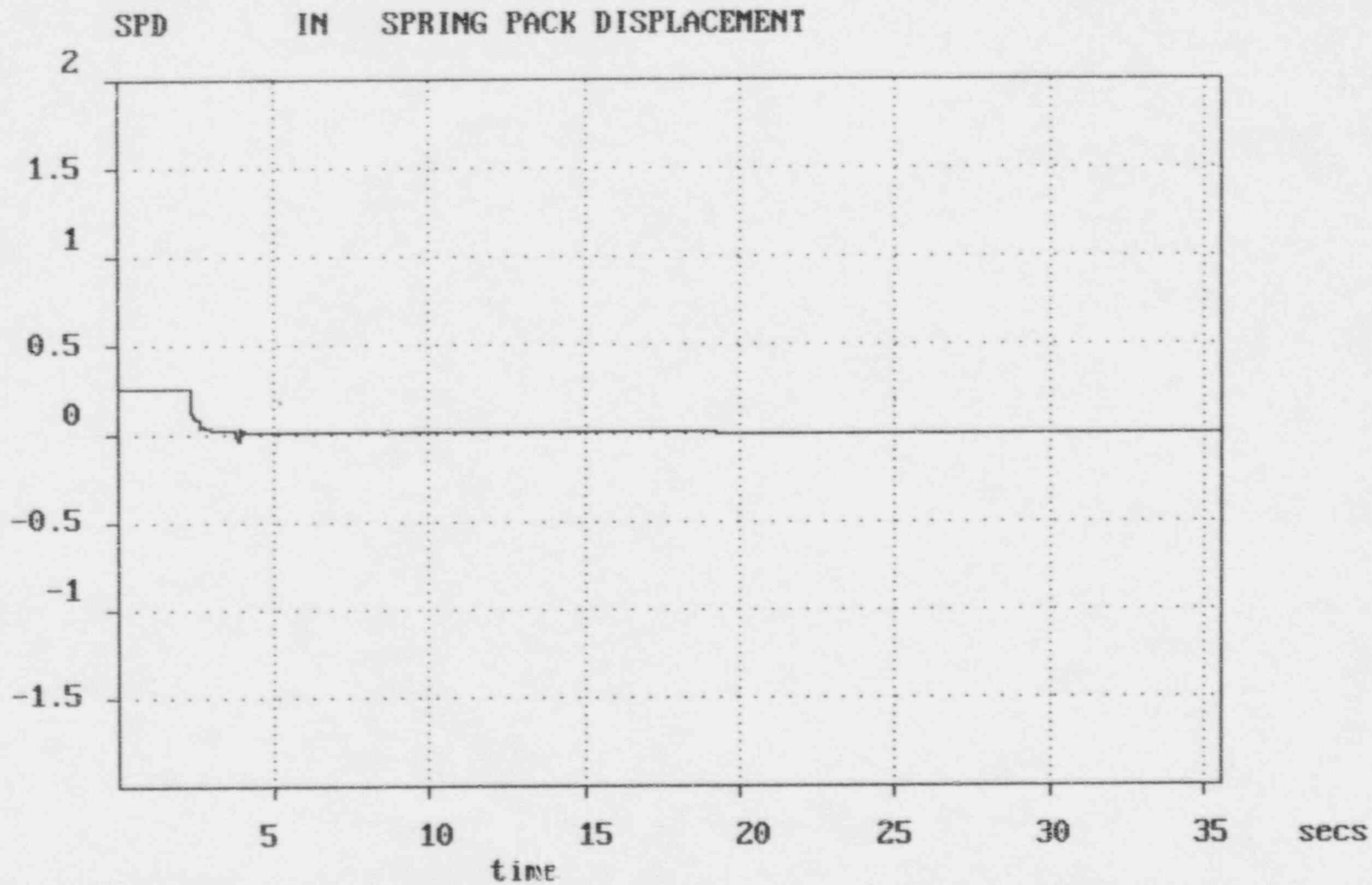
B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)



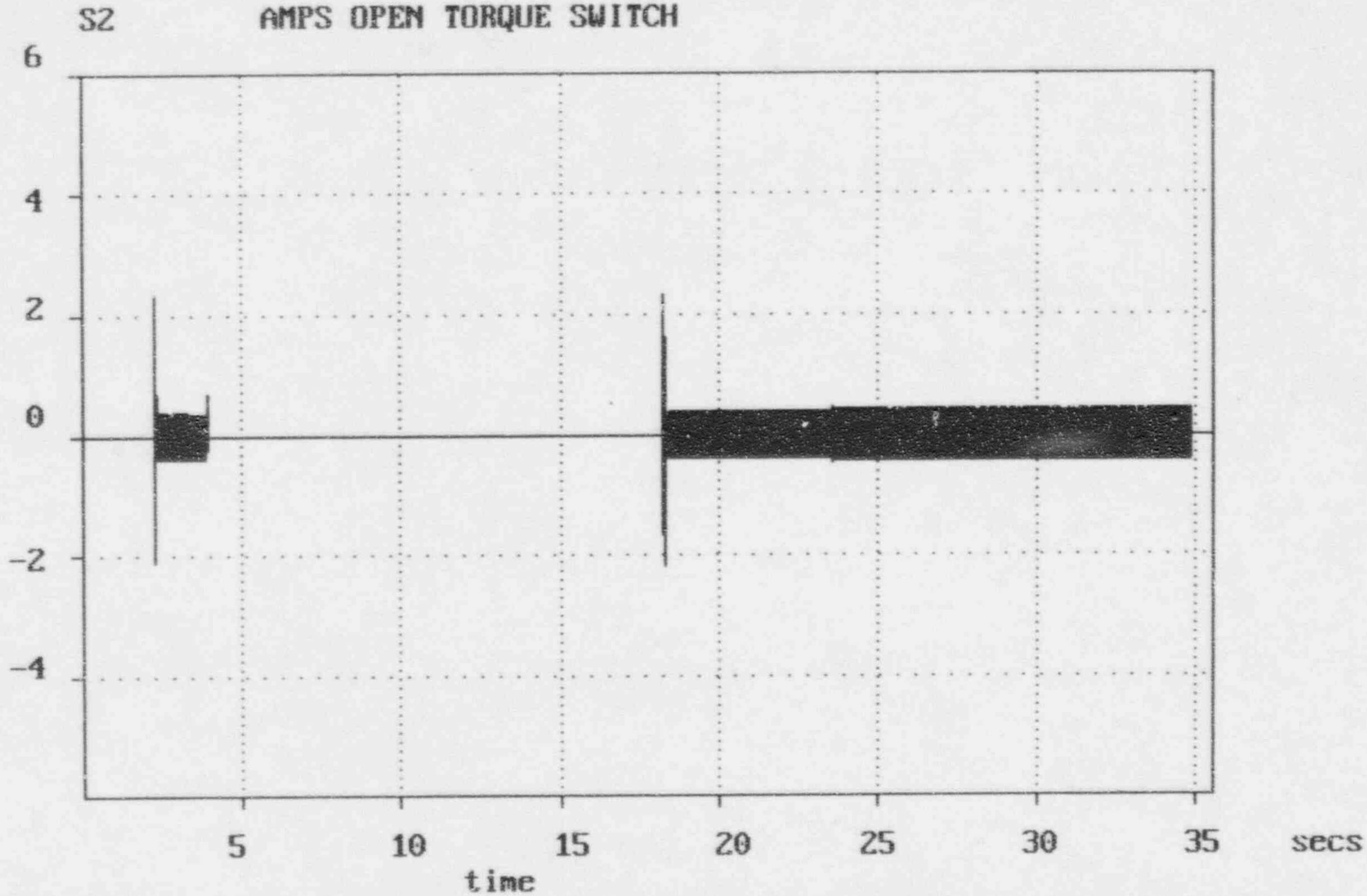
B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)



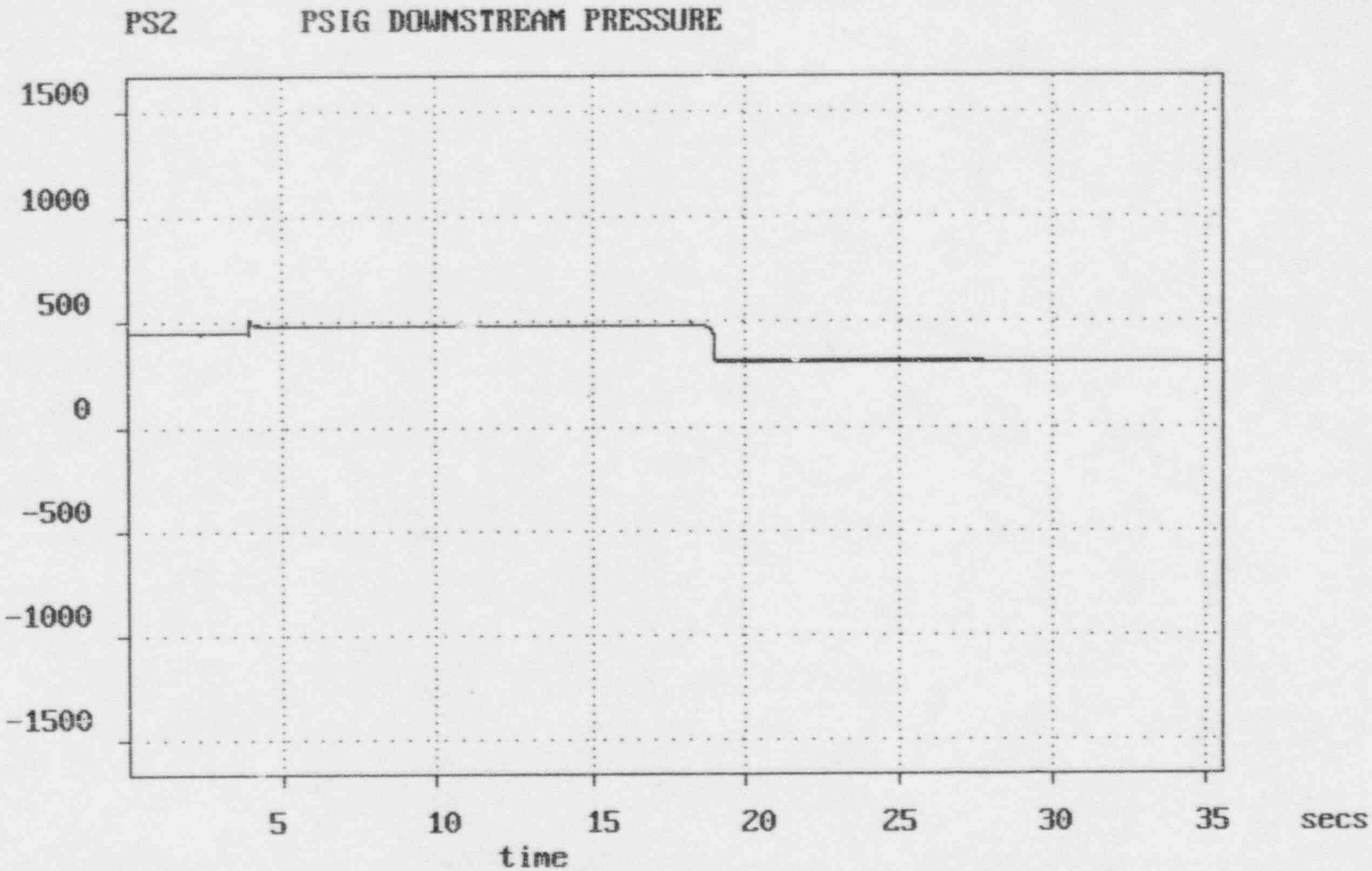
B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)



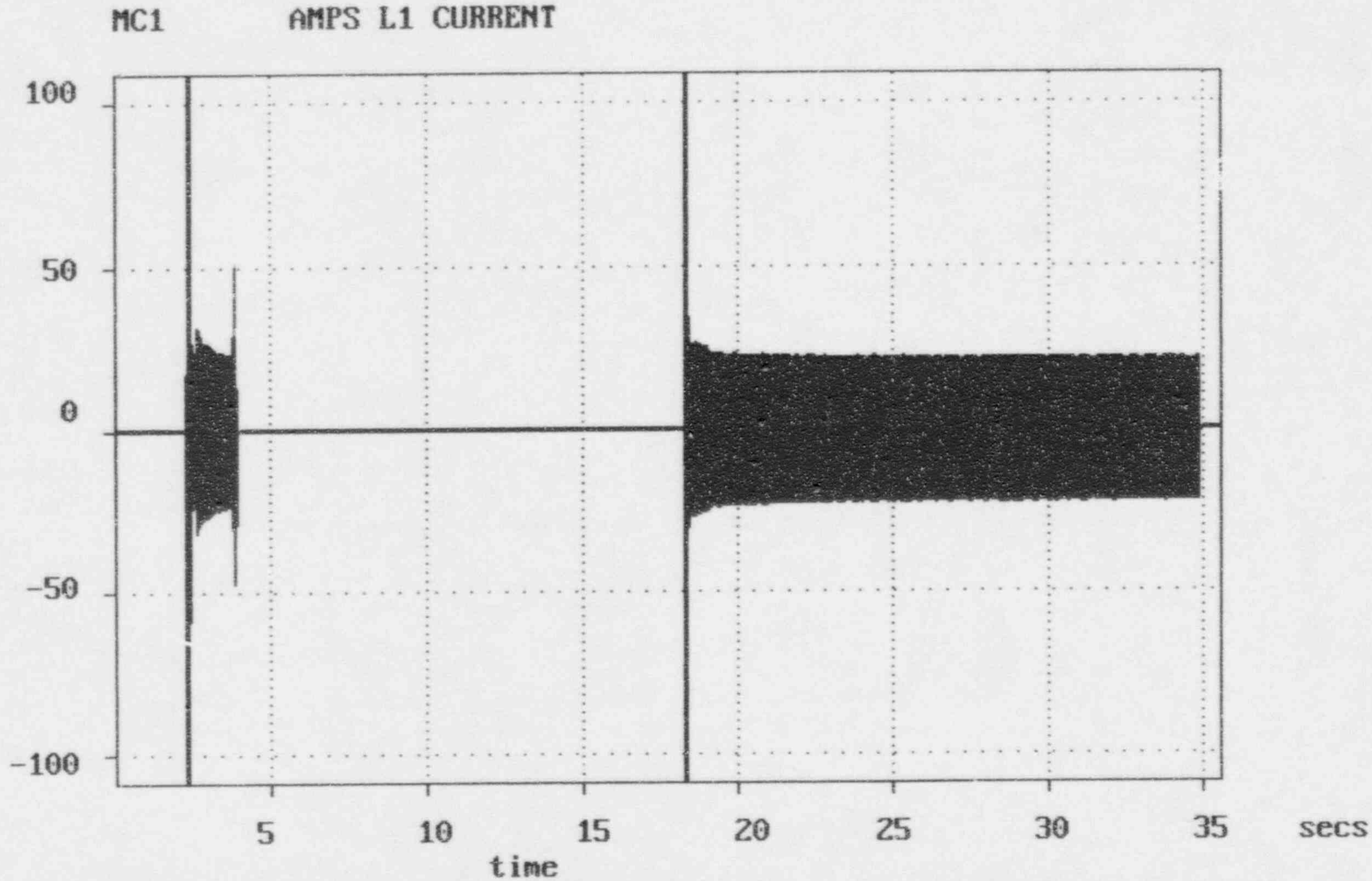
B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)



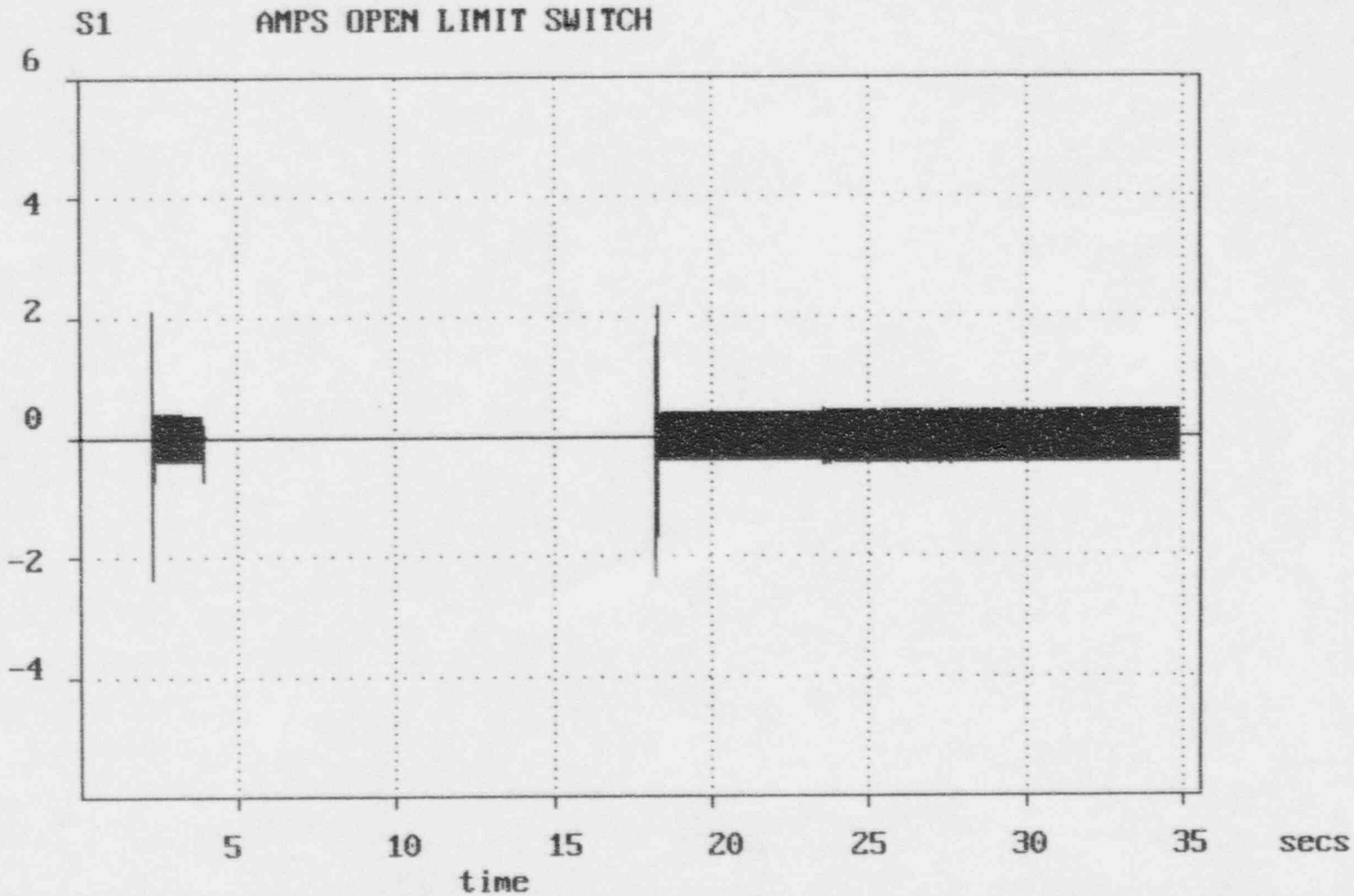
B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST   TEST #5 a   (TORQUE SWITCH SET TO APROX. 1.75)



B430081   DataSet 009   Duration 00:00:35:545   Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)



B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
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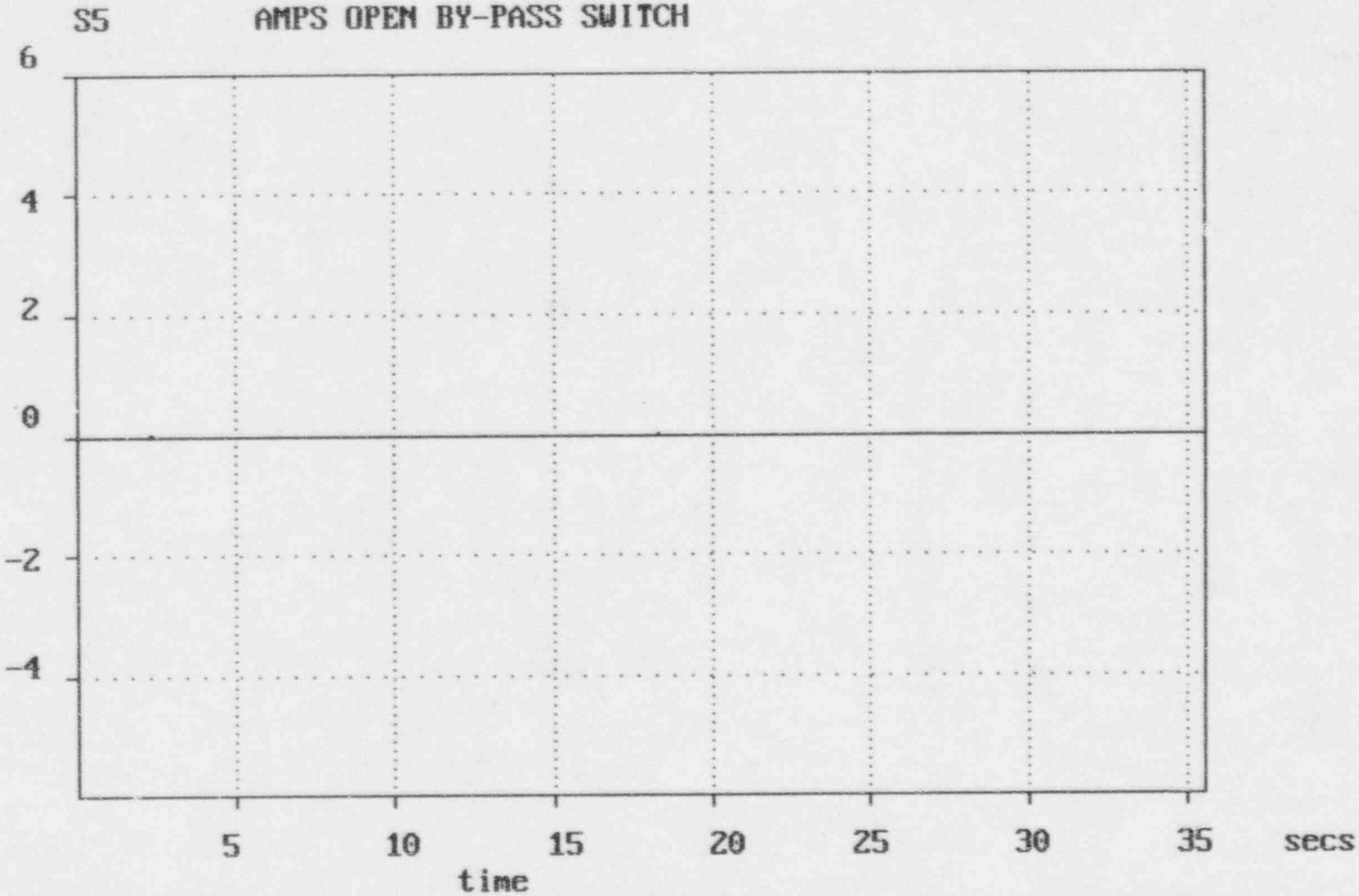
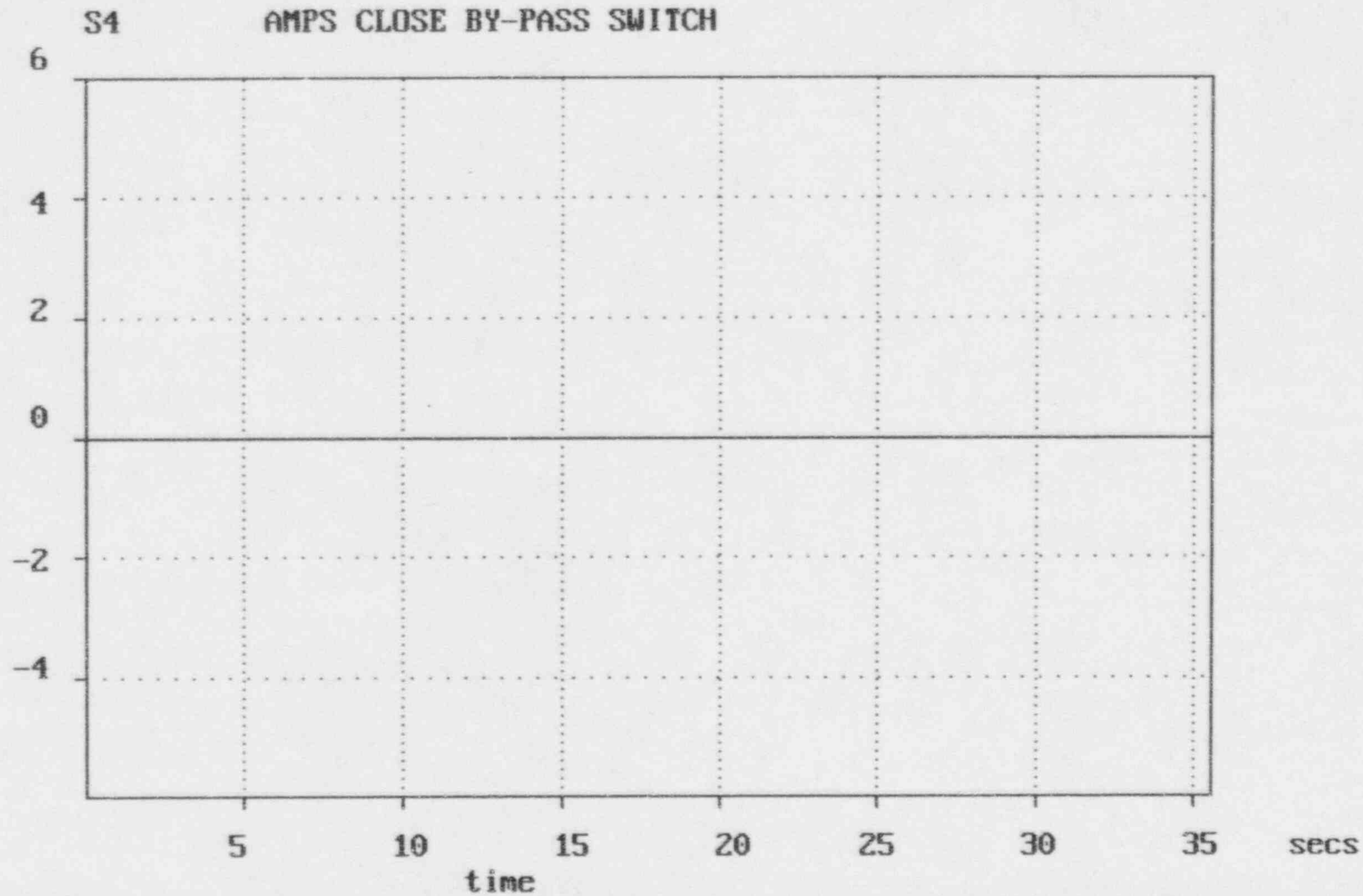


B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

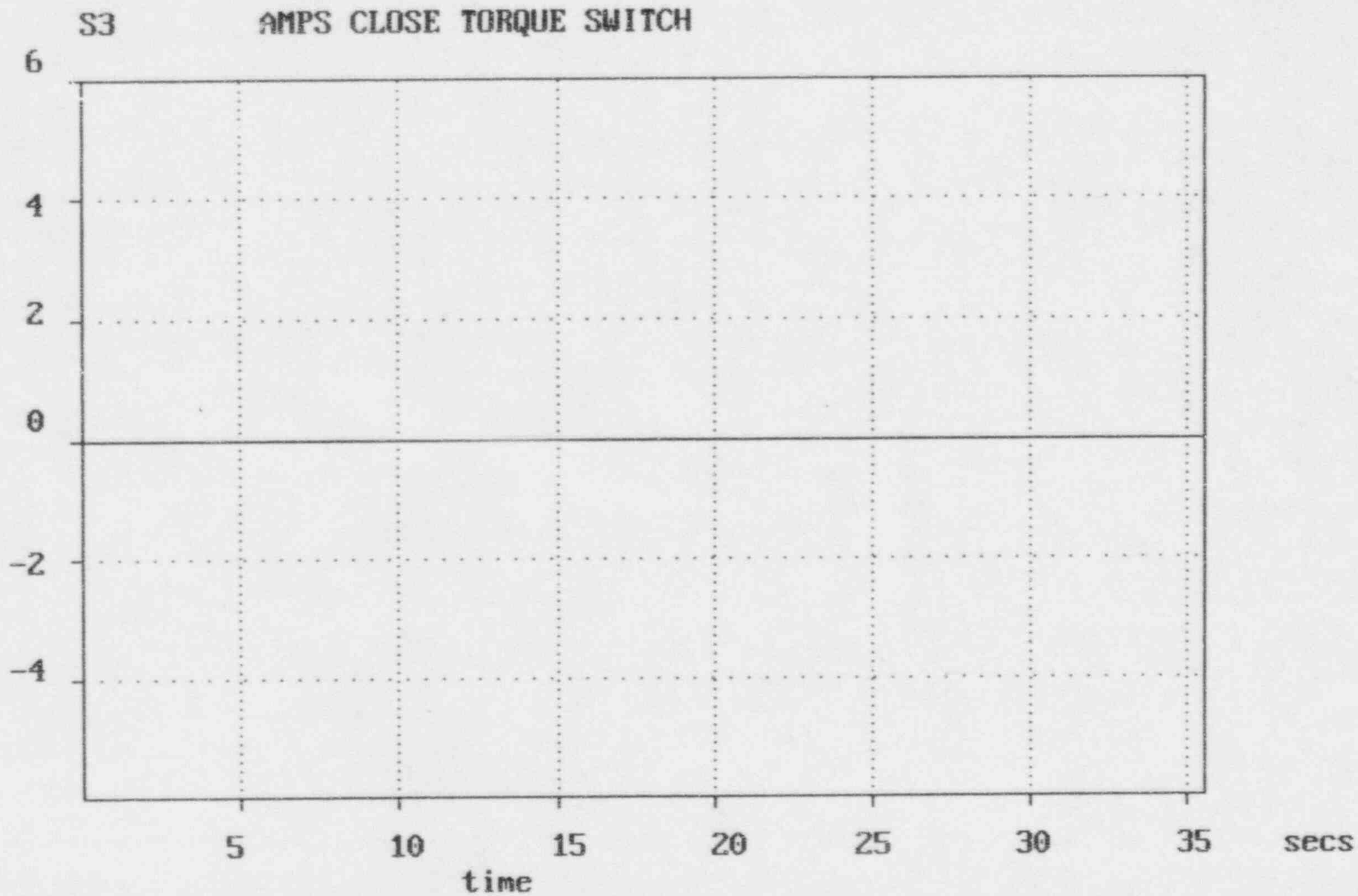
TEST COMPLETE

6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)



B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

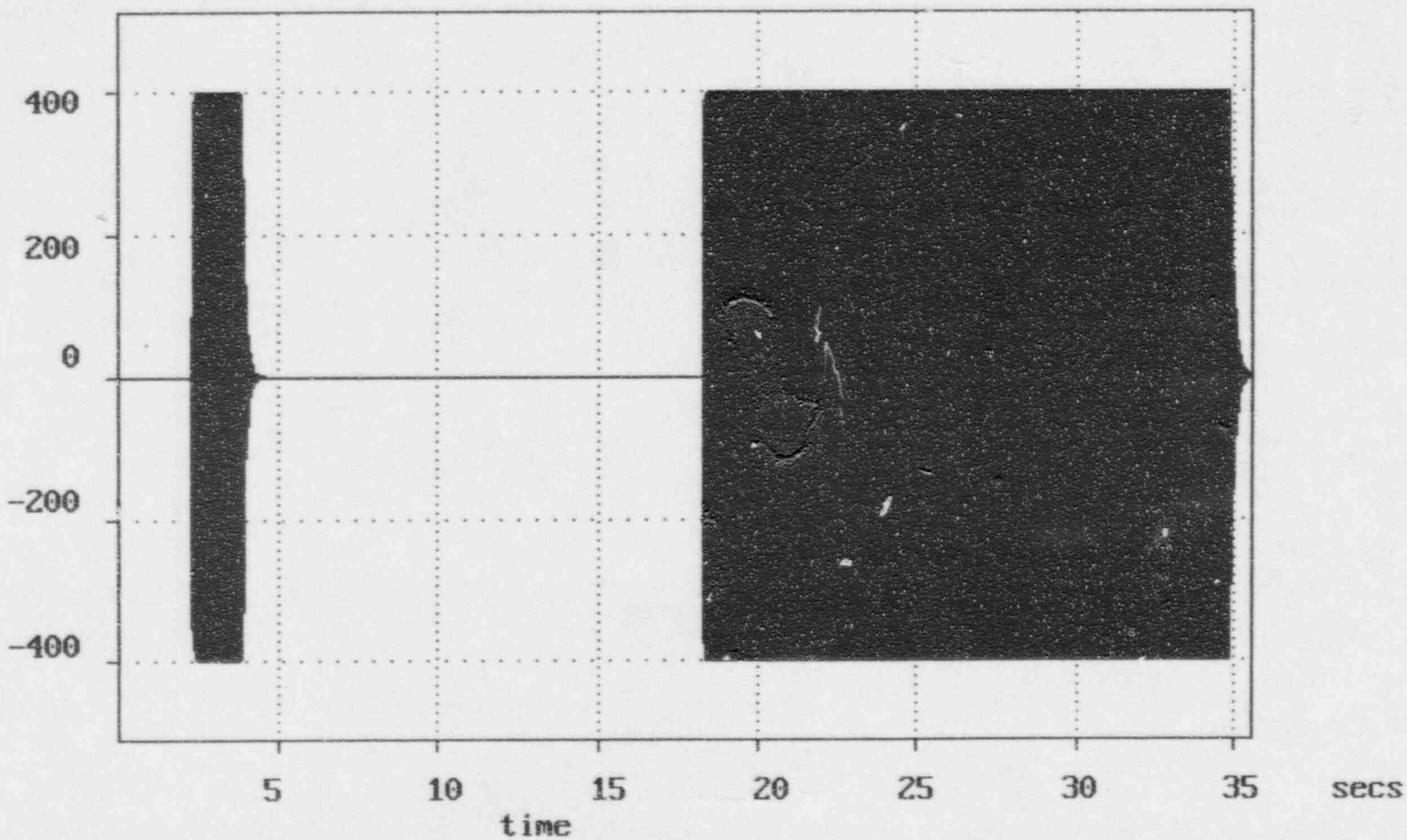
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a   (TORQUE SWITCH SET TO APROX. 1.75)



B430081 Dat/Set 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)

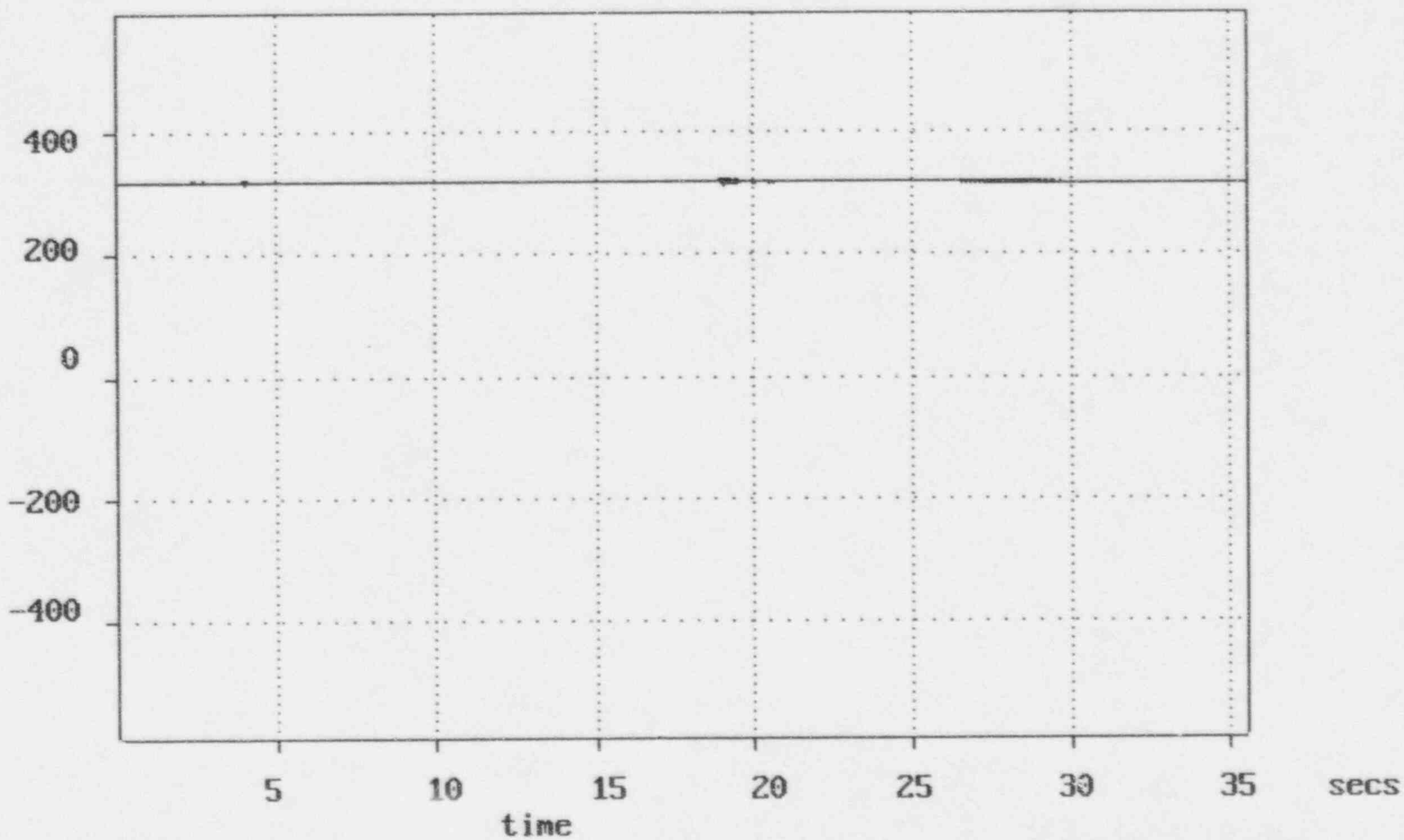
MV1 VAC L1 to NEUTRAL VOLTAGE



B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

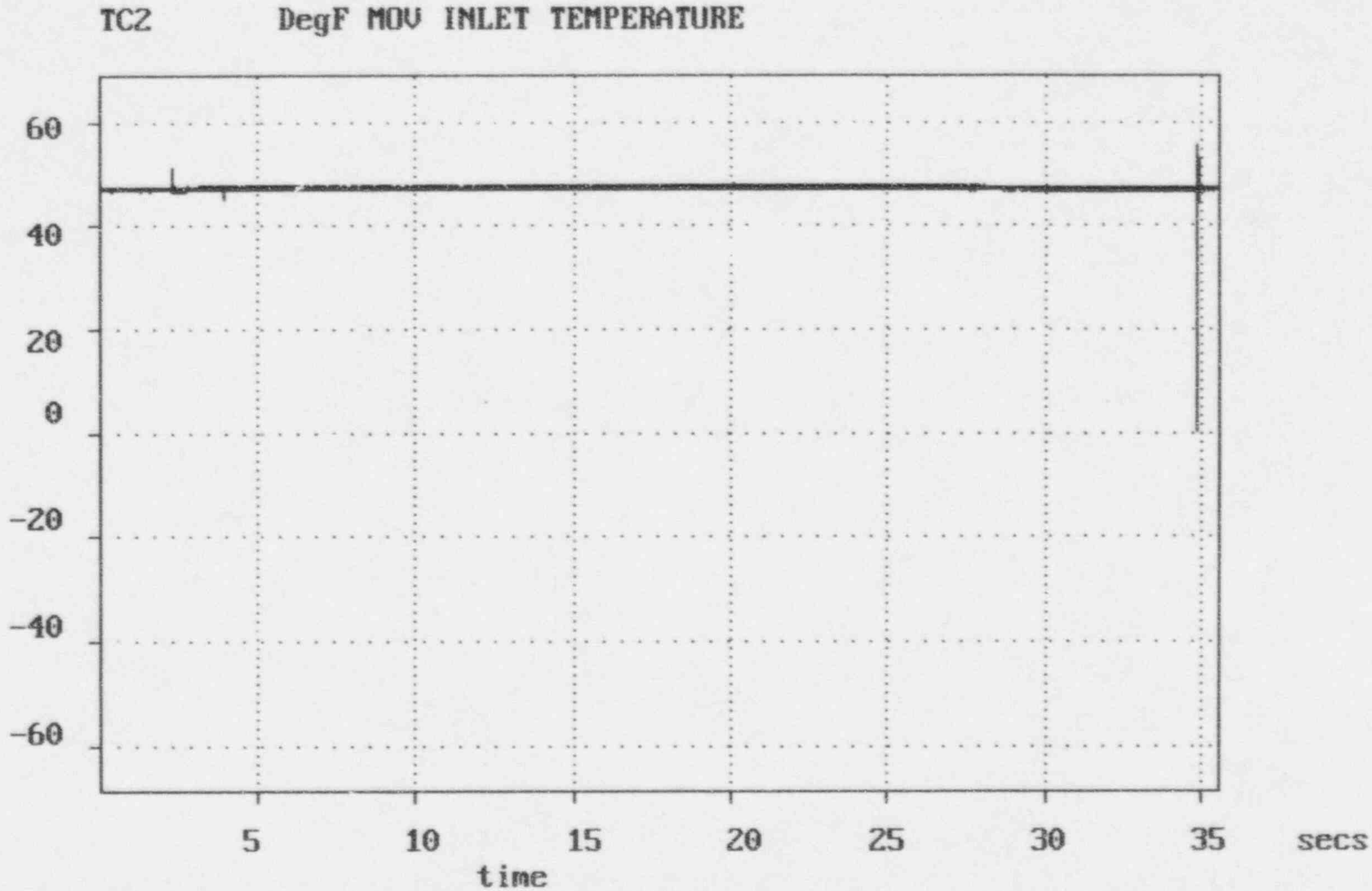
TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)

PS1 PSIG UPSTREAM PRESSURE



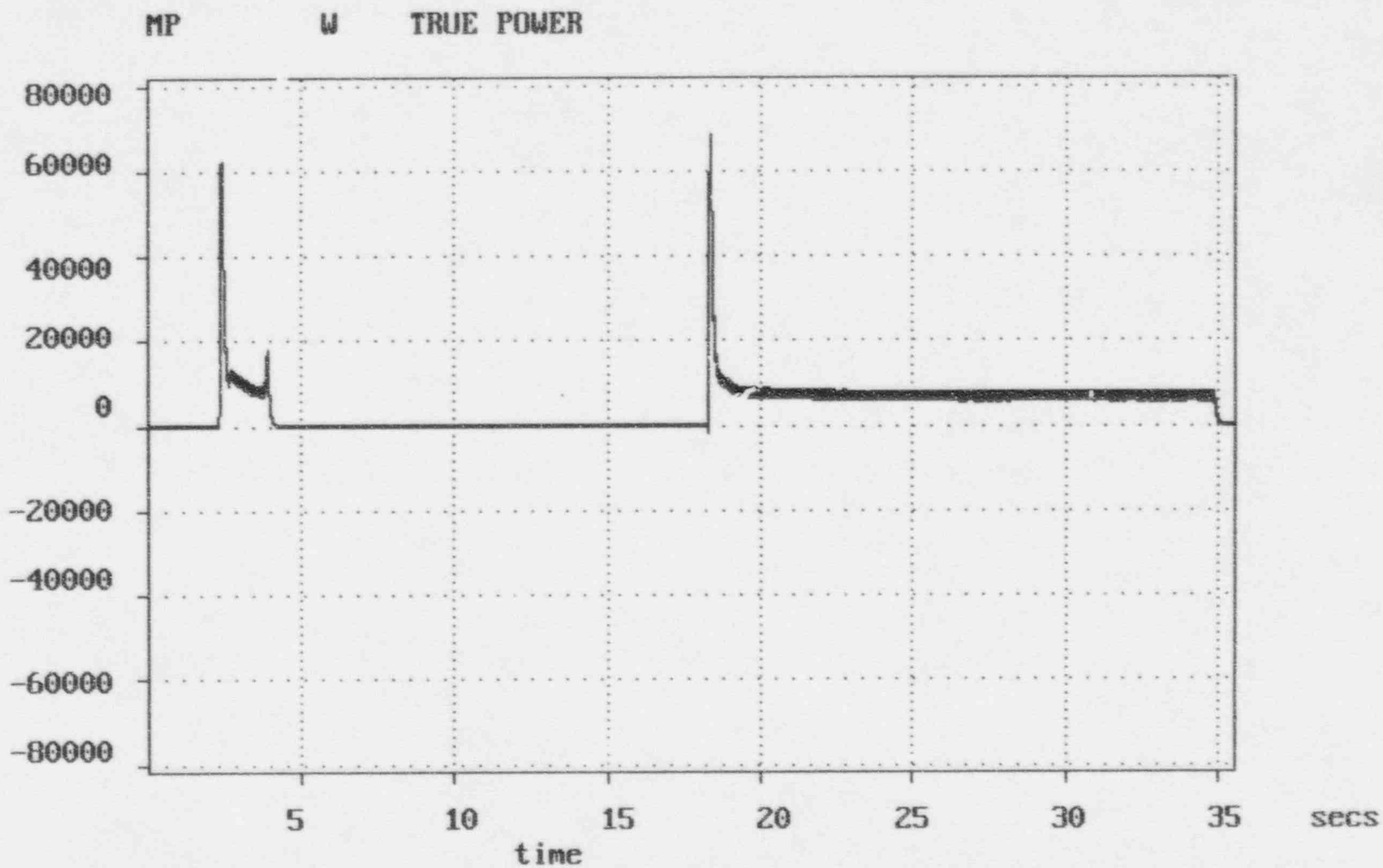
B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)



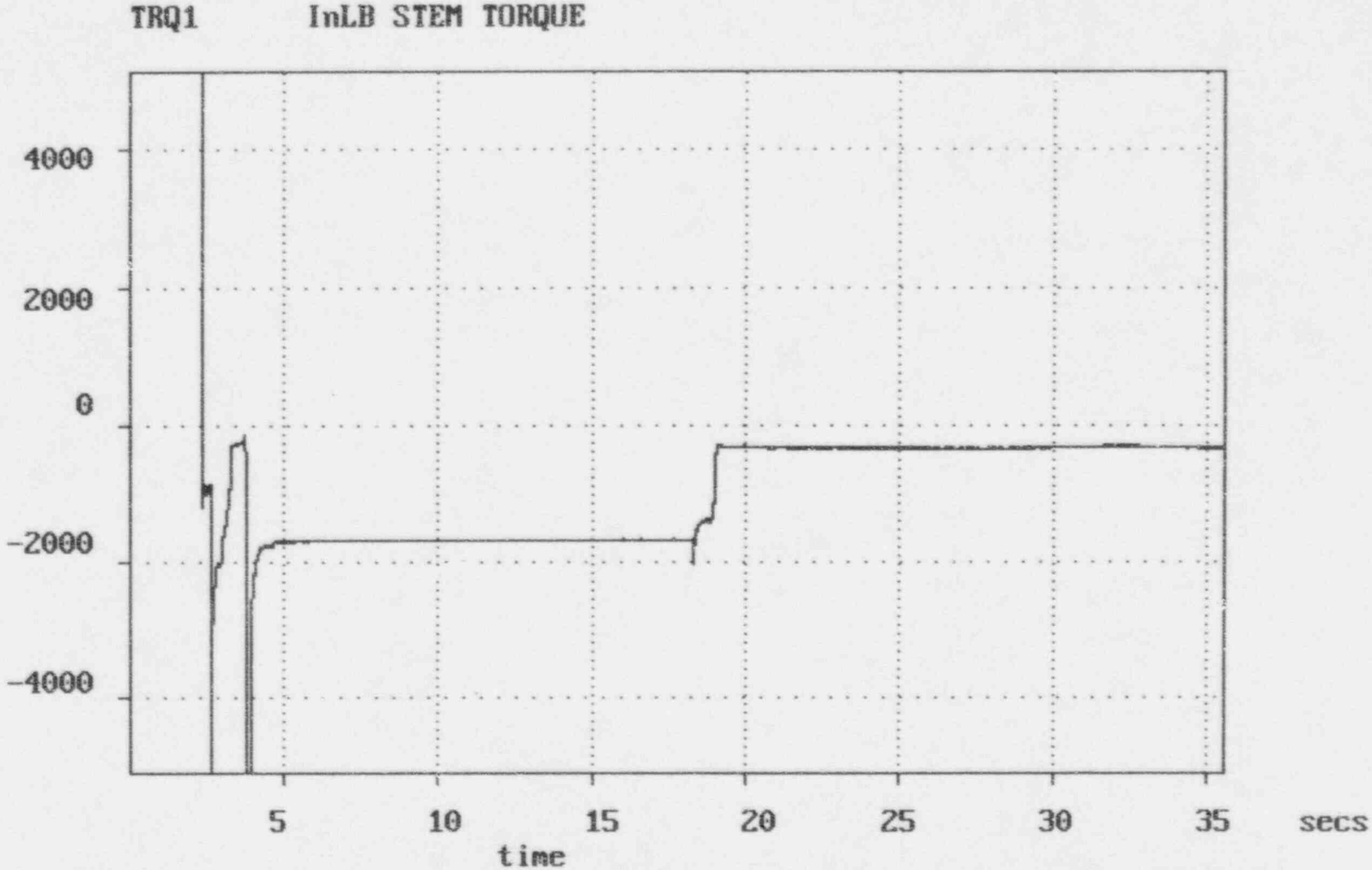
B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST TEST#5 a (TORQUE SWITCH SET TO APROX. 1.75)



B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

TEST COMPLETE
6.3.3 PRESSURE LOCK TEST   TEST#5 a   (TORQUE SWITCH SET TO APROX. 1.75)



B430081 DataSet 009 Duration 00:00:35:545 Recorded On 12/29/92 11:24:50

Attachment 1 to:
GNRO-97/00056

APPENDIX 2

DRAFT TEST PLAN FOR PRESSURE LOCKING AND THERMAL BINDING TESTING OF 2 GATE VALVES FOR ENTERGY OPERATIONS

Draft Test Plan for Pressure Locking and Thermal Binding Testing of 2 Gate Valves for Entergy Operations 5/13/97

1.0 Test Specimen

The valves to be tested are as follows.

a) One 14", 900# Powell flex wedge gate valve with an SB-3 actuator. This valve has flanges welded to each end and will be provided with associated blind flanges and bolting. Wyle Labs will provide gaskets.
b) One 3", 900# Velan flex wedge gate valve with an SMB-00 actuator. This valve has flanges welded to each end to accept blind flanges. Wyle Labs will provide the required blind flanges, gaskets, and bolting.

2.0 Valve Diagnostic Equipment

a) Strain gages shall be mounted on/in the valve stems. These gages shall be compatible with the Wyle Megadat data collection system.

3.0 Instrumentation

a) Three pressure transmitters shall be installed to monitor pressure on the upstream/downstream side of the disc and within the confines of the bonnet. The pressure measuring devices shall be capable of accurately measuring pressure within 0.5% in the range of 0 - 1500 psig. Bonnet pressure may be measured off the packing leakoff line as long as packing below the lantern ring is replaced with a material that does not create a pressure drop between the bonnet and the pressure transmitter. If this is not possible, then tapping of the valve may be done with the prior approval of the Entergy Operations contract/test coordinator. The upstream/downstream pressure taps shall be located in the valve blind flanges.

b) A temperature sensing device capable of measuring the valve fluid temperature in the vicinity of the bonnet pressure monitoring device and the ambient room temperature shall be available.

4.0 Pretest Work

a) Entergy will obtain critical valve dimensions.

b) Entergy will supply torque switch settings and weak link analysis for the valves.

c) Entergy will supply the friction factor calculation method.

d) Wyle will perform spring pack displacement calibration.

e) Wyle will receive and uncrate the valves and the motor/actuators.

f) Wyle will inspect all components for possible damage from shipping. Any damage shall be reported to the Entergy Operations contract/test coordinator for disposition.

g) Wyle will purchase and install 3", 900# blind flanges, gaskets, and bolting on the 3" Velan valve. Wyle will purchase gaskets for the 14", 900# Powell valve and install blind flanges, gaskets, and bolting.

h) Wyle will designate a downstream and upstream reference for each valve and install pressure taps on the valves.

i) Wyle will assemble and connect protective torque switch and thermal overload control circuits typical for a Limitorque actuator. The torque switches shall not be bypassed during the open stroke.

j) Wyle will set up valve diagnostic equipment and instrument the valves per section 3.0. All instruments shall have documented calibration such that the following traces and data points are available for the following test sequences:

Test Point Matrix

Combined Test	Upstream Test	Bonnet Test	Bypass Test	EET	Trace or Data Point	Parameter
X	X		X		1	Upstream Pressure
X					2	Downstream Pressure
X	X	X	X		3	Bonnet Pressure
X	X	X		X	4	Motor Current
X	X	X		X	5	Spring Pack Displacement
X	X	X		X	6	Stem Torque
X	X	X		X	7	Stem Thrust
X	X	X		X	8	Open Torque Switches
				X	9	Close Torque Switches
X	X	X	X	X	10*	Valve Temperature
X	X	X	X	X	11*	Room Temperature
X	X	X		X	12*	Bus Voltage (Phase to Phase)
					13*	Friction Factor Validation

* Indicates data point; no trace required

Monitoring equipment will be capable of producing a continuous smooth time trace over every stroke for the above parameters. *A common time scale will be utilized for the various required for each test sequence.* Open strokes may be terminated after the valve is 10% open.

k) Wyle will adjust torque switch settings to limit stem thrust and torque to within the maximum limits provided by the Entergy Operations contract/test coordinator.

l) Wyle will perform a pretest LLRT. The test will be performed separately on both the upstream and downstream side of the disc for each valve. Test pressure shall be 20% of the peak test pressure. The Entergy test coordinator shall be present for the test and will determine further actions if leakage is large enough to preclude performance of the test sequences.

5.0 Test Fluid

The test fluid will be ordinary tap water charged by hydro pumps. Alternate charging methods may be acceptable if pre-approved by the Entergy test coordinator.

6.0 Test Sequence

6.1 *Ambient* Friction Factor Test

The purpose of this test sequence is to establish a valve disk to seat friction factor *at ambient temperature for the 3" and 14" valves.*

a) The valve shall be filled with ambient temperature test fluid and vented such that pressure is zero (0) psig at all locations. The valve/fluid temperature shall be allowed to stabilize for 15 minutes. The valve and ambient room temperatures shall then be measured and recorded. A contact probe may be used for obtaining the valve temperature.

b) The valve shall be stroked closed and open a minimum of 20 to a maximum of 50 strokes. If the change in friction factor between tests drops to less than 1% this test sequence may be terminated. The friction factor shall be calculated using equations provided by Entergy Operations. This test shall be witnessed by the Entergy test coordinator or designee.

c) Traces/data points required are numbers 4,5,6,7,8,9,10,11 and 12.

6.2 High Temperature Friction Factor Test

The purpose of this test sequence is to establish a valve disk to seat friction factor for the 3" valve at an elevated temperature.

a) The valve shall be filled with ambient temperature test fluid and vented such that pressure is zero (0) psig at all locations. The valve shall be wrapped with heat blankets and the temperature rise will commence with the vents closed and the valve in the closed position. A contact probe may be used for obtaining the valve temperature.

b) Pressure shall be monitored during the rise and will be limited to no more than the maximum test pressure supplied by Entergy Operations. Pressure will be controled manually with the vent valves in each cavity. Safety relief valves will be installed on the vent lines with a relief setting equal to 1.1 times the max test pressure. Temperature will be limited to 50 °F below the boiling point for water at the maximum test pressure.

c) The valve shall be stroked closed and open a minimum of 20 to a maximum of 50 strokes. If the change in friction factor between tests drops to less than 1% this test sequence may be terminated and pressure relieved. The friction factor shall be calculated using equations provided by Entergy Operations. This test shall be witnessed by the Entergy test coordinator or designee.

d) *Traces/data points required are numbers 4,5,6,7,8,9,10,11 and 12.*

6.3 Bypass Leakage Test

a) The purpose of this test sequence is to determine the flexibility of the disk/seat structural system and will be performed as follows.

b) The valve shall be filled with ambient temperature test fluid and vented such that pressure is zero (0) psig at all locations. The valve/fluid temperature shall be allowed to stabilize for 15 minutes. The valve and ambient room temperatures shall then be measured and recorded. A contact probe may be used for obtaining the valve temperature.

c) *Close the valve and* ramp up fluid pressure in the upstream side of the valve at a rate not to exceed 240 psig/min. The pressure shall in no circumstance exceed the maximum working pressure of the valve at the fluid temperature. Pressure traces shall be recorded for the entire event.

d) The pressure rise test shall be terminated after the bonnet pressure rate of increase tracks the upstream rate of increase. This test shall be witnessed by the Entergy test coordinator or designee.

e) Depressurize the valve for the next test sequence.

f) Traces/data points required are numbers 1,3,10 and 11

6.4 Bonnet Test

The purpose of this test sequence is to determine the maximum open thrust required for the valve given a known seating thrust and internal bonnet pressure.

a) The valve shall be filled with ambient temperature test fluid and vented such that pressure is zero (0) psig at all locations. The valve/fluid temperature shall be allowed to stabilize for 15 minutes. The valve and ambient room temperatures shall then be measured and recorded. A contact probe may be used for obtaining the valve temperature. Test conditions shall be controlled such that no appreciable change in valve or ambient temperature occurs during the test sequence.

b) The bonnet will be pressurized in three stages during this test. The first pressurization will begin at 33.3% of the maximum bonnet pressure specified for the test. The second and third tests will increase the pressure in 33.3% increments. ~~Upstream and downstream pressures shall remain at atmospheric pressure throughout the test.~~ *With the valve closed, pressure rise will first be attempted from the upstream side allowing pressure from the upstream cavity to unseat the disk and pressurize the bonnet to the specified pressure. The upstream cavity will then be depressurized to 0 psig. If the specified pressure cannot be reached in this manner, additional pressure will be added directly through the bonnet vent. The actual method used will be recorded in the test report.*

c) Traces/data points required for this test sequence are 3,4,5,6,7,8,10,11 and 12. The maximum stem thrust on the open stroke and the previous close stroke shall also be recorded.

d) After each open stroke the valve shall be depressurized to 0 psig, stroked closed, and then repressurized to the next test pressure. This test shall be witnessed by the Entergy test coordinator or designee.

e) The bonnet test shall be followed by five close-to-open strokes as specified in section 6.1. Friction factors shall be calculated and recorded.

6.5 Upstream pressure Test

The purpose of this test sequence is to determine the combined effects of upstream pressure and pressure trapped in the bonnet. Traces/data points required for this test sequence are 1,3,4,5,6,7,8,10,11 and 12.

a) The valve shall be filled with ambient temperature test fluid and vented such that pressure is zero (0) psig at all locations. The valve/fluid temperature shall be allowed to stabilize for 15 minutes. The valve and ambient room temperatures shall then be measured and recorded. A contact probe may be used for obtaining the valve temperature.

b) Three test sequences shall be run. (See Figure 1) The bonnet shall be pressurized in order to the (low), (medium) and (high) specified test pressures. The downstream side shall be maintained at atmospheric pressure throughout the test.

Upstream Pressure Test Sequences

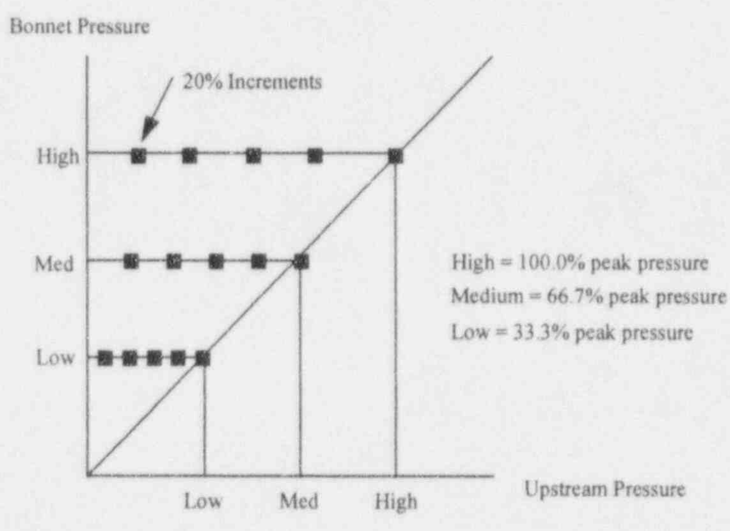


Figure 1

c) For each series of bonnet pressures, the up stream side of the disk shall be pressurized in 20% increments until it is equal to the bonnet pressure. At each 20% increment the valve shall be stroked open. Required thrust and the last closing thrust before the open stroke shall be recorded.

d) Following each open stroke, the valve will be depressurized, stroked closed, and repressurized to the next increment. This test shall be witnessed by the Entergy test coordinator or designee. The Entergy test coordinator may decrease the number of required test points for the medium and high bonnet pressures if a consistent, repetitive trend is established.

e) Each of the three test sequences shall be followed by five close-to-open strokes as specified in section 6.1. Friction factors shall be calculated and recorded.

6.6 Combined Test

The purpose of this test sequence is to determine the combined effects of upstream/downstream DP and pressure trapped in the bonnet. Traces/data points required for this test sequence are 1,2,3,4,5,6,7,8,10,11 and 12.

a) The valve shall be filled with ambient temperature test fluid and vented such that pressure is zero (0) psig at all locations. The valve/fluid temperature shall be allowed to stabilize for 15 minutes. The valve and ambient room temperatures shall then be measured and recorded. A contact probe may be used for obtaining the valve temperature.

b) The bonnet shall be pressurized to the (high) specified pressure.

c) The downstream side of the disk shall be pressurized at 20% of the bonnet pressure. The upstream side of the disk shall be pressured at 20%, 60% and 100% increments. At each increment, the valve shall be stroked open. Required thrust and the last closing thrust before the open stroke shall be recorded.

d) Following each open stroke, the valve will be depressurized, stroked closed, and repressurized to the next increment. This test shall be witnessed by the Entergy test coordinator. The Entergy test coordinator may decrease the number of required test points if a consistent, repetitive trend is established.

e) The first combined test series described in (c) and (d) above shall be followed by five close-to-open strokes as specified in section 6.1. Friction factors shall be calculated and recorded.

f) After the completion of the (c/d) test above, the downstream side of the disk shall then be pressurized at 40% of the bonnet pressure. The upstream side of the disk shall be pressured at 40%, 60% and 100% increments until equal to bonnet pressure. At each increment, the valve shall be stroked open. Required thrust and the last closing thrust before the open stroke shall be recorded.

g) Following each open stroke, the valve will be depressurized, stroked closed, and repressurized to the next increment. This test shall be witnessed by the Entergy test coordinator. The Entergy test coordinator may decrease the number of required test points if a consistent, repetitive trend is established.

h) The second combined test series described in (f) and (g) above shall be followed by five close-to-open strokes as specified in section 6.1. Friction factors shall be calculated and recorded.

7.0 Test Report Content

The test report prepared by Wyle shall contain the following information

a) A copy of the test procedure.

b) Description of the test set-up including sketches of the instrumentation points and a description of the test specimen.

c) Results and conclusions including a comparison of predicted vs. actual required stem thrust for the specified conditions. The associated inaccuracy of each test shall be reported.

d) Anomalies and disposition.

e) Copies of traces, calculations, and other plots generated in support of the test. *The various traces for each test sequence will utilize a common time scale.*

f) Pre and post test calibration data and due dates for all test equipment used.

APPENDIX 3

COMPARISON OF 0.4 AND 0.2 FRICTION FACTORS

VALVE DISC PRESSURE LOAD ANALYSIS

INTERNAL BONNET PRESSURE BETWEEN THE DISCS
TABLE 24 CASE 2d (Reference Roark's Formulas for Stress & Strain, 6th Edition)

	a	b	q	ro	C2	C3	C8	C9	L11	L17	Qb	Qa
	in	in	psi	in							lb/in	lb/in
VALVE NO												
E12-F042A w/0.4	6.07125	1.875	1080	1.875	0.17012338	0.029524235	0.683382154	0.284753005	0.006199321	0.146382647	4793.958101	-1485.251374
E12-F042A w/0.2	6.07125	1.875	1080	1.875	0.17012338	0.029524235	0.683382154	0.284753005	0.006199321	0.146382647	4793.958101	-1485.251374

PRESSURE ANALYSIS FOR REACTOR SIDE PRESSURE ON REATOR SIDE DISC (452 PSI)
TABLE 24 CASE 2d (Reference Roark's Formulas for Stress & Strain, 6th Edition)

	a	b	q	ro	C2	C3	C8	C9	L11	L17	Qb	Qa
	in	in	psi	in							lb/in	lb/in
VALVE NO												
E12-F042A w/0.4	6.07125	1.875	452	1.875	0.17012338	0.029524235	0.683382154	0.284753005	0.006199321	0.146382647	2006.360242	-621.6052047
E12-F042A w/0.2	6.07125	1.875	452	1.875	0.17012338	0.029524235	0.683382154	0.284753005	0.006199321	0.146382647	2006.360242	-621.6052047

PRESSURE ANALYSIS FOR PUMP SIDE PRESSURE ON PUMP SIDE DISC (300 PSI)
TABLE 24 CASE 2d (Reference Roark's Formulas for Stress & Strain, 6th Edition)

	a	b	q	ro	C2	C3	C8	C9	L11	L17	Qb	Qa
	in	in	psi	in							lb/in	lb/in
VALVE NO												
E12-F042A w/0.4	6.07125	1.875	300	1.875	0.17012338	0.029524235	0.683382154	0.284753005	0.006199321	0.146382647	1331.655028	-412.5698261
E12-F042A w/0.2	6.07125	1.875	300	1.875	0.17012338	0.029524235	0.683382154	0.284753005	0.006199321	0.146382647	1331.655028	-412.5698261

PRESSURE ANALYSIS FOR ADDITIONAL REACTOR SIDE PRESSURE ON PUMP SIDE DISC DUE TO DIFFERENTIAL PRESSURE
TABLE 24 CASE 1b (Reference Roark's Formulas for Stress & Strain, 6th Edition)

	a	ro	q	HUB AREA	HUB CIRC	W hub	Qb 452	Qb 300	W	W total	Qa
	in	in	psi	in²	in	lb/in	lb/in	lb/in	lb/in	lb/in	lb/in
VALVE NO											
E12-F042A w/0.4	6.07125	1.875	152	11.04466167	11.78097245	142.5	2006.360242	1331.655028	674.7052142	817.2052142	-252.3796214
E12-F042A w/0.2	6.07125	1.875	152	11.04466167	11.78097245	142.5	2006.360242	1331.655028	674.7052142	817.2052142	-25[illegible].3796214

	SEAT RING LOAD REACTOR SIDE	SEAT RING LOAD PUMP SIDE	SEAT RING RADIUS	SEAT RING CIRCUM	NORMAL FORCE AT SEAT RING REACTOR SIDE	NORMAL FORCE AT SEAT RING PUMP SIDE
	lb/in	lb/in	in	in	lb	lb
VALVE NO						
E12-F042A w/0.4	-863.6461694	-1325.061169	6.07125	38.1467888	-32945.32802	-50546.82857
E12-F042A w/0.2	-863.6461694	-1325.061169	6.07125	38.1467888	-32945.32802	-50546.82857

	COEFF OF FRICTION	DISC FACTOR STATED	PRESSURE LOAD THRUST	MEASURED UNWEDGING LOAD THRUST	TOTAL REQUIRED THRUST	TOTAL THEORETICAL THRUST	DISC FACTOR CALCULATED
	μ		lbf	lbf	lbf	lbf	
VALVE NO							
E12-F042A w/0.4	0.4	0.388	32394.95676	50000	82394.95676	72781.97633	0.387951401
E12-F042A w/0.2	0.2	0.198	16531.447	50000	66531.447	41187.07729	0.197311466

VALVE NO	MEASURED CLOSING THRUST lbf	CALCULATED WEDGING LOAD lbf	SEAT ANGLE °	SEAT ANGLE cos	SEAT ANGLE sin	THEORETICAL UNWEDGING lbf
E12-F042A w/0.4	63000	64863.71325	5	0.996194698	0.087155743	40387.01958
E12-F042A w/0.2	63000	109988.0757	5	0.996194698	0.087155743	24655.63028

EXPLANATION OF PREVIOUS LOAD CASE SYMBOLS

a =	½ Valve disc sealing diameter (Mean seat diameter)
b =	Valve hub radius
C2 through C9 =	Plate constants dependent upon the ratio a/b
L11 and L17 =	Loading constants dependent upon the ratio a/b
Qa and Qb =	Reactions at points a and b
q =	(For Case 1) Internal Pressure based upon the Tech Spec maximum allowable value for reactor scram, or 5° rise from Suppression Pool Heat-up
	(For Case 2) High Side Pressure based upon maximum LPCI/LPCS cut-in permissive
	(For Case 3) Low Side Pressure based upon RHR/LPCS pump head on minimum flow
	(For Case 4) Differential Pressure between the High Side and the Low Side of the Disc
W hub =	Force around the perimeter of the Hub due to the differential pressure over the hub area
W =	Qb for the High PSI Pressure Case - Qb for the Low PSI Pressure Case
W total =	W total = W hub + W

SEAT RING LOAD

High Side = Qa for the Internal Pressure Case - Qa for the High PSI Pressure Case

Low Side = Qa for the Internal Pressure Case - Qa for the Low PSI Pressure Case + Qa for the Differential Pressure Case

NORMAL FORCE AT SEAT RING

High Side = High Side Seat Ring Load * Seat Ring Circumference

Low Side = Low Side Seat Ring Load * Seat Ring Circumference

COEFF. OF FRICTION =

0.4 For stellite on stellite with high temperature water (Reference NUREG/CR-5807, Page 41)

0.2 For illustration purposes

DISC FACTOR =

μ / (cosSA + μsinSA) (Reference NUREG/CR-5807, Page 8)

Where μ = coefficient of friction

SA = seat angle, °

PRESSURE LOAD THRUST =

Thrust required to overcome pressure loads only

(Normal Force at High Side + Normal Force at Low Side) * Disc Factor

MEASURED UNWEDGING LOAD THRUST =

Measured opening thrust (under static conditions) from last diagnostic test

TOTAL REQUIRED THRUST =

PRESSURE LOAD THRUST + MEASURED UNWEDGING LOAD THRUST

TOTAL THEORETICAL THRUST =

PRESSURE LOAD THRUST + THEORETICAL UNWEDGING LOAD THRUST

MEASURED CLOSING THRUST =

Measured closing thrust (under static conditions) from last diagnostic test

CALCULATED WEDGING LOAD =

The following will be used to determine the seat contact force during closing with no differential pressure across the valve. (Reference NUREG/CR-5807, Page 8)

Fswc = 2(sinSA + μcosSA)Fn

Where Fswc = Stem thrust applied during closing, lbf (from plant supplied data)

SA = Seat angle, °

μ = .4 (for stellite on stellite with high temperature water) or .2 for illustration purposes

Fn = Normal seat contact force, lbf

THEORETICAL UNWEDGING =

The following will be used to determine the unwedging thrust required during opening with no differential pressure across the valve. (Reference NUREG/CR-5807, Page 8)

Fswo = 2(μcosSA - sinSA)Fn

Where Fswo = Stem thrust applied during opening, lbf

Other symbols as defined above

APPENDIX 4

PRESSURE LOCKING THRUST AND ACTUATOR CAPABILITY

CALCULATION RESULTS SUMMARY

FLEX DISC VALVE ANALYSIS FOR VARIOUS VALVES

CALCULATION RESULTS SUMMARY

The Total Required Thrust for opening any valve, under stated pressure locking conditions, is dependent on the final wedging force from the previous closing cycle. For a given torque switch setting, the wedging force from valve closure can vary because the inertia overshoot is affected by the magnitude of the differential pressure across the disc. Typically, the highest wedging force would be introduced when the valve is closed without differential pressure. This calculation conservatively quantifies the unwedging force based upon a calculated closing thrust. Regardless of the approach used, the dependence of the opening thrust during unwedging on the wedging force from the previous closing cycle must be quantified to ensure proper operation of the valve. Furthermore, the unwedging force is affected by the pressure loading of the valve discs. As the differential pressure across a disc decreases so does the unwedging force.

The Total Required Thrust for opening these valves, under the stated pressure locking conditions, is as follows:

Valve	Load Case high/internal/low (psig)	Total Required Thrust (lbf)	Limiting Component Allowable Thrust (lbf)
1E12-F028A	0/242/0	26,390	34,459
1E12-F028B	0/240.4/0	39,299	42,872
1E12-F064C	3/344/0	2,374	7,698
1P41-F064A	0/45/0	1,843	5,818
1P41-F064B	0/45/0	2,518	6,545
1P41-F081A	0/45/0	2,128	5,818
1P41-F081B	0/45/0	3,232	6,545
1P41-F237	0/45/0	3,570	5,727
1P41-F238	0/45/0	3,459	5,727