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May 5, 1995

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Subject: **Docket Nos. 50-361 and 50-362**
Diesel Generator Loading
San Onofre Nuclear Generating Station
Units 2 and 3

During the NRC Maintenance Reliability Inspection (MRI), the NRC questioned the loading capability of a Unit 2 or Unit 3 emergency diesel generator (DG) following a Loss of Voltage Signal (LOVS) without a coincident Safety Injection Actuation Signal (SIAS). This question arose because the actual loads applied to a DG at time zero for the LOVS worst case (not currently surveilled) could be higher than for the LOVS with a SIAS case. Although the questioning initially focused on the acceptability of the DG Technical Specification (TS) LOVS surveillance testing, as the issue was investigated the primary issue shifted to the acceptability of the DG to handle the higher load case.

In response to the NRC questioning, Edison initiated an evaluation that focused on five different areas. Those areas and their relative priority were:

1. The first concern was the safety of the plants. In particular, since Unit 3 was operating at full power would the Unit 3 DGs perform their specified functions; i.e., were they operable?

2. The second issue was the desirability of the current design and/or testing. Are there improvements that should be made in either the design or testing?

3. The third issue was the adequacy of existing surveillance testing. What is the background associated with the current TS Surveillance Requirement and should it be changed? Also, does our Technical Specification Improvement Program submittal require revision?

4. The fourth issue was a concern voiced by the NRC that our initial as-built/as-licensed DG loading has changed without recognizing a conflict

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with the FSAR descriptions; i.e., has there been a change to the design LOVS loading of the DGs?

5. The fifth issue dealt with the adequacy of our initial DG qualification testing. Do the DGs satisfy the design basis qualification commitments in the UFSAR?

A discussion of our evaluations in each of these areas as well as our conclusions is provided below. To fully understand the issue a brief discussion of the DG loading follows. (Please note this discussion reflects the plant at the time of the MRI and does not reflect implementation of the degraded grid voltage modifications. We do not believe these modifications affect the conclusions of this discussion.)

DG LOADING ASSESSMENT

The loading connected to the DG depends on the condition of the plant. In addition, there are several different signals which can result in loads being connected to the DG. A LOVS by itself will result in permanently connected loads being connected at time zero; there are no auto-connected shutdown loads. A LOVS with a SIAS will result in permanently connected loads being connected at time zero and the accident mitigation loads being auto-connected in sequence. Other automatic devices may result in consequential loads being connected at various times depending on specific plant conditions. (For example, a low level in a steam generator may result in auxiliary feedwater loading as a consequence of the specific transient. In this letter, such loads are termed "consequential loads.")

LOVS Actions Without a SIAS

In the case of a loss of power on a 4.16 kV Class 1E bus, the associated undervoltage relays will initiate a LOVS which effects the following actions:

1. After about 1 second, trip the 4.16 kV Class 1E bus preferred power supply breakers and send a start signal to the DG.

2. Transfer the 4.16 kV Class 1E bus to the second source of offsite power, if it is available.

3. If step 2 is unsuccessful, 4 seconds after the LOVS, shed all 4kV loads except load centers [and High Pressure Safety Injection (HPSI) pump(s) if connected] and the Non-1E UPS.

4. About 10 seconds after the LOVS, the DG breaker closes when the DG is at nominal voltage and frequency.

If a SIAS signal is not present, the above actions would normally result in an estimated design loading of about 473 kW of permanently connected loads being loaded on the DG at time zero. Time zero is when the DG breaker has closed onto the bus. (See separate discussion on HPSI pump below.) For the purposes of this discussion, the estimated design loads correspond to the values in kW for particular devices based on the power requirement at the worst case design

operating condition, not the expected startup load. Permanently connected loads are defined as the 480 V load center and motor control centers.

LOVS Actions With a SIAS

If there is a SIAS present, coincident with loss of both preferred offsite sources, the four actions described above will occur, except the non-1E UPS is shed on SIAS. In addition, the required accident mitigation loads are auto-connected to the bus in the sequence shown in UFSAR Table 8.3-1. These loads are connected to the bus in time steps from zero to 35 seconds. At time zero, an estimated design loading of about 1257 kW would be connected to the DG.

Actions From Other Automatic Devices (Consequential Loads)

As indicated in UFSAR Table 8.3-1, Note 4, consequential loads may be energized by automatic devices such as thermostats, pressure switches, etc. In the case of a LOVS with a SIAS there are no additional 4 kV or 480 V loads which could be added at time zero due to other devices. However, for a LOVS alone [e.g., Loss of Offsite Power (LOP) without a Loss of Coolant Accident (LOCA), Main Steam Line Break (MSLB), or Feedwater Line Break (FWLB)] there are several consequential loads which could be started early in the event. The specific events that could result in these consequential loads are:

1. Low discharge pressure occurs in both Component Cooling Water (CCW) trains due to pump coastdown following a loss of offsite power. A low pressure in the opposite train of CCW will cause a CCW pump to start as soon as bus voltage is available. This will occur following actuation of the LOVS reset relay (expected at about 0.3 seconds after time zero based on past ESF surveillance test data).

2. Starting a CCW pump will result in an automatic demand for a Saltwater Cooling (SWC) pump to start. There is a time delay built into the SWC circuit, such that this will occur about 5 seconds after the CCW pump starts.

3. Following a loss of offsite power, a low level in the steam generators will initiate an Emergency Feedwater Actuation Signal (EFAS), which will start an Auxiliary Feedwater (AFW) Pump as soon as bus voltage is available. In accordance with UFSAR Table 15.2-3, the EFAS would occur 19.9 seconds after the LOP. Based on data from a July 1993 trip of Unit 3, EFAS occurred about 18 seconds after the trip. Therefore, the AFW pump would be loaded several seconds after time zero.

4. Following a Loss of Feedwater (LOFW) event coincident with a loss of offsite power, a low level in the steam generators will initiate an EFAS and start an AFW pump. In accordance with UFSAR Table 15.2-6, following a LOFW, an EFAS will occur shortly after a reactor trip (and consequently it is assumed shortly after LOVS). Therefore, in this case the AFW pump would be loaded following actuation of the LOVS reset relay (about 0.3 seconds after time zero.)

The result of these actions is that there are consequential loads that could be connected to the DG at, or close to, time zero. Specifically: (1) following a LOVS alone, a CCW pump could start, bringing the estimated design loading up to 950 kW at about time 0.3 seconds, and (2) following a LOFW with LOVS, both a CCW pump and an AFW pump could start, bringing the estimated design loading up to 1632 kW at about time 0.3 seconds.

HPSI Pump Connection

Another consideration is the unlikely event that a HPSI pump is connected to the bus at the time of a LOVS. This would be the case, for example, if a loss of offsite power were to occur during TS allowed testing or the quarterly inservice testing of the pump. The HPSI pump is also run infrequently for other plant evolutions, such as filling Safety Injection Tanks or ECCS valve tests. The HPSI pumps are not disconnected from the bus by the LOVS during load shedding. Although this could add 405 kW to the DG loads at time zero, the probability of a HPSI pump being connected to a bus coincident with a loss of offsite power is considered small; the probability of this occurring coincident with a LOFW and loss of offsite power is considered very small. It is therefore Edison's conclusion that the addition of the HPSI pump load would not normally be considered under these scenarios.

UNIT 3 SAFETY CONSIDERATIONS

To assess the operability of the Unit 3 DGs, three separate loading cases were assessed: (1) an "expected load case" of 1632 kW, including permanent connected loads plus a CCW pump and an AFW pump, (2) a case with an added HPSI pump corresponding to 2037 kW, and (3) a bounding case of 2436 kW. These cases were evaluated using both analyses and available test data. The conclusion of these evaluations was that the Unit 3 DGs are operable.

The transient voltage analyses (dynamic voltage simulation calculations) utilized in our operability evaluation were performed using the PSS/E power system simulator program (Release 19.0) developed by Power Technologies, Inc. This program has been widely used by other utilities in performing electrical power system analyses. It features power flow and dynamic simulation calculations dealing with machine flux and inertial dynamics. The results of these analyses are provided in the Enclosure to this letter. We conclude that the DG would start all required loads and operate properly under worst case conditions.

In addition, our operability evaluation considered past test data from three different tests with significant loading at time zero; specifically:

1. An ESF test performed in 1983 where a second HPSI pump started at time zero.

2. An ESF test performed in 1982 where an AFW pump started at time zero.

3. The original factory margin qualification test performed by the manufacturer.

Expected Load Case

The expected load case consists of a LOFW with a loss of offsite power resulting in the DG being loaded at essentially time zero with permanently connected loads and consequential loads of a CCW pump and an AFW pump. This does not include a HPSI pump. This corresponds to an estimated design loading of 1632 kW.

A dynamic analysis was performed to determine the acceptability of this loading condition. Plots from the analysis of this condition are designated as Case 2 in the Enclosure. This analysis demonstrated that the DGs could capably start and accelerate to rated speed all the loads in the required sequence. The inrush current for this case was 1190 amps and the DG voltage dipped momentarily to 74.2%.

Every refueling outage the DG is tested to demonstrate that it will start and energize the loads associated with a LOVS in conjunction with a SIAS. As noted above, the estimated design loading associated with a LOVS with a SIAS is 1257 kW at time zero. During some of these tests an additional large 4KV pump was started and loaded during the test. One test in 1983 included the addition of a HPSI pump and resulted in an estimated design loading at time zero of about 1665 kW. This is comparable to the expected load case of 1632 kW. Another test in 1982 included the addition of an AFW pump at time zero and resulted in an estimated design loading of 1939 kW. In each of these tests the connected loads started and accelerated successfully.

Based on the dynamic analysis and the 1982 and 1983 surveillance tests, it is concluded that the DGs would perform their safety function and are therefore operable.

Loading with HPSI Pump

This case is similar to the expected load case above except that a HPSI pump is included at time zero. This would correspond to a LOFW with a loss of offsite power occurring at the same time as a HPSI pump is being run for maintenance or IST testing. The estimated design loading is 2037 kW.

Two dynamic analyses were performed which relate to this case. Case 4 considered 2037 kW being added to the DG at time zero. Case 3 considered the HPSI pump starting at time zero, but the AFW pump and CCW pump were delayed to time 0.3 seconds based on the LOVS reset relay operating time. Plots for these cases are provided in the Enclosure. Both analyses demonstrated that the DGs could start and accelerate to rated speed all the loads in the required sequence. The inrush current for Case 3 was 1540 amps and for Case 4 was 1500 amps. The DG voltage dipped momentarily to 76.1% for Case 3 and 68.1% for Case 4.

The estimated design loading for this case of 2037 kW corresponds to a loading of about 2200 hp. In 1978 the vendor performed a qualification test which included about 2100 hp and a 3000 KVA transformer resulting in an inrush current of 1900 Amps. When compared with the bounding dynamic analysis in Case 1 (see discussion below) this test was 23% more conservative than the

dynamic analysis based on the actual applied amperage during the test. Therefore, the original qualification test bounds the worst case loading scenario. This 1978 qualification test was approved by the vendor and the Architect-Engineer. (See separate discussion of this test in the discussion of Design Basis Qualification below.)

Based on the dynamic analysis and the vendor qualification test it is concluded that the DGs would perform their safety function and are operable.

Bounding Case

Early in the evaluation a conservative (bounding) loading scenario was analyzed. It assumed a loading similar to that used in the analysis of the DG performance during automatic load sequencing post accident (SIAS), except for the following:

- The AFW and CCW pumps start at time zero
- The Non-1E UPS is reenergized at time zero
- The SWC pump starts at time 5 seconds
- The Containment Emergency Fans, the LPSI pump, the Dome Air Circulators, and the Containment Spray Pump are not included.

Also, consistent with the accident loading analysis, each 480V motor control center was assumed to be operating at 75% of its total connected load which included a 15 horsepower and 5 KVA static load margin for future growth. The estimated design loading for this case corresponds to 2436 kW. This analysis demonstrated that the DG could start and accelerate to rated speed all the loads in the required sequence. The plots for this case are shown as Case 1 in the Enclosure. The inrush current for this case was 1630 amps and the DG voltage dipped momentarily to 66.2%.

The vendors for the DG were contacted to obtain their assessment of the capability of the DG to start bounding loads. MKW Power Systems, the authorized diesel engine nuclear vendor, indicated there would be no problem for the tandem diesels to start 2400 kW of inductive load. Ideal, the generator vendor, evaluated the predicted inrush current and voltage dip for a 2250 kW step load (they were not asked about a 2400 kW load) and concluded the generator would not fail at this load. The generator vendor predicted a momentary voltage dip to about 60%.

Since 2250 kW and 2400 kW significantly exceed the loads under consideration, this further supports the operability of the DGs.

Summary

In order to confirm the operability of the DGs, three paths were followed. First, new dynamic analyses were performed. All of these analyses demonstrated that the DGs would start the required loads. Second, test data was evaluated. Both factory qualification tests and onsite surveillance tests support the analytical conclusion that the DGs would be able to start loads greater than or comparable to the LOVS loads. Third, the vendors of the diesel engine and the generator indicated that the DGs could start loads in

excess of the worst case LOVS loads. Consequently, we have concluded that the San Onofre DGs would perform their design basis functions and are therefore operable.

PLANNED CORRECTIVE ACTIONS

Although, based on the preceding evaluation, Edison concludes that the DGs will perform their safety function with the current plant design, we also recognize that a design change would reduce the stress on the DG, restore margin to the DG starting sequence, and make the plant design consistent with refueling interval testing. Just as it is prudent to reduce the number of fast starts on the DG, it is also prudent to reduce the load that is connected to the DGs at time zero.

Therefore, Edison is modifying the appropriate load circuitry such that the consequential loads are sequenced on the DG following a LOVS rather than being connected at, or near, time zero. Thus, the LOVS DG load at time zero would be reduced to a value bounded by the LOVS with SIAS event.

The scope of the design changes includes the following:

1. Revise the AFW electric pump circuitry so that an EFAS signal will always cause the pump to start after the 30 second time delay sequencing relay has functioned. (The manual pushbutton on the main control panel will continue to cause an immediate start of the pump.)

2. Revise the CCW pump circuitry so that the low pressure auto start signal from the opposite train will always cause the pump to start after the 15 second time delay sequencing relay has functioned. (The manual pushbutton on the main control panel will continue to cause an immediate start of the pump.)

Edison completed the above modifications on Unit 2 during the current Unit 2 refueling outage. For Unit 3, only the CCW control circuits were modified during the Unit 2 outage, as this effort could be accomplished on each Unit 3 CCW pump circuit with the plant at power and without entering a TS action statement. Edison does not plan to similarly modify the Unit 3 AFW pump control circuits with the plant at power as this would require exposing Unit 3 to an unnecessary risk since entrance into the AFW TS action statement would be necessary. The Unit 3 AFW pump modifications will be completed during the Unit 3 Cycle 8 refueling outage scheduled to begin in July 1995.

TECHNICAL SPECIFICATION CONSIDERATIONS

The San Onofre Technical Specifications, Section 4.8.1.1.2.d.4, have the following Surveillance Requirement:

"4. Simulating a loss of offsite power by itself, and:

a) Verifying de-energization of the emergency busses and load shedding from the emergency busses.

b) Verifying the diesel starts on the auto-start signal, energizes the emergency busses with permanently connected loads within 10 seconds and operates for greater than or equal to 5 minutes while its generator is loaded with the permanently connected loads. After energization, the steady state voltage and frequency of the emergency busses shall be maintained at 4360 +/- 436 volts and 60 +/- 1.2 Hz during this test."

This Surveillance Requirement has not changed since originally issued in February 1982.

This Surveillance Requirement has been understood to require that a LOVS signal by itself should be simulated and the DG energized with the normal loads (the load center and motor control centers) that are not disconnected during load shedding; i.e., the permanently connected loads. There is no LOVS load sequencer at San Onofre Units 2 and 3, and therefore there are no auto-connected shutdown loads. Loads connected by events other than a LOVS (consequential loads) were not included in the test.

Historical Review

Our understanding of the LOVS Surveillance Requirement is consistent with the historical development of this Technical Specification.

The original FSAR submittal in November 1976 included draft Technical Specifications. These draft Technical Specifications did not include a surveillance requirement to perform a LOVS test by itself. During the NRC's review of the FSAR, the NRC requested (Question 040.47) that a Surveillance Requirement be added:

"Verifying that on loss of offsite power the diesel generators start on the autostart signal, the emergency buses are energized with permanently connected loads, the auto-connected shutdown loads are energized through the load sequencer, and the system operates for five minutes while the generators are loaded with the shutdown loads."

In response to the NRC request, Amendment 9 to the FSAR in May 1978 added the following Surveillance Requirement related to just a loss of offsite power:

"5. Simulating a loss of offsite power signal and verifying de-energization of the engineered safety features buses and load shedding from the engineered safety features buses."

The Standard Technical Specifications for Combustion Engineering Plants that were available in August 1979 (NUREG 0212, Rev. 1) included the following Surveillance Requirement:

"4. Simulating a loss of offsite power by itself, and:

a) Verifying de-energization of the emergency busses and load shedding from the emergency busses.

b) Verifying the diesel starts on the auto-start signal, energizes the emergency busses with permanently connected loads within _____ seconds, energizes the auto-connected shutdown loads through the load sequencer and operates for greater than or equal to 5 minutes while its generator is loaded with the shutdown loads. After energization, the voltage and frequency of the emergency busses shall be maintained at _____ +/- ____ volts and _____ +/- ____ Hz during this test."

In September of 1981, Amendment 26 to the FSAR submitted a major rewrite of all of the proposed Technical Specifications. This rewrite included a Surveillance Requirement essentially the same as that originally issued in February 1982.

The history of this surveillance requirement shows that the NRC and Edison recognized a distinction between auto-connected shutdown loads and permanently connected loads since at least 1978. None of the draft Technical Specifications proposed for San Onofre include auto-connected shutdown loads. The Technical Specifications issued by the NRC for San Onofre did not include auto-connected shutdown loads. Edison personnel responsible for development of the original Technical Specifications indicate that this resulted from agreements with the NRC staff to delete Standard Technical Specification requirements pertaining to a masterload sequencer. Since the San Onofre design does not include a master load sequencer these requirements were determined to be not applicable. As a result, the San Onofre Technical Specifications on LOVS loading have always included only the permanently connected loads.

Assessment of Surveillance Requirement

Notwithstanding the above historical perspective, Edison reevaluated this Surveillance Requirement to assess whether it should be improved.

The primary objectives of the loss of offsite power Surveillance Requirement in the Standard Technical Specifications are to demonstrate (1) the DGs are automatically started, (2) the load sequencer for shutdown loads functions properly, and (3) the DGs operate acceptably with the appropriate loads. The existing San Onofre Surveillance Requirement demonstrates that a LOVS starts the DGs and that the DGs operate acceptably with the permanent loads. Since there is no load sequencer at San Onofre, this aspect of the Standard Technical Specification is not applicable.

It is recognized that certain consequential loads may also start following a loss of offsite power and therefore it is important to demonstrate that the DGs operate properly with these loads. With the design changes discussed above, these loads are sequenced on the DGs following a LOVS with the same time delays as for a LOVS with a SIAS. Therefore, the ability of the DGs to operate with the consequential loads is appropriately demonstrated by the existing Surveillance Requirement simulating a loss of offsite power in combination with a SIAS (Surveillance Requirement 4.8.1.1.2.d.7).

In addition, testing of one of the starting circuits for the consequential loads will be improved. This involves the relay in the SWC circuit which provides the 5 second time delay after the CCW pump starts. This relay will be added to the LOVS and Sequencing Relay Circuit test procedures to ensure that it is tested each refueling outage.

Based on this evaluation, it is concluded that the San Onofre loss of offsite power Surveillance Requirement is acceptable as is.

POTENTIAL DESIGN LOADING CHANGE REVIEW

One of the questions that was assessed is whether design changes have been improperly made to the sequencing of loads on the DG. Based on this review, Edison believes that the current LOVS circuitry is consistent with the original FSAR design assumptions; specifically, no modifications have been made to the CCW pump or AFW pump LOVS auto-connect circuitry.

DESIGN BASIS QUALIFICATION

The UFSAR describes a qualification program for the San Onofre DGs. This qualification program included, among other things, a commitment to perform a margin test (FSAR Section 8.3.1.1.4.11). The objective of the margin test was to demonstrate the DG capability to start and carry loads that are greater than the most severe step-load change within the plant design loading sequence plus 10%.

The DG purchase specification included a requirement to perform a margin qualification test to demonstrate the ability of the DG to start the most severe step load change in the design loading sequence plus 10%. This was identified in the specification as 1753 kW (conservative with respect to the 1632 kW Edison currently believes should be assumed) plus 10%, or 1928 kW.

At this point in time, nearly 20 years after performance of these tests, it is difficult to reconstruct precisely how the tests were conducted. A summary description of the margin test and a plot of certain electrical parameters are available. The test summary indicates the test objective was to "demonstrate the capability of the SSDG Set to start and carry a load 10% greater than the most severe step load change ... without experiencing generator voltage collapse and/or loss of torque significant enough to cause engine stall or inability of the engine to recover rated speed. "At 10 seconds after a DG start signal, the test loaded motors corresponding to 2100 hp. This test met the test acceptance criteria and was approved by both the vendor and the Architect-Engineer.

CONCLUSION

Based on the evaluations summarized above it is concluded that the San Onofre DGs would perform their specified function and are therefore operable. Notwithstanding this conclusion, Edison believes that it is prudent to change the starting circuitry of the CCW pumps and AFW pumps to reduce the LOVS loading on the DGs at time zero. These design changes are being accomplished on the schedules identified above.

Should you have any questions or comments regarding this information, please let us know.

Sincerely,

Walter C. Marsh

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Enclosure

cc: L. J. Callan, Regional Administrator, NRC Region IV
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M. B. Fields, NRC Project Manager, San Onofre Units 2 and 3

Enclosure

EMERGENCY DIESEL GENERATOR CAPABILITY ANALYSES
SAN ONOFRE NUCLEAR GENERATING STATION UNITS 2 & 3

CASE 1

Sequence	Running Load	KW	KVAR
@ t=0 sec	HPSI Pump P017	405.10	172.60
	AFW Pump P141	582.20	368.40
	CCW Pump P025	476.60	270.10
	Non 1E UPS	142.90	91.20
	Chrg Pump P190	57.40	35.50
	Chrg Pump P191	57.40	35.50
	MCC 2BRA	16.13	10.00
	MCC 2BD	162.18	92.74
	MCC 2BE	117.15	63.99
	MCC 2BY	201.87	125.67
	MCC BQ	117.33	72.76
	Total	2436.26	1338.46
@ t=5 sec	Load @ t=0	2436.26	1338.46
	Cont Rm AC E418	122.10	78.50
	SWC Pp P307	331.30	214.00
	Total	2889.66	1630.96
@ t=30 sec	Load @ t=5	2889.66	1630.96
	Chiller E336	461.90	261.30
	Total	3351.56	1892.26

CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
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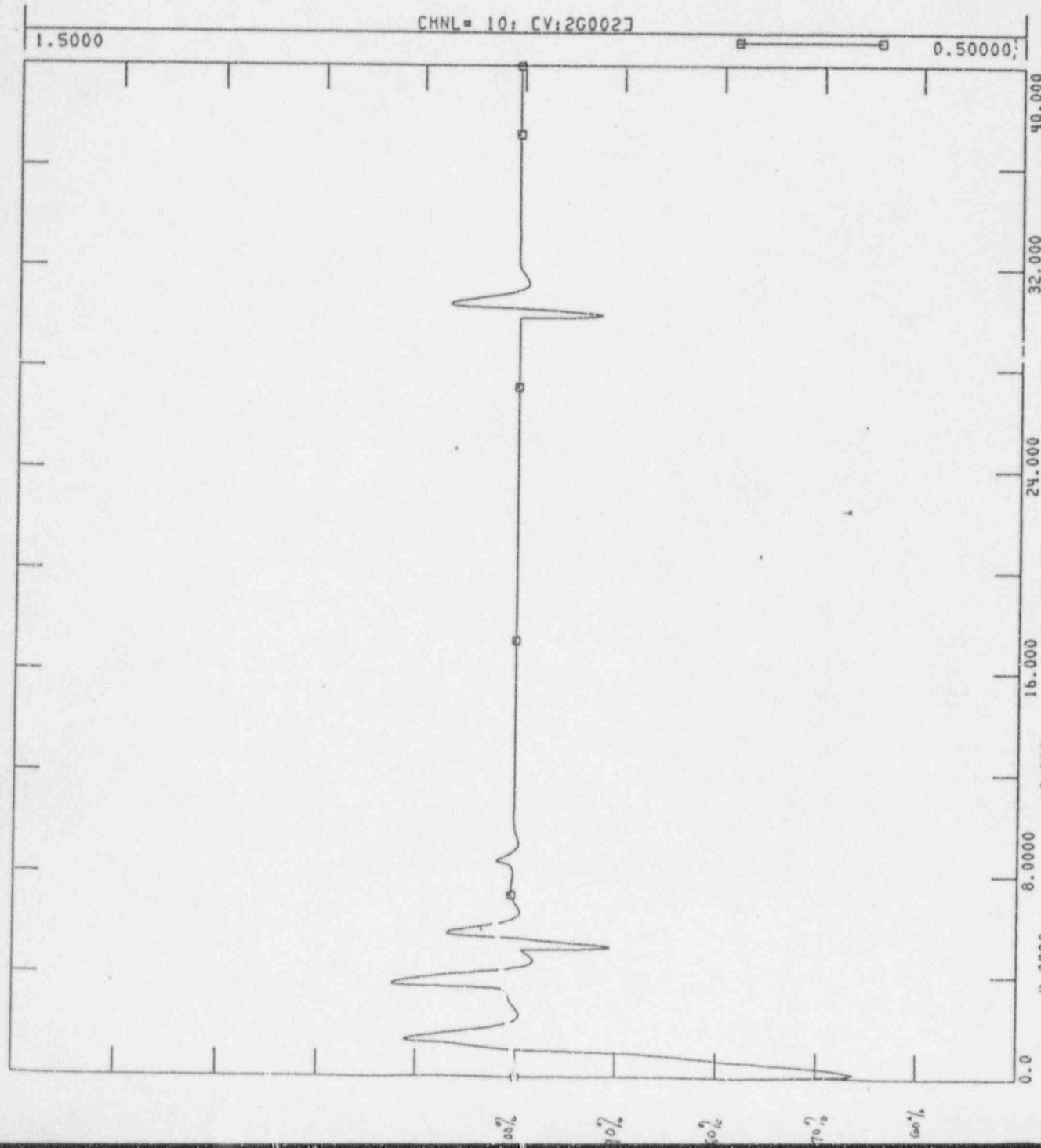

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POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
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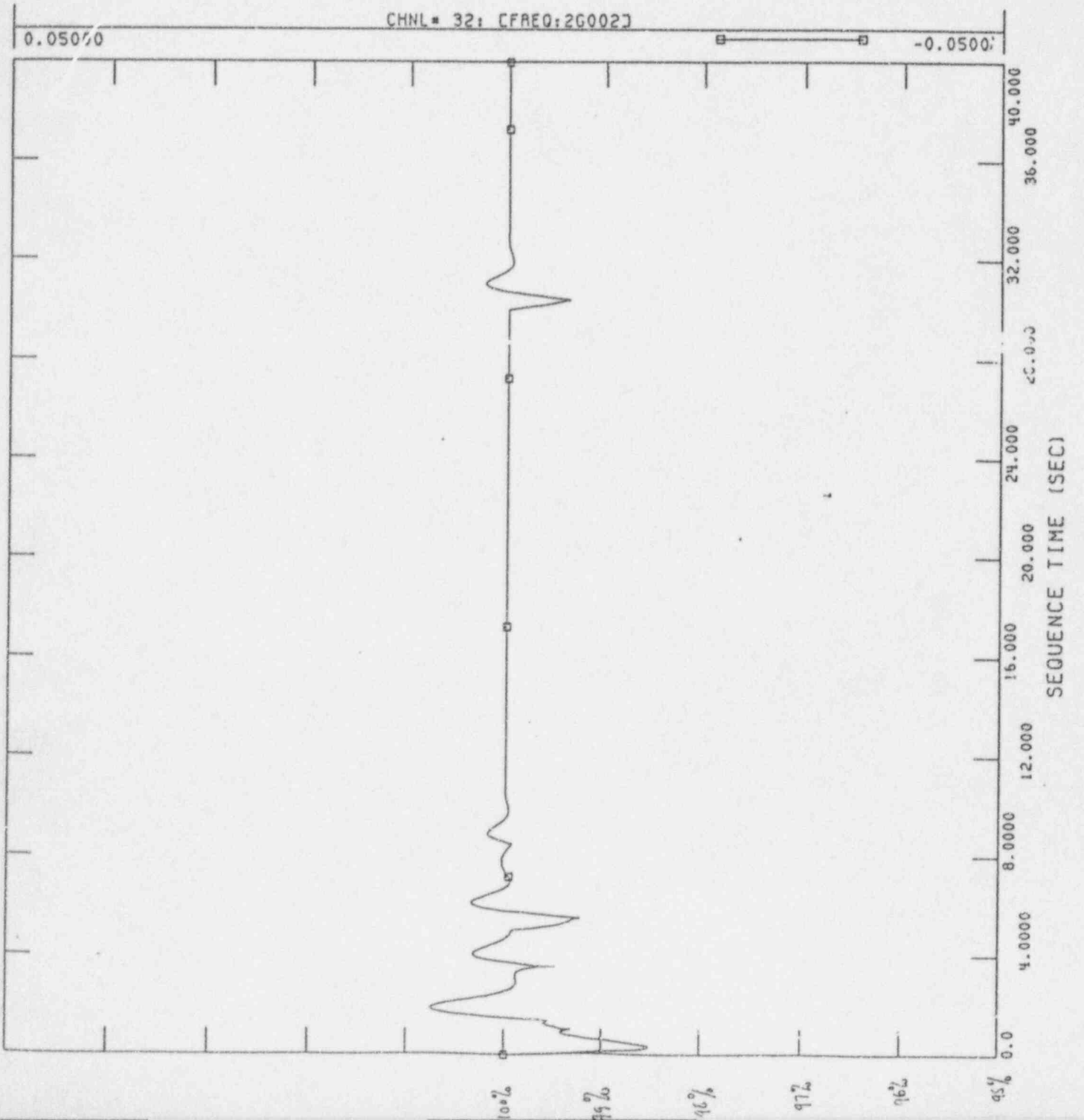

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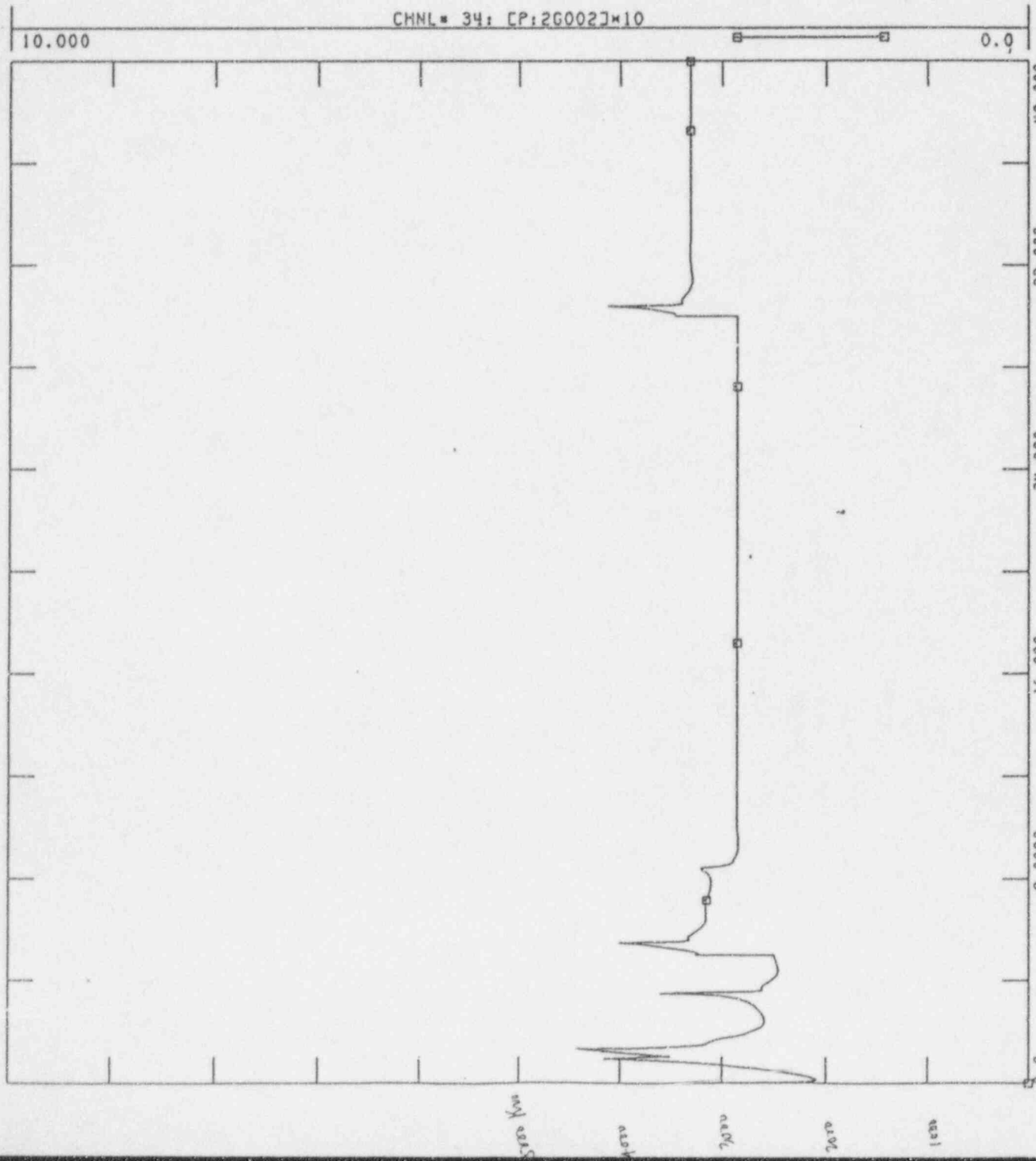

2G002 P (MW)

CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
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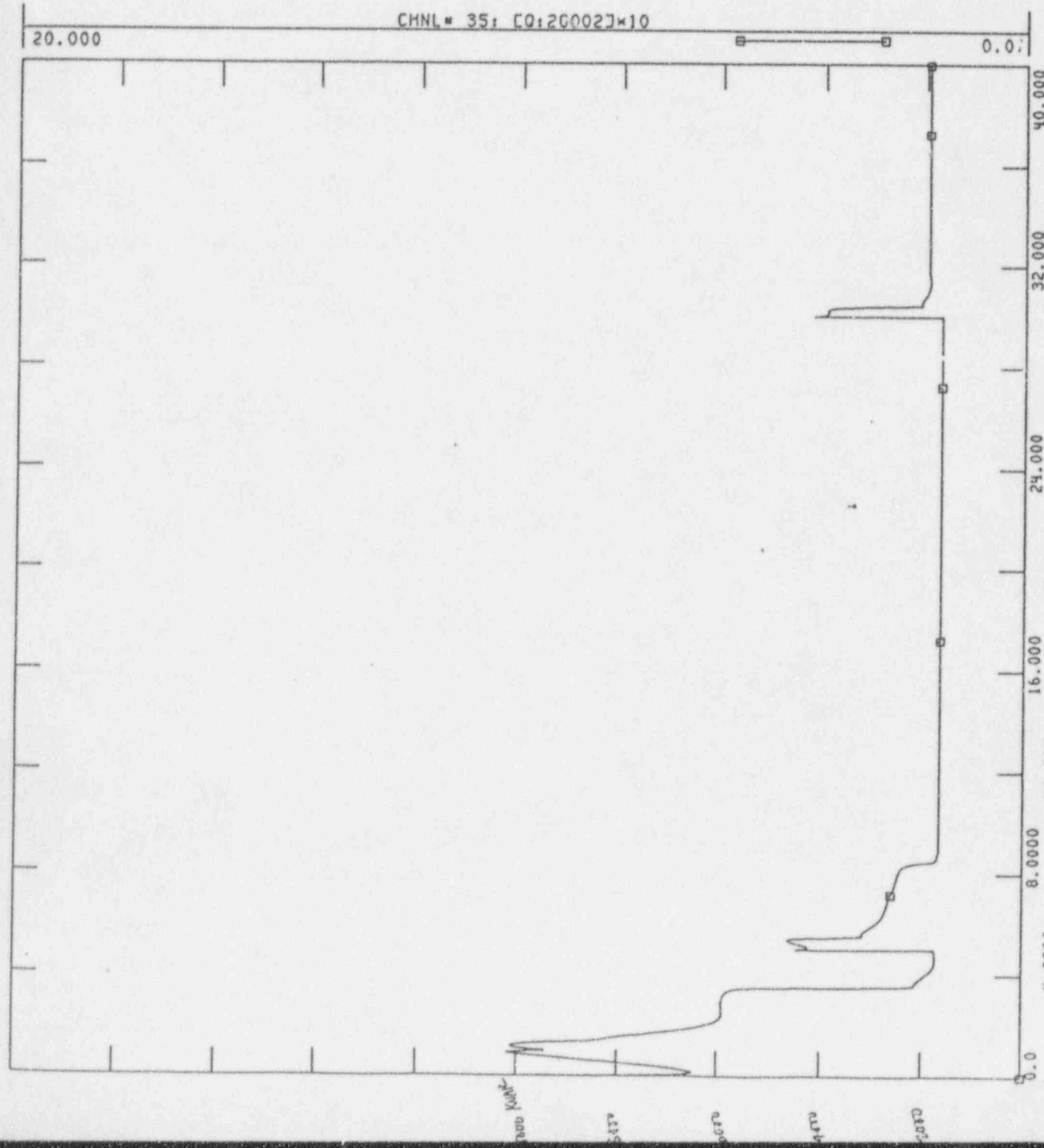

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POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
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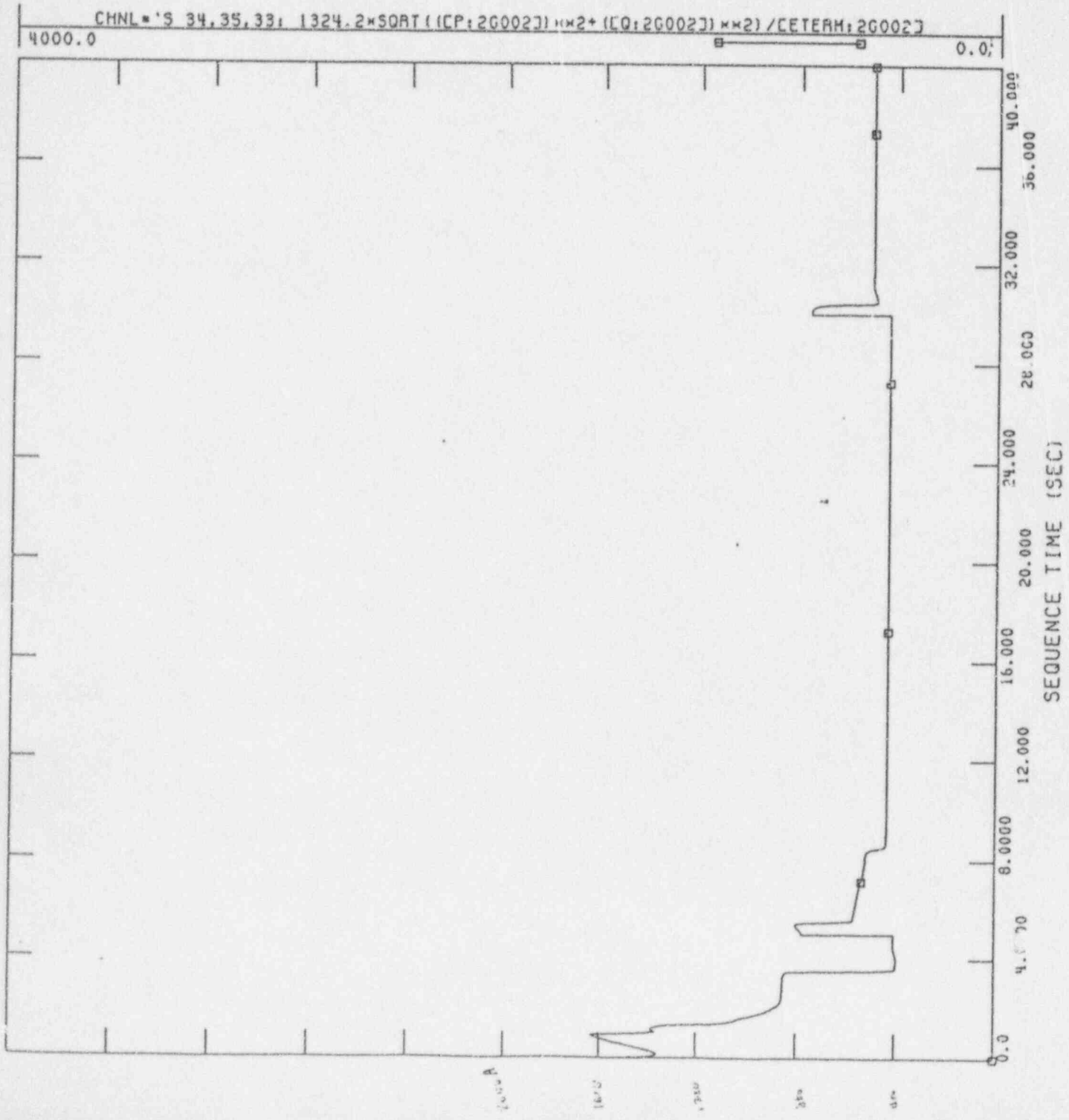

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POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
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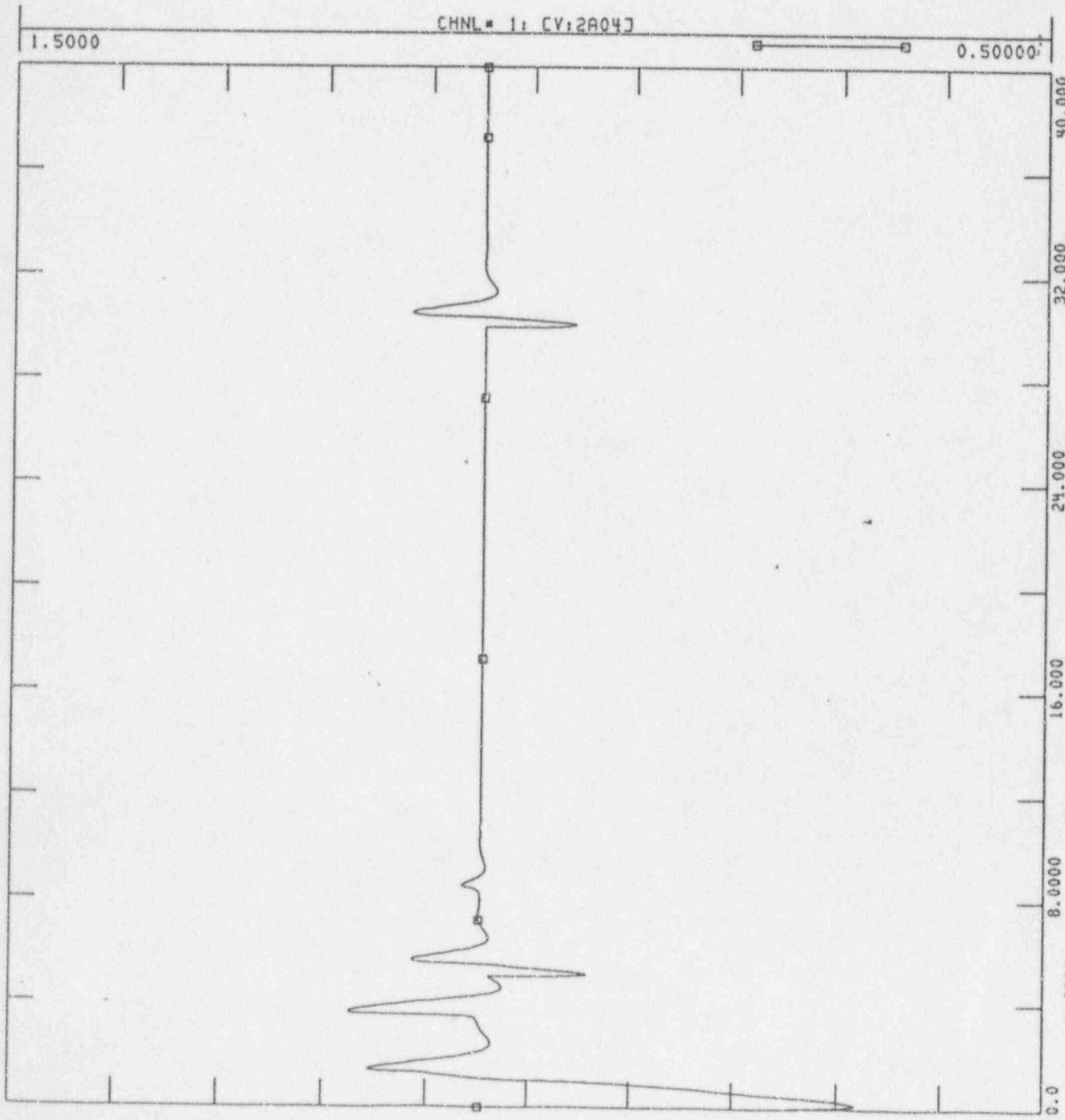

SAT, MAR 04 1995 18:01
BUS 2A04 (4.16-KV BASE)

CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
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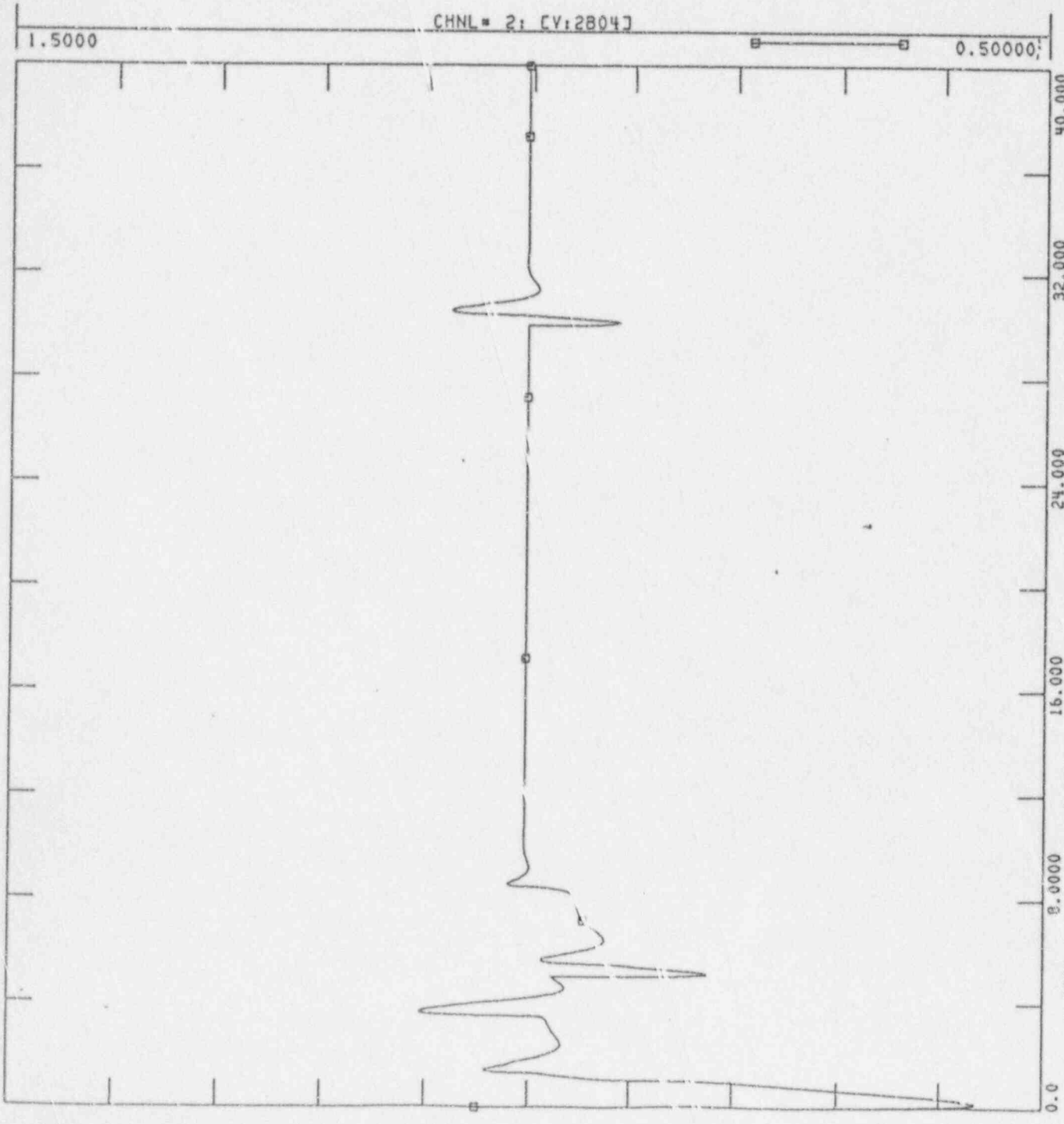
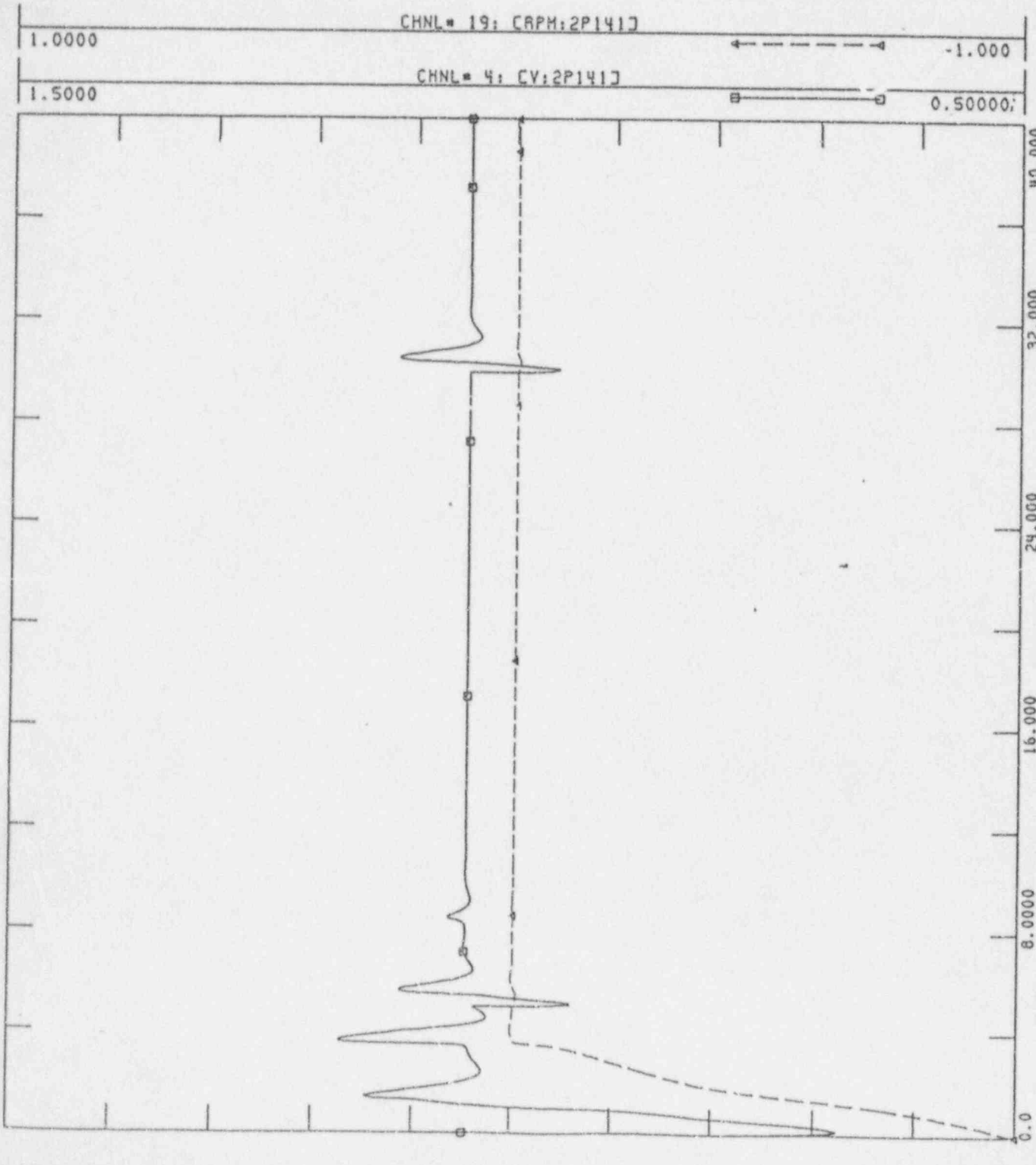


SAT, MAR 04 1995 18:01
BUS 2804 (480-V BASE)

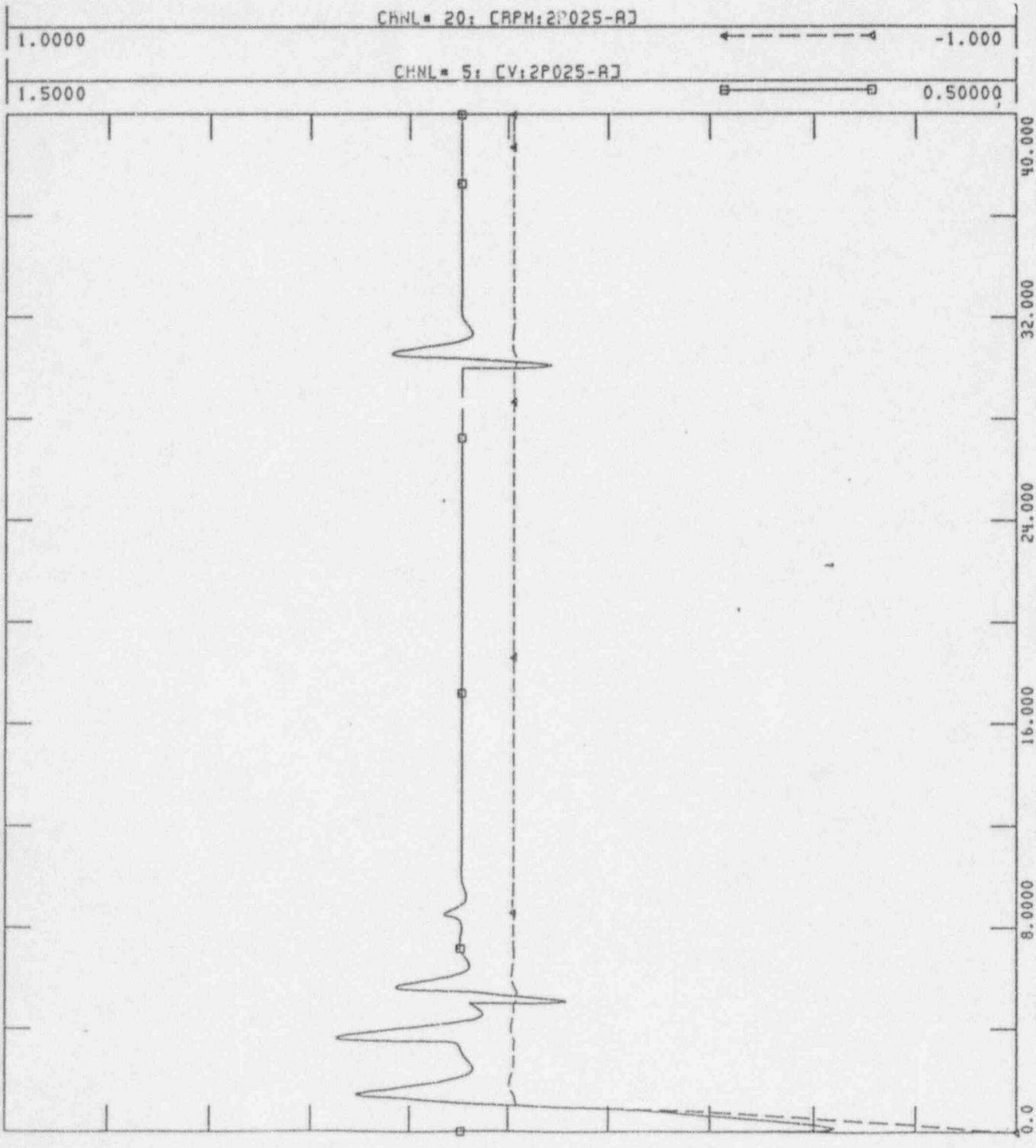
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-1

SAT, MAR 04 1995 18:01
AFW 2P141



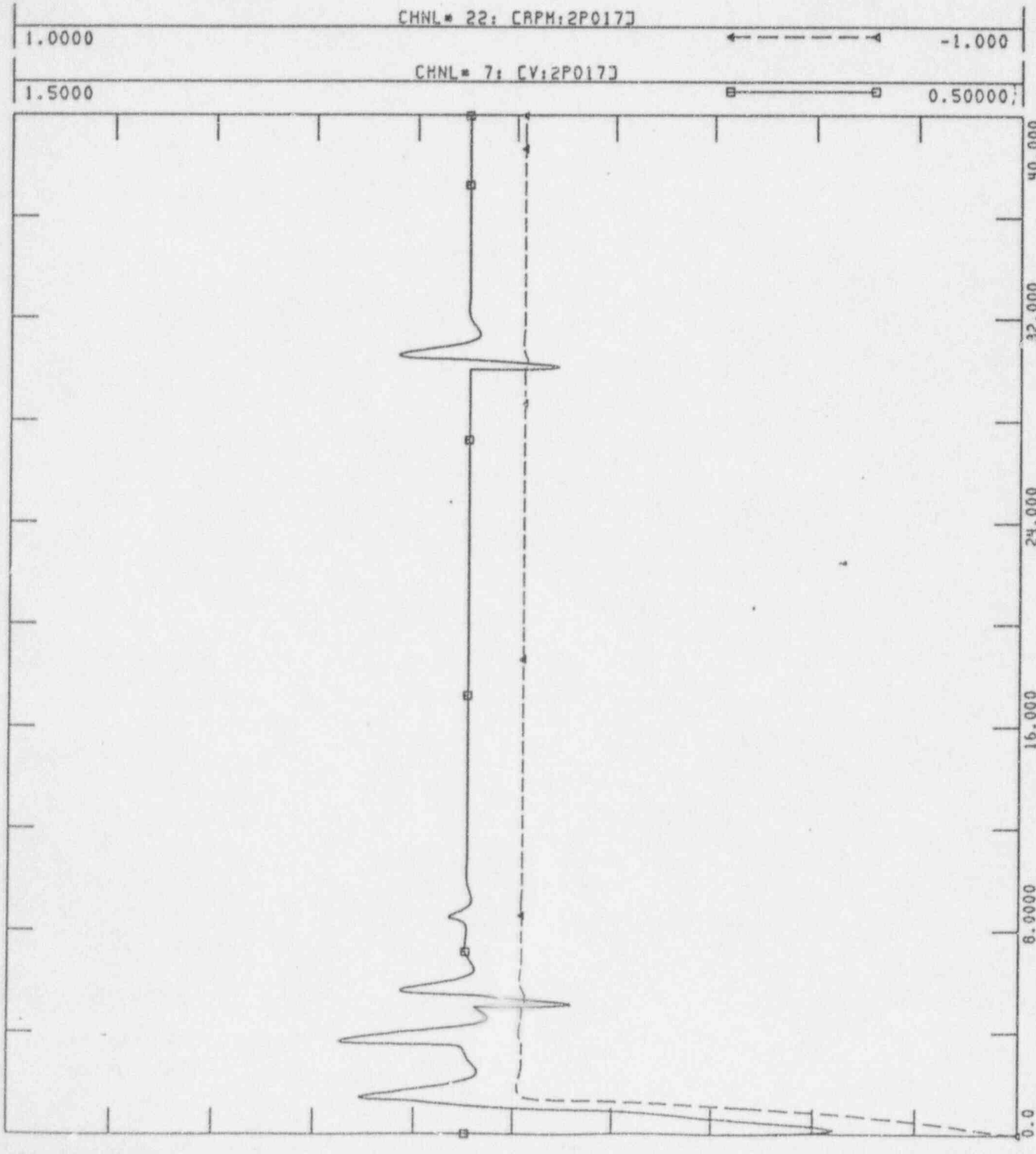
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-1

SAT, MAR 04 1995 18:01
CCW 2P025-A



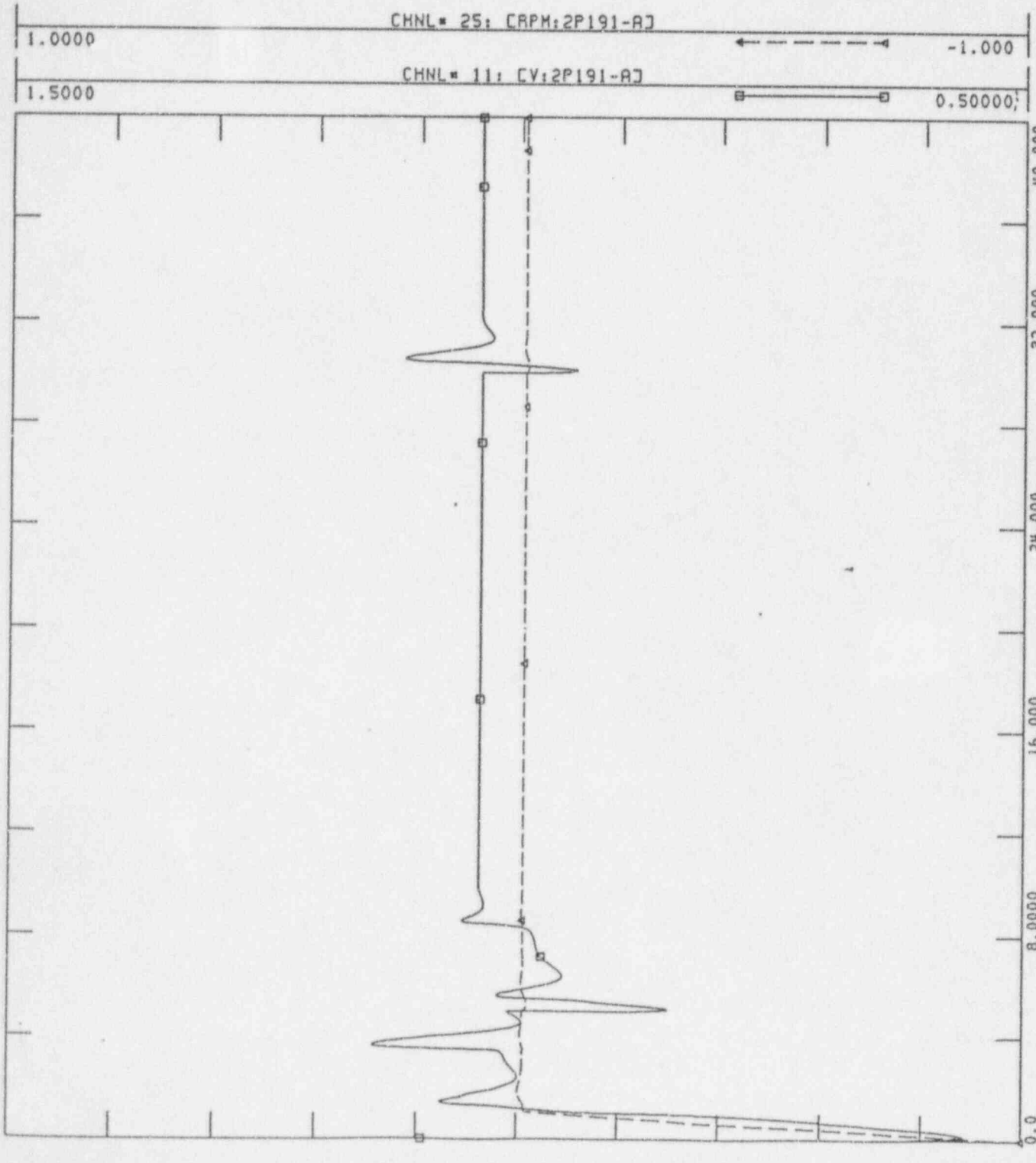
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-1

SAT, MAR 04 1995 18:01
HPSI 2P017



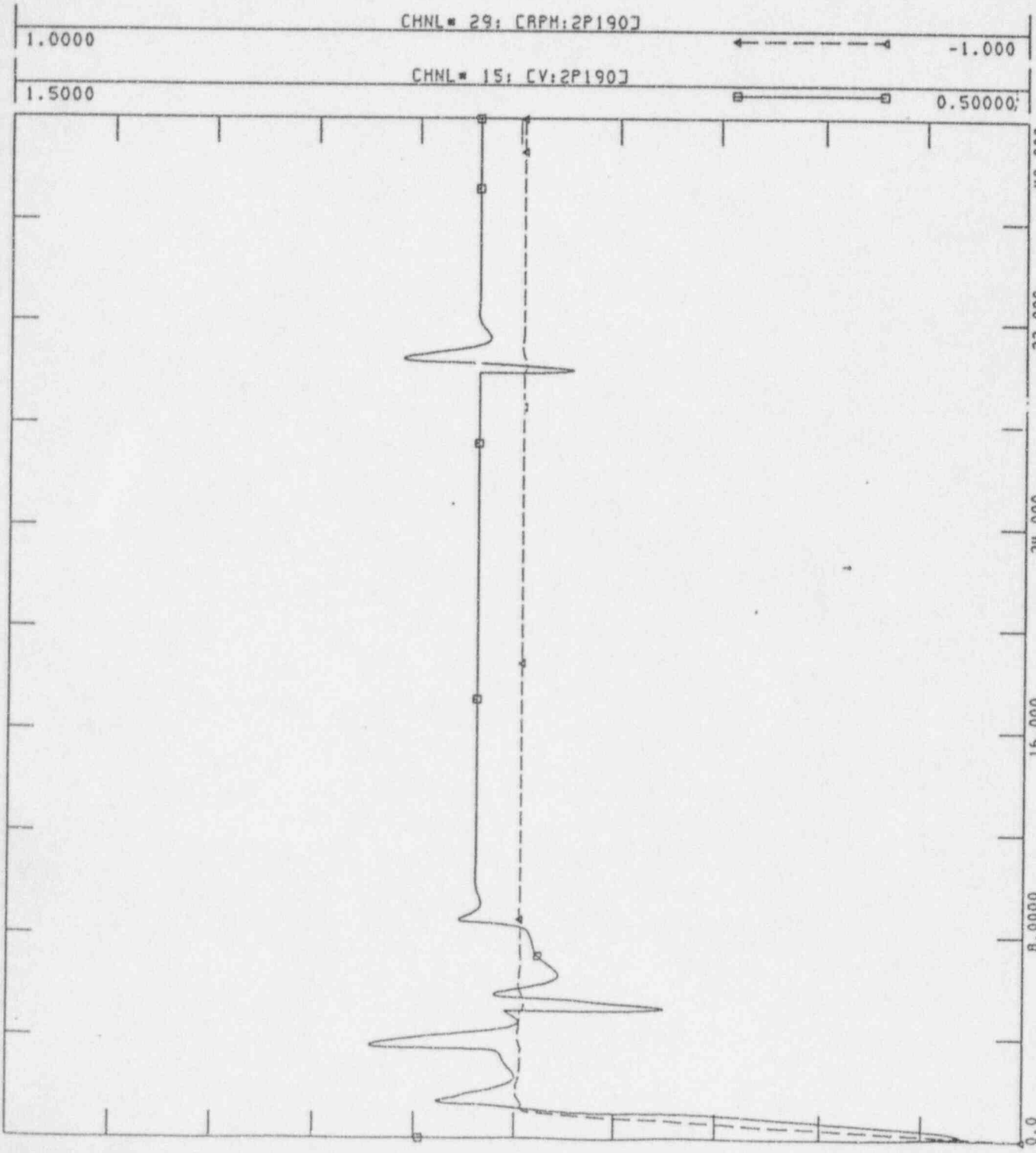
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-1

SAT, MAR 04 1995 18:01
CHRG PUMP 2P191-A



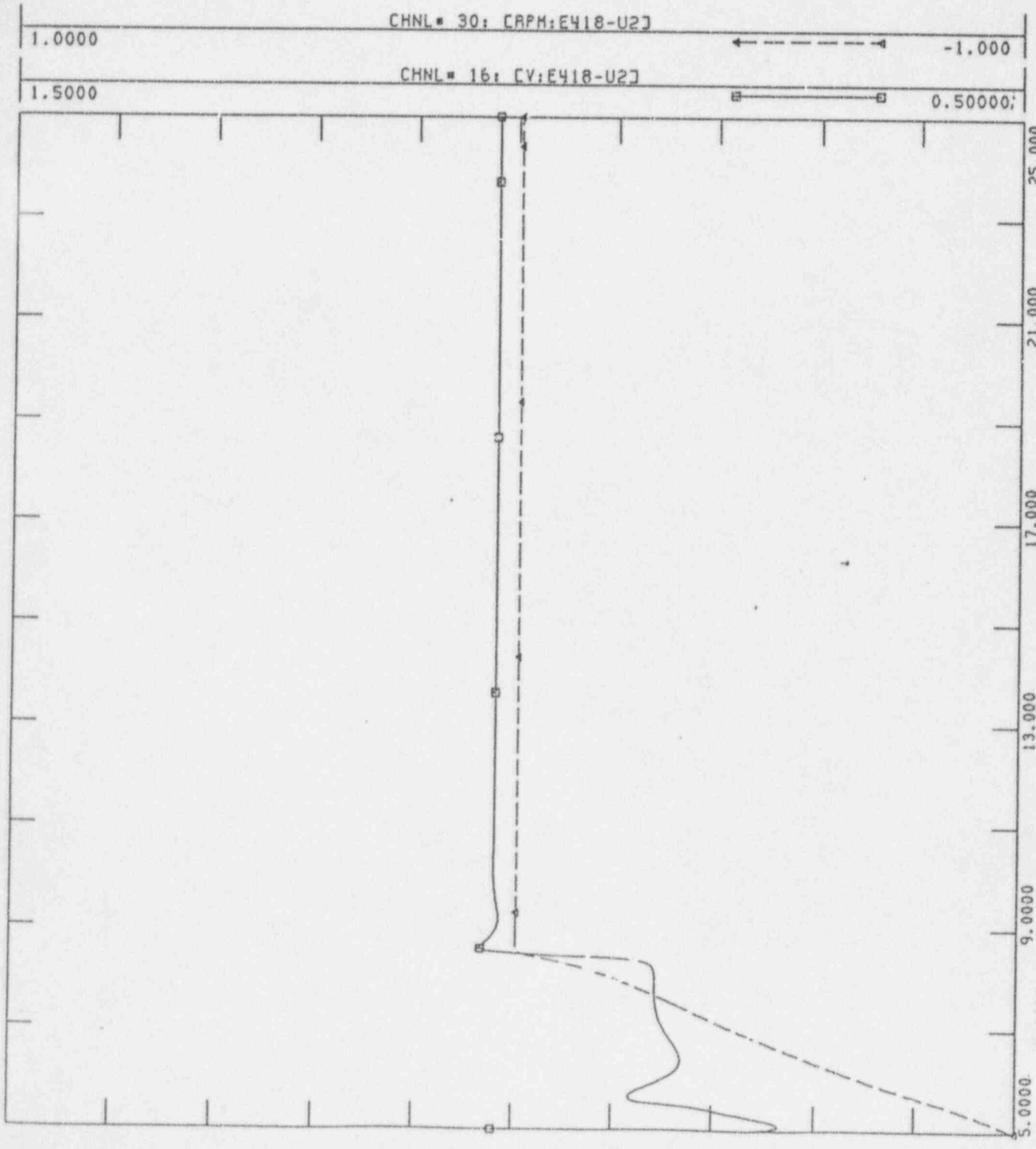
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-1

SAT, MAR 04 1995 18:01
CHRG PUMP 2P190



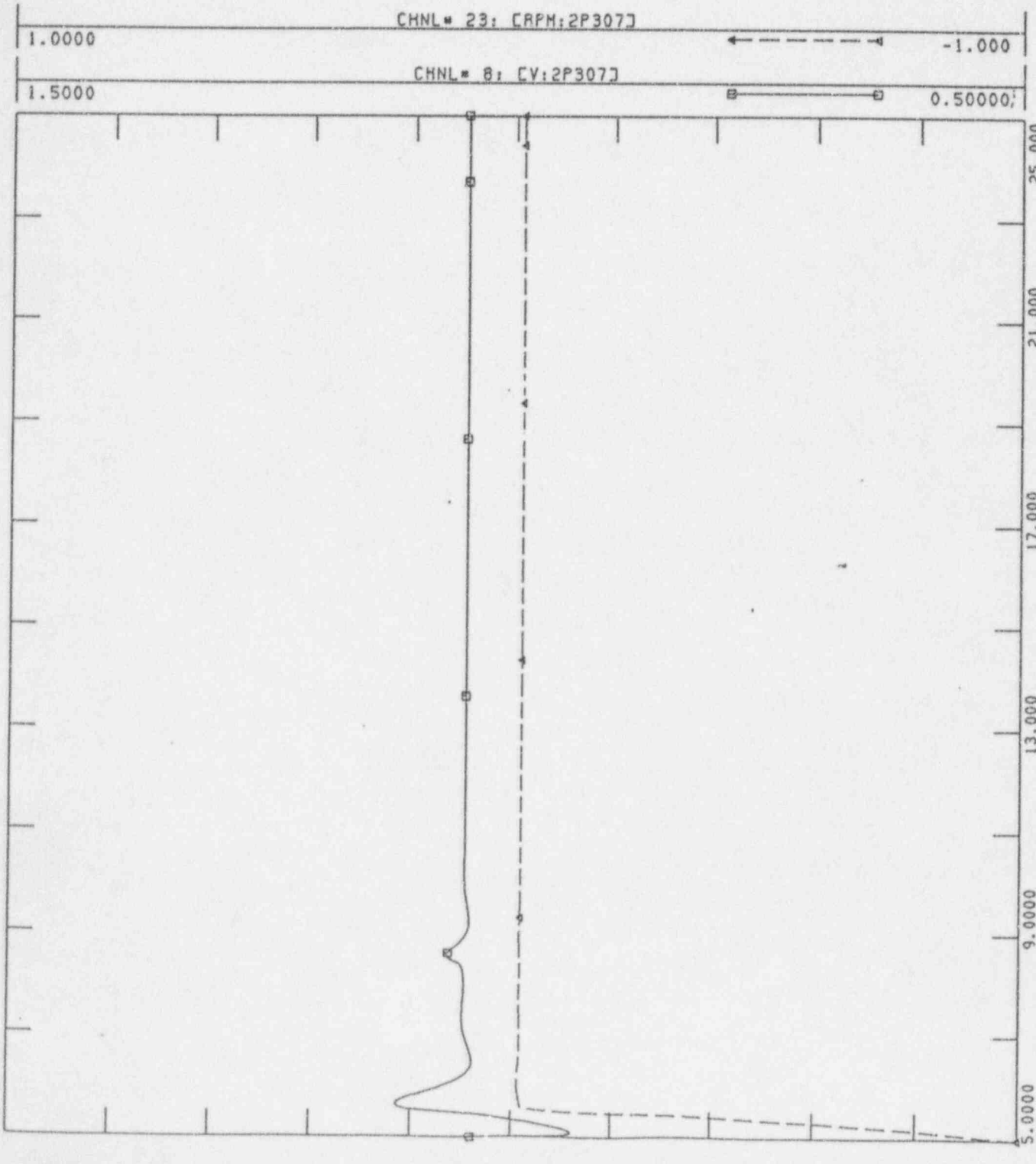
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-1

SAT, MAR 04 1995 18:01
CONT RM AC E418-U2



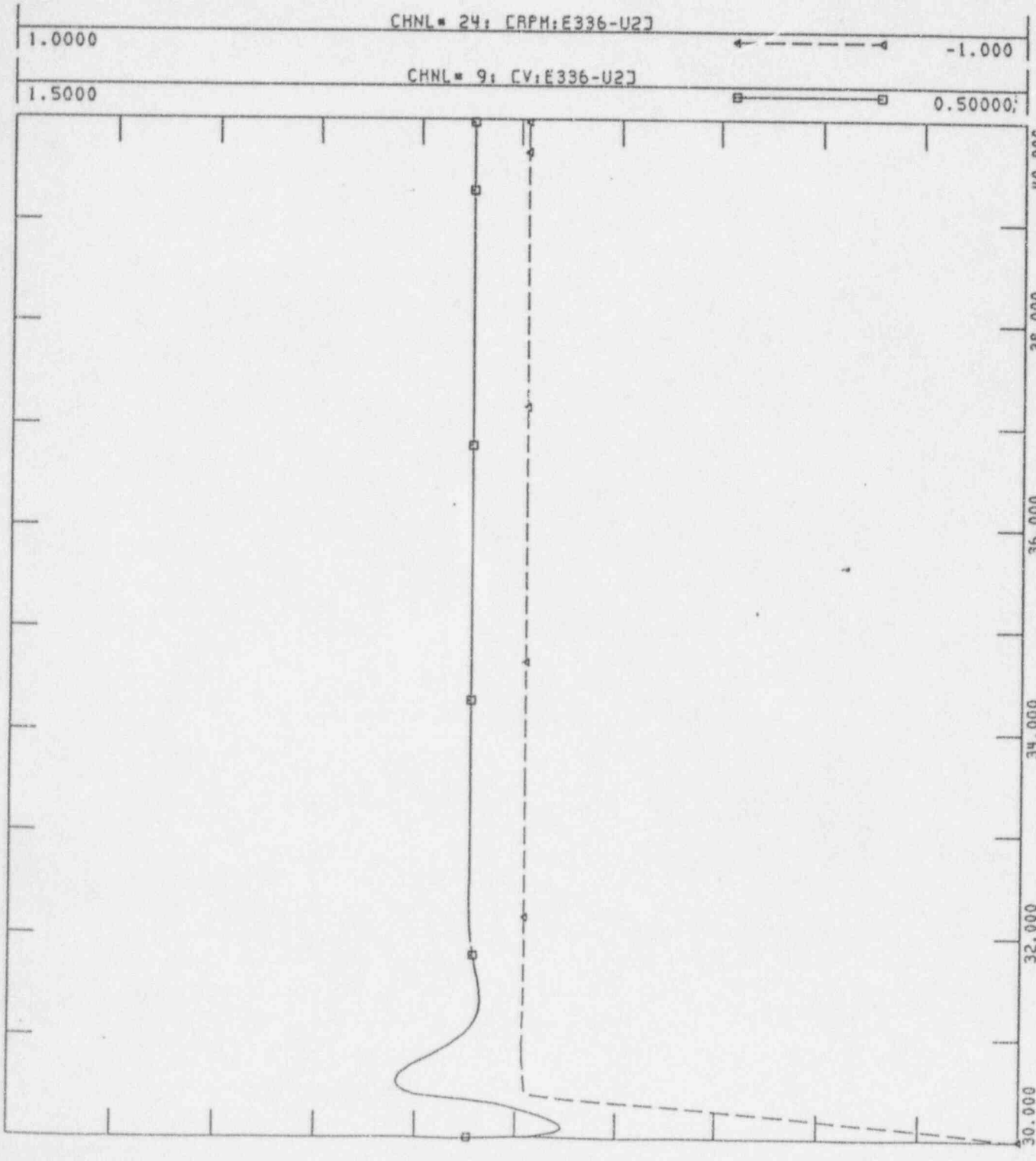
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-1

SAT, MAR 04 1995 18:01
SWC 2P307



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-1

SAT, MAR 04 1995 18:01
CHILLER E336-U2

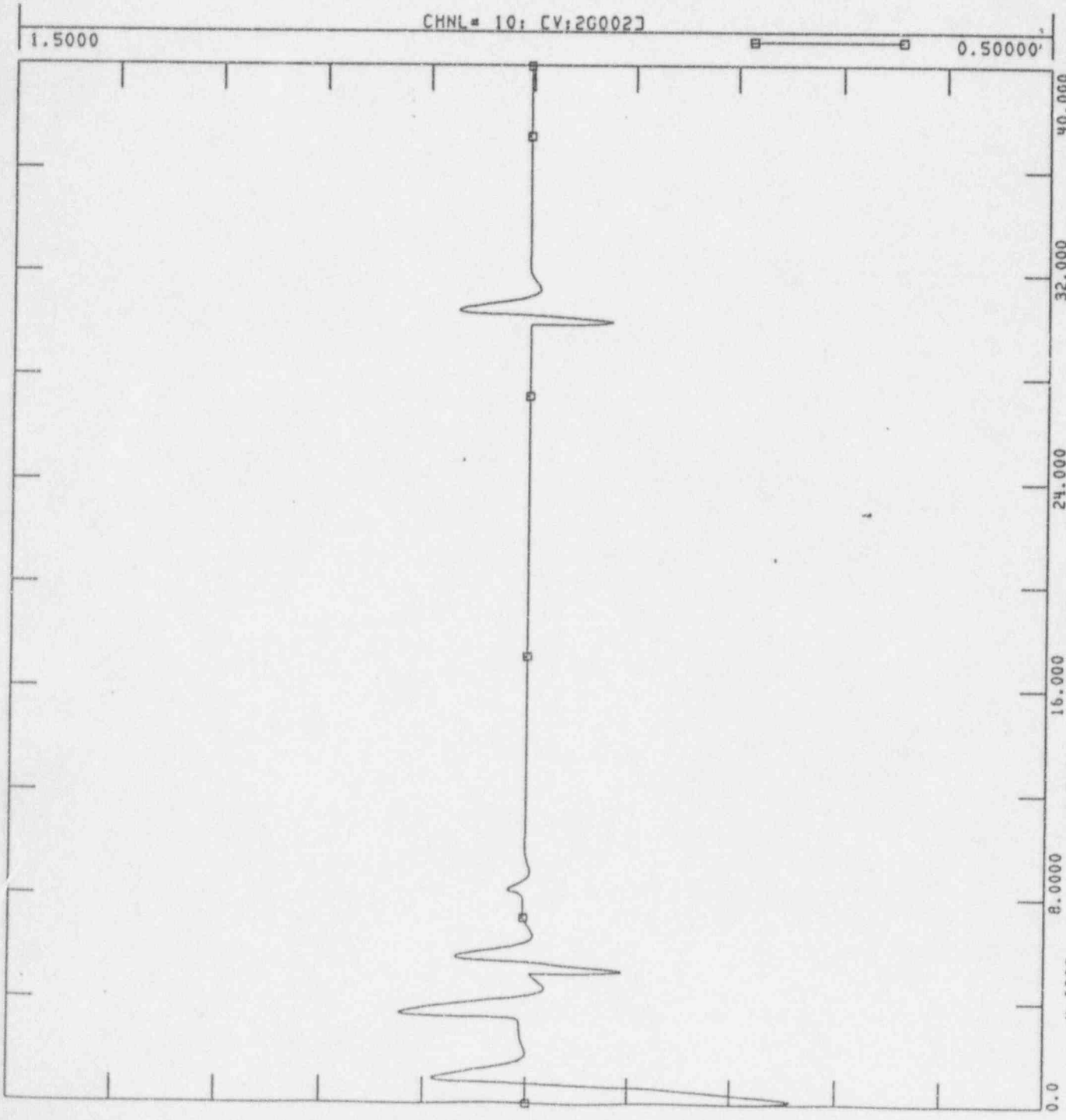


CASE 2[SEE NOTE]

Sequence	Running Load	KW	KVAR
@ t=0 sec	AFW Pump P141	682.20	368.40
	CCW Pump P025	476.60	270.10
	Non 1E UPS	142.90	91.20
	Chrg Pump P190	57.40	35.50
	Chrg Pump P191	57.40	35.50
	MCC 2BRA	4.25	2.63
	MCC 2BD	13.07	8.17
	MCC 2BE	23.40	17.70
	MCC 2BY	113.90	68.22
	MCC BQ	60.92	36.05
	Total	1632.04	933.47
@ t=5 sec	Load @ t=0	1632.04	933.47
	Control Rm AC E418	122.10	78.50
	SWC Pump P307	331.30	214.00
	Total	2085.44	1225.97
@ t=30 sec	Load @ t=5	2085.44	1225.97
	Chiller E336	461.90	261.30
	Total	2547.34	1487.27

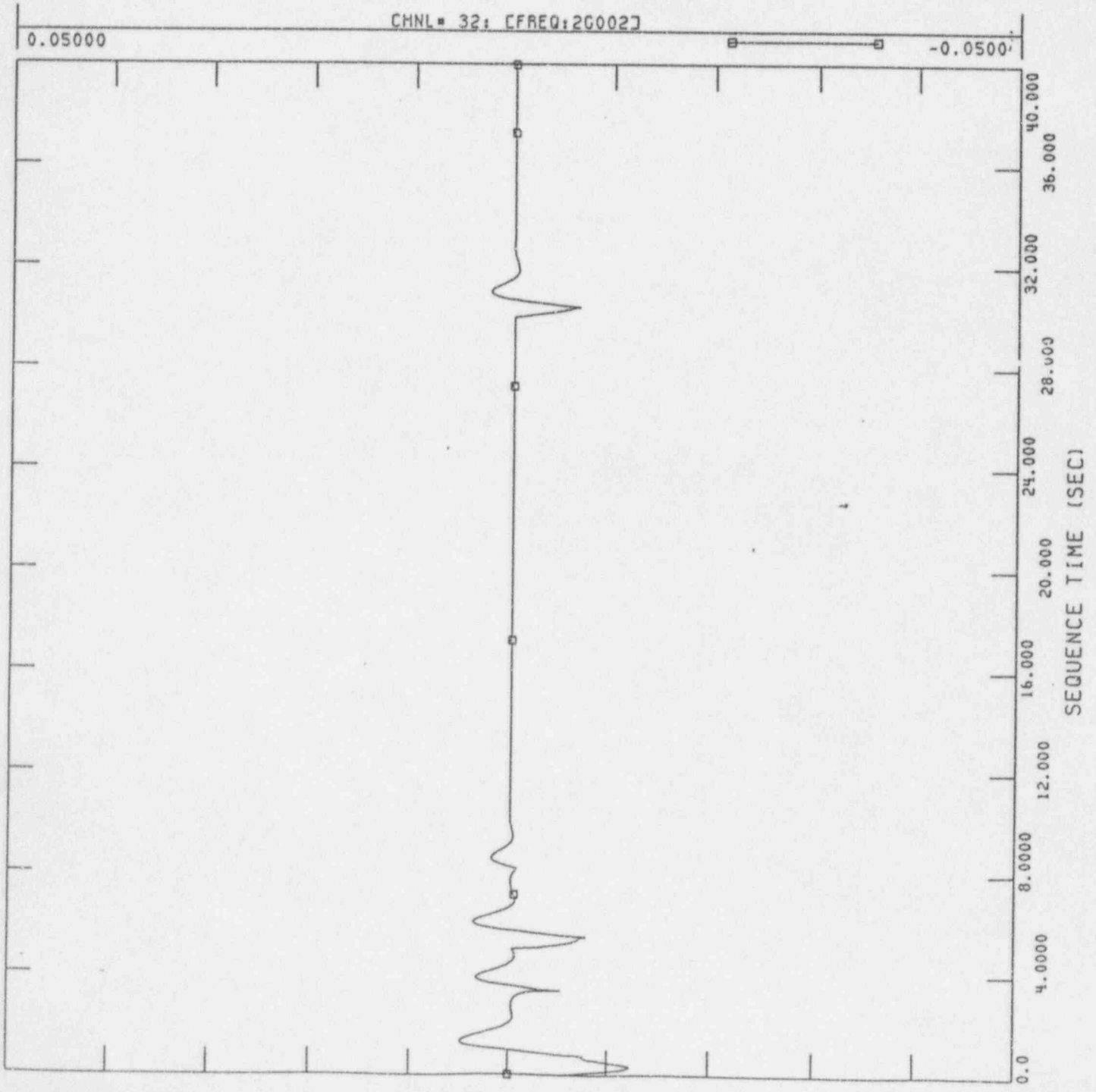
NOTE: In CASEs 2 thru 4, dynamic simulations do not include the starting of Diesel Radiator Fans E550 and E546 at t=10 seconds, and the Diesel Generator Building Emergency Supply Fans A274 and A275 at t=15 seconds. These loads may start at these designated times, however, they are not considered in this case since the condition at t=0 second, which is more limiting, is used to verify the operability of the diesel generator. If these loads are considered, an additional load of 65.78 kW + 44.20 kVAR would be added at t=10 seconds and 90.14 kW + 60.58 kVAR would be added at t=15 seconds. Accordingly, the total load at the end of the automatic loading sequence would include these values.

CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2



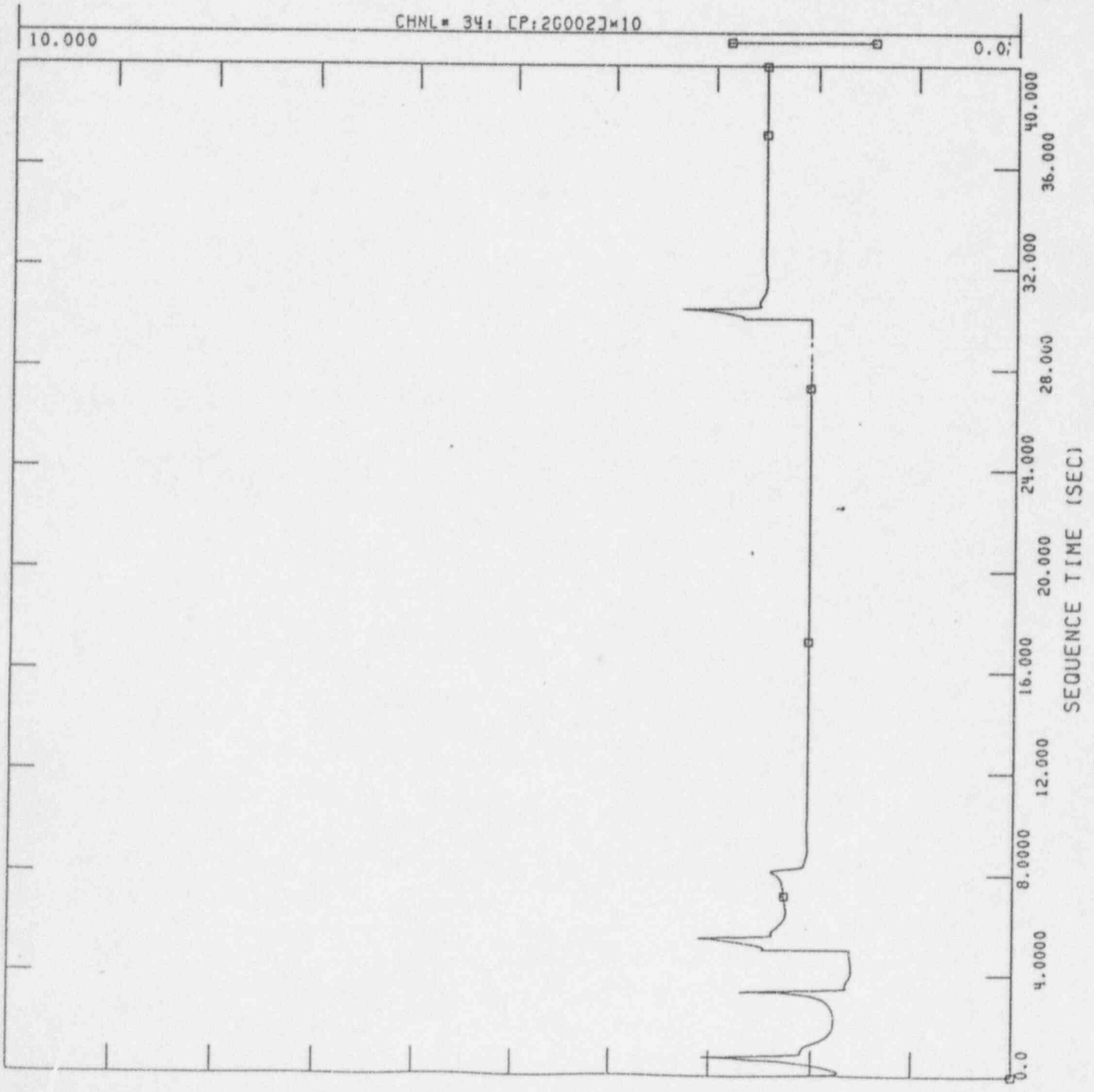
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

SAT, MAR 04 1995 18:06
20002 FREQUENCY



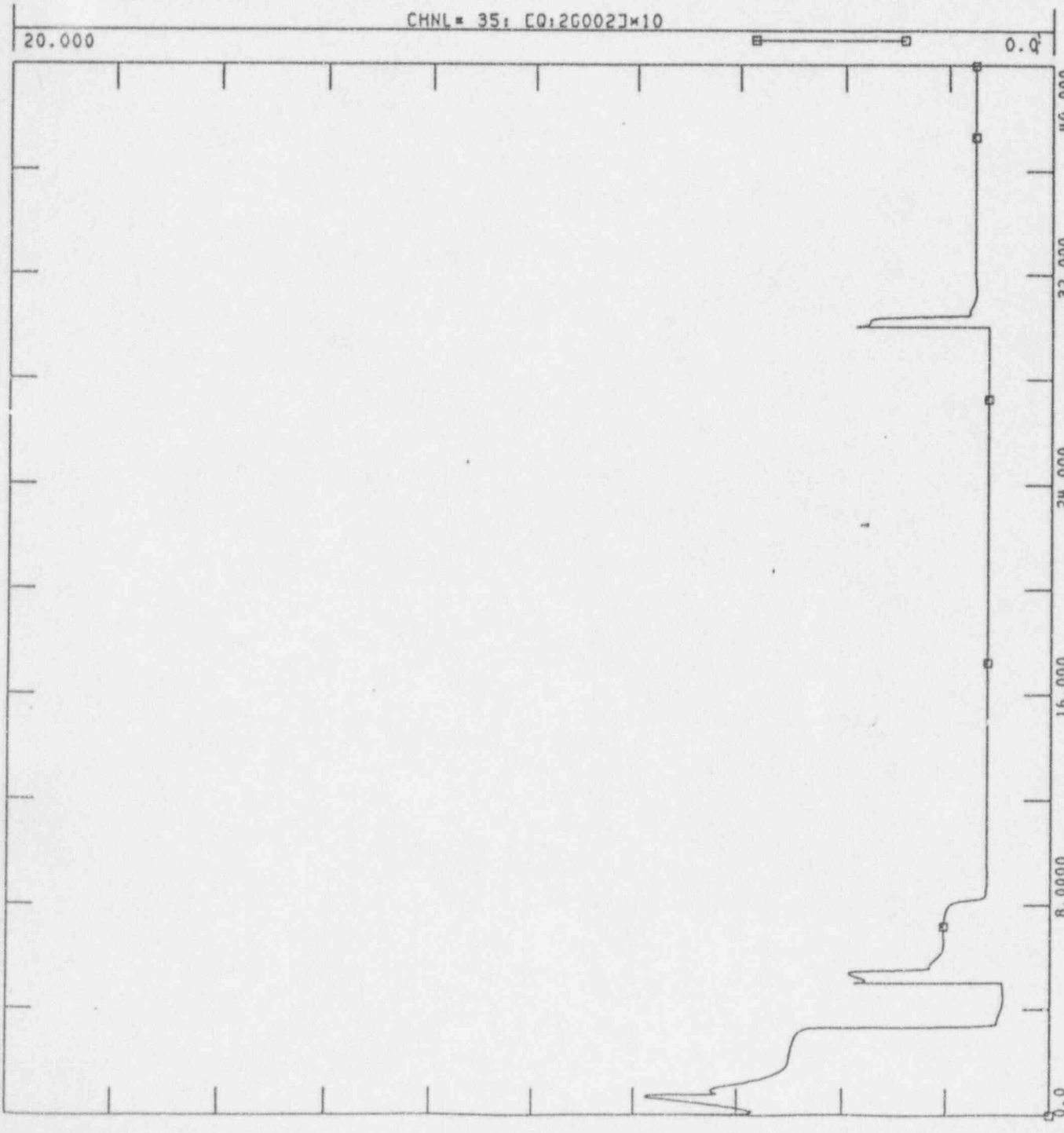
CALCULATION A-95-E-KJR-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

SAT, MAR 04 1995 18:07
20002 P (MW)



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

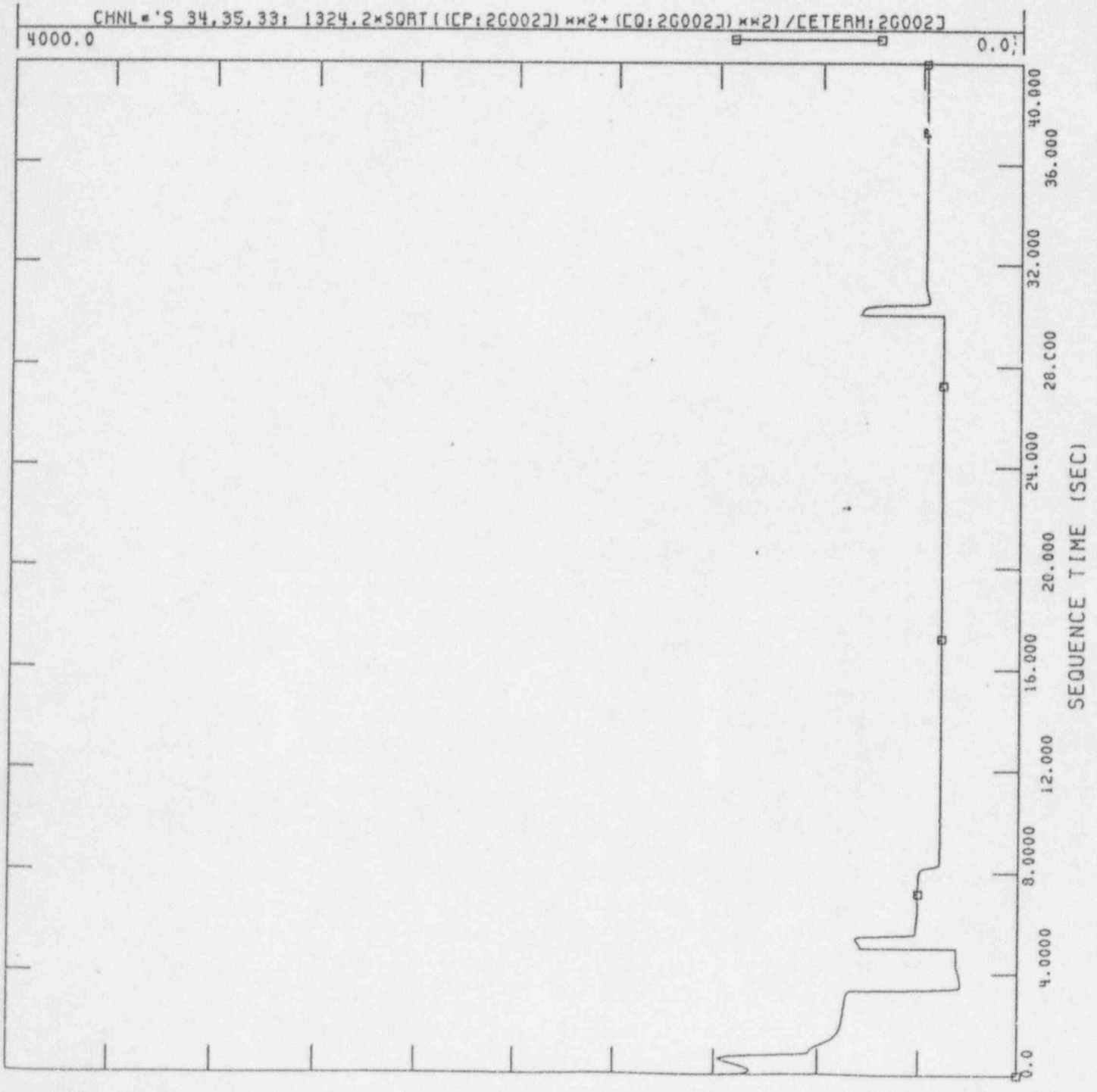
SAT, MAR 04 1995 18:07



2G002 Q (MVAR)

CALCULATION A-95-E-KJR-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

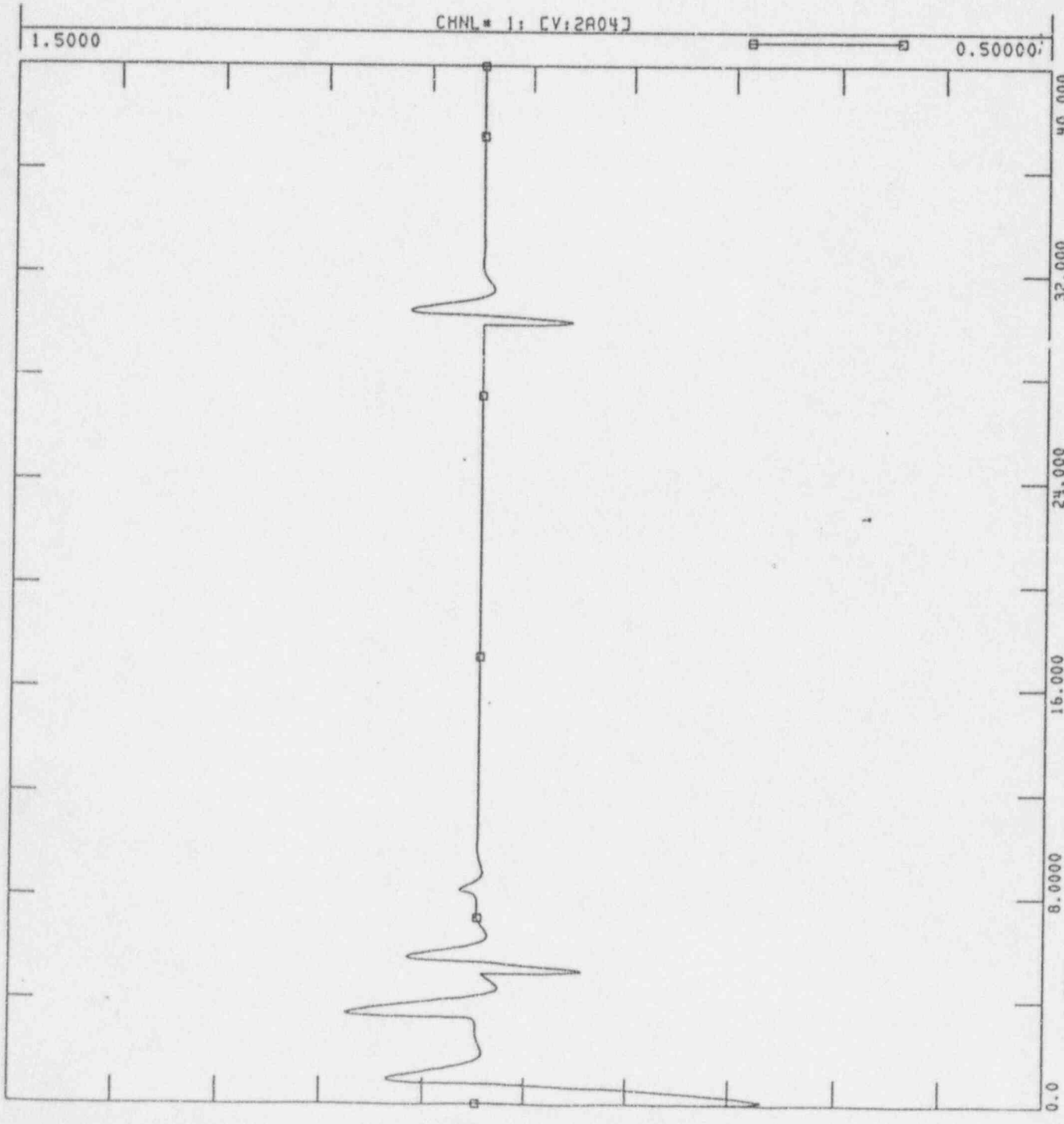
SAT, MAR 04 1995 18:07
2G002 AMPS



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

SAT, MAR 04 1995 18:06

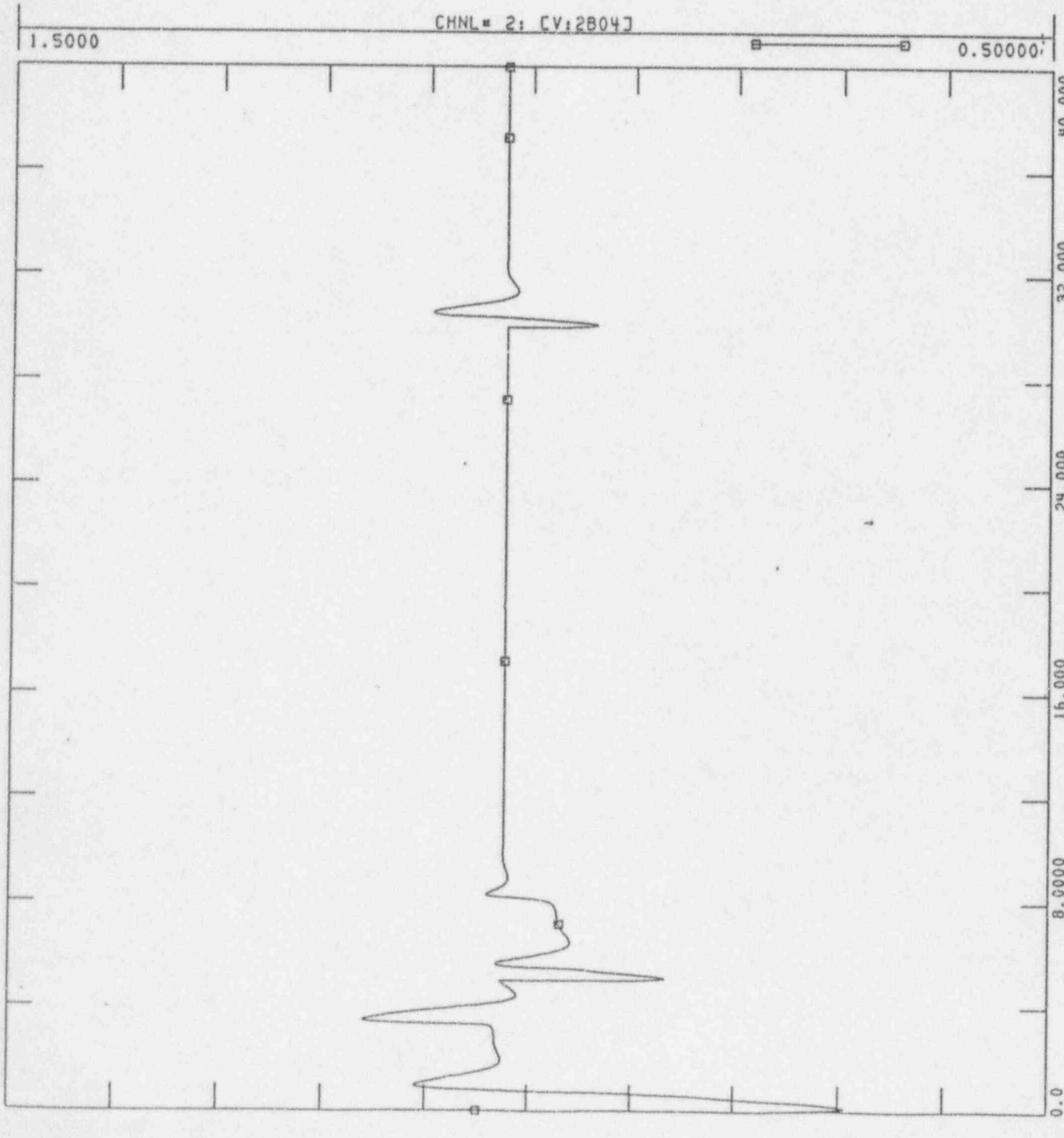
BUS 2A04 (4.16-KV BASE)



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

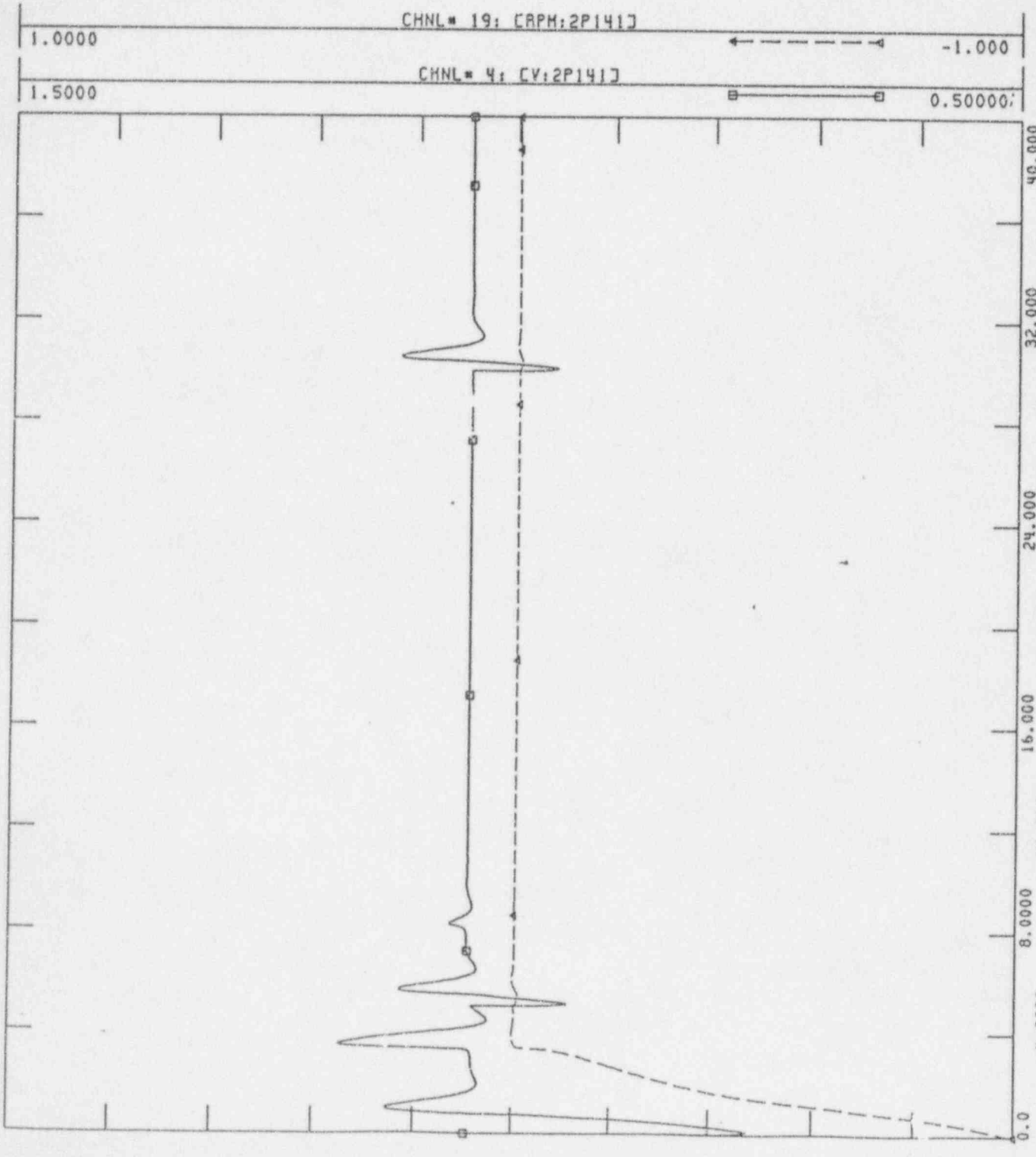
SAT, MAR 04 1995 18:06

BUS 2804 (480-V BASE)



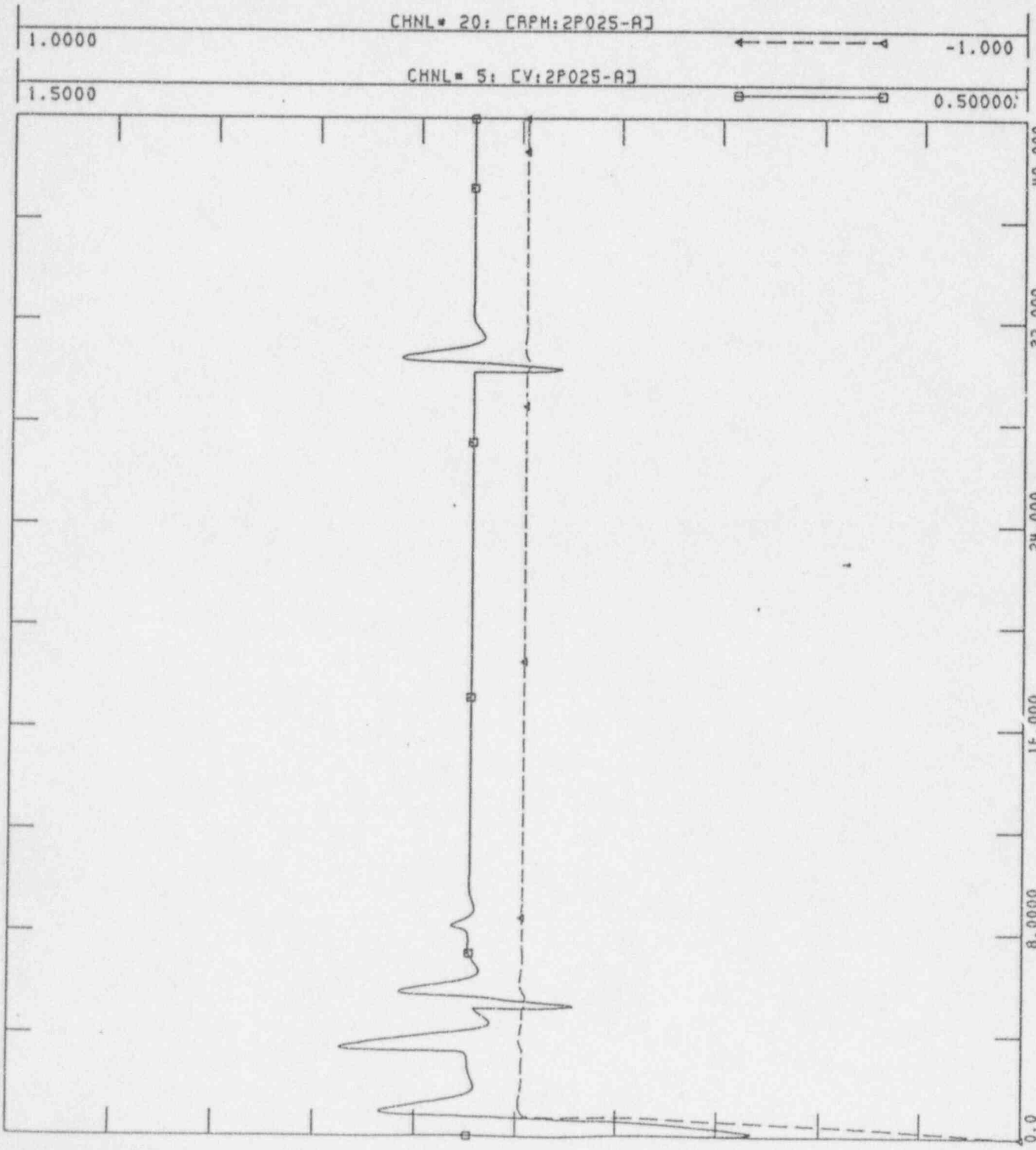
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

SAT, MAR 04 1995 18:06
AFW 2P141



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

SAT, MAR 04 1995 18:06
CCW 2P025-A



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

SAT, MAR 04 1995 18:06
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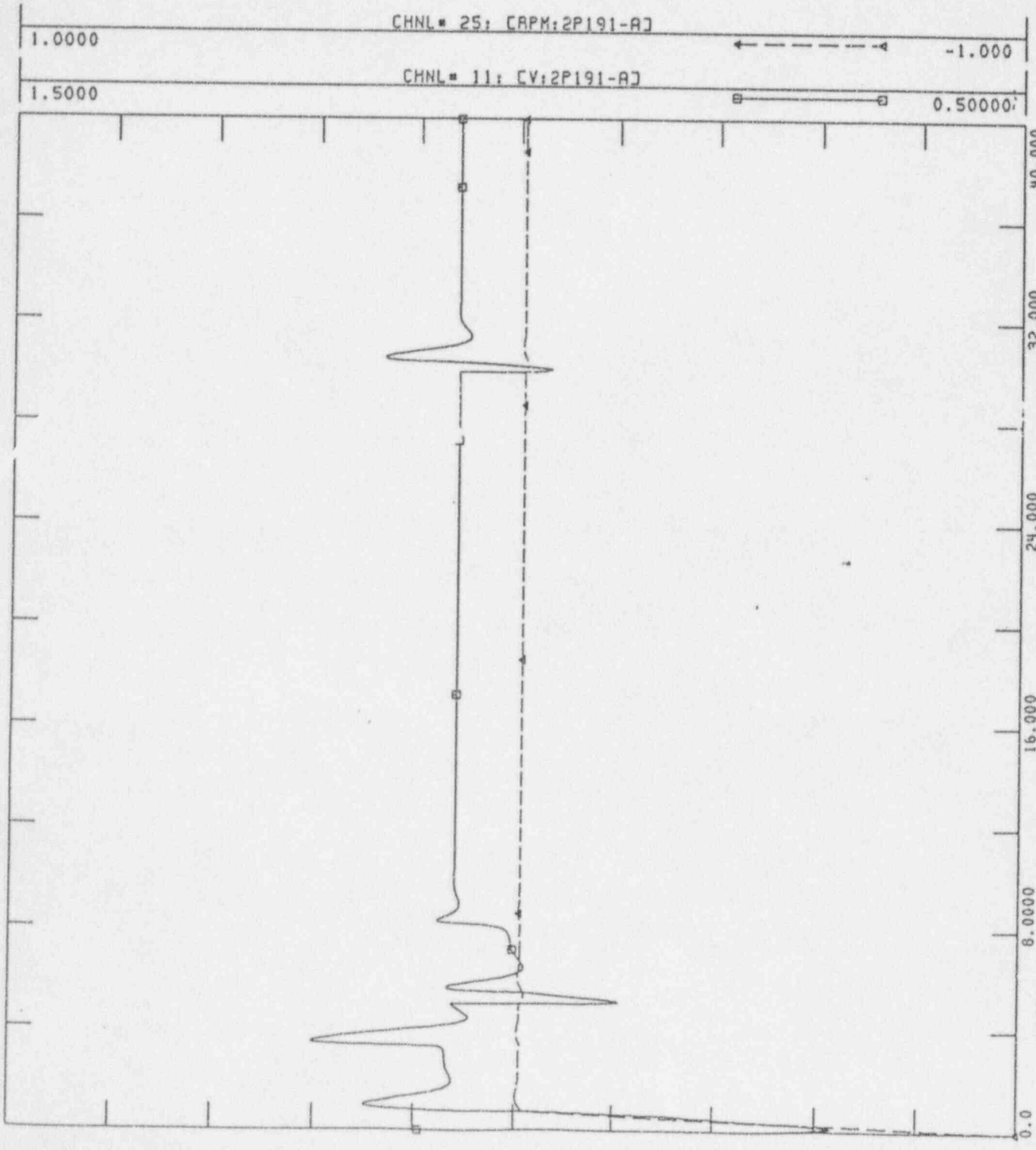

CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

SAT, MAR 04 1995 18:06
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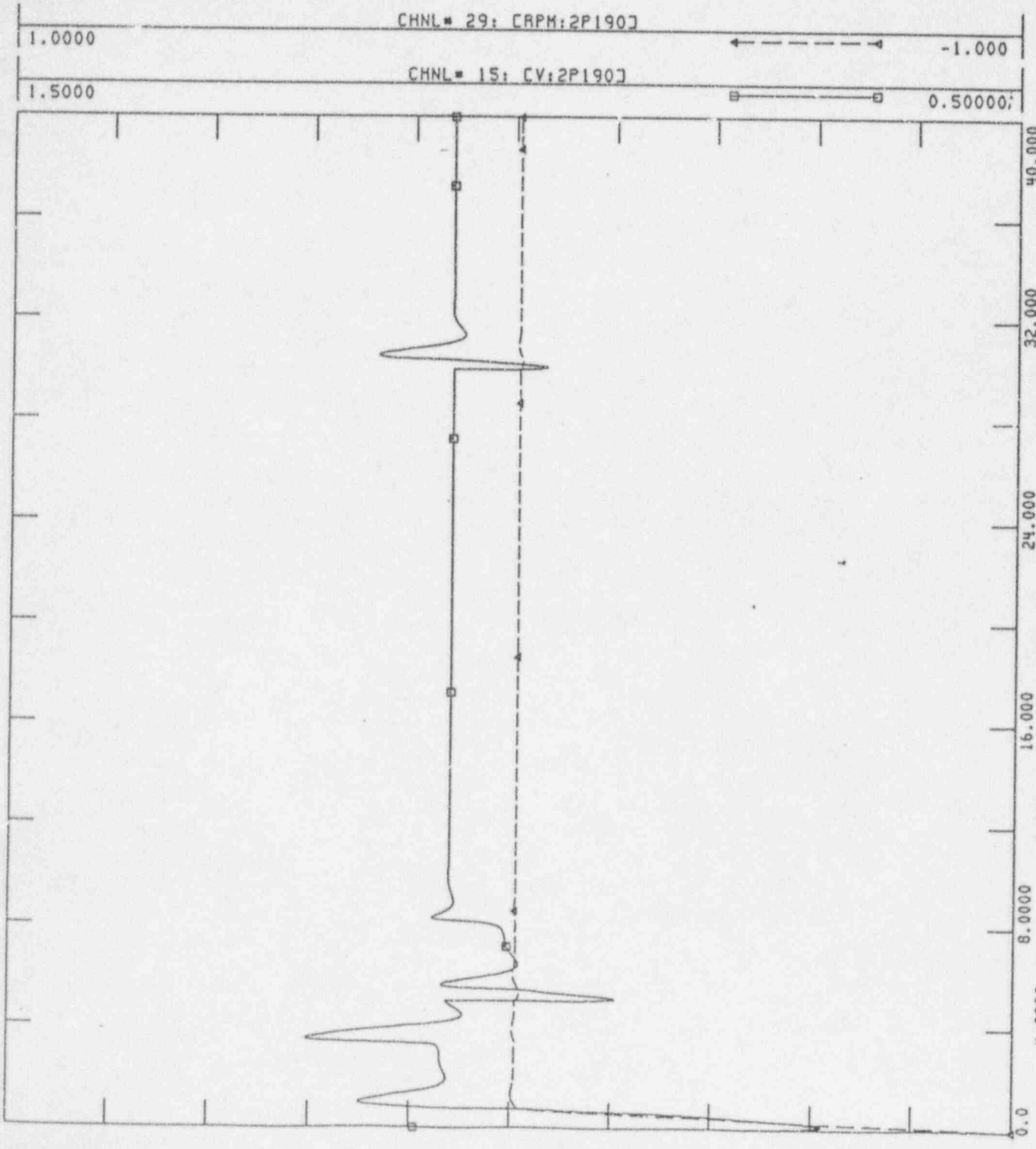
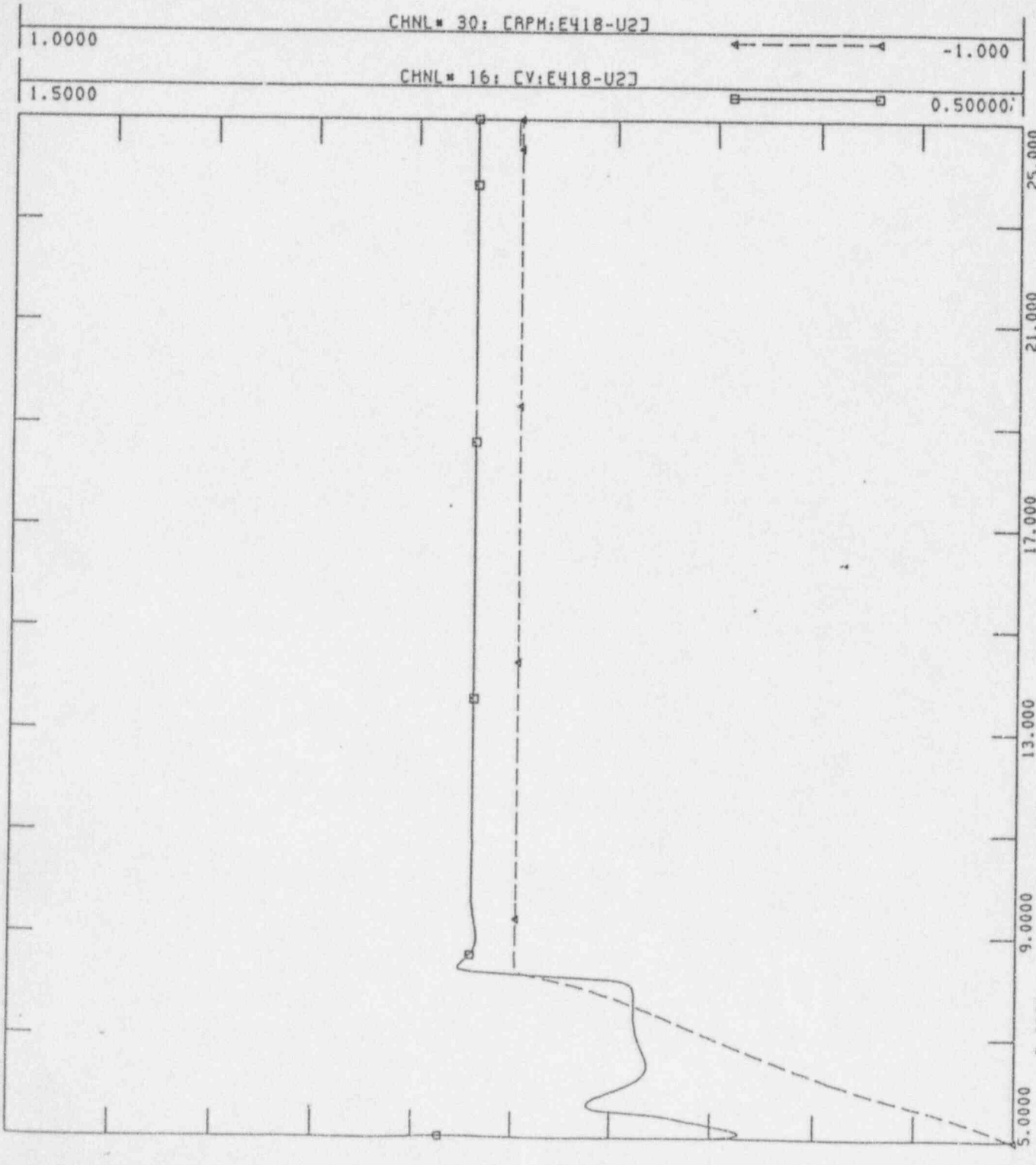


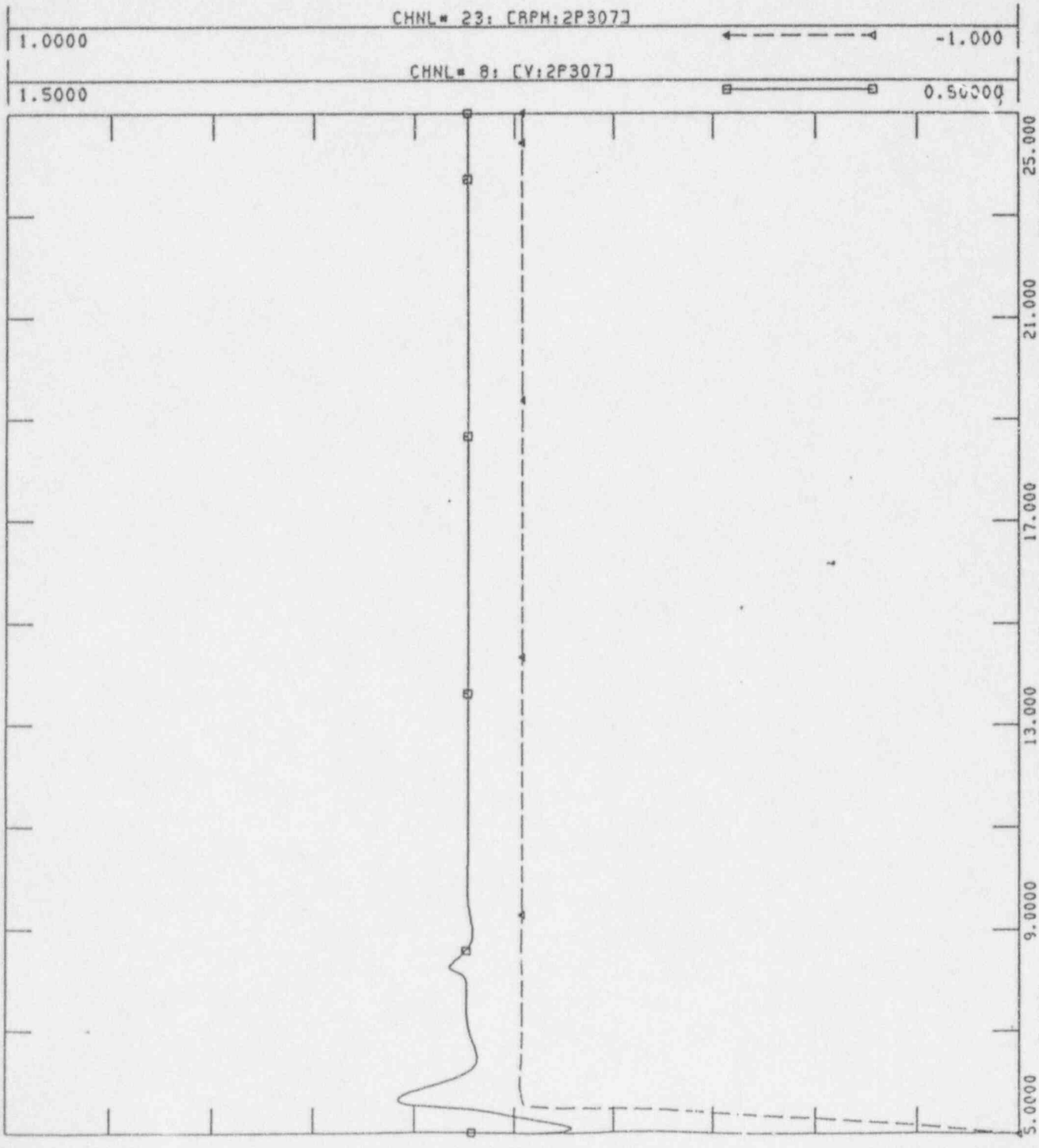
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

SAT, MAR 04 1995 18:06
CONT RM AC E418-U2



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-2

SAT, MAR 04 1995 18:06
SWC 2P307



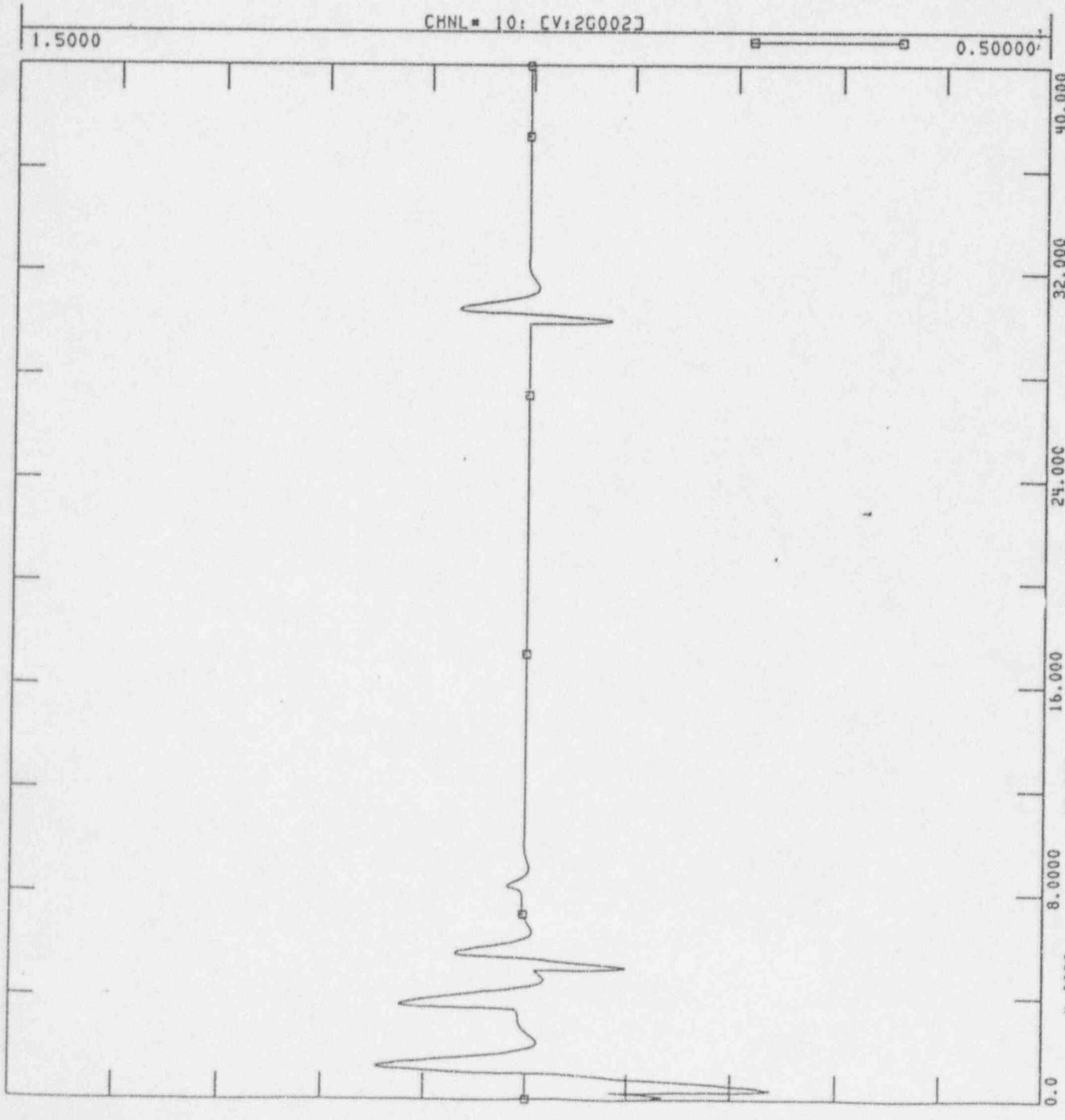
CASE 3

Sequence	Running Load	KW	KVAR
@ t=0 sec	HPSI Pump P017	405.10	172.60
	Non 1E UPS	142.90	91.20
	Chrg Pump P190	57.40	35.50
	Chrg Pump P191	57.40	35.50
	MCC 2BRA	4.25	2.63
	MCC 2BD	13.07	8.17
	MCC 2BE	23.40	17.70
	MCC 2BY	113.90	68.22
	MCC BQ	60.92	36.05
	Total	878.34	467.57
@ t=0.3 sec	Load @ t=0	878.34	467.57
	AFW Pump P141	682.20	368.40
	CCW Pump P025	476.60	270.10
	Total	2037.14	1106.07
@ t=5 sec	Load @ t=0.3	2037.14	1106.07
	Control Rm AC E418	122.10	78.50
	SWC Pump P307	331.30	214.00
	Total	2490.54	1398.57
@ t=30 sec	Load @ t=5	2490.54	1398.57
	Chiller E336	461.90	261.30
	Total	2952.44	1659.87

CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

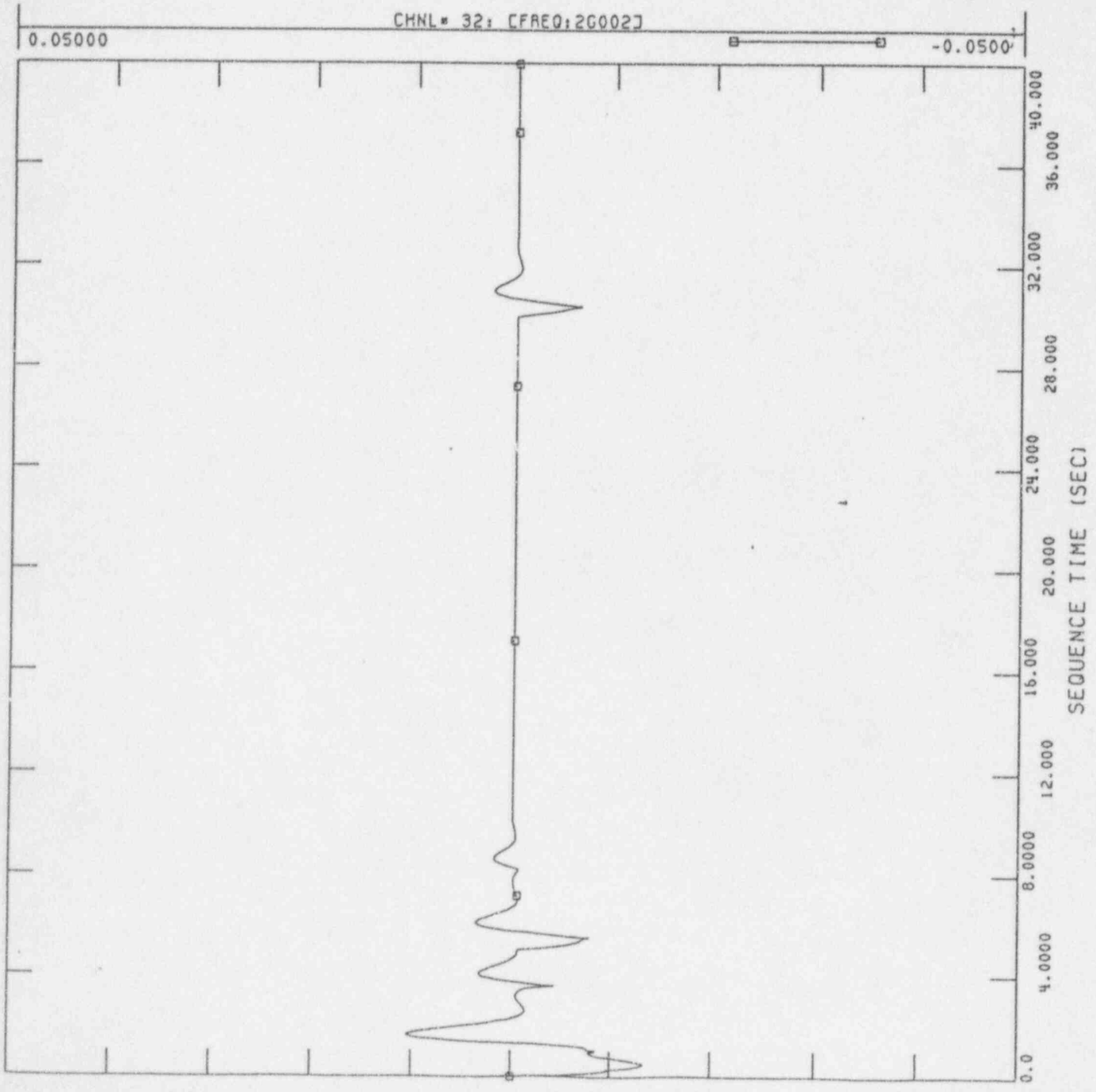
SAT, MAR 04 1995 18:15

EDG 2G002 (4.36-KV BASE)



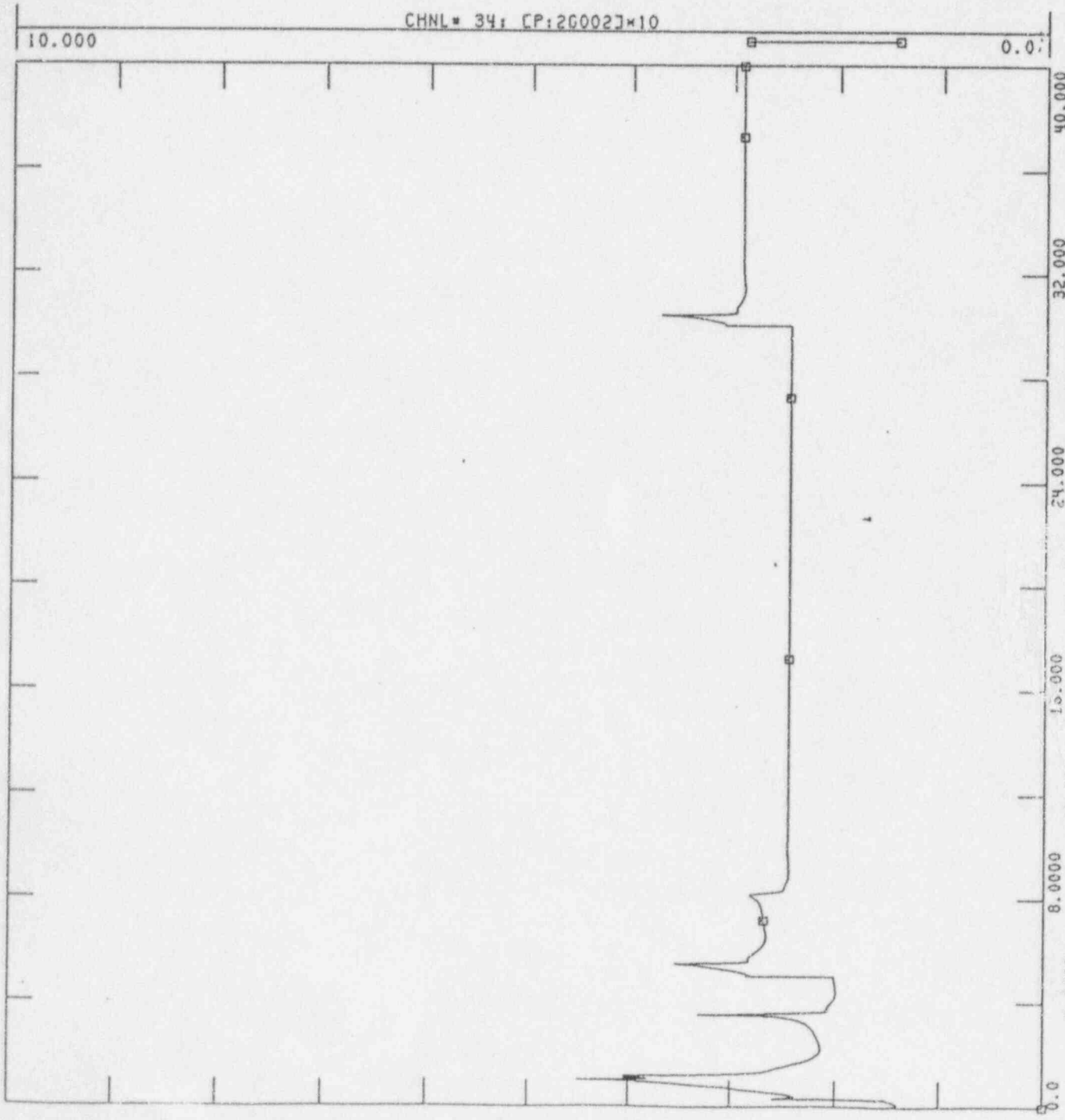
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:15
2G002 FREQUENCY



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

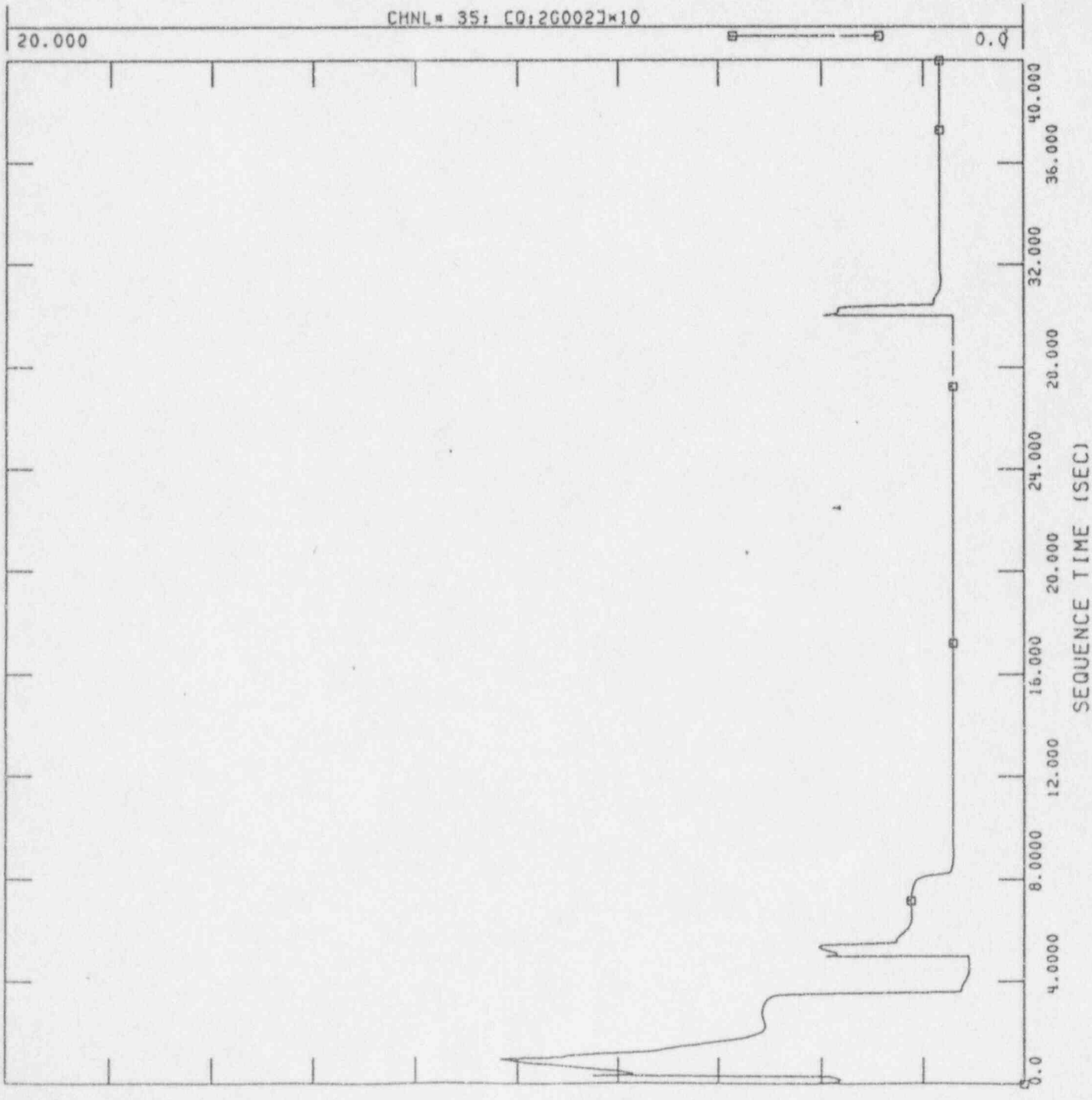
SAT, MAR 04 1995 18:16



26002 P (MW)

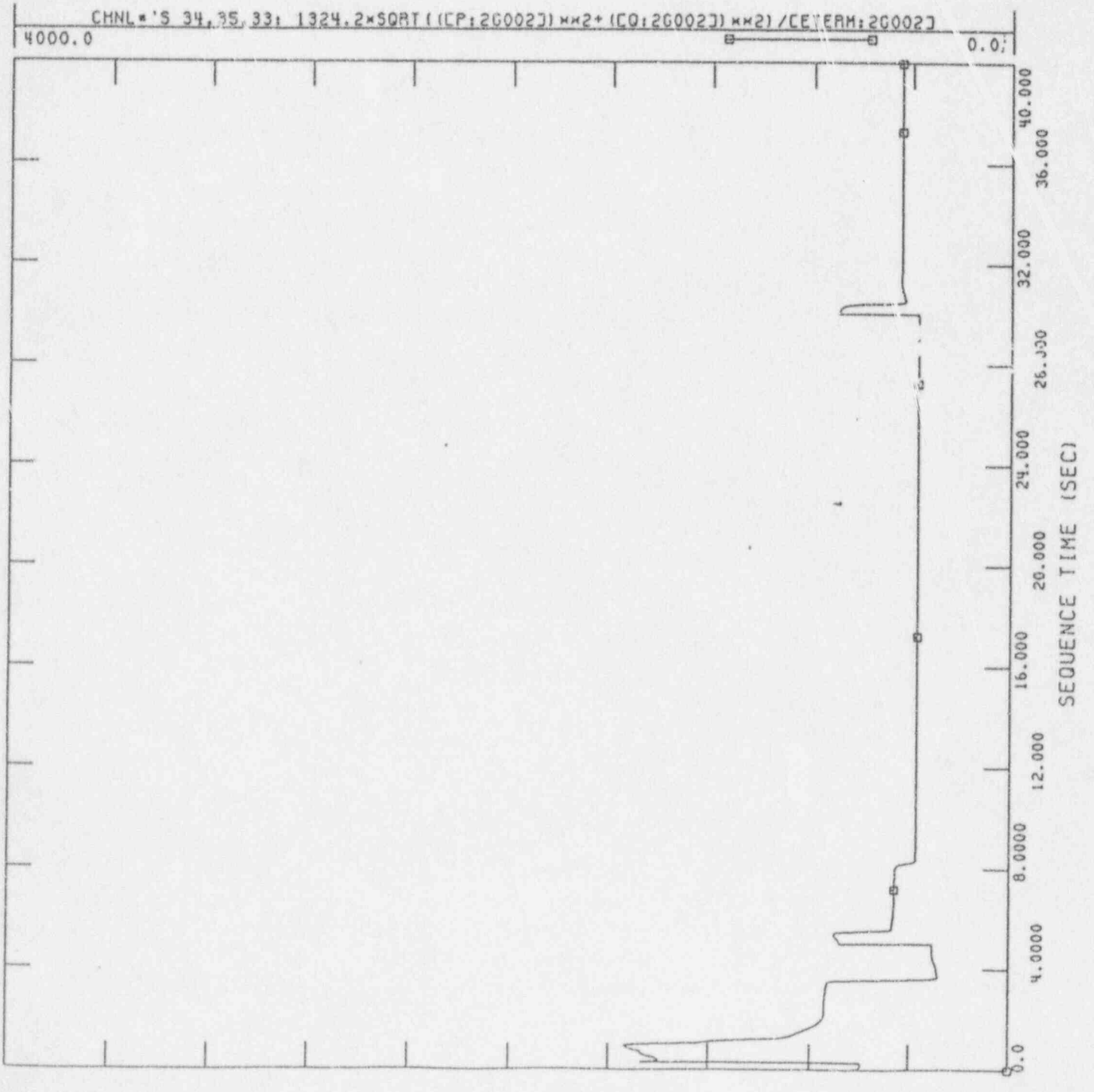
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:16
26002 Q (MVAR)



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

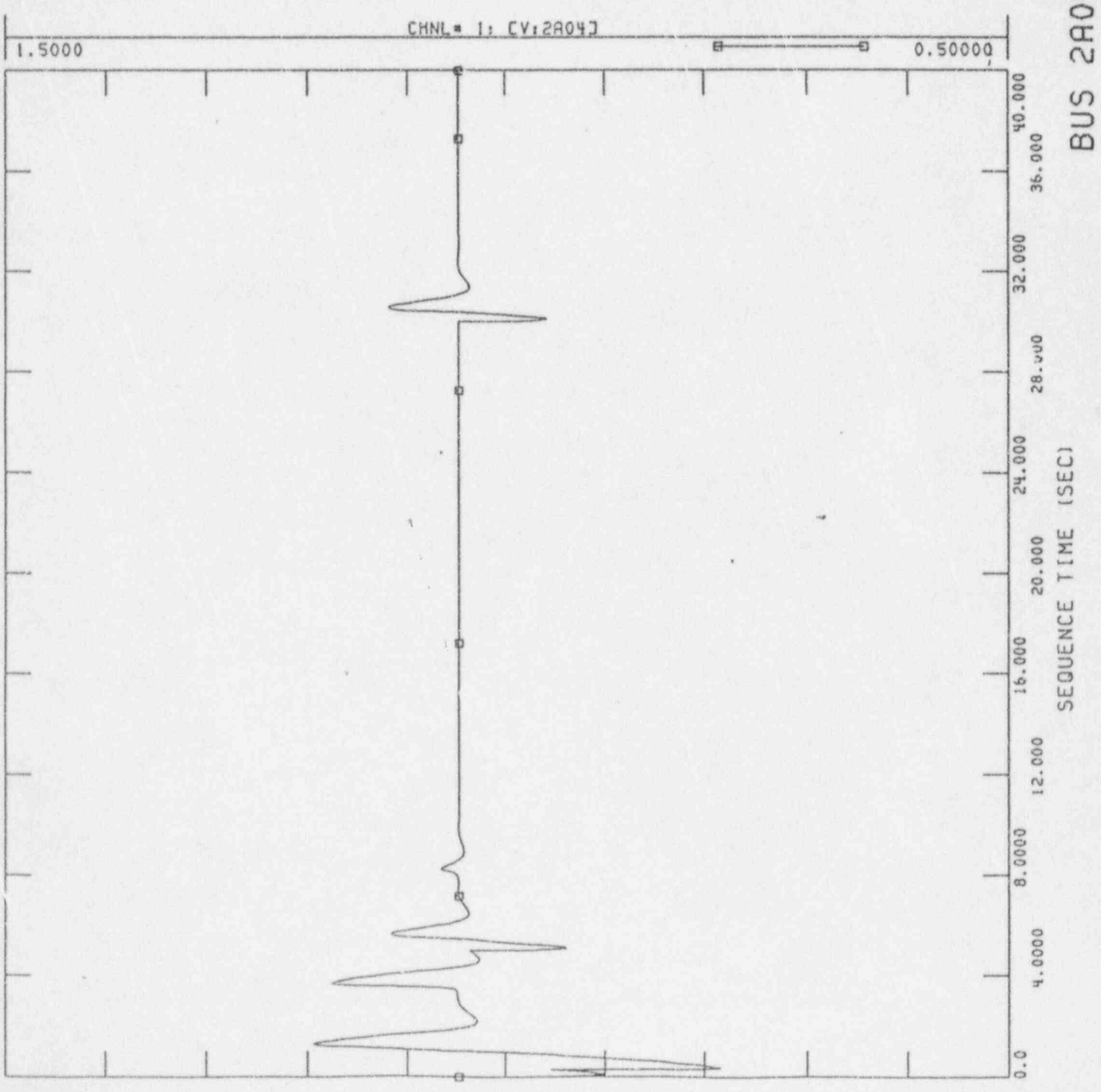
SAT, MAR 04 1995 18:16
2G002 AMPS



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:15

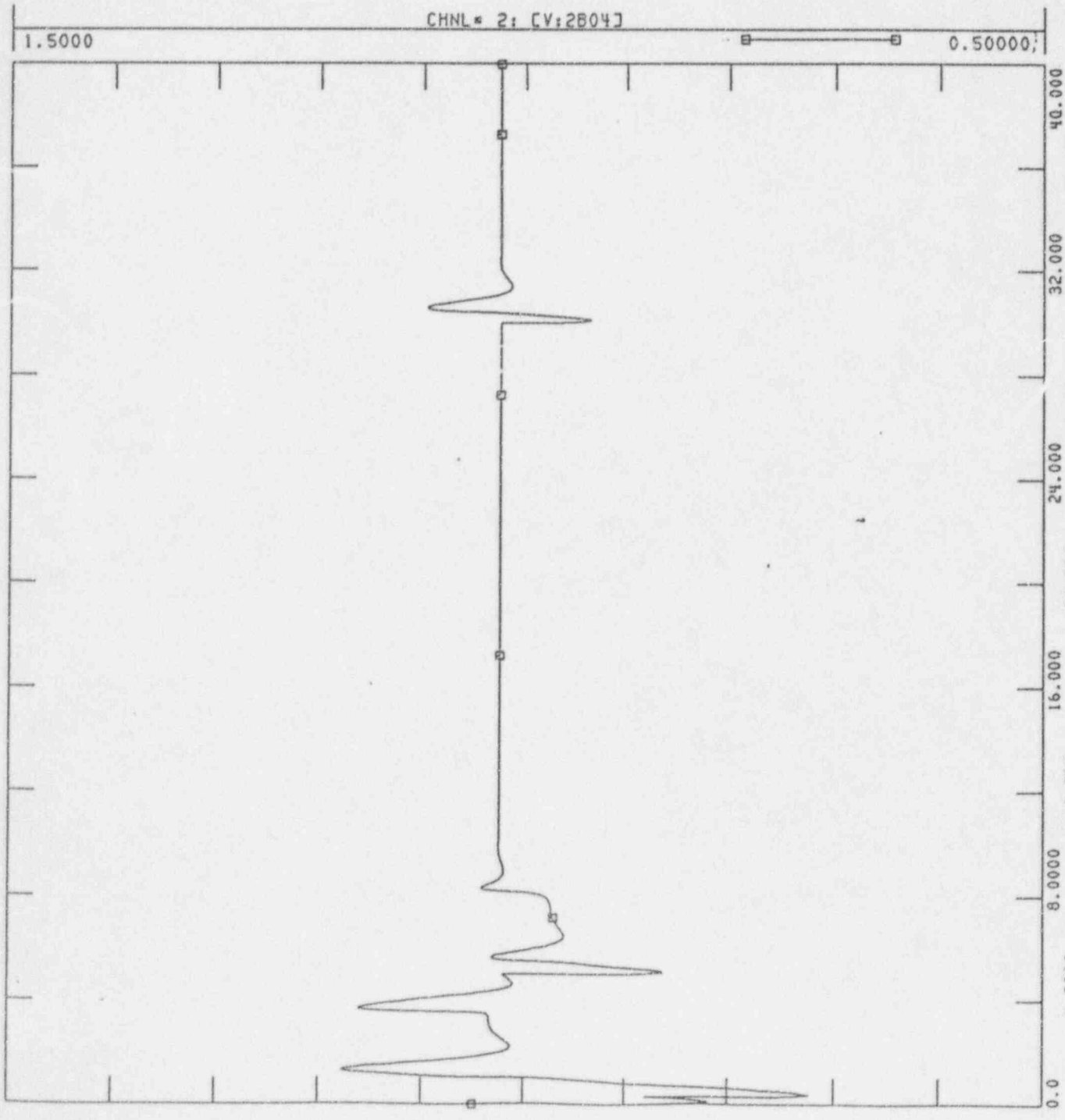
BUS 2A04 (4.16-KV BASE)



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

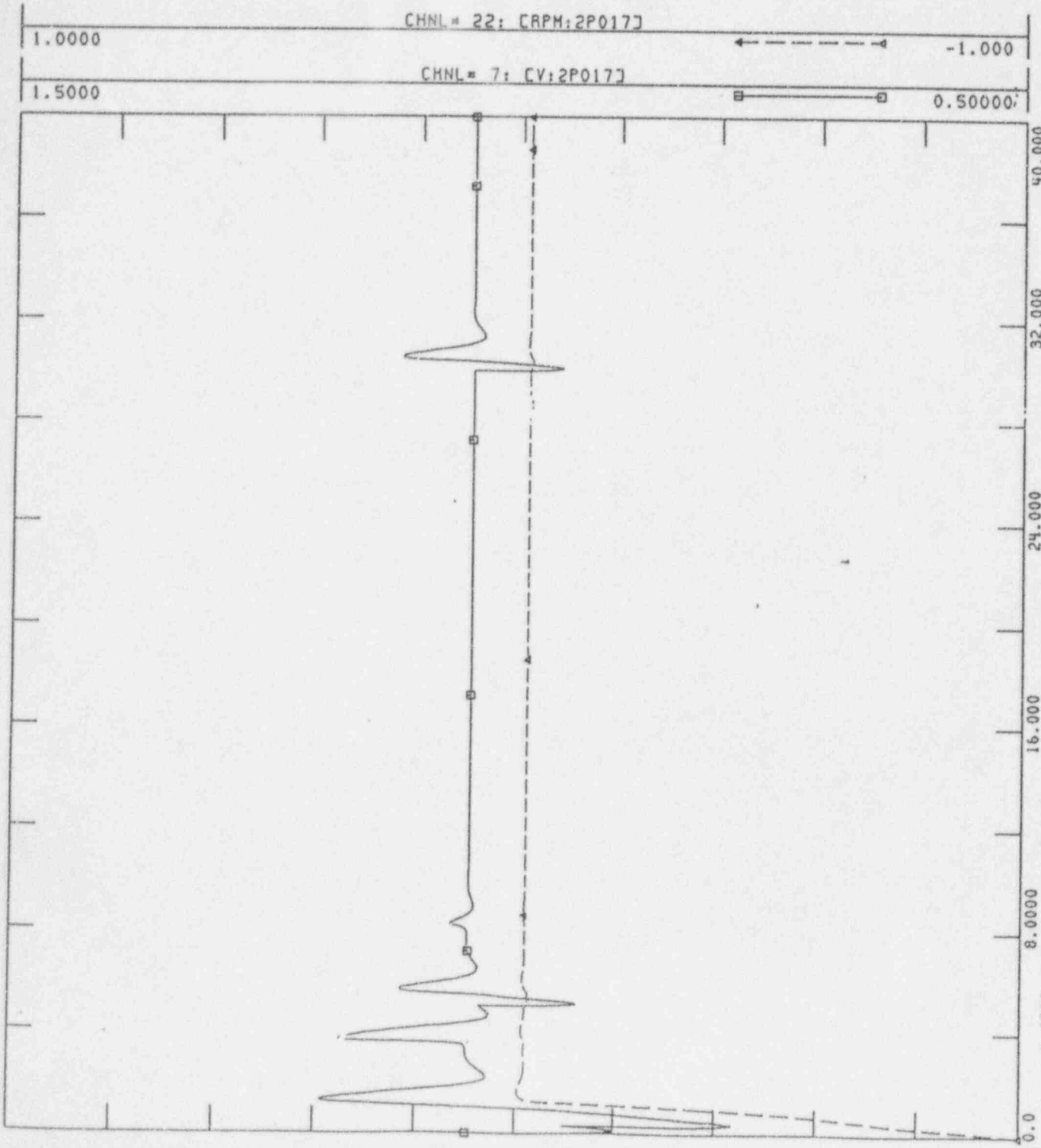
SAT, MAR 04 1995 18:15

BUS 2804 (480-V BASE)



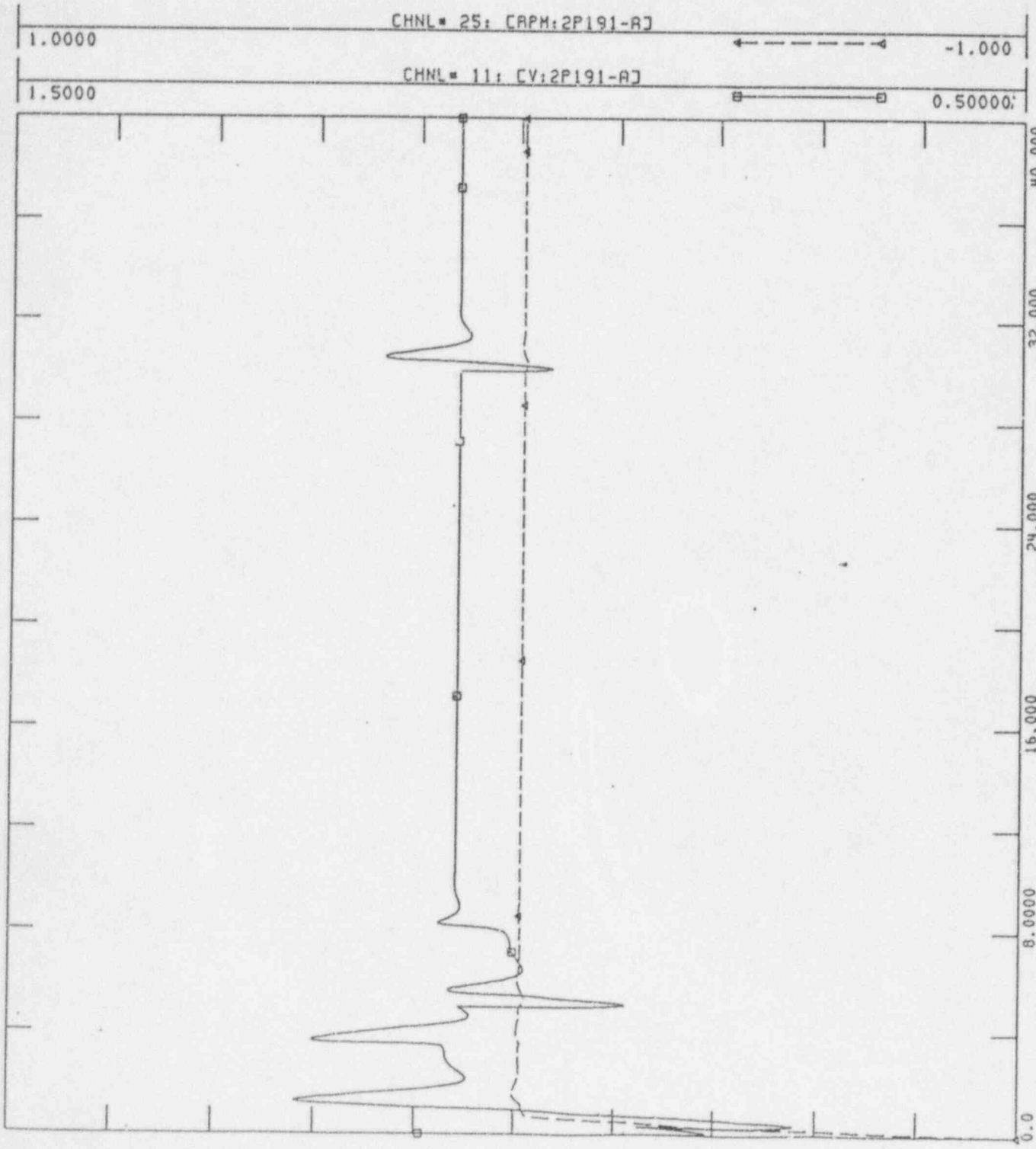
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:15
HPSI 2P017



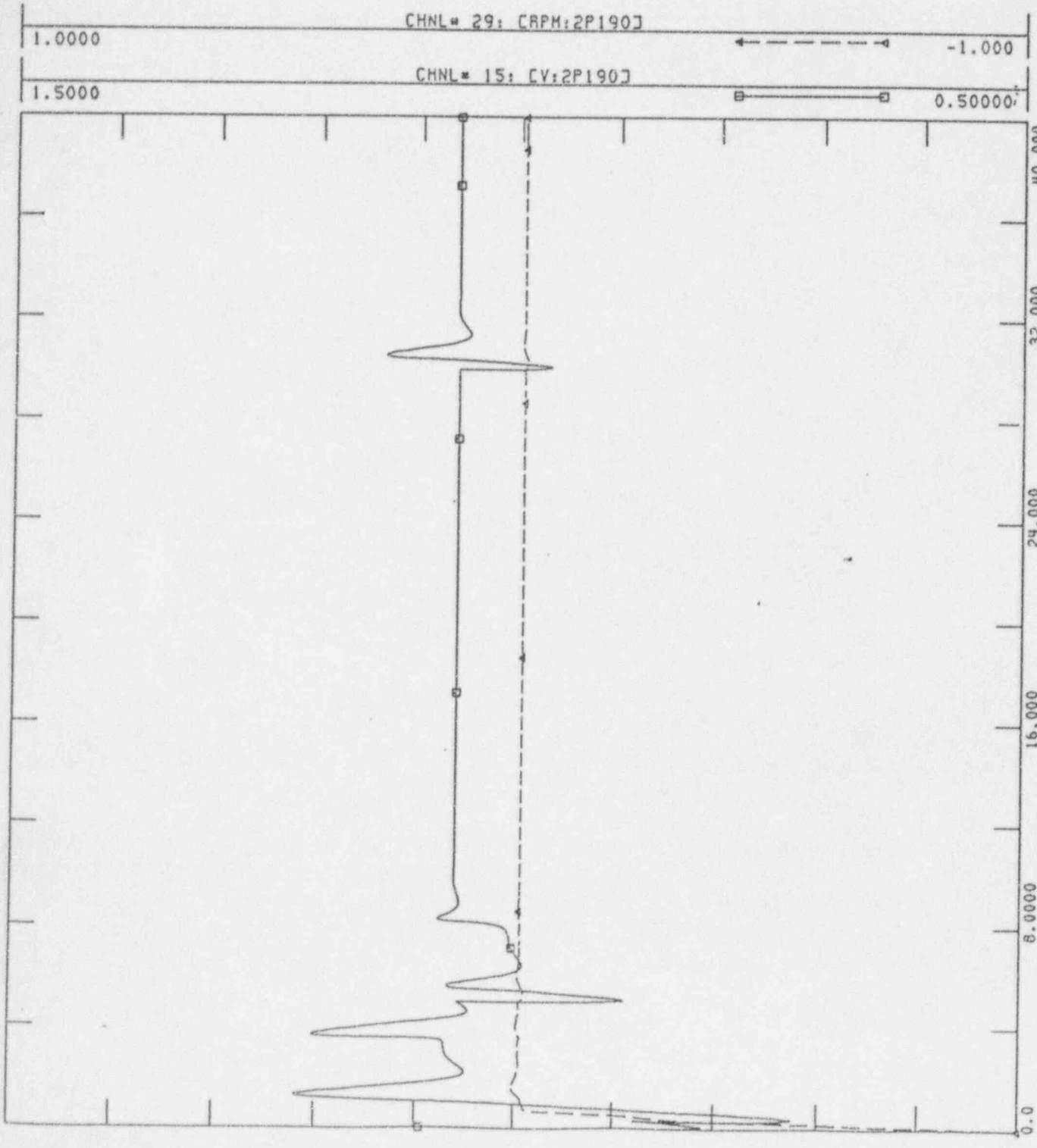
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:15
CHRG PUMP 2P191-A



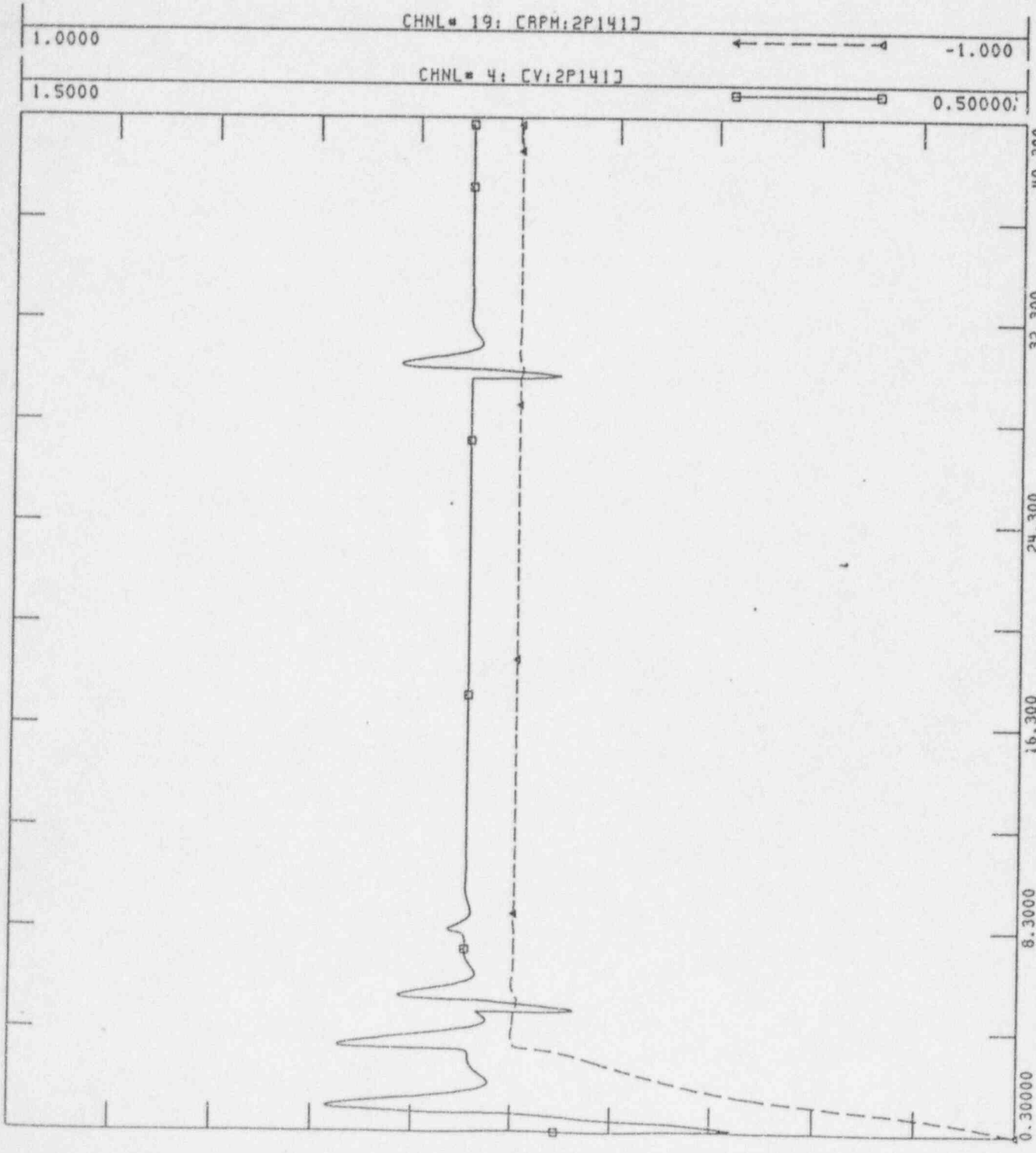
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:15
CHRG PUMP 2P190



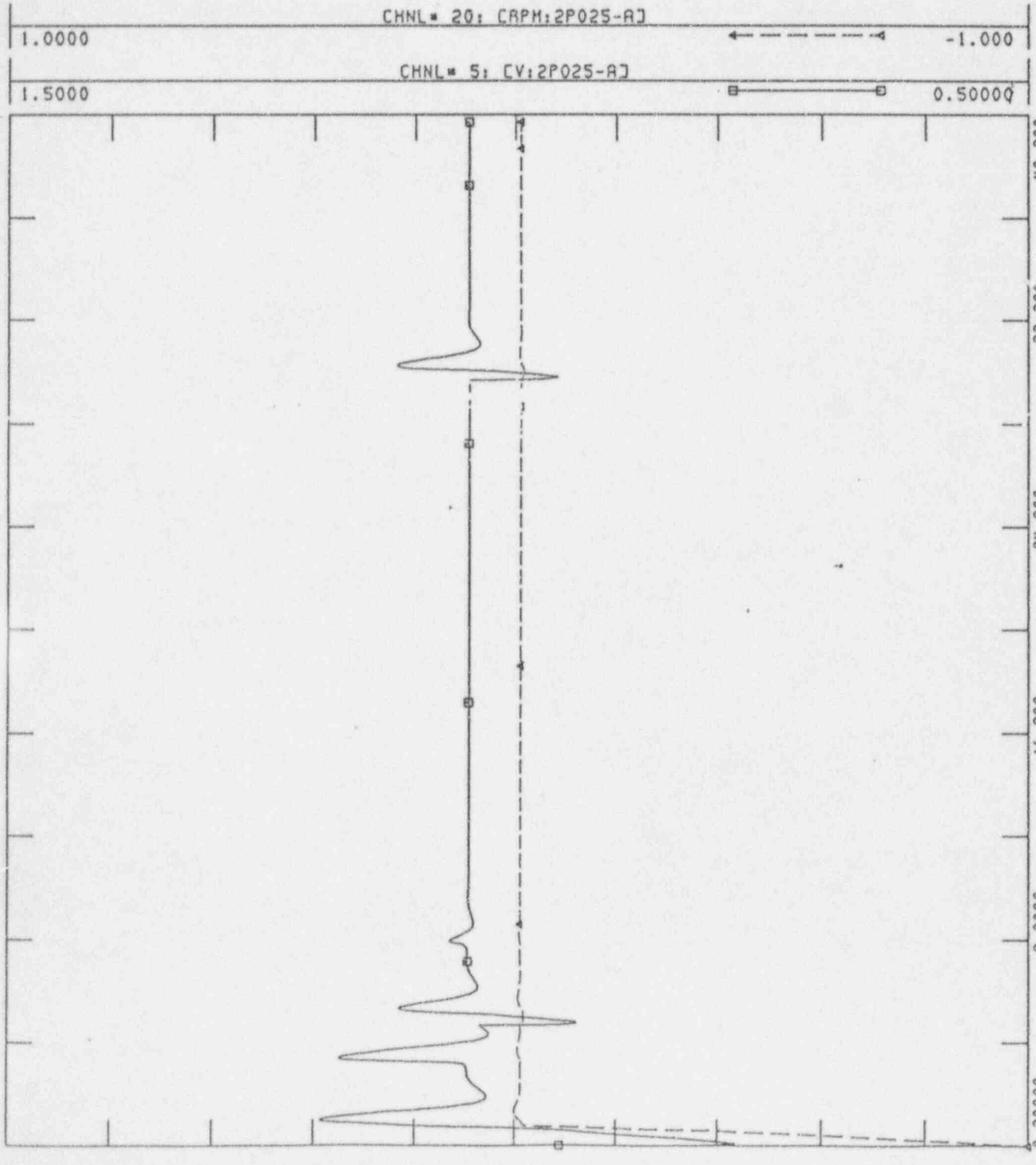
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:15
AFW 2P141



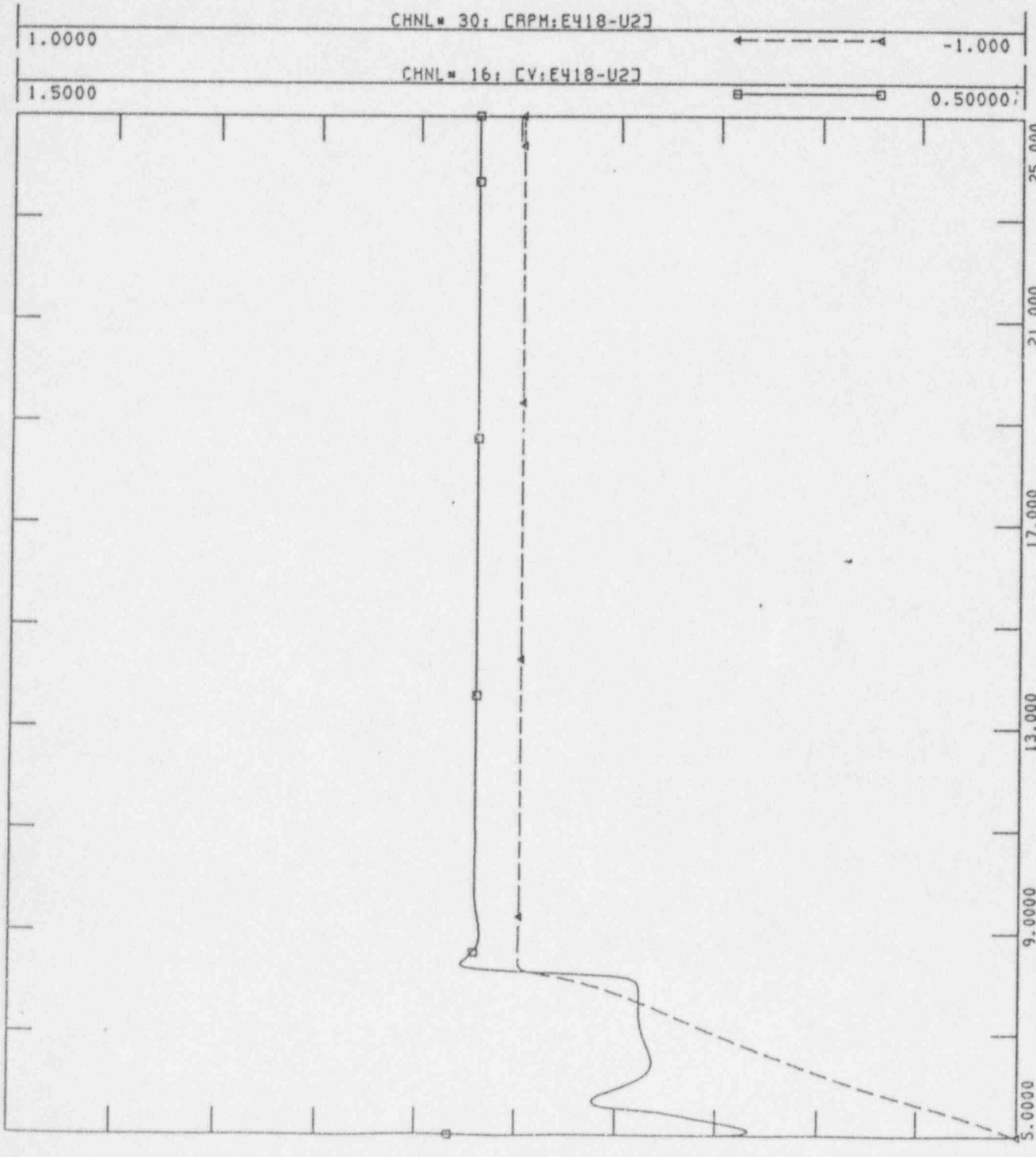
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:15
CCW 2P025-A



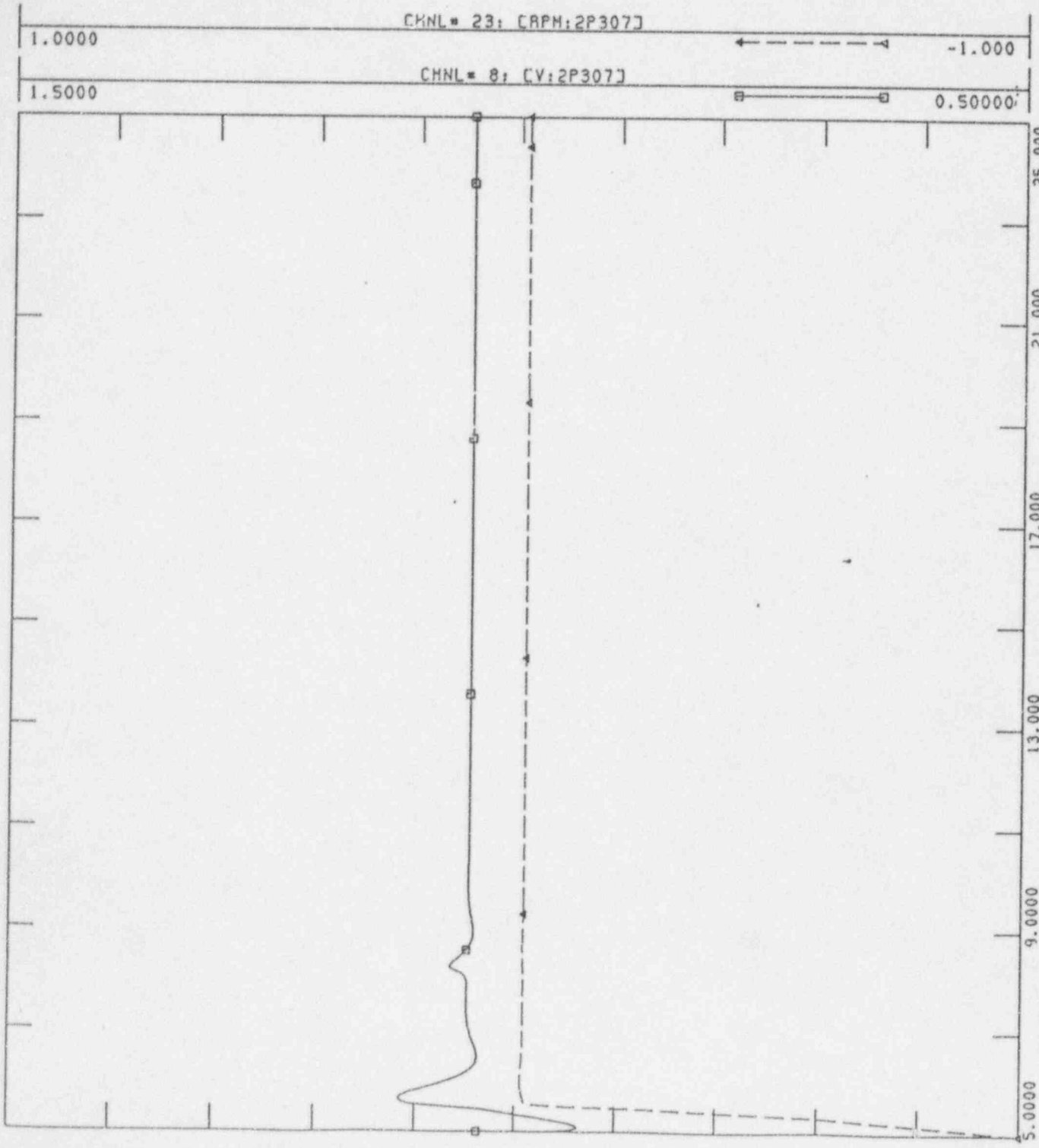
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:16
CONT RM AC E418-U2



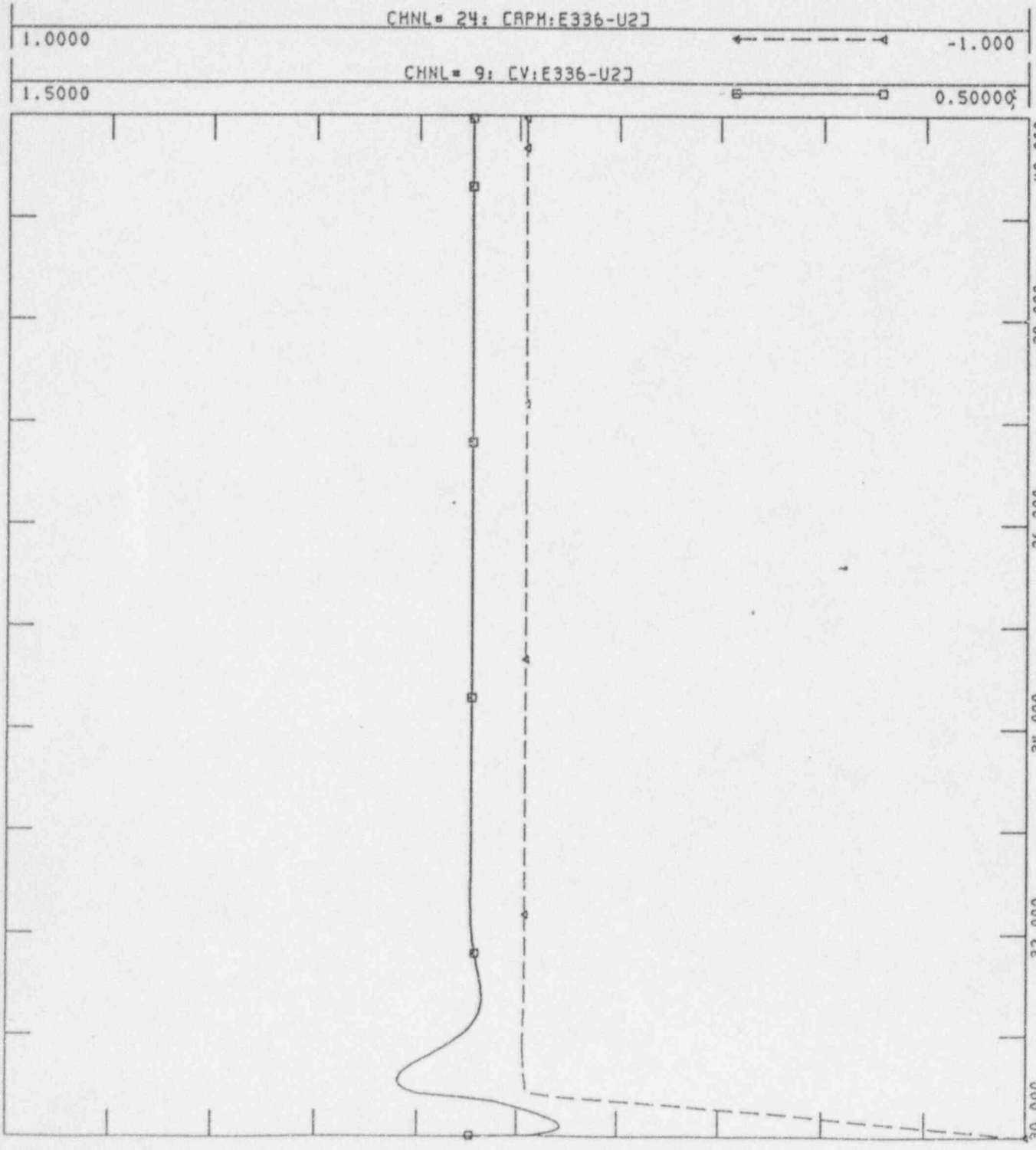
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

SAT, MAR 04 1995 18:16
SWC 2P307



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-3

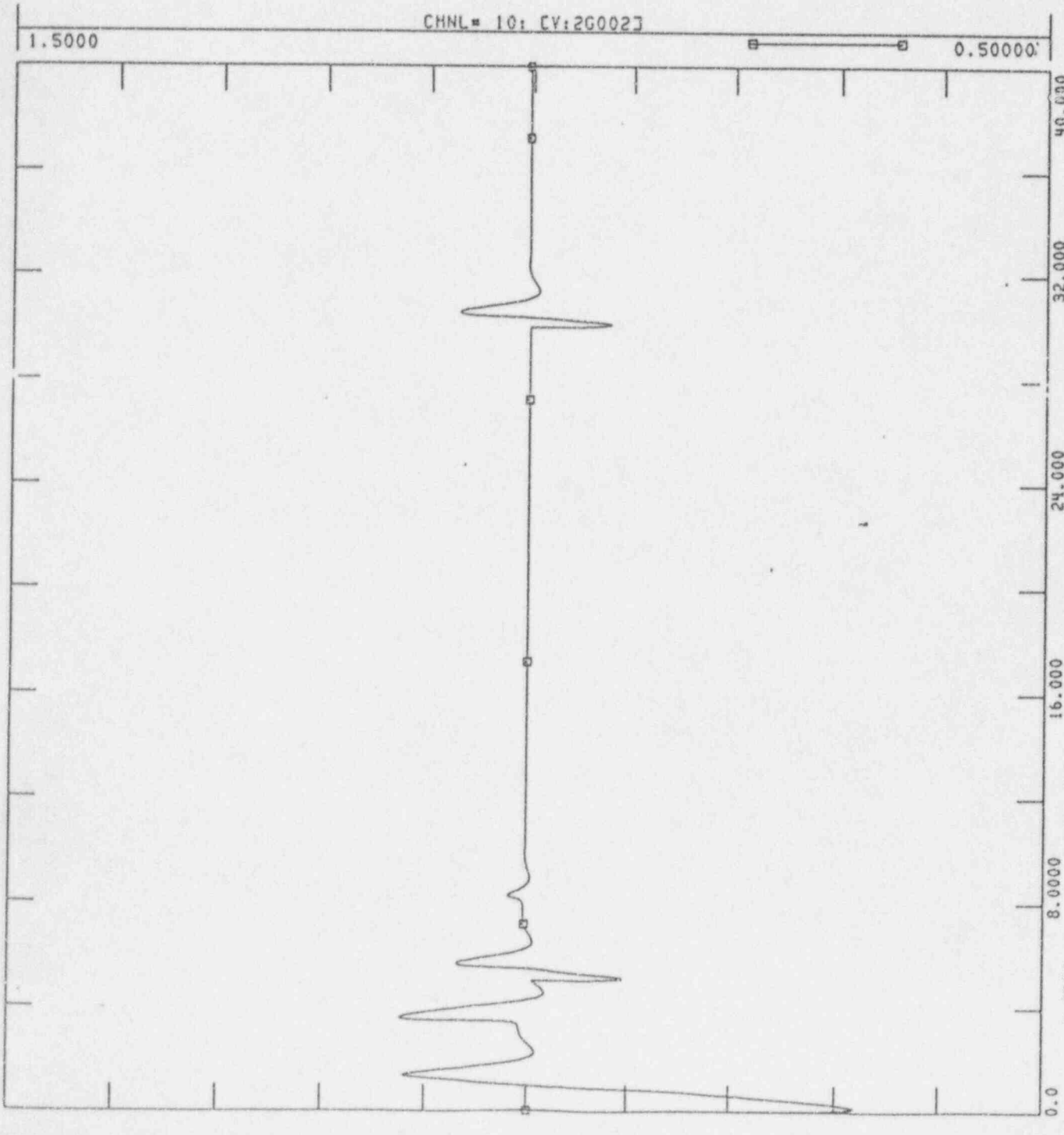
SAT, MAR 04 1995 18:16
CHILLER E336-U2



CASE 4

Sequence	Running Load	KW	KVAR
@ t=0 sec	HPSI Pump P017	405.10	172.60
	AFW Pump P141	682.20	368.40
	CCW Pump P025	476.60	270.10
	Non 1E UPS	142.90	91.20
	Chrg Pump P190	57.40	35.50
	Chrg Pump P191	57.40	35.50
	MCC 2BRA	4.25	2.63
	MCC 2BD	13.07	8.17
	MCC 2BE	23.40	17.70
	MCC 2BY	113.90	68.22
	MCC BQ	60.92	36.05
	Total	2037.14	1106.07
@ t=5 sec	Load @ t=0	2037.14	1106.07
	Control Rm AC E418	122.10	78.50
	SWC Pump P307	331.30	214.00
	Total	2490.54	1398.57
@ t=30 sec	Load @ t=5	2490.54	1398.57
	Chiller E336	461.90	261.30
	Total	2952.44	1659.87

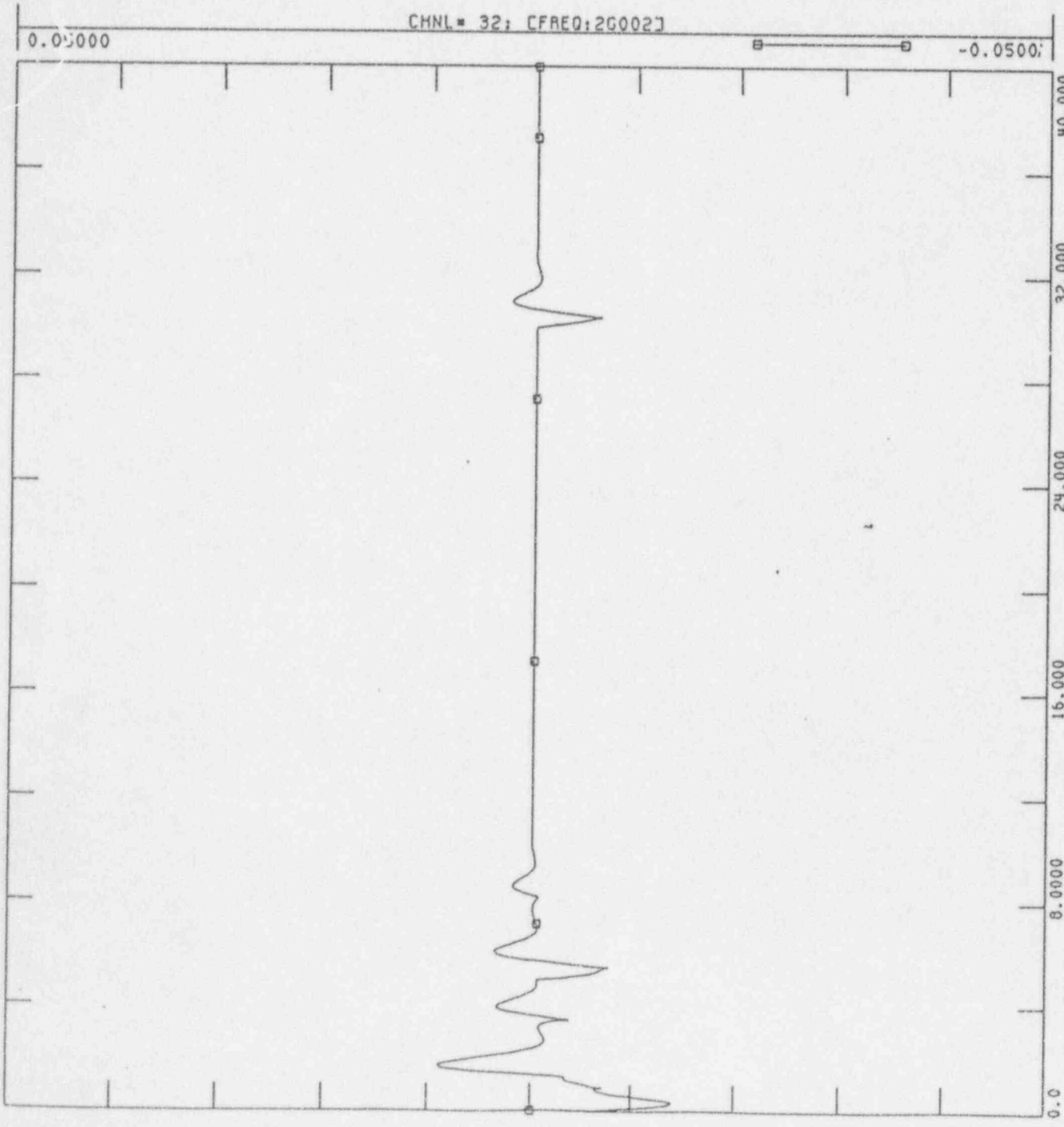
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4



SAT, MAR 04 1995 18:24
EDG 2G002 (4.36-KV BASE)

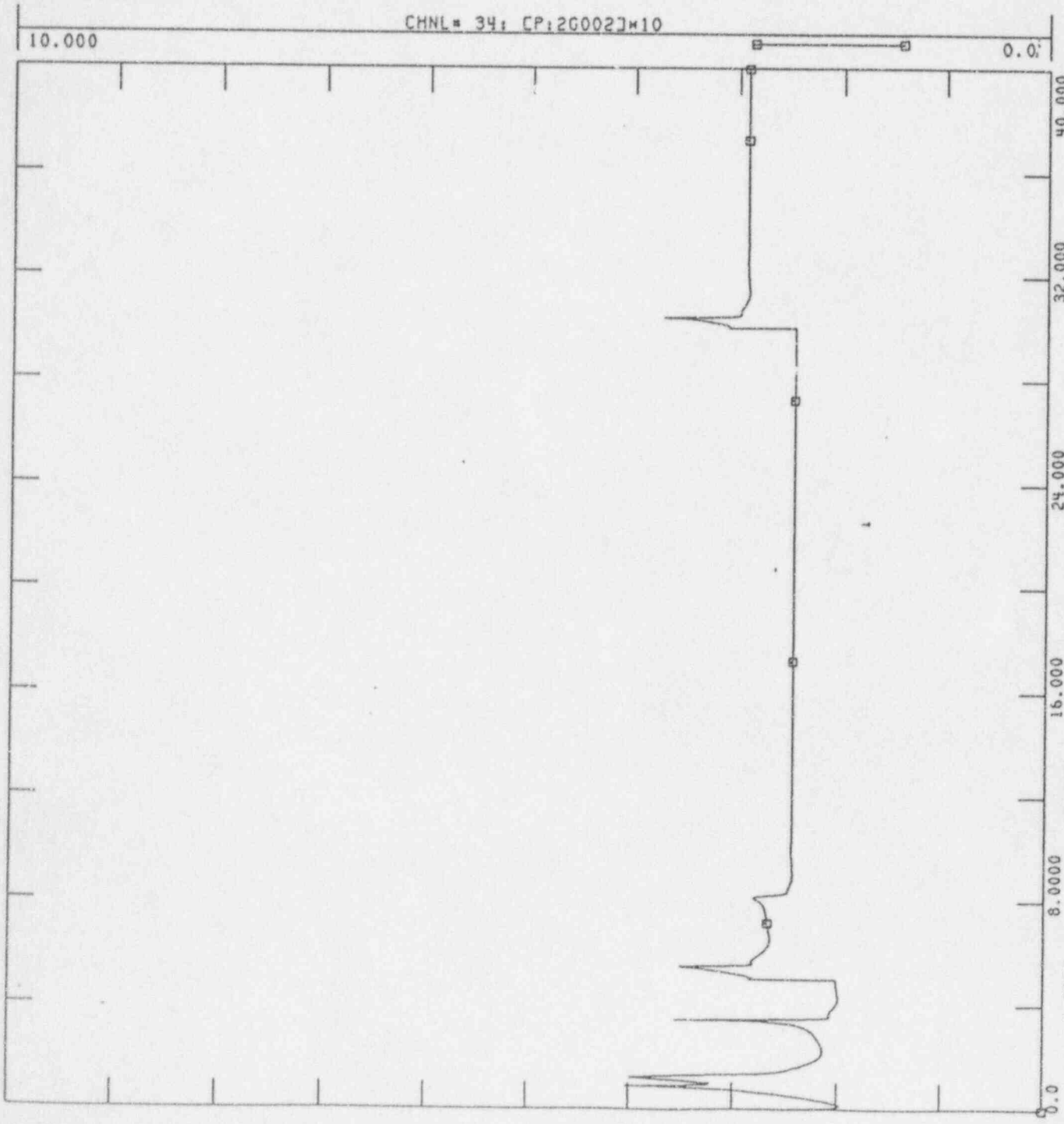
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:24
2G002 FREQUENCY



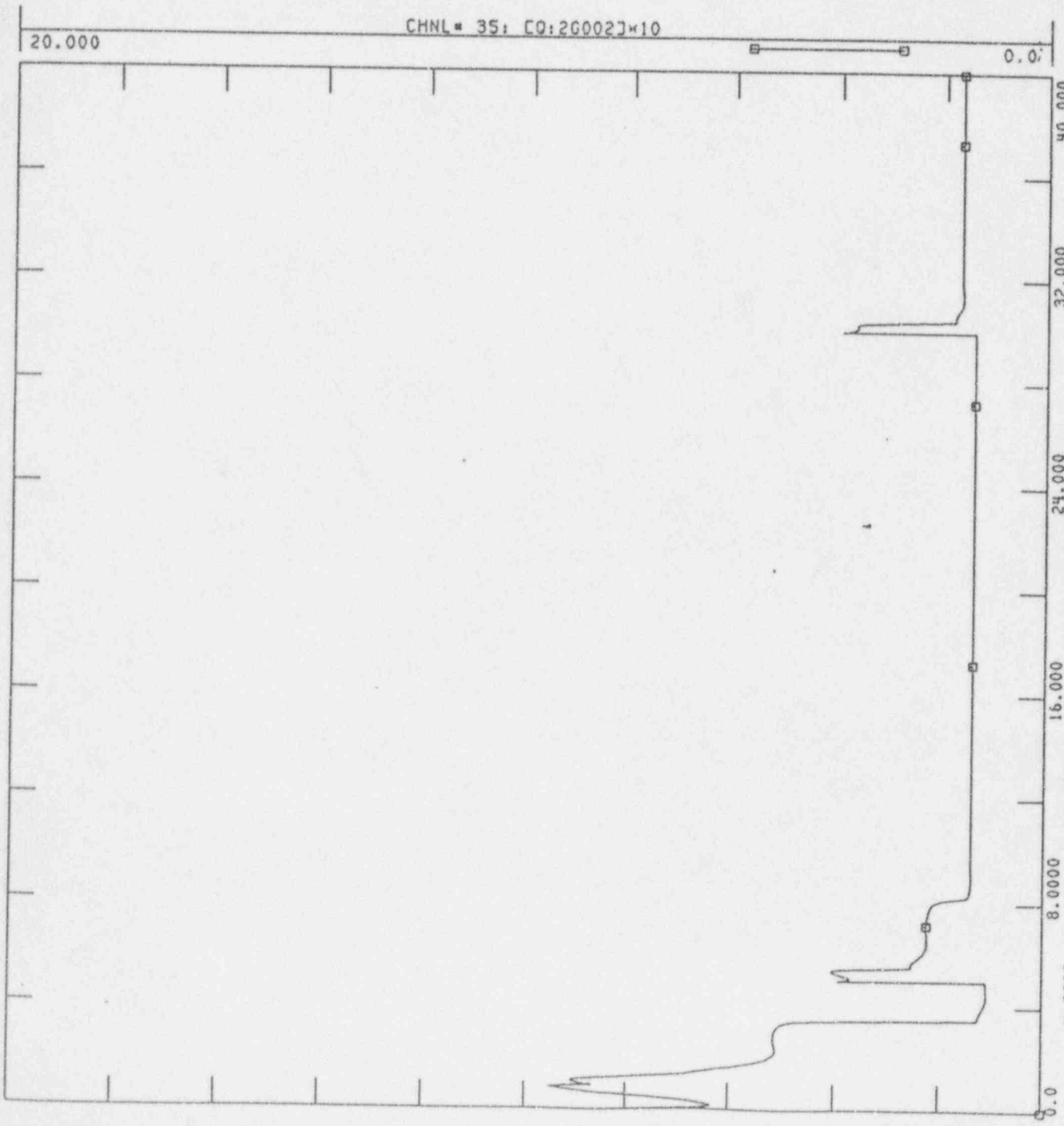
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:25
2G002 P (MW)



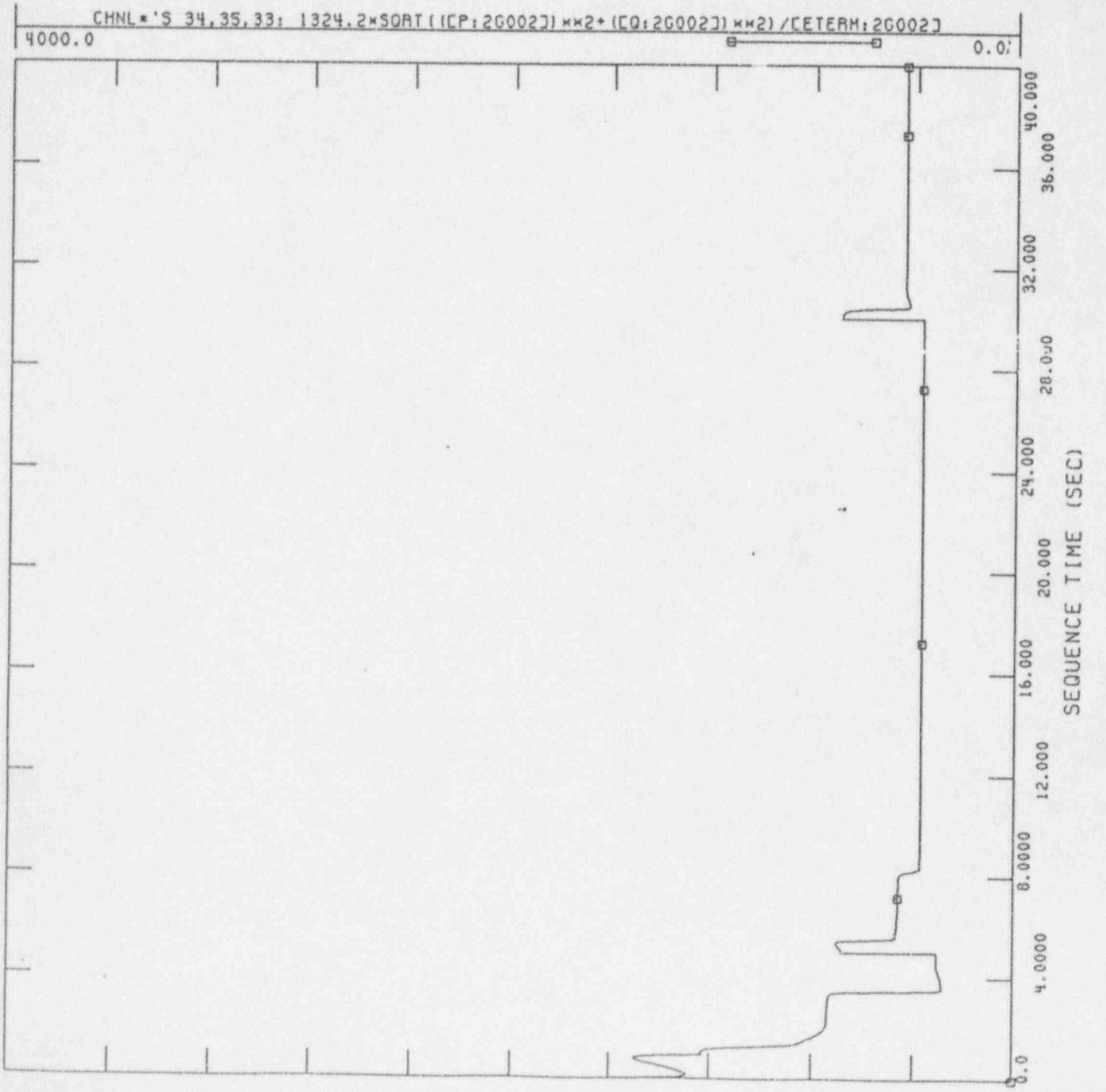
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:25
26002 Q (MVAR)



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

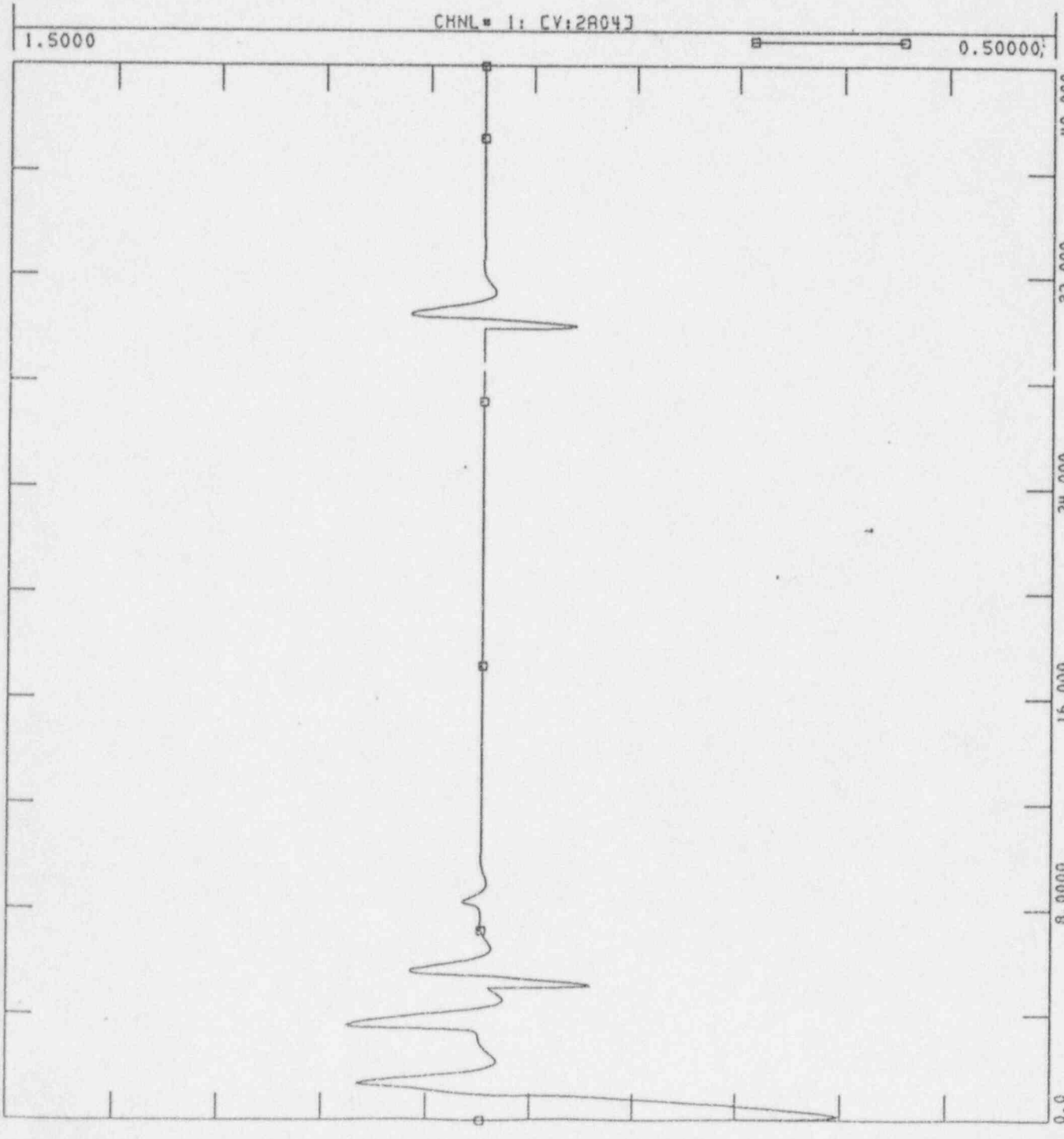
SAT, MAR 04 1995 18:25
2G002 AMPS



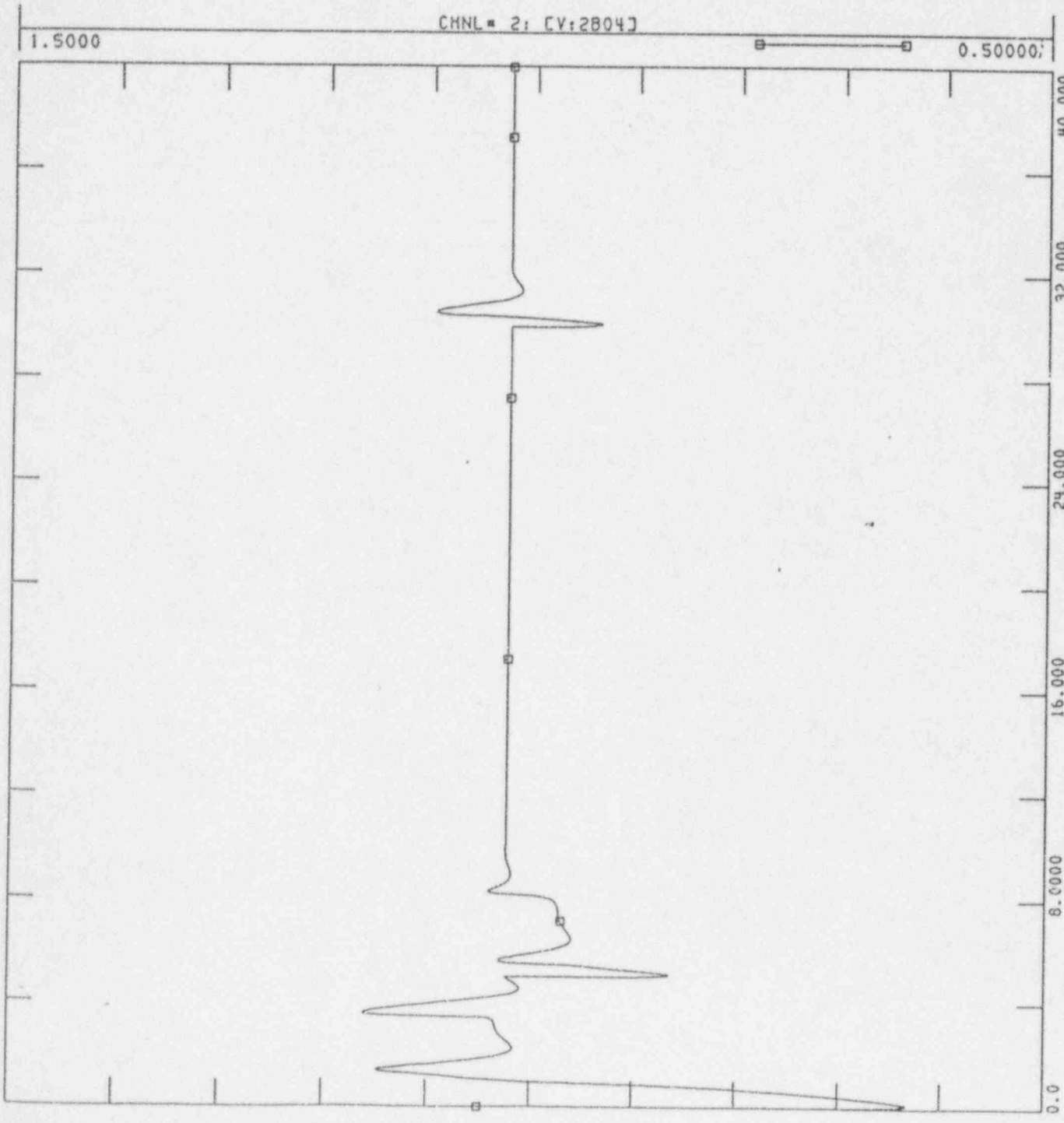
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:2

BUS 2A04 (4.16-KV BASE)



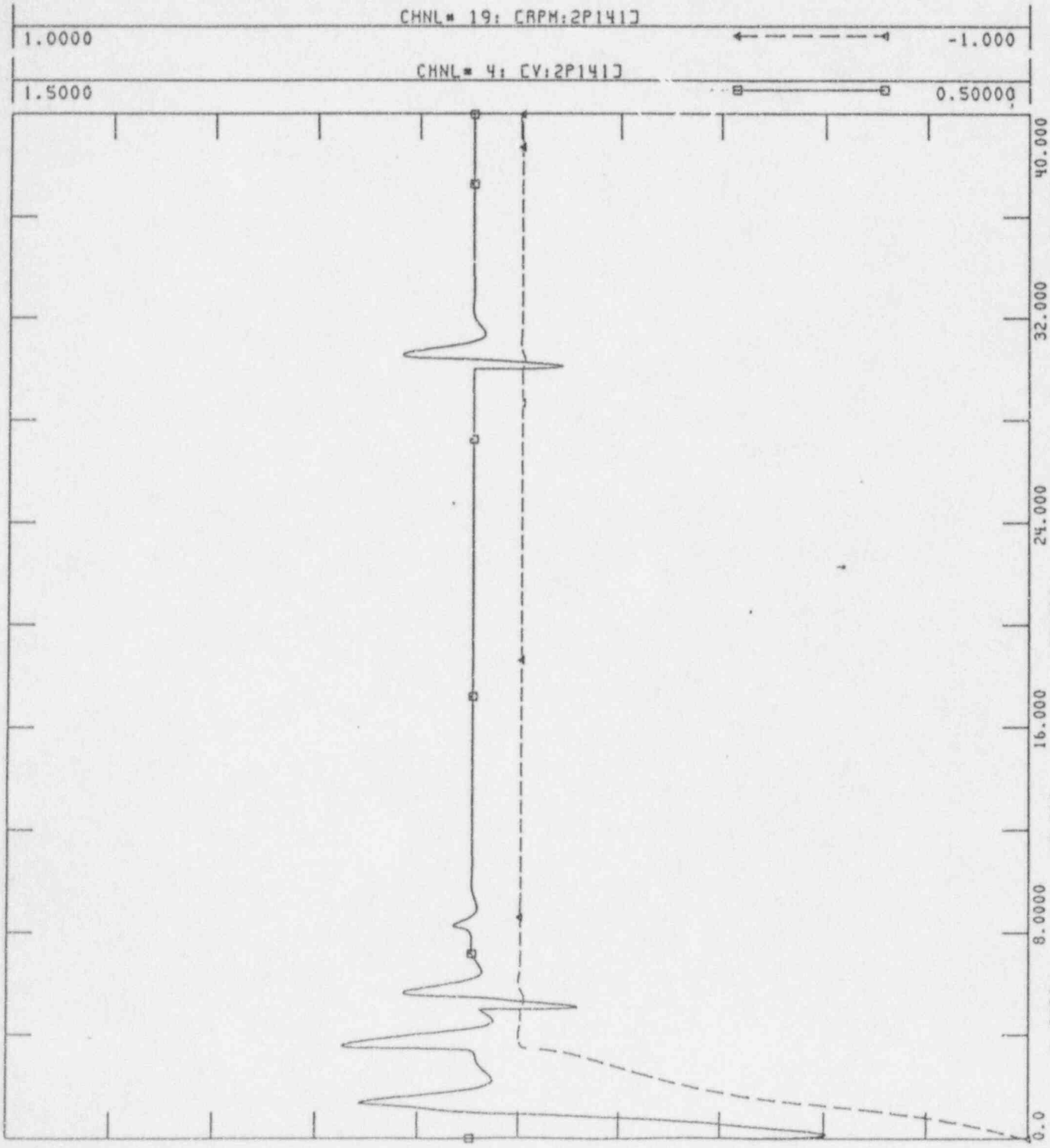
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4



SAT, MAR 04 1995 18:24
BUS 2804 (480-V BASE)

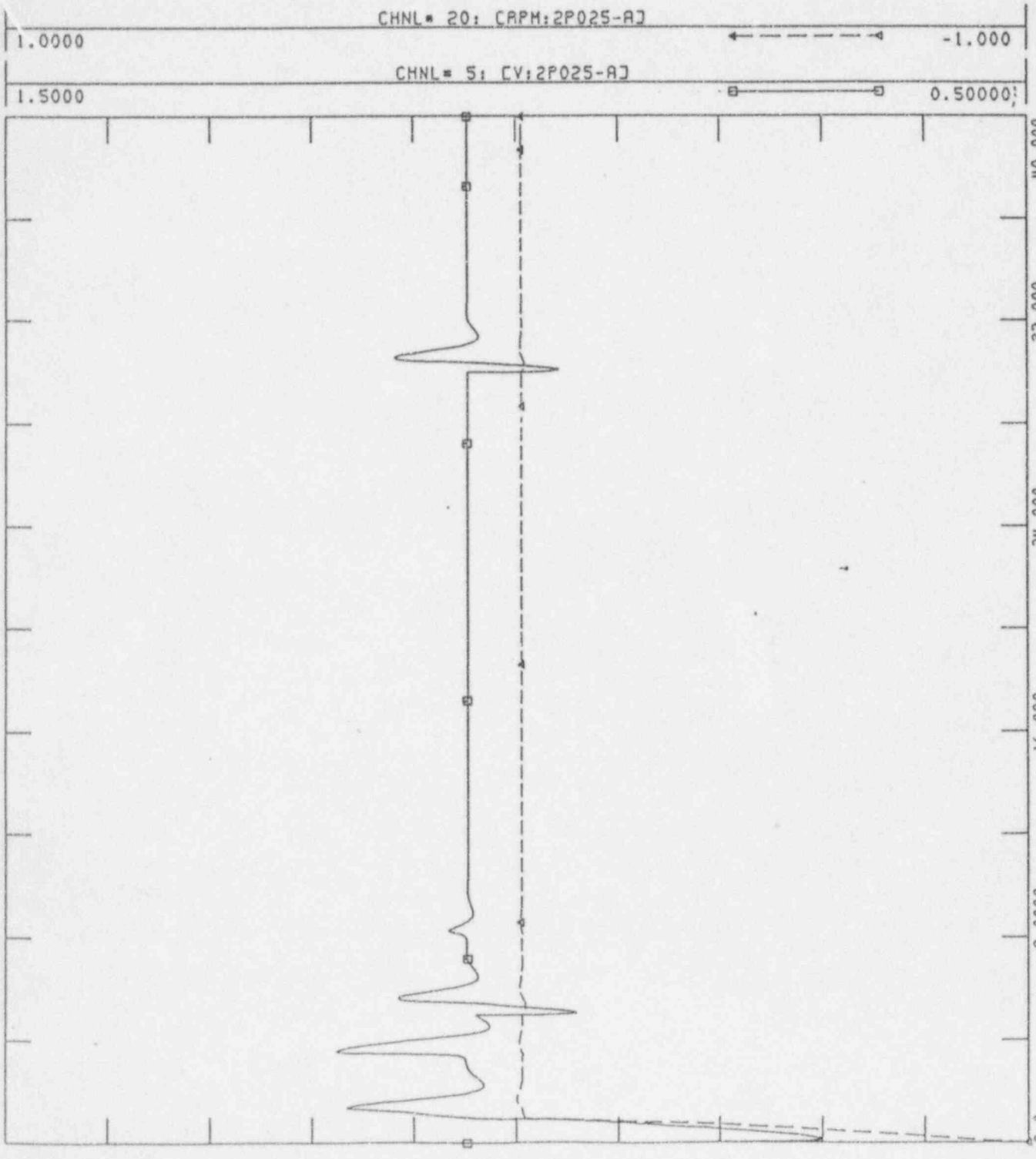
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:24
AFW 2P141



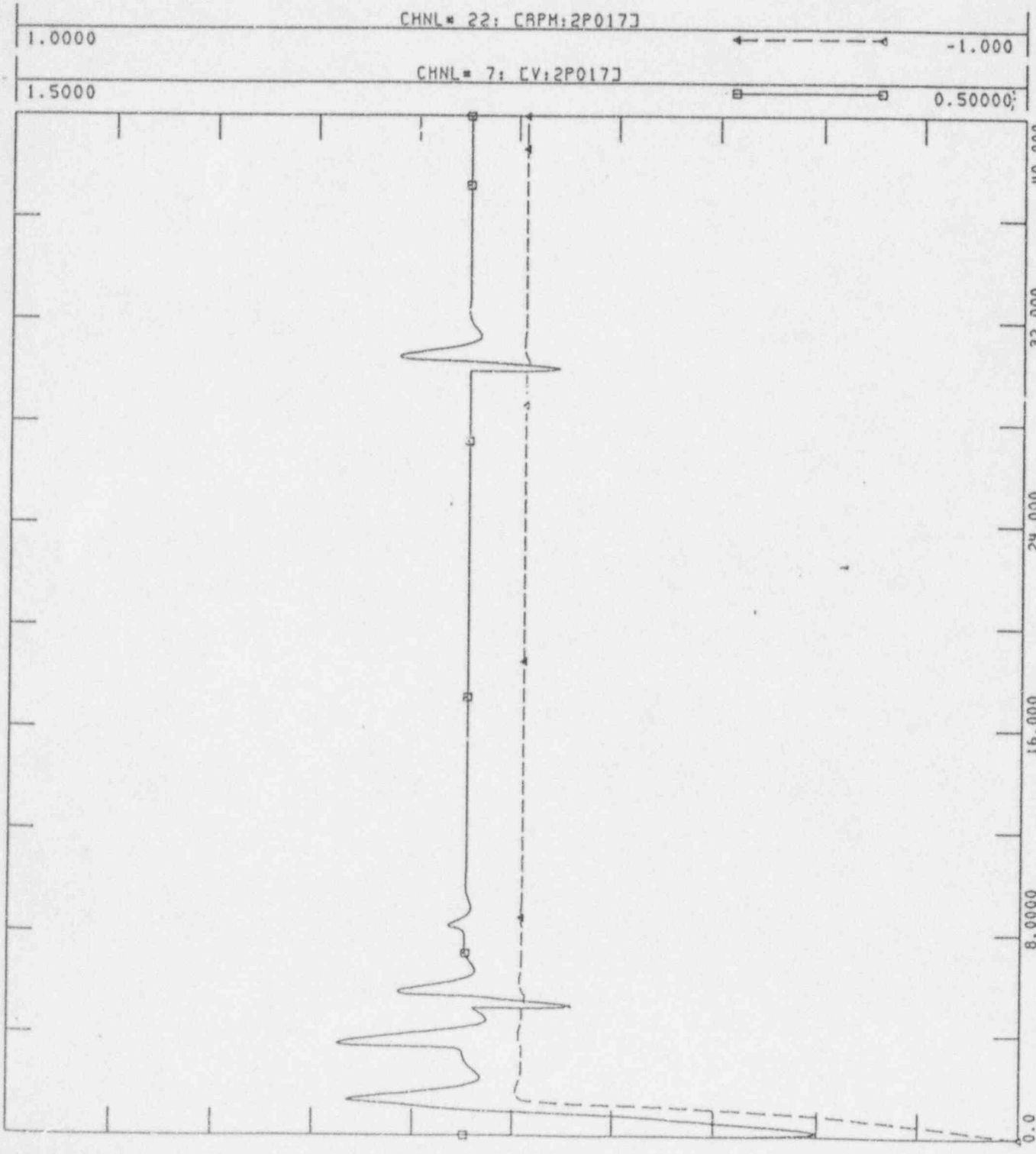
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:24
CCW 2P025-A



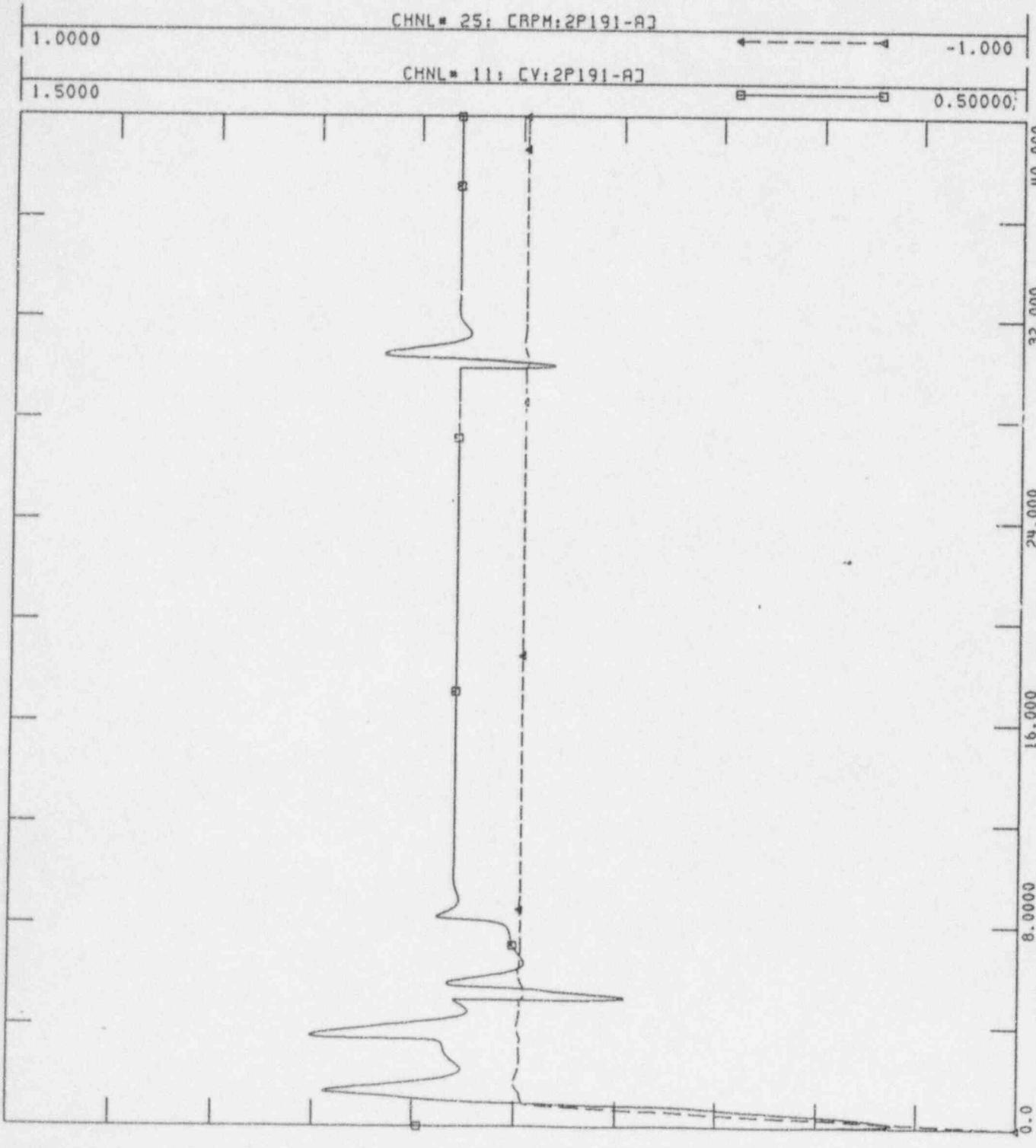
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:24
HPSI 2P017



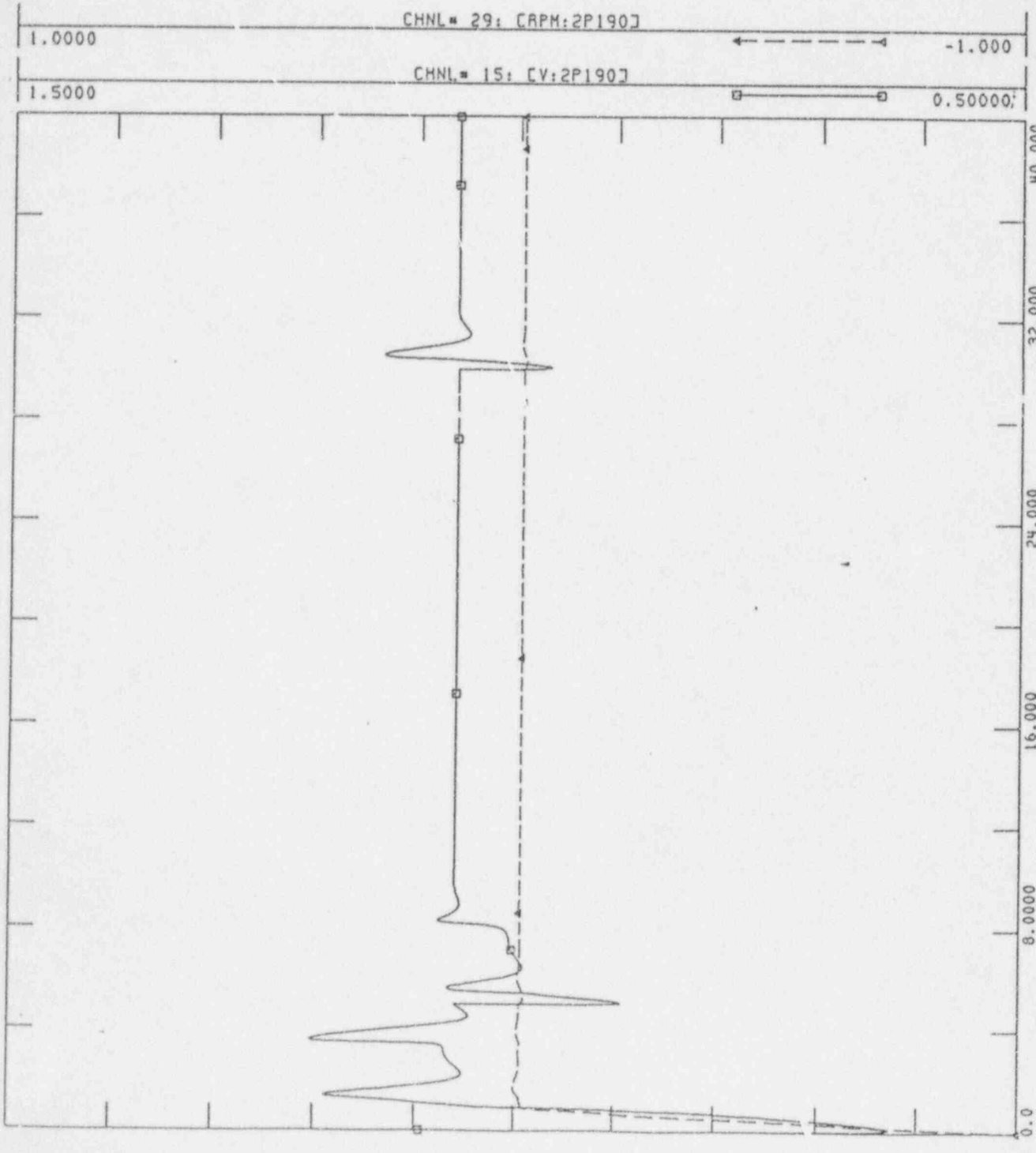
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:24
CHRG PUMP 2P191-A



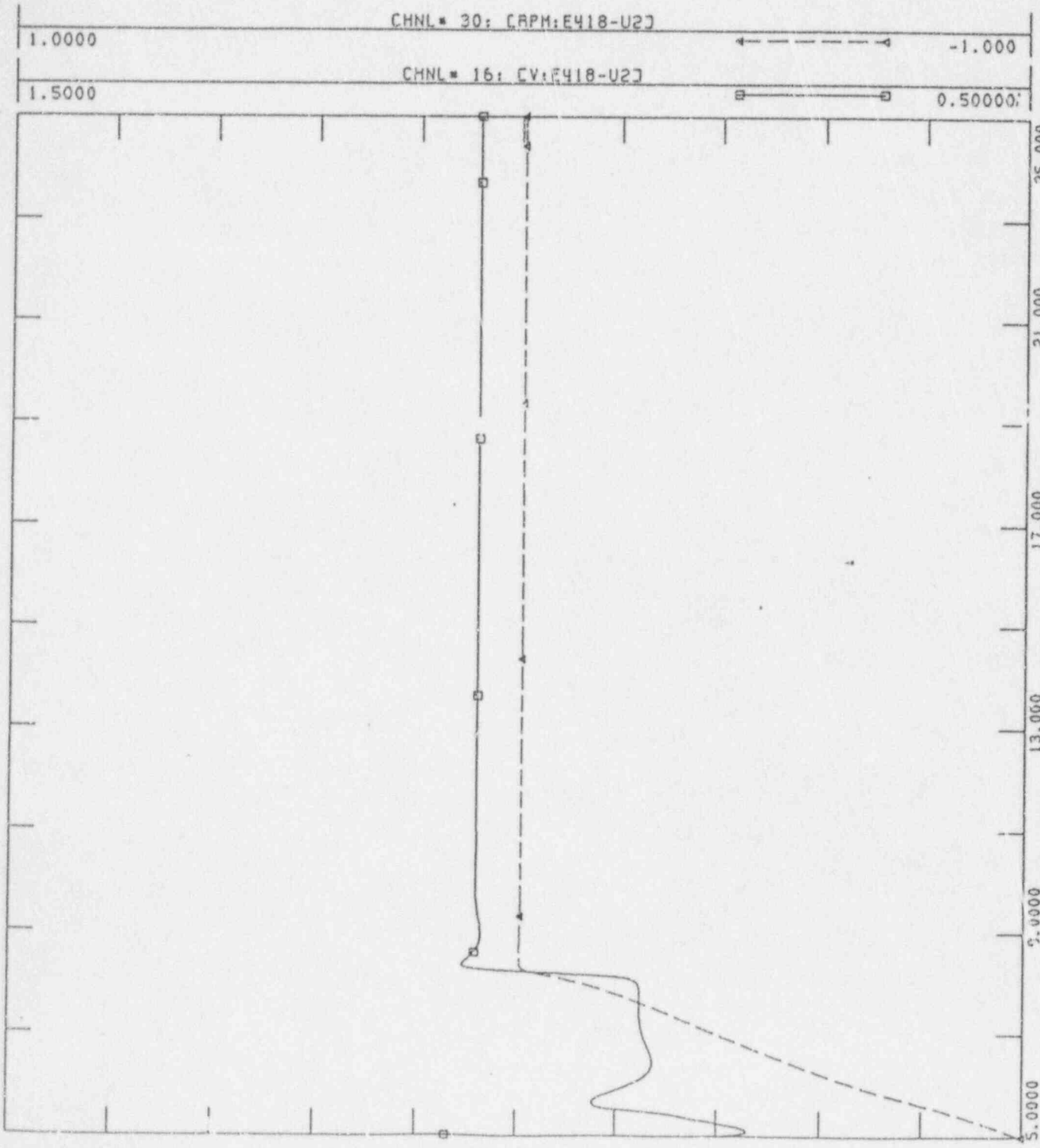
CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:24
CHRG PUMP 2P190



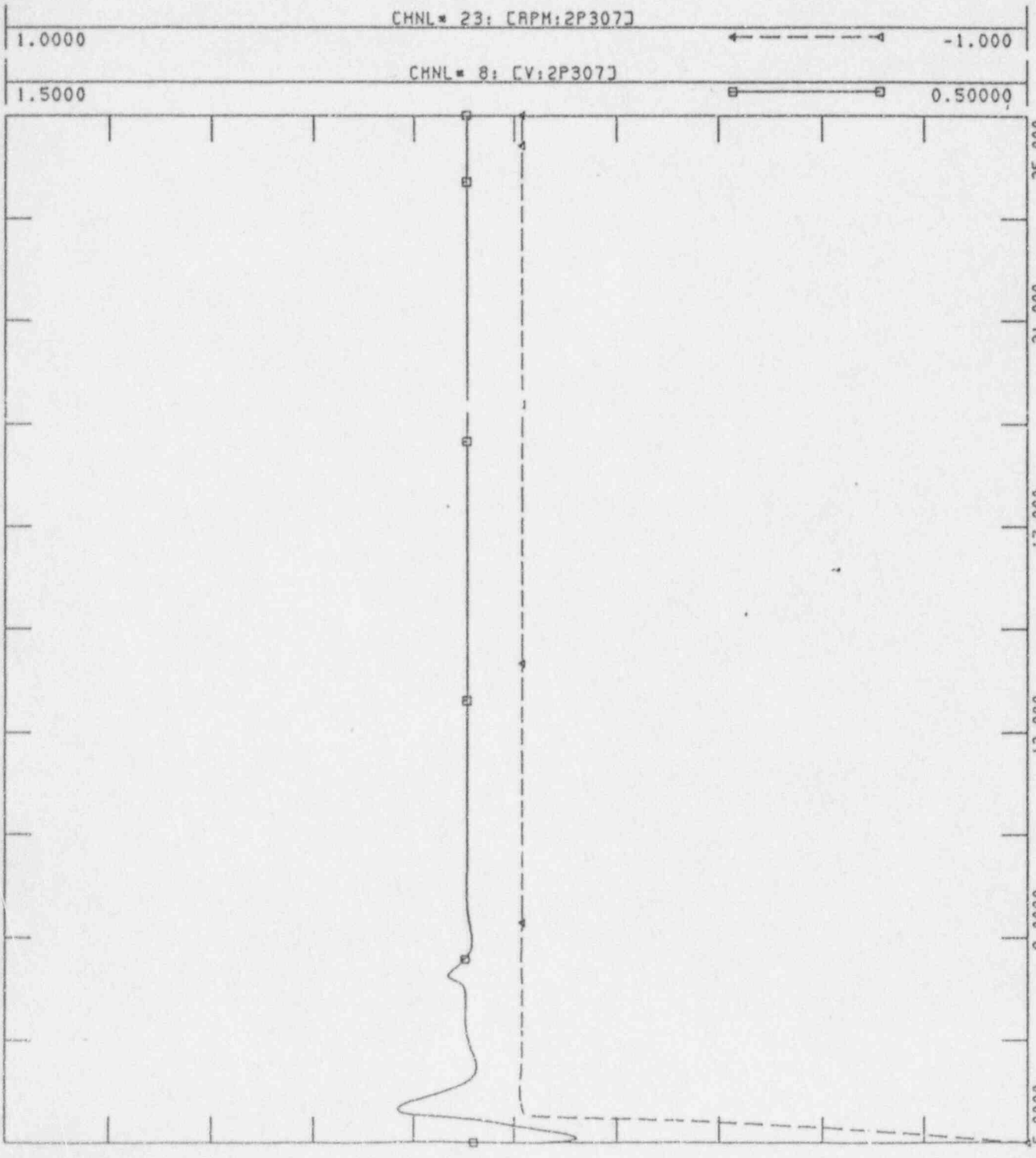
CALCULATION R-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:24
CONT RM AC E418-U2



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:25
SWC 2P307



CALCULATION A-95-E-KJA-001 REVISION 0
SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3
POWER TECHNOLOGIES INC., PSS/E RELEASE 19.0
PTI INTERACTIVE PLOTTING PROGRAM - PSSPLT
FILE: CASE-4

SAT, MAR 04 1995 18:25
CHILLER E336-U2