CP&L
A Progress Energy Company

John S. Keenan
Vice President
Brunswick Nuclear Plant

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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 AND 50-324/LICENSE NOS. DPR-71 AND DPR-62
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING
REQUEST FOR LICENSE AMENDMENTS - EXTENDED POWER UPRATE
(NRC TAC NOS. MB2700 AND MB2701)

Ladies and Gentlemen:

On August 9, 2001 (Serial: BSEP 01-0086), Carolina Power & Light (CP&L) Company requested a revision to the Operating Licenses (OLs) and the Technical Specifications for the Brunswick Steam Electric Plant, Units 1 and 2. The proposed license amendments increase the maximum power level authorized by Section 2.C.(1) of OLs DPR-71 and DPR-62 from 2558 megawatts thermal (MWt) to 2923 MWt. Subsequently, on October 16, 2001, the NRC requested a copy of the grid stability analysis discussed in Section 6.1.1 of NEDC-33039P, "Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2 Extended Power Uprate," dated August 2001 (i.e., the Power Uprate Safety Analysis Report (PUSAR)). The requested analysis is enclosed.

Please refer any questions regarding this submittal to Mr. David C. DiCello, Manager - Regulatory Affairs, at (910) 457-2235.

Sincerely,

John S. Keenan

John S. Keenan

MAT/mat

P.O. Box 10429
Southport, NC 28461

T> 910.457.2496
F> 910.457.2803

A001
Rec'd 01/18/02

Enclosure:

Response to Request For Additional Information (RAI) 4

John S. Keenan, having been first duly sworn, did depose and say that the information contained herein is true and correct to the best of his information, knowledge and belief; and the sources of his information are officers, employees, and agents of Carolina Power & Light Company.

Dean S. Mason
Notary (Seal)

My commission expires: 8|29/04

cc:

U. S. Nuclear Regulatory Commission, Region II
ATTN: Dr. Bruce S. Mallett, Regional Administrator
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, GA 30303-8931

U. S. Nuclear Regulatory Commission
ATTN: Mr. Theodore A. Easlick, NRC Senior Resident Inspector
8470 River Road
Southport, NC 28461-8869

U. S. Nuclear Regulatory Commission
ATTN: Mr. Donnie J. Ashley (Mail Stop OWFN 8G9)
11555 Rockville Pike
Rockville, MD 20852-2738

U. S. Nuclear Regulatory Commission
ATTN: Mr. Mohammed Shuaibi (Mail Stop OWFN 8H4A)
11555 Rockville Pike
Rockville, MD 20852-2738

Ms. Jo A. Sanford
Chair - North Carolina Utilities Commission
P.O. Box 29510
Raleigh, NC 27626-0510

Mr. Mel Fry
Director - Division of Radiation Protection
North Carolina Department of Environment and Natural Resources
3825 Barrett Drive
Raleigh, NC 27609-7221

ENCLOSURE

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
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Response to Request For Additional Information (RAI) 4

An Assessment of Brunswick Plant Extended Power Uprates On Plant and Grid Stability

June 2001

Transmission Department

CP&L
A Progress Energy Company

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Executive Summary

Additional uprates are planned for both Brunswick Plant units over the next few years. A report dated October 1996 detailed the results of the stability assessment for the first five percent uprate of the units planned at that time and currently in place. It showed that the Brunswick Units would be stable for a double-line-to-ground fault with backup clearing. While limited Out-of-Step protection was deemed desirable for the first five percent uprate, it was not required since the probability of instability was extremely small.

This present report details the analysis of transmission and plant stability for the extended power uprates now planned for the Brunswick Plant. The analysis assumed gross outputs for each unit of 1000 MW. The study results show that Out-of-Step (OOS) protection (blocking) is required on all transmission lines terminating in the Brunswick Plant switchyards. This should mitigate loss of off-site power issues resulting from tripping of the lines for any occurrence of plant instability. Instability of one Brunswick unit can result in instability in the second Brunswick unit also. Out-of-Step protection (tripping) and an anticipatory OOS fast trip scheme on each generator will remove the unstable unit(s) as quickly as feasible and mitigate issues of generator damage from instability and loss of other area generation and transmission facilities.

The extended power uprates will worsen existing potential problems with oscillations. The installation of power system stabilizers on both Brunswick units is needed to provide the necessary damping for oscillations occurring after a system disturbance.

The extended power uprates are not anticipated to degrade grid voltage support for a LOCA condition at the plant.

The following recommendations will allow the extended power uprates to be made while providing adequate protection to the grid and plant.

- Install Out-of-Step protection and associated fast tripping protection on each BNP unit prior to it beginning to operate at its Phase I output.

- Install a power system stabilizer on each BNP unit prior to it beginning to operate at its Phase I output. Installation of a PSS on BNP1 can be deferred until the Phase II uprate if the outputs of both BNP units are reduced to levels sufficient to maintain adequate damping during known or planned remote line outages.

- Revise and expand the operating procedure for reducing BNP outputs during line outages.

- Ensure no automatic reclosing from the BNP terminal for a line fault until 15 seconds or longer after the initial fault.

Introduction

This report describes how the planned extended power uprates of the Brunswick Plant generators will impact the stability of the transmission system and the plant. The extended power uprates will reduce overall system stability, but measures are outlined which mitigate problems created by the reduced stability margin. Out-of-Step (OOS) protection to block opening of the transmission lines will be relied upon to mitigate loss of off-site power issues. OOS tripping will be relied upon to mitigate potential generator damage and disruption to other grid facilities remote from the faulted line. An additional fast trip relay scheme will be used on each BNP unit which will trip the unstable BNP unit connected to the faulted line faster than is feasible with OOS tripping alone. This will be relied upon to limit instability to the unit connected to the faulted line. Power system stabilizers will be relied upon to mitigate potential problems from post-disturbance oscillations.

Description of Brunswick/Wilmington Area Transmission System

The transmission grid serving the Brunswick Plant and the Wilmington area has changed very little in the past fifteen years. Little change is anticipated for the next several years, certainly over the period that the extended power uprates (EPU) will be completed. Each Brunswick Unit has four 230 kV lines terminating in its switchyard. The lines emanating from the Unit 1 switchyard terminate in the Castle Hayne, Delco, Jacksonville, and Weatherspoon Plant substations. The lines from the Unit 2 switchyard terminate at the Castle Hayne, Delco, Wallace, and Whiteville substations. The Castle Hayne and Delco substations are major stations in the Wilmington area. Three additional transmission lines also connect the Wilmington area into CP&L's Eastern System. These are the Castle Hayne-Jacksonville, Cumberland-Delco, Sutton Plant-Wallace 230 kV Lines. The Sutton Plant 230 kV switchyard is connected to the Castle Hayne and Delco stations and also to the Wallace station. There is also some Sutton generation connected to the 115 kV lines connected into the Castle Hayne and Delco substations. The only other generation in the vicinity is at Southport Cogentrix whose stub is connected to the Brunswick Plant Unit 1 – Delco 230 kV East Line about 0.1 miles from the BNP 1 switchyard

Review of Previous Uprate Stability Results

A report produced in October, 1996 detailed the results of the assessment on plant stability for the first uprate (105%) stage. The decreasing order of fault severity for the Brunswick generation was: three-phase fault with delayed clearing, double-line-to-ground (DLGR) fault with delayed clearing, three-phase fault with normal clearing, and single-line-to-ground (SLGR) fault with delayed clearing. The report showed that the plant was stable for a DLGR fault with delayed clearing (stuck breaker) condition when the fault was close-in to the unit switchyard (>0.6 miles from the switchyard). It detailed the need for limited Out-of-Step (OOS) protection to mitigate the consequences of unit instability. The stability simulations done for that study showed that instability in one Brunswick unit could also cause instability in the other unit. Several or all of the lines into the unit switchyard(s) could also be tripped if the unstable unit was not removed from the grid as quickly as possible. The installation of OOS protection (tripping) on the unit step-up transformers and generators was recommended in the report.

Stability simulations done after the first uprate and with additional hypothetical generation installed in the Eastern System showed potential problems with prolonged oscillations. The installation of Power System Stabilizers (PSS) on the Brunswick Plant units was shown to be an effective method to improve damping of these prolonged oscillations, especially in light of known interest in further uprates to the Brunswick units.

Evaluation of Stability for Extended Power Uprates

Simulations have been run at peak and minimum off-peak load periods to envelope the impact of EPU on plant and grid stability. Simulations for peak load periods use an Eastern Control Area Load (ECAL) of 12000 MW. Minimum off-peak load cases use an ECAL of 4000 MW. Unless otherwise noted, the gross outputs for both uprated Brunswick Units are assumed to be 1000 MW. Preliminary assessment showed that Brunswick Plant cannot remain stable for a DLGR fault with delayed clearing as seen in the previous uprate. After obtaining a more accurate model for the Brunswick unit excitation systems, preliminary simulations were re-run with the new model. These simulations resulted in an increase in the magnitude of oscillations seen in the preliminary simulations. Plots of the re-run simulations are in Appendices A1-A6.

Appendix A1 shows that one or both uprated Brunswick units can become unstable for a DLGR fault for a fault just outside the unit switchyard if the fault is cleared by backup protection (breaker-failure protection). This is due to the continued restriction on maximum MVAR levels after EPU. The study done in 1996 for the first uprate of the Brunswick units showed that a fault resulting in unit instability might also cause the other Brunswick unit to become unstable and possibly result in the loss of one or more lines connected to the unit switchyards. Simulations done for the EPU shows that OOS protection is critical due to the increased risk from reduced stability margin. OOS blocking is proposed at both terminals for all of the lines connected at the Brunswick Plant switchyards. This should mitigate loss-of-offsite power issues. An OOS protective scheme that will detect the out-of-step condition in the lines or unit step-up transformers is proposed for the purpose of tripping the unstable unit(s) as quickly as feasible. Because the OOS tripping protection may be too slow to prevent instability in generators remote from the fault, an additional protective scheme will be used to give faster tripping of the BNP unit connected to the faulted line. The additional protection will detect the presence of a breaker-failure condition, a multi-phase fault, and a fault within a given distance from the unit switchyard. It will use these conditions to anticipate that an unstable condition exists for the protected generator. The protected generator can then be tripped up to 0.5 seconds faster than possible with the OOS tripping protection alone. The OOS protective schemes and the additional relay protection should mitigate damage to the unstable generator(s) and disruption to other grid facilities in the Brunswick/Wilmington area.

Appendix A2 contains the plots for simulations of normally cleared three-phase faults on the Brunswick lines. The uprated Brunswick units do maintain transient stability (first swing stability) for three-phase faults with normal clearing and SLGR faults with delayed clearing for all postulated system conditions. A three-phase fault with normal clearing envelopes a SLGR fault with delayed clearing for the Brunswick units. Even though the Brunswick units will remain transiently stable for the three-phase faults with normal clearing, prolonged oscillations of significant magnitude can occur for some system conditions after the fault is cleared. Examination of the plots and Table I show that the worst three-phase fault is on the Brunswick Plant-Weatherspoon 230 kV Line.

Category C of Table 1A of the NERC Planning Standards shows that the grid should remain stable for a SLGR fault with delayed clearing (Category C.7) and for a three-phase fault with normal clearing during the outage of another transmission circuit (Category C.3). This Category C.3 scenario has not been studied previously (for design purposes) for evaluating the stability of the Brunswick Plant. (Stability simulations for planned line outage conditions have been run for system operating studies, with the criterion here typically being delayed clearing of a DLGR fault on a Brunswick line.) As mentioned above, simulations show higher magnitudes for oscillations with the recently acquired and more accurate BNP excitation system model than with the older and more generic excitation system model. These results revealed that Category C.3 scenarios are a concern at present plant output levels. Since an existing operating procedure, DTRM – TP-12, requires a Brunswick unit to reduce its MW output during the outage of a transmission line connected to its switchyard, simulations done outside the scope of the EPU study were run to identify other lines whose outage would significantly impact Brunswick Plant stability. Simulations of the enveloping three-phase fault (on the Brunswick Plant-Weatherspoon line) during an outage of the Cumberland-Delco, Castle Hayne-Jacksonville, or Sutton Plant-Wallace 230 kV Lines showed the worst outage was the Cumberland-Delco 230 kV Line. Appendices A3-A6 include plots of oscillations at peak and minimum off-peak load periods using the enveloping three-phase fault and line outage condition. The pre-fault line outage increases the magnitude and decreases the damping of the oscillations that occur after the fault is cleared.

Damping ratio is a measure of how well the magnitude of an oscillation decreases with time. A stable oscillation with decreasing magnitude has a positive damping ratio. Damping ratios between .01 (1%) and 0.0 (0%) are considered very poorly damped in this report. Damping ratios between .01 (1%) and .03 (3%) are considered poorly damped. A damping ratio of zero means the magnitude of the oscillation remains constant over time. A negative damping ratio means that the oscillation's magnitude will increase over time and the system is unstable. Plans are to use a 3% damping ratio as the minimum criterion for future generation projects. Future generation projects whose post-fault oscillations have a damping ratio less than 3% will be required to install power system stabilizers.

Appendix A3 shows plots for the enveloping three-phase fault with normal clearing during the enveloping line outage condition at peak load periods. Table I shows a damping ratio of 0.0027 for such a fault. Installing a PSS on Sutton 3 increases the damping ratio to 3.61%. Putting the PSS on BNP2 or on BNP 1&2 increases the damping ratio to 3.94% and 7.03%, respectively.

Appendix A4 shows plots for the enveloping three-phase fault condition at minimum off-peak load periods. Damping is almost non-existent at a damping ratio of 0.02%. Installing a PSS on BNP2 only or on BNP 1&2 increases the damping ratios to 3.09% and 5.86%, respectively.

Appendix A5 shows plots for the enveloping three-phase fault and line outage condition at minimum off-peak load periods. Brunswick Plant is transiently unstable for outputs above 930 MW (gross). BNP is transiently stable (1st swing stable) at 930 MW gross output on each unit, but becomes unstable when reclosing from the BNP terminal at 15 seconds after the initial fault. Putting a PSS on BNP2 (non-faulted unit) or on BNP 1&2 results in the BNP units remaining stable even after the 15 second reclosure. The damping ratios of 2.78% and 5.76% show the potential of the PSS to improve overall plant stability following the initial first swing.

Appendix A6 shows plots for the enveloping three-phase fault, both with and without the enveloping line outage condition, at minimum off-peak load periods. BNP output corresponds to that after Phase I of the BNP 1 extended power uprate. Without the line outage, BNP1 rotor angle damping is poor with a damping ratio of 1.28%. Outaging the Cumberland-Delco 230 kV Line prior to the fault decreases the damping ratio to 0.01%. Installing a PSS on BNP1 brings the damping back within adequate range with a damping ratio of 4.45%.

Replacement Generator Step-up Transformers

Stability simulations show that the impedance of any replacement generator step-up transformers should have the same impedance on a 100 MVA base as do the present unit step-up transformers. Significantly higher impedances will result in the BNP units being unstable for a three-phase fault with normal clearing after EPU.

Output Levels During Line Outages

An existing system operating procedure, DTRM-TP-12, requires a BNP unit to reduce its MW output for the outage of a line terminated at its switchyard. Utilization of this procedure will continue after EPU. Post-EPU simulations show BNP1 will remain stable for a three-phase fault with normal clearing at gross outputs of 750-880 MW, depending upon the pre-fault line outage. Similarly, BNP2 will remain stable at gross outputs of 840-900 MW, depending upon the pre-fault line outage. Simulations also show it will be necessary to reduce BNP unit outputs during some remote line outages, the most enveloping case being reduction to 930 MW (gross) on each unit for outage of the Cumberland-Delco 230 kV Line.

Pre-uprate simulations utilizing the more accurate BNP unit excitation system model, discussed previously, revealed that power reductions on both units (to approximately 750-775 MW) might be required during a remote line outage.

LOCA Voltage Support and Reactive Issues

System operating procedures, DTRM-GP-24, exist to help maintain adequate voltage support for a LOCA condition at the Brunswick Plant. These procedures restrict the maximum gross MVAR outputs to 170 MVARs for Unit 1 and 130 MVARs for Unit 2.

The maximum gross reactive capability anticipated after EPU is 220-240 MVARs. Restrictions on unit MVARs for LOCA support are anticipated to continue even after the uprates. Unit operation in the 220-240 MVAR range is only expected to occur for a short time following a contingency until unit outputs can be adjusted to new system operating conditions. Such a contingency may involve tripping one of the Brunswick lines, tripping generation at the Brunswick or Sutton Plants, or tripping a 230 kV capacitor bank. Area transmission and distribution capacitor banks will operate after any contingency to restore area voltage to adequate levels. No additional capacitor banks are required in the Brunswick/Wilmington vicinity specifically to offset the reduced MVAR capability of the generators after the extended power uprate.

Operating the BNP units at the present generation voltage schedules will allow the units to remain stable for three-phase faults with normal clearing after EPU. Assuming the BNP voltage schedules and LOCA loads remain unchanged after EPU, the anticipated EPU LOCA switchyard voltage is .0002-.0007 pu higher than at present output levels. Thus the EPU is not anticipated to degrade grid LOCA voltage support.

Transmission Lines Ratings and Loading Levels

Loadflow cases were run to determine the MVA loadings on the BNP lines at the plant switchyards under various system conditions. The maximum MVA loadings here are with BNP1 or 2 reduced as needed for line outages. The facility ratings are the minimum line or equipment ratings from the BNP switchyards out to the first load points along the lines.

	Min. Line Rating (MVA)	Max Line Loading (MVA)
BNP1 - Castle Hayne East Line	637	567
BNP1 – Delco East Line	557	527
BNP1 – Jacksonville Line	590	370
BNP1 – Weatherspoon Line	557	226
BNP2 – Castle Hayne West Line	637	525
BNP2 – Delco West Line	557	484
BNP2 – Wallace Line	557	331
BNP2 – Whiteville Line	557	298

While there are facilities beyond the first load points with ratings lower than these given, their ratings should not be a problem since the line loadings will be less at those facilities. Analysis of the anticipated maximum loadings shows that any overload problems during the outage of a Brunswick line will be of short duration. Reduction of the unit output in accordance with operating procedures should correct any overload condition.

Conclusion

Stability studies for the five percent uprate and for the EPU show the need for OOS protection for the BNP units and its associated transmission lines. This OOS protection becomes more critical for EPU because of the significantly reduced stability margin compared to the five percent uprate. The OOS blocking protection for the lines will mitigate loss of off-site power issues for the plant. The OOS tripping scheme and additional protection scheme to speed up tripping of the unstable generator connected to faulted line will mitigate damage to the unstable generator(s) and disruption to other grid facilities in the Brunswick/Wilmington area.

A tabulation of the conditions studied and the damping of the resulting oscillations is given in Table I. The damping ratios for faults for which BNP will remain transiently stable after EPU are 0.02% - 2.16%. These values represent poor to very poor damping of post-fault oscillations and demonstrate the necessity for power system stabilizers on the BNP units. While there is a benefit to installing a PSS on Sutton 3, the benefit will be lost when Sutton 3 is shutdown during low load periods. Installing a PSS on both BNP units provides the most benefit to damping post-disturbance oscillations at all load levels. This will also allow adequate damping should one PSS be temporarily out-of-service. Installation of the PSS on the BNP units increases the output level at which BNP can be operated and still remain stable during line reclosure attempts from the BNP terminals following fault clearing. No automatic line reclosures from the BNP switchyards should be attempted until 15 seconds or longer after the initial fault. This is necessary to maintain transient stability and is the current design. Adequate control design will ensure that this feature is not modified in the future.

Installation of a PSS on BNP1 for Phase I will allow adequate damping of post-disturbance oscillations on the transmission system. The alternative to this will be to have an additional operating procedure to reduce the outputs of both BNP units to levels sufficient to maintain adequate damping during known or planned remote line outages. Some preliminary simulations show BNP unit outputs may have to be reduced to 750-775 MW outputs (gross) each to maintain poor damping levels of oscillations for the enveloping three-phase fault and line outage condition.

Any replacement generator step-up transformers should have the same impedance on a 100 MVA base as do the present unit step-up transformers.

The operating procedure requiring a reduction in BNP outputs during BNP line outages will continue after EPU. Actually, the procedure will probably need to be expanded to include additional line outages remote from the plant, but this will require smaller reductions in unit output levels. Further study will be required to develop appropriate output levels for the various remote line outages. The present procedure of operating so as to maintain stability for delayed clearing of a DLGR fault on a BNP line during a remote line outage lasting longer than a few hours should continue until OOS protection is installed on the generator served by the faulted line.

Restrictions on BNP reactive output levels will continue after EPU due to equipment limitations and to LOCA support requirements. EPU is not anticipated to reduce grid LOCA support capability.

Analysis of the anticipated maximum loadings on the transmission lines connected to the BNP switchyards shows that any overload should be of short duration and manageable through administrative controls.

Recommendations

Install Out-of-Step protection on each BNP unit prior to it beginning to operate at its Phase I output. This should include the additional scheme to allow faster tripping of an unstable generator than is possible with the OOS tripping scheme alone.

Install a power system stabilizer on each BNP unit prior to it beginning to operate at its Phase I output.

Revise and expand the operating procedure for reducing BNP outputs during line outages.

Ensure no automatic reclosing from the BNP terminal for a line fault until 15 seconds or longer after the initial fault. This is critical for transient stability.

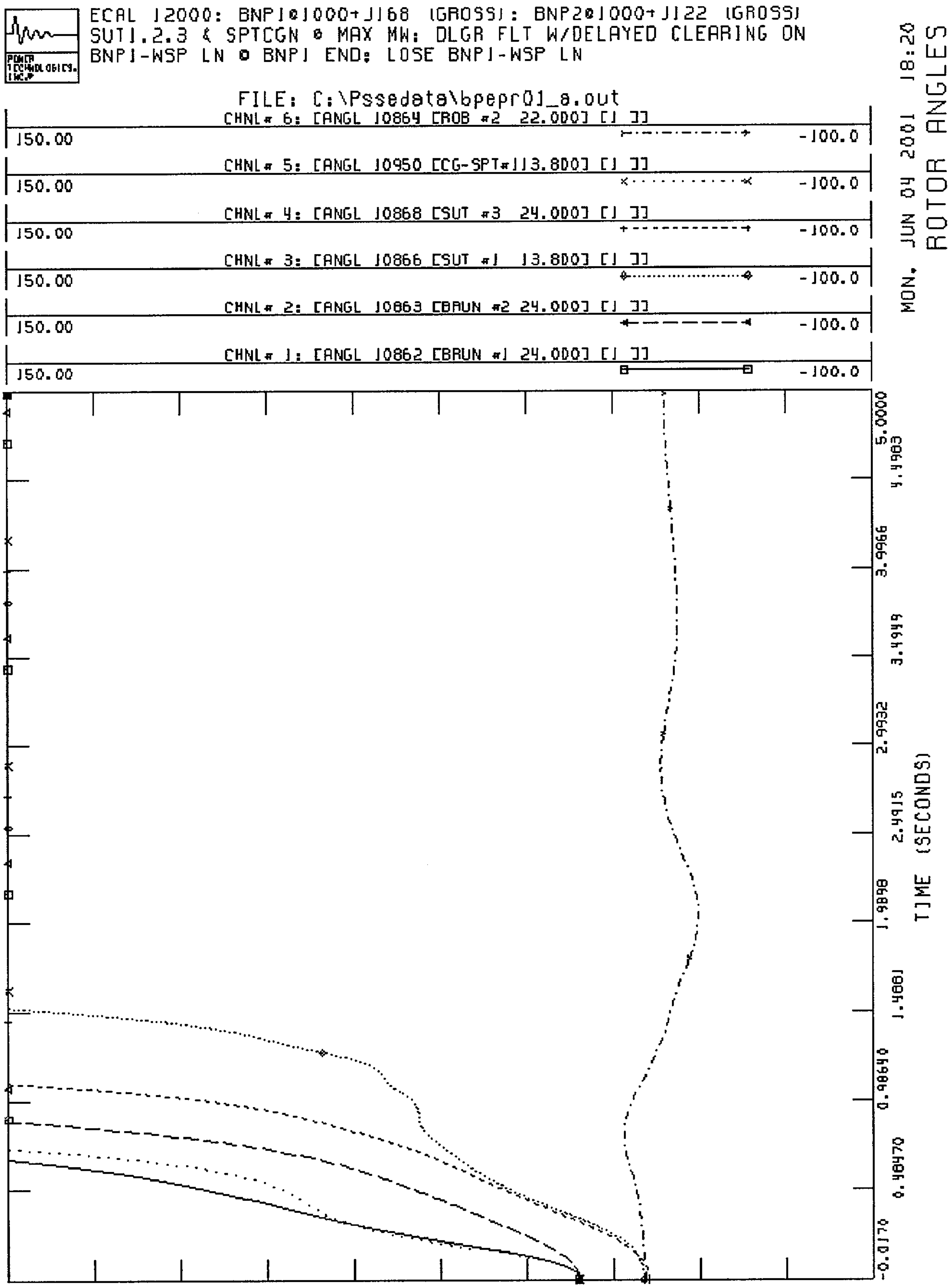
Table 1

BNP UPRATE FAULT DAMPING VALUES

All faults are three-phase faults with normal clearing, with fault located just outside BNP switchyard
Oscillation parameters are for rotor angle for faulted BNP unit for t=20-40 seconds

Case ID	ECAL	BNP1/BNP2 Gross Outputs	Pre-fault Outages	Faulted Line	Damping Ratio	Oscillation Frequency	Oscillation Magnitude	Miscellaneous Comments
BPEPR01_A1.OUT	12000	1000/1000	none	BNP1-Wsp	0.0091	0.87	12.4	enveloping case
BPEPR01_A2.OUT	12000	1000/1000	none	BNP1-Jax	0.0174	0.9	5.2	enveloped by BNP1-Wsp line fault
BPEPR01_A3.OUT	12000	1000/1000	none	BNP1-CH	0.0188	0.9	5	enveloped by BNP1-Wsp line fault
BPEPR01_A4.OUT	12000	1000/1000	none	BNP1-Del	0.0216	0.9	4.2	enveloped by BNP1-Wsp line fault
BPEPR01_A5.OUT	12000	1000/1000	none	BNP2-CH	0.0209	0.9	4.1	enveloped by BNP1-Wsp line fault
BPEPR01_A6.OUT	12000	1000/1000	none	BNP2-Wal	0.0191	0.9	4.6	enveloped by BNP1-Wsp line fault
BPEPR01_A7.OUT	12000	1000/1000	none	BNP2-Del	0.0207	0.9	4.4	enveloped by BNP1-Wsp line fault
BPEPR01_A8.OUT	12000	1000/1000	none	BNP2-Wht	0.0096	0.88	9.1	enveloped by BNP1-Wsp line fault
BPEPR01_A9.OUT	12000	1000/1000	Cumb-Delco	BNP1-Wsp	0.0027	0.81	15	
BPEPR01_A16.OUT	12000	1000/1000	Cumb-Delco	BNP1-Wsp	0.0394	0.83	11.8	PSS on BNP2
BPEPR01_A17.OUT	12000	1000/1000	Cumb-Delco	BNP1-Wsp	0.0703	0.87	2.7	PSS on BNP1&2
BPEPR01_A24.OUT	12000	1000/1000	Cumb-Delco	BNP1-Wsp	0.0361	0.82	14.2	PSS on Sut3
BPEPR01_A18.OUT	4000	1000/1000	none	BNP1-Wsp	0.0002	0.88	11.1	
BPEPR01_A19.OUT	4000	1000/1000	none	BNP1-Wsp	0.0309	0.9	7.7	PSS on BNP2
BPEPR01_A20.OUT	4000	1000/1000	none	BNP1-Wsp	0.0586	0.87	0.7	PSS on BNP1&2
BPEPR01_A13.OUT	4000	930/930	Cumb-Delco	BNP1-Wsp	--------	-----------	-----------	reclosure attempt caused instability
BPEPR01_A14.OUT	4000	930/930	Cumb-Delco	BNP1-Wsp	0.0278	0.87	9	PSS on BNP2
BPEPR01_A15.OUT	4000	930/930	Cumb-Delco	BNP1-Wsp	0.0576	0.88	1.4	PSS on BNP1&2
BPEPR01_A21.OUT	4000	924/865	none	BNP1-Wsp	0.0128	0.93	8.2	Phase I uprate
BPEPR01_A22.OUT	4000	924/865	Cumb-Delco	BNP1-Wsp	0.0001	0.85	11.7	Phase I uprate
BPEPR01_A23.OUT	4000	924/865	Cumb-Delco	BNP1-Wsp	0.0445	0.88	5.8	Phase I Uprate; PSS on BNP1

Appendix
A1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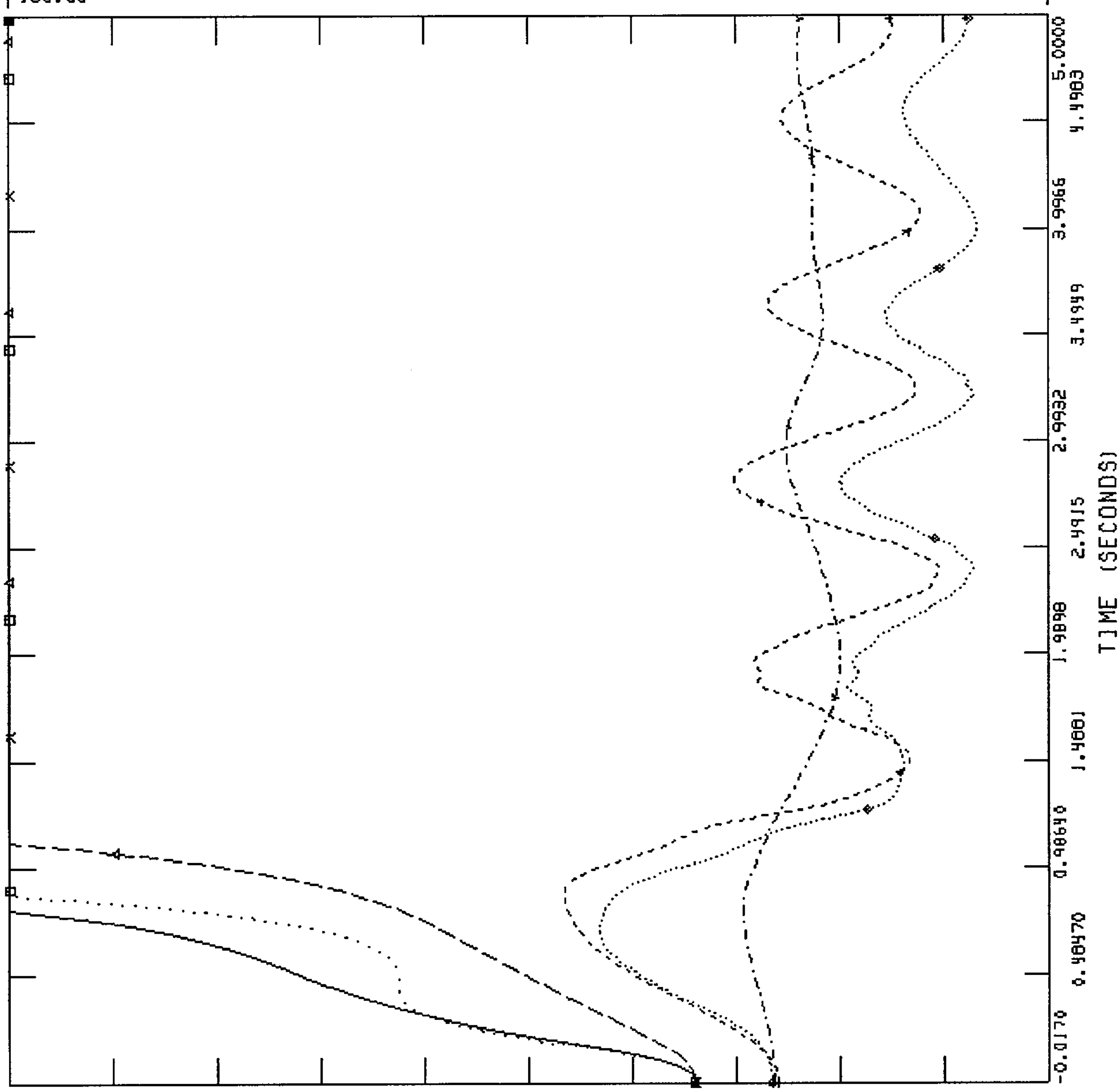

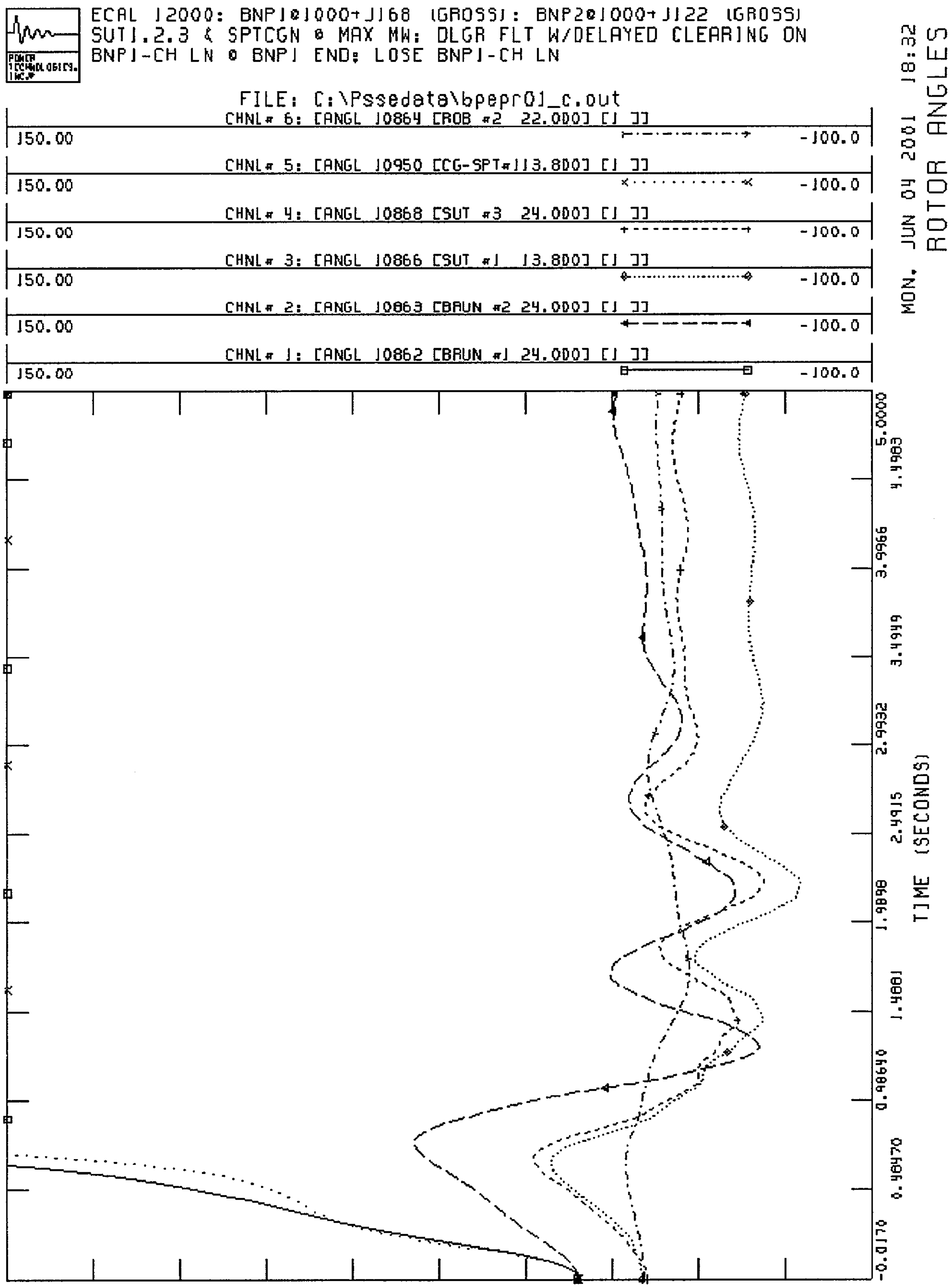
POWER TECHNOLOGIES, INC.
ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1,2,3 & SPTCGN @ MAX MW: DLGR FLT W/DELAYED CLEARING ON
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150.00 -100.0
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MON, JUN 04 2001 18:32
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3.9966
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2.4915
1.9898
1.4881
0.98640
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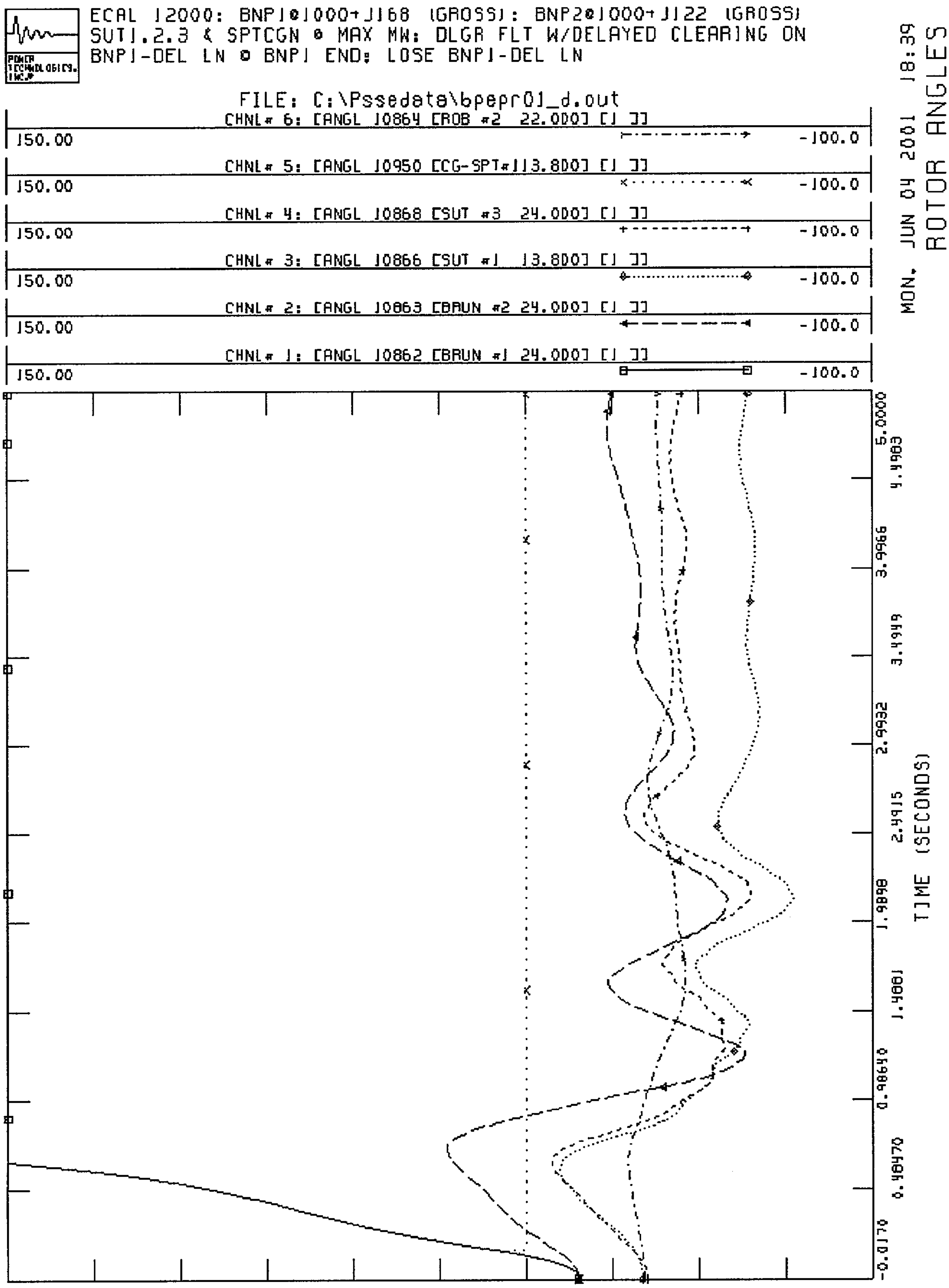
-0.0170
TIME (SECONDS)



ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1,2,3 & SPTCGN @ MAX MW: DLGR FLT W/DELAYED CLEARING ON
BNP1-DEL LN @ BNP1 END: LOSE BNP1-DEL LN
POWER TECHNOLOGIES, INC.
FILE: C:\Pssedata\bpepr01_d.out
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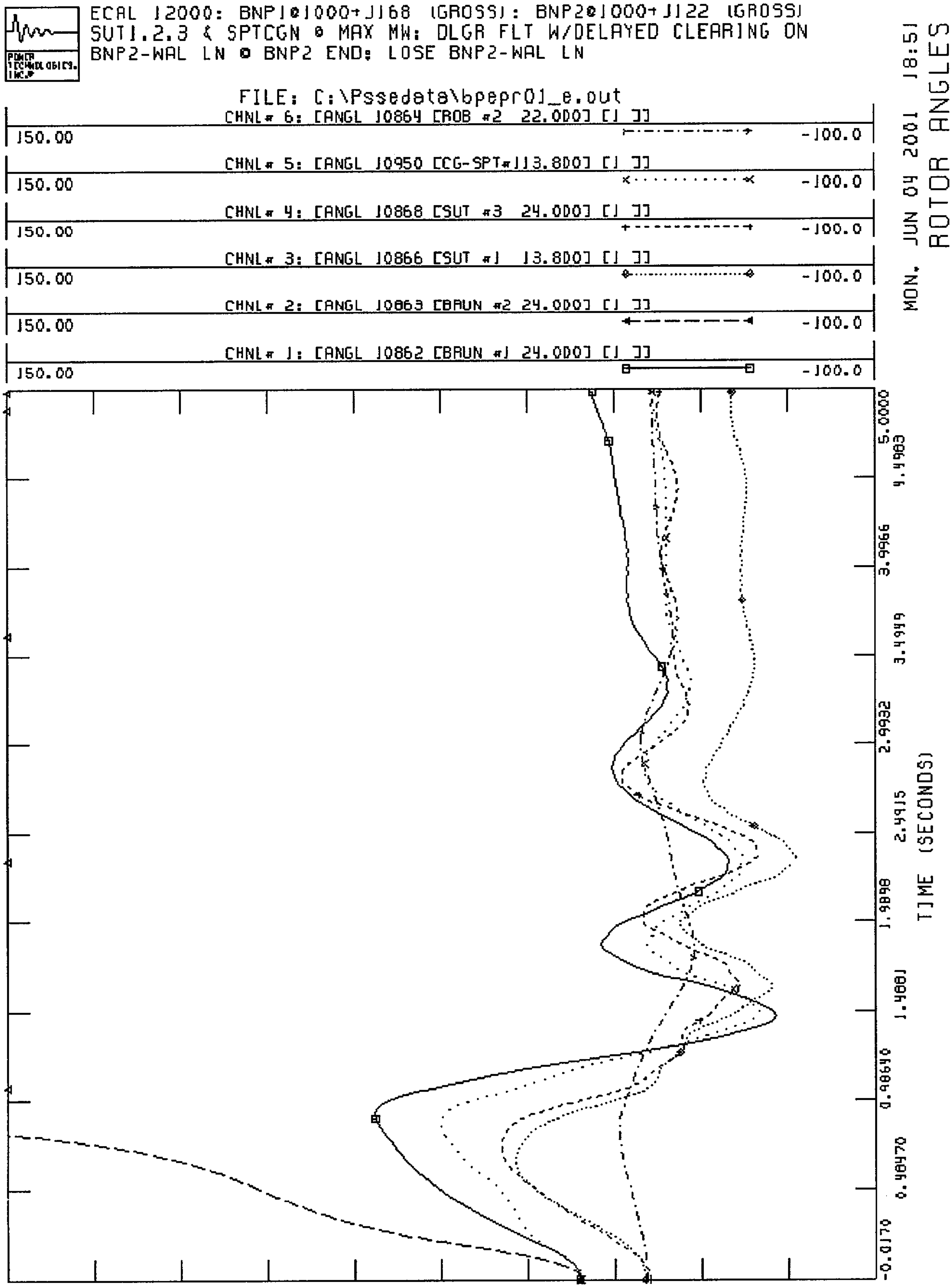
TIME (SECONDS)
MON, JUN 04 2001 18:39
ROTOR ANGLES


ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1,2,3 & SPTCGN @ MAX MW: DLGR FLT W/DELAYED CLEARING ON
BNP2-WAL LN @ BNP2 END; LOSE BNP2-WAL LN
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CHNL# 3: [ANGL 10866 [SUT #1 13.800] []]]
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CHNL# 1: [ANGL 10862 [BRUN #1 24.000] []]]
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MON, JUN 04 2001 18:51
ROTOR ANGLES
TIME (SECONDS)
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1.4881
1.9898
2.4915
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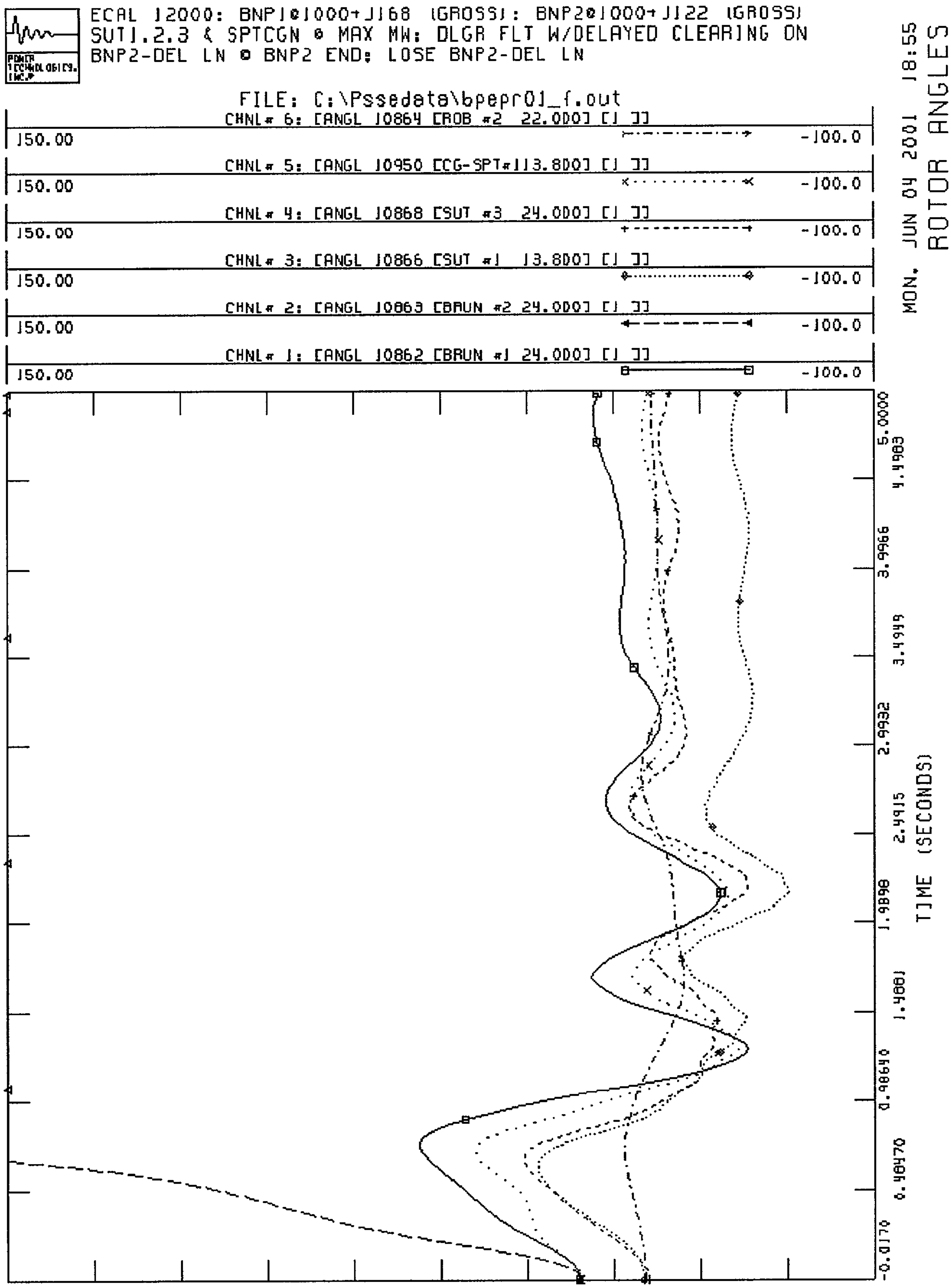
3.4949
3.9966
4.4983
5.0000


ECAL 12000: BNP1@1000+1168 (GROSS): BNP2@1000+1122 (GROSS)
SUT1,2,3 & SPTCGN @ MAX MW: DLGR FLT W/DELAYED CLEARING ON
BNP2-DEL LN @ BNP2 END; LOSE BNP2-DEL LN
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-100.0
CHNL# 4: [ANGL 10868 [SUT #3 24.000] []]]
150.00
-100.0
CHNL# 3: [ANGL 10866 [SUT #1 13.800] []]]
150.00
-100.0
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] []]]
150.00
-100.0
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] []]]
150.00
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-0.0170
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0.98640
1.4881
1.9898
2.4915
2.9932
3.4949
3.9966
4.4983
5.0000
TIME (SECONDS)
MON, JUN 04 2001 18:55
ROTOR ANGLES

ECAL 12000: BNP1@1000+1168 (GROSS): BNP2@1000+1122 (GROSS)
SUT1,2,3 & SPTCGN @ MAX MW: DLGR FLT W/DELAYED CLEARING ON
BNP2-WHTVL LN @ BNP2 END: LOSE BNP2-WHTVL LN

FILE: C:\Pssedata\bpepr01_g.out

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150.00	CHNL# 4: [ANGL 10868 [SUT #3 24.000] []]]	-100.0
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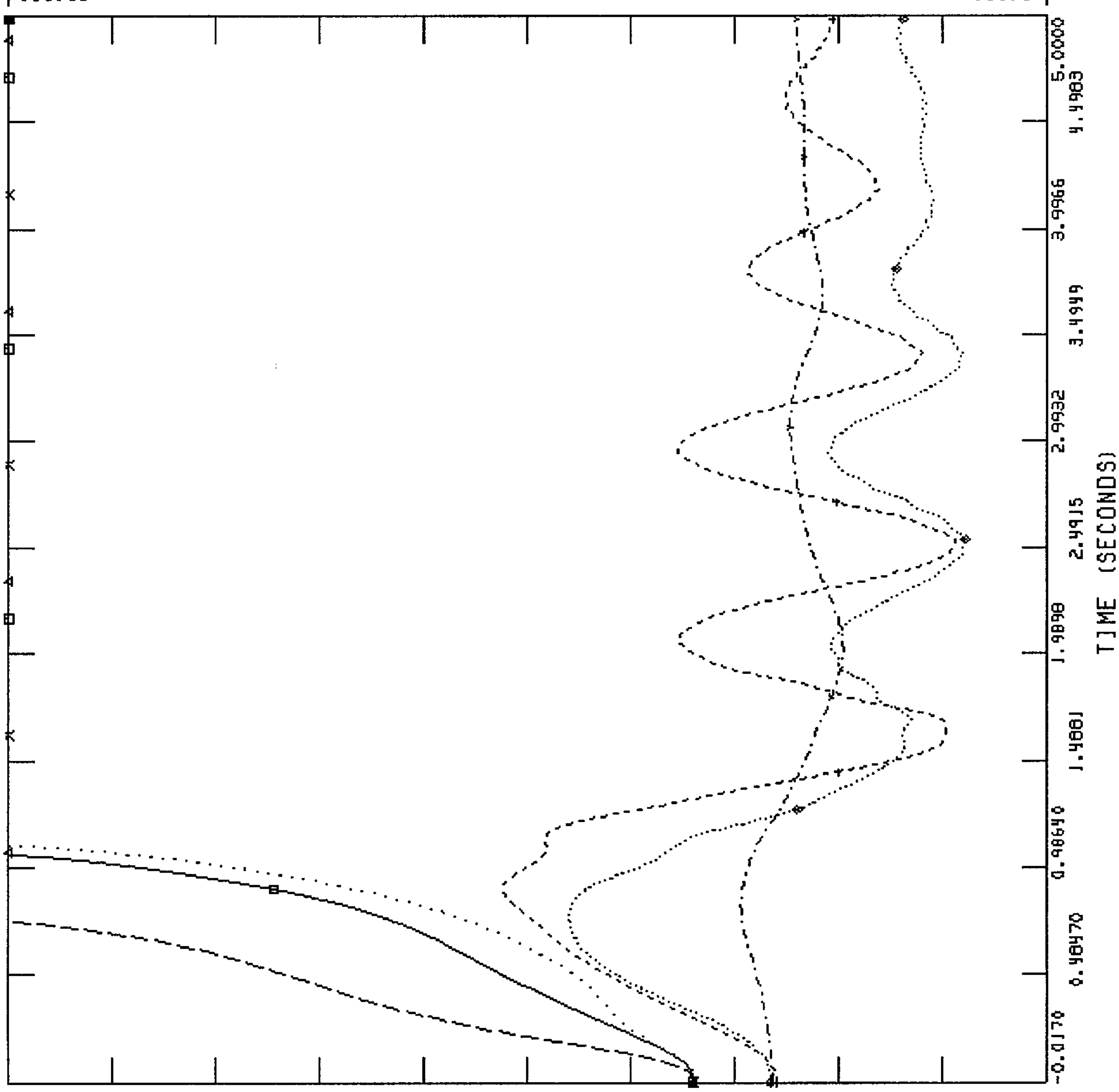
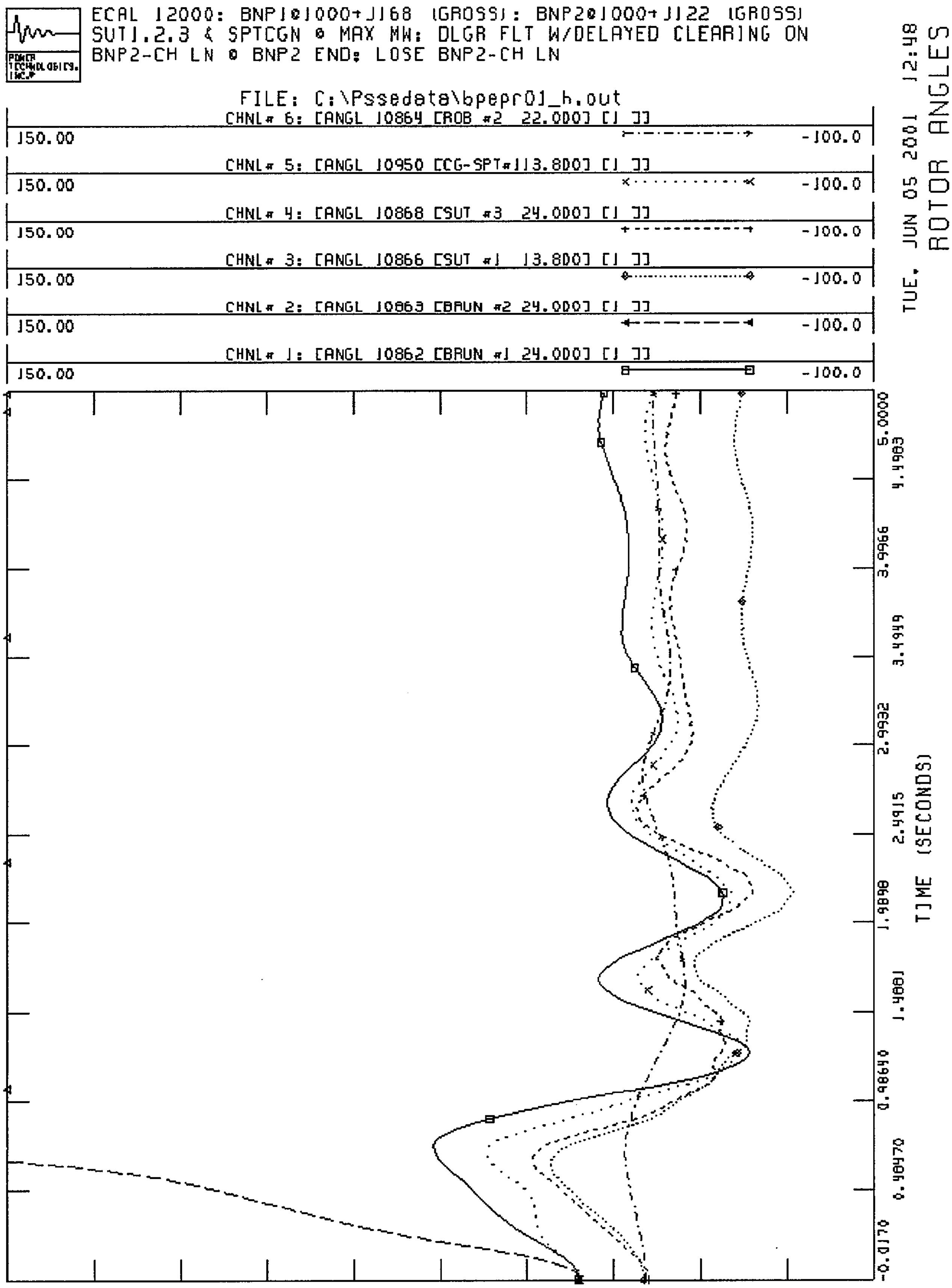


MON, JUN 04 2001 19:00
ROTOR ANGLES



ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1,2,3 & SPTCGN @ MAX MW: DLGR FLT W/DELAYED CLEARING ON
BNP2-CH LN @ BNP2 END; LOSE BNP2-CH LN
FILE: C:\Pssedata\bpepr01_h.out
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-100.0
CHNL# 5: [ANGL 10950 [CG-SPT#113.800] []]]
150.00
-100.0
CHNL# 4: [ANGL 10868 [SUT #3 24.000] []]]
150.00
-100.0
CHNL# 3: [ANGL 10866 [SUT #1 13.800] []]]
150.00
-100.0
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] []]]
150.00
-100.0
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] []]]
150.00
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TUE, JUN 05 2001 12:48
ROTOR ANGLES
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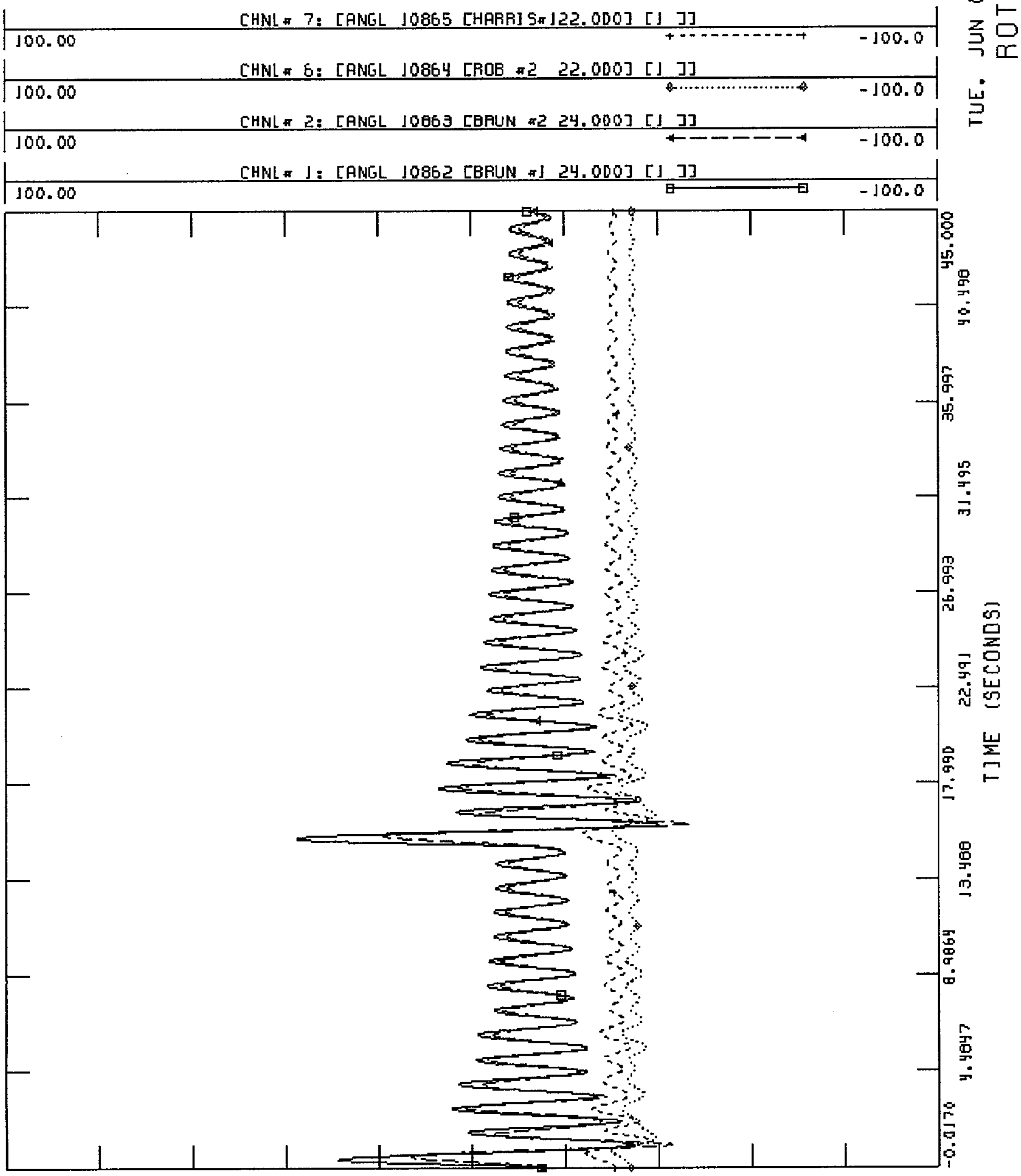
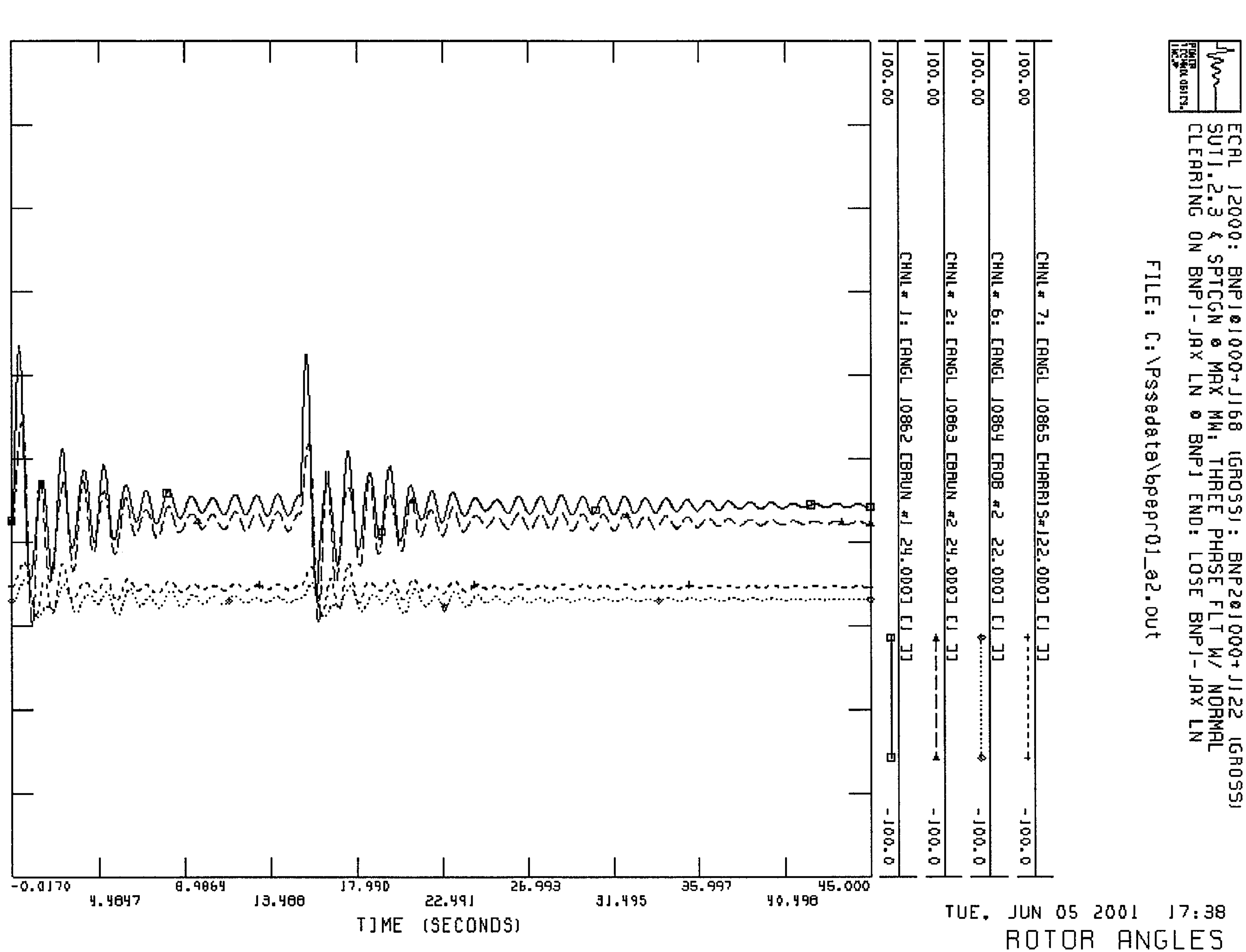
3.9966
3.4949
2.9932
2.4915
1.9898
1.4881
0.98640
0.48470
-0.0170
TIME (SECONDS)

Appendix
A2

ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1.2.3 & SPTCGN @ MAX MW: THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END: LOSE BNP1-WSP LN

FILE: C:\Pssedata\bpepr01_a1.out




ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1.2.3 & SPTCGN @ MAX MW: THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-JAX LN @ BNP1 END: LOSE BNP1-JAX LN
FILE: C:\Pssedata\bpepr01_a2.out
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CHNL# 6: [ANGL 10864 [ROB #2 22.000] []]
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] []]
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] []]
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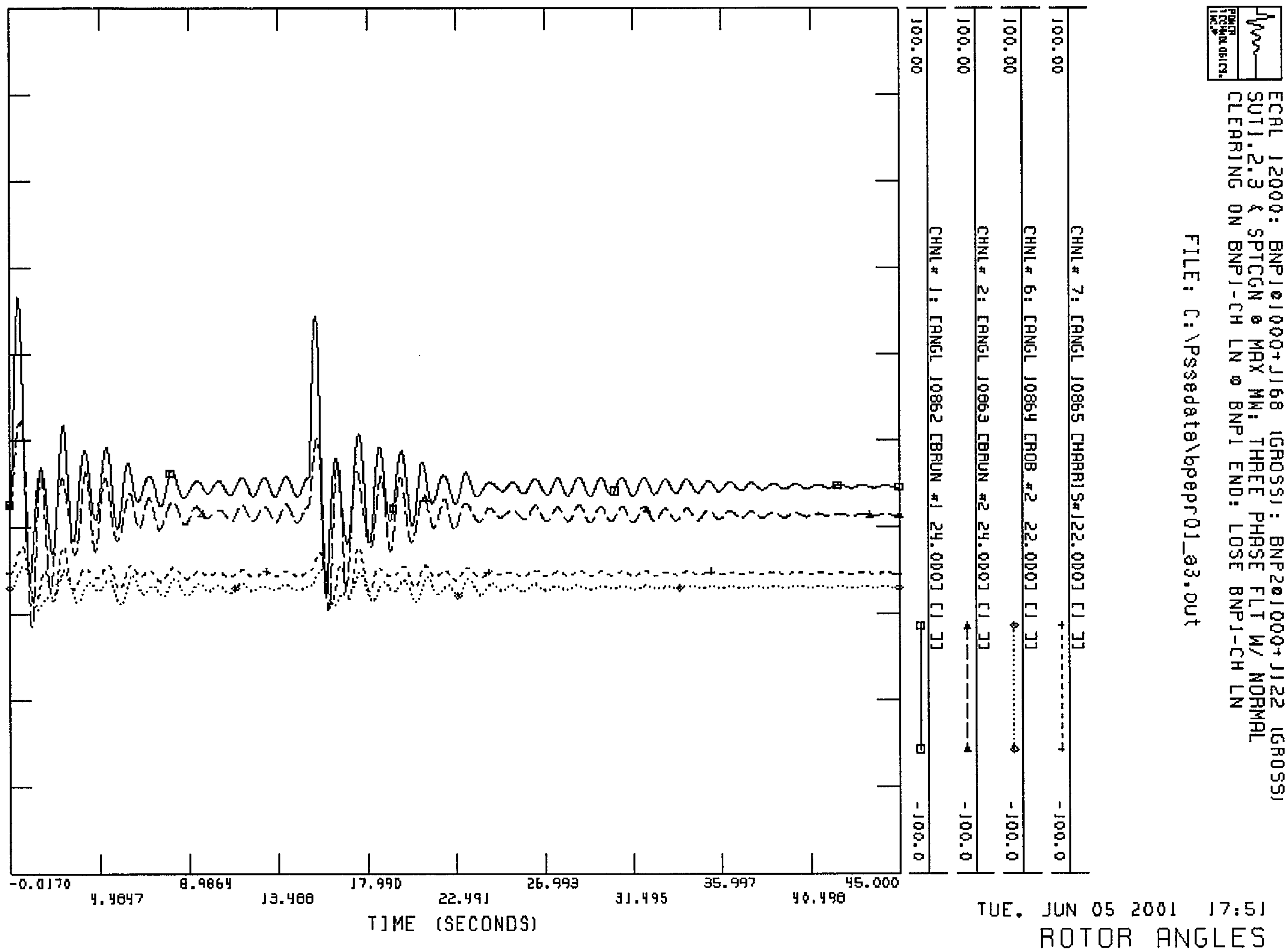
-0.0170
4.4847
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
TUE, JUN 05 2001 17:38
ROTOR ANGLES


ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1.2.3 & SPTCGN @ MAX MW: THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-CH LN @ BNP1 END: LOSE BNP1-CH LN
FILE: C:\Pssedata\bpepr01_a3.out
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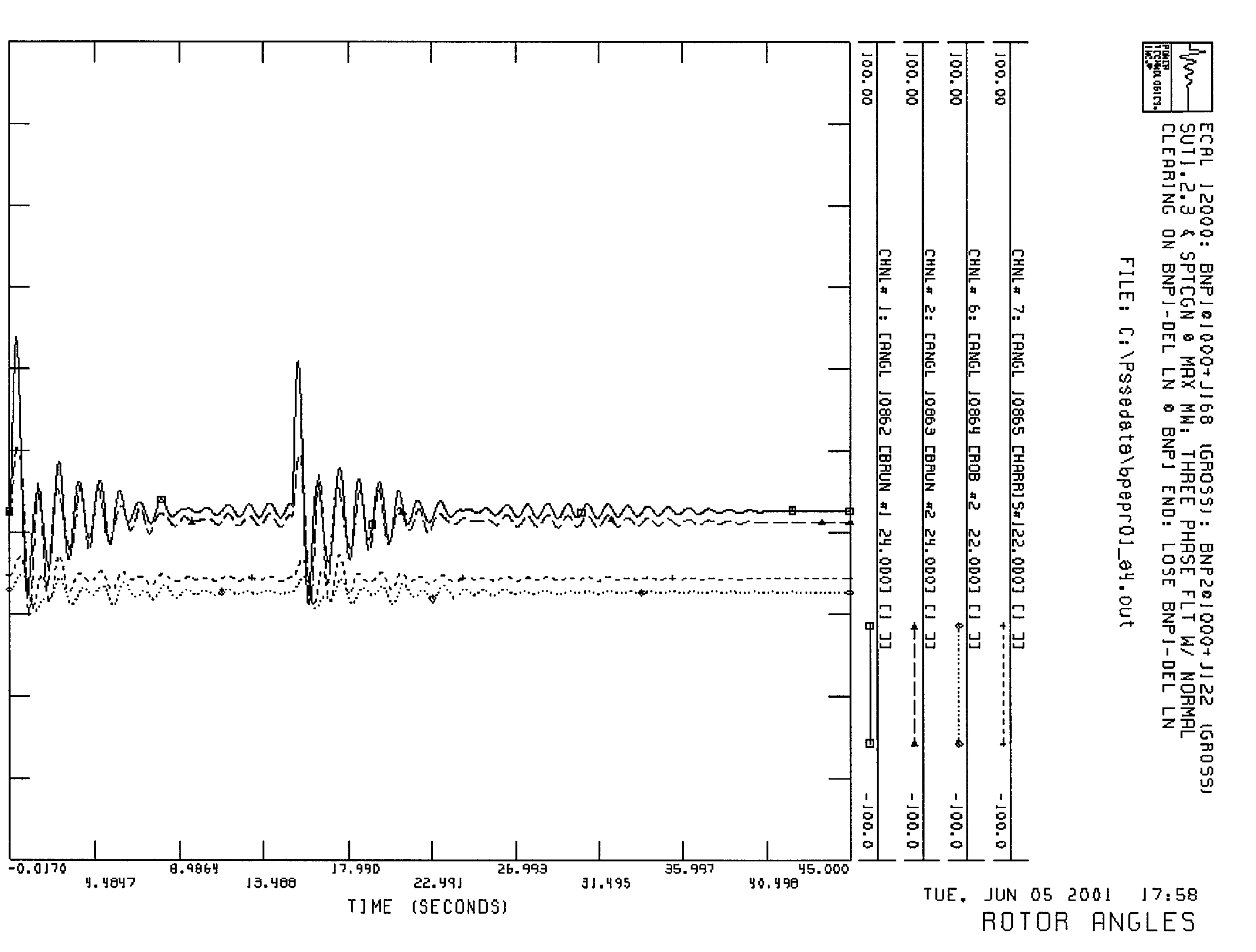
CHNL# 6: [ANGL 10864 [ROB #2 22.000] [1 1]]
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] [1 1]]
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] [1 1]]
100.00
-100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
TUE, JUN 05 2001 17:51
ROTOR ANGLES


ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1.2.3 & SPTCGN @ MAX MW: THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-DEL LN @ BNP1 END: LOSE BNP1-DEL LN
FILE: C:\Pssedata\bpepr01_e4.out
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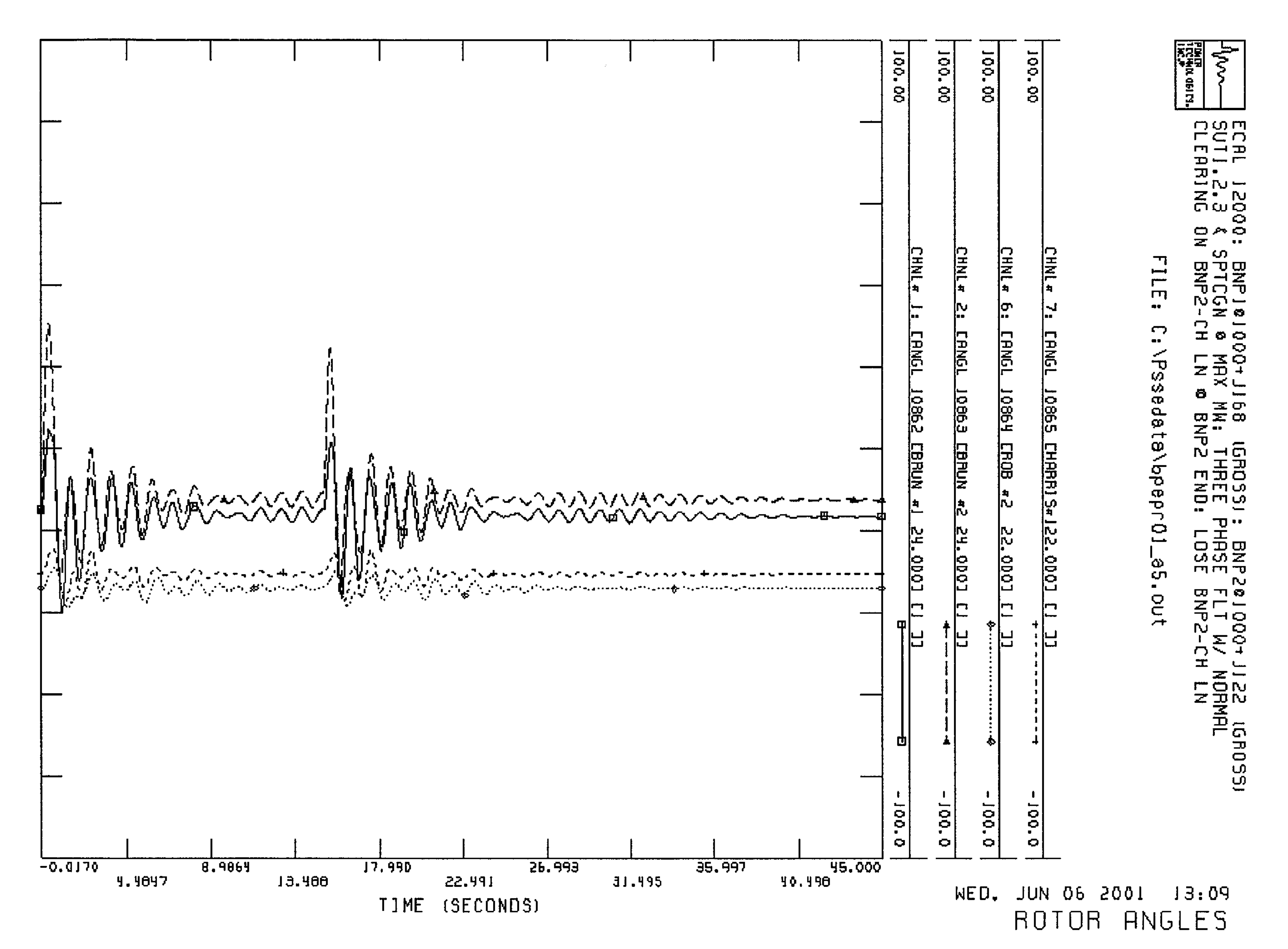
CHNL# 6: [ANGL 10864 [ROB #2 22.000] []]
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] []]
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] []]
100.00
-100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
TUE, JUN 05 2001 17:58
ROTOR ANGLES


ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1.2.3 & SPTCGN @ MAX MW: THREE PHASE FLT W/ NORMAL
CLEARING ON BNP2-CH LN @ BNP2 END: LOSE BNP2-CH LN
FILE: C:\Pssedata\bpepr01_a5.out
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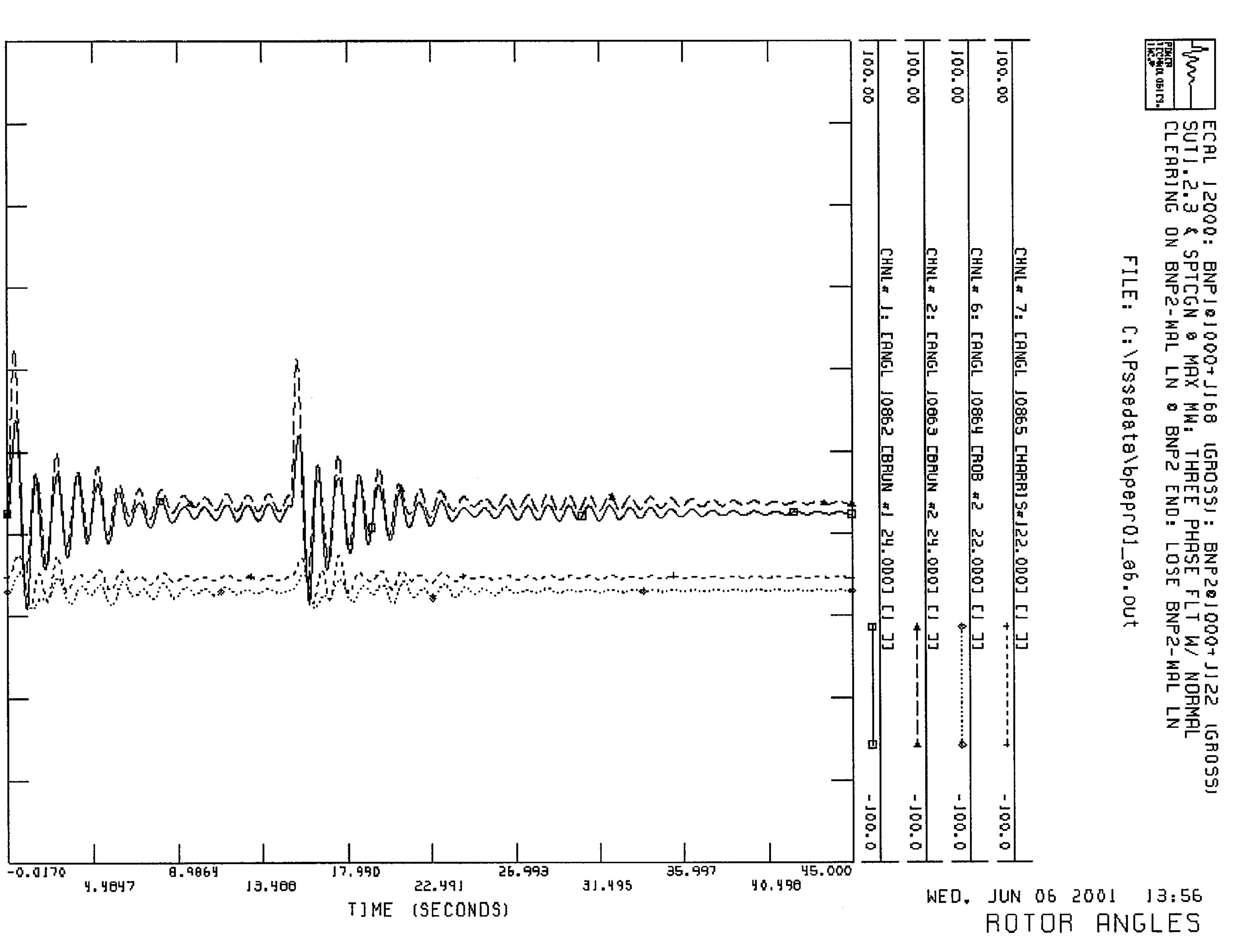
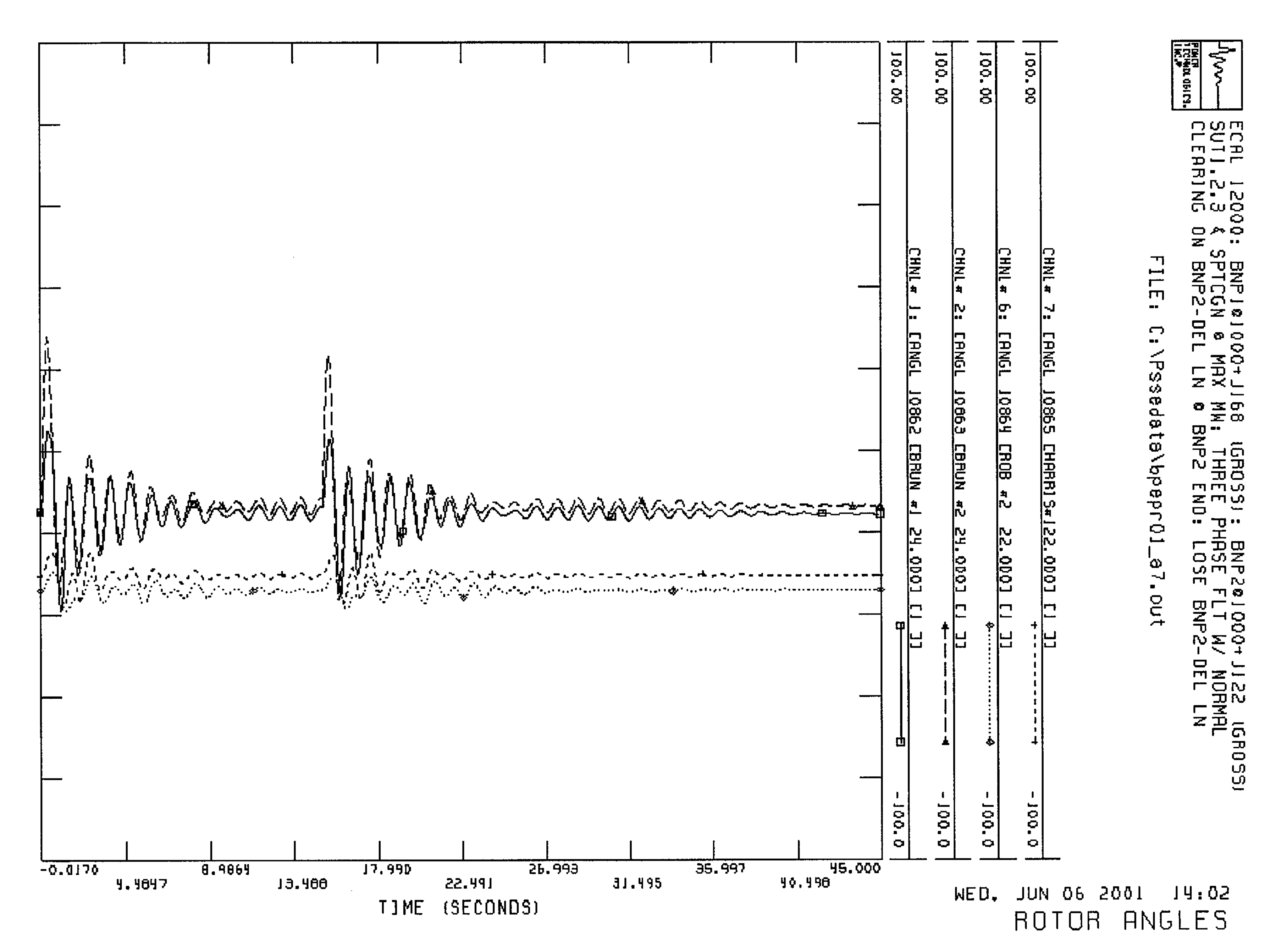
CHNL# 6: [ANGL 10864 CROB #2 22.000] []] 100.00 -100.0
CHNL# 2: [ANGL 10863 CBRUN #2 24.000] []] 100.00 -100.0
CHNL# 1: [ANGL 10862 CBRUN #1 24.000] []] 100.00 -100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
WED. JUN 06 2001 13:09
ROTOR ANGLES


ECAL I2000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1,2,3 & SPTCGN @ MAX MW: THREE PHASE FLT W/ NORMAL
CLEARING ON BNP2-WAL LN @ BNP2 END: LOSE BNP2-WAL LN
FILE: C:\Pssedata\bpepr01_a6.out
CHNL# 7: [ANGL J0865 [HARRIS#1 22.000] []]
CHNL# 6: [ANGL J0864 [ROB #2 22.000] []]
CHNL# 2: [ANGL J0863 [BRUN #2 24.000] []]
CHNL# 1: [ANGL J0862 [BRUN #1 24.000] []]
100.00
-100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
WED, JUN 06 2001 13:56
ROTOR ANGLES


ECAL 12000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1.2.3 & SPTCGN @ MAX MW; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP2-DEL LN @ BNP2 END: LOSE BNP2-DEL LN
FILE: C:\Pssedata\bpepr01_a7.out
CHNL# 7: [ANGL J0865 [HARRIS#1 22.000] []]
CHNL# 6: [ANGL J0864 [ROB #2 22.000] []]
CHNL# 2: [ANGL J0863 [BRUN #2 24.000] []]
CHNL# 1: [ANGL J0862 [BRUN #1 24.000] []]
100.00
-100.0
-0.0170
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8.9864
13.488
17.990
22.491
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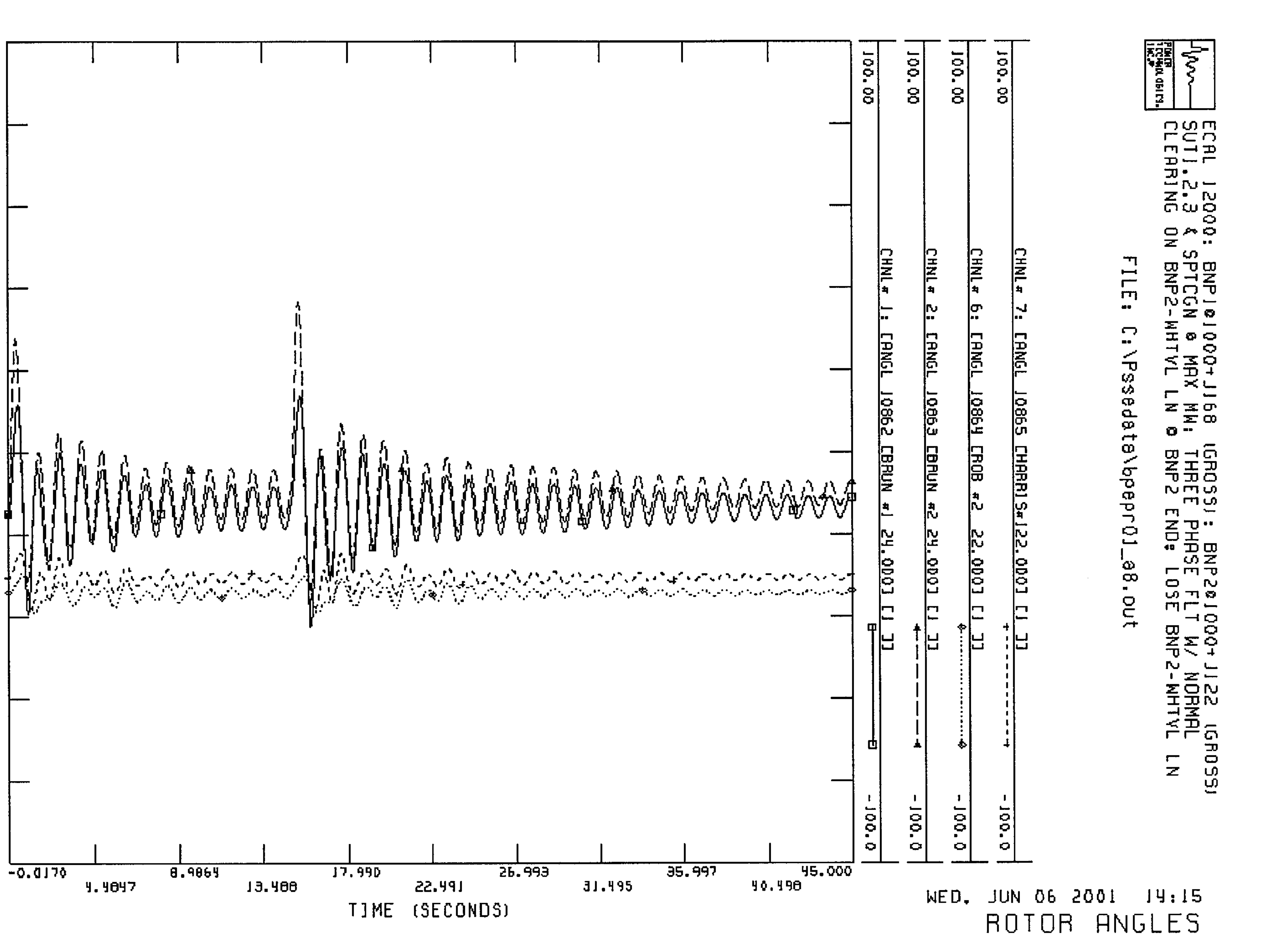
31.495
35.997
40.498
45.000
TIME (SECONDS)
WED, JUN 06 2001 14:02
ROTOR ANGLES



ECAL J2000: BNP1@1000+J168 (GROSS): BNP2@1000+J122 (GROSS)
SUT1.2.3 & SPTCGN @ MAX MW: THREE PHASE FLT W/ NORMAL
CLEARING ON BNP2-WHTVL LN @ BNP2 END: LOSE BNP2-WHTVL LN
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CHNL# 6: [ANGL J0864 CROB #2 22.000] [1 1]
CHNL# 2: [ANGL J0863 CBRUN #2 24.000] [1 1]
CHNL# 1: [ANGL J0862 CBRUN #1 24.000] [1 1]
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-100.0
-0.0170
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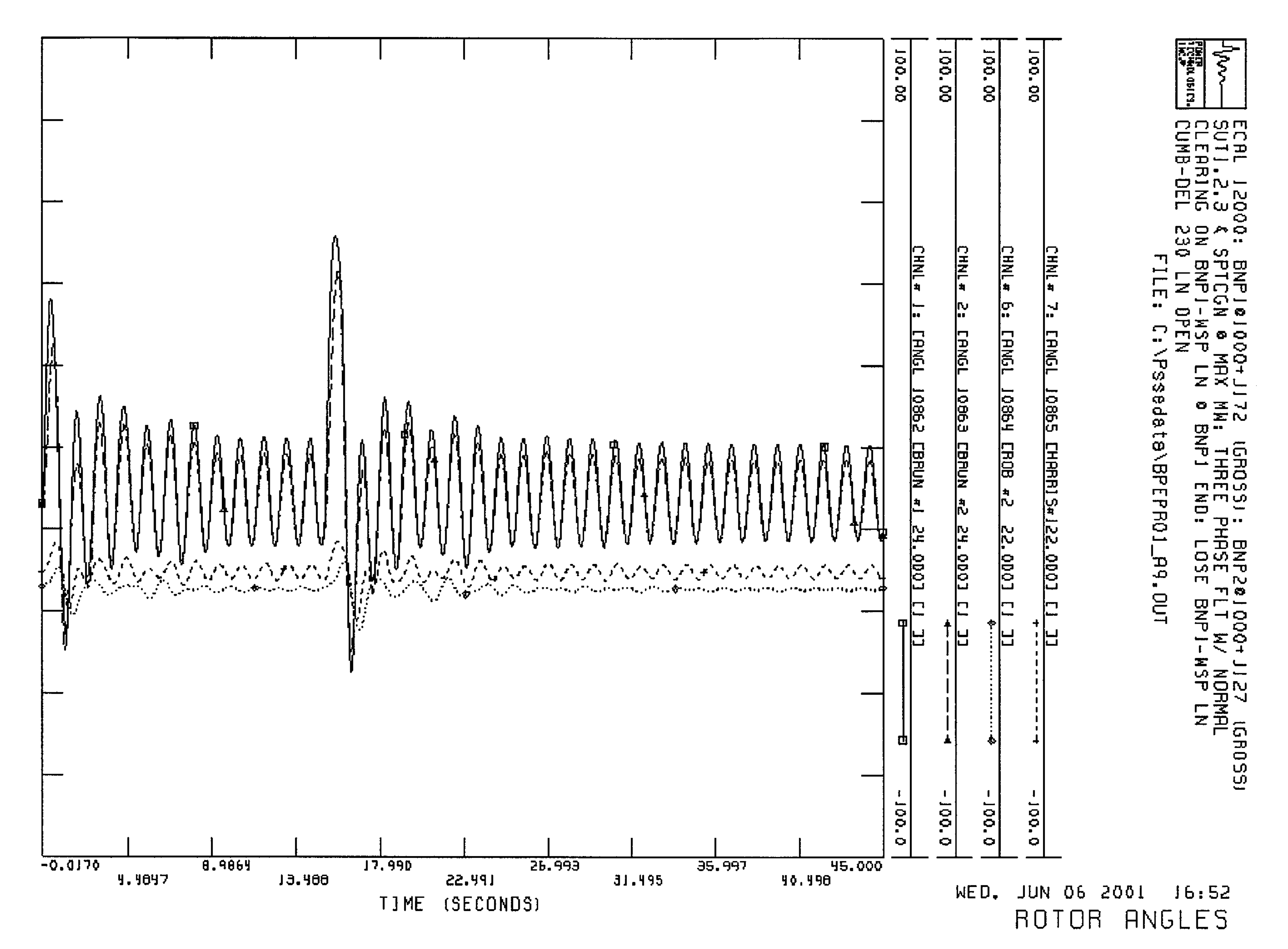
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
WED, JUN 06 2001 14:15
ROTOR ANGLES

Appendix
A3


ECAL J2000: BNP1@1000+J172 (GROSS): BNP2@1000+J127 (GROSS)
SUT1,2,3 & SPTCGN @ MAX MW; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END; LOSE BNP1-WSP LN
CUMB-DEL 230 LN OPEN
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CHNL# 6: [ANGL J0864 [ROB #2 22.000] []]
CHNL# 2: [ANGL J0863 [BRUN #2 24.000] []]
CHNL# 1: [ANGL J0862 [BRUN #1 24.000] []]
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-100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
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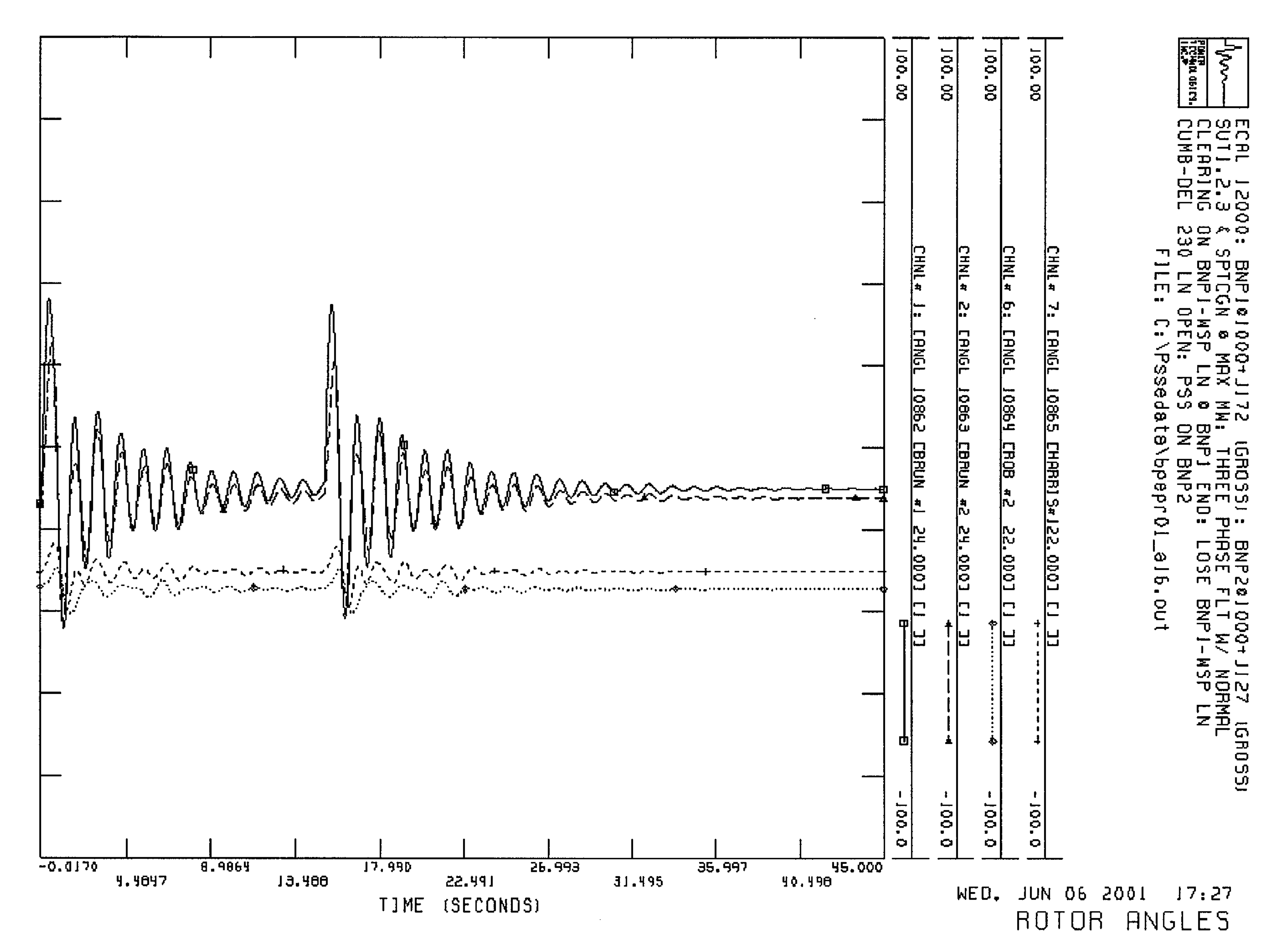
31.495
35.997
40.498
45.000
TIME (SECONDS)
WED, JUN 06 2001 16:52
ROTOR ANGLES


ECAL 12000: BNP1@1000+J172 (GROSS): BNP2@1000+J127 (GROSS)
SUT1.2.3 & SPTCGN @ MAX MW; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END; LOSE BNP1-WSP LN
CUMB-DEL 230 LN OPEN; PSS ON BNP2
FILE: C:\Pssedata\bpepr01_a16.out
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CHNL# 6: [ANGL 10864 [ROB #2 22.000] []]]
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] []]]
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] []]]
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-100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
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31.495
35.997
40.498
45.000
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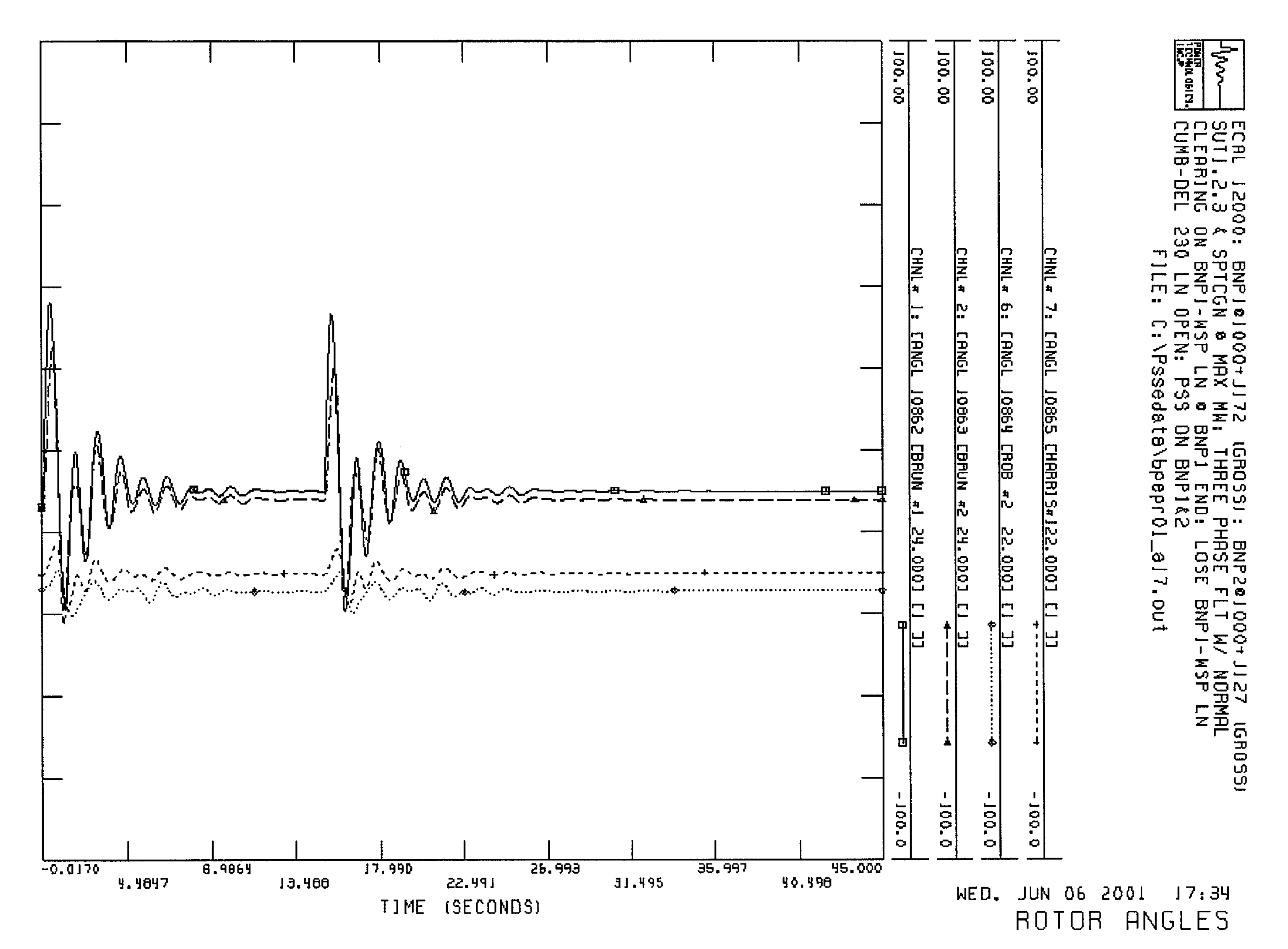
WED, JUN 06 2001 17:27
ROTOR ANGLES


ECAL 12000: BNP1@1000+J172 (GROSS): BNP2@1000+J127 (GROSS)
SUT1.2.3 & SPTCGN @ MAX MW; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END; LOSE BNP1-WSP LN
CUMB-DEL 230 LN OPEN; PSS ON BNP1&2
FILE: C:\Pssedata\bpepr01_a17.out
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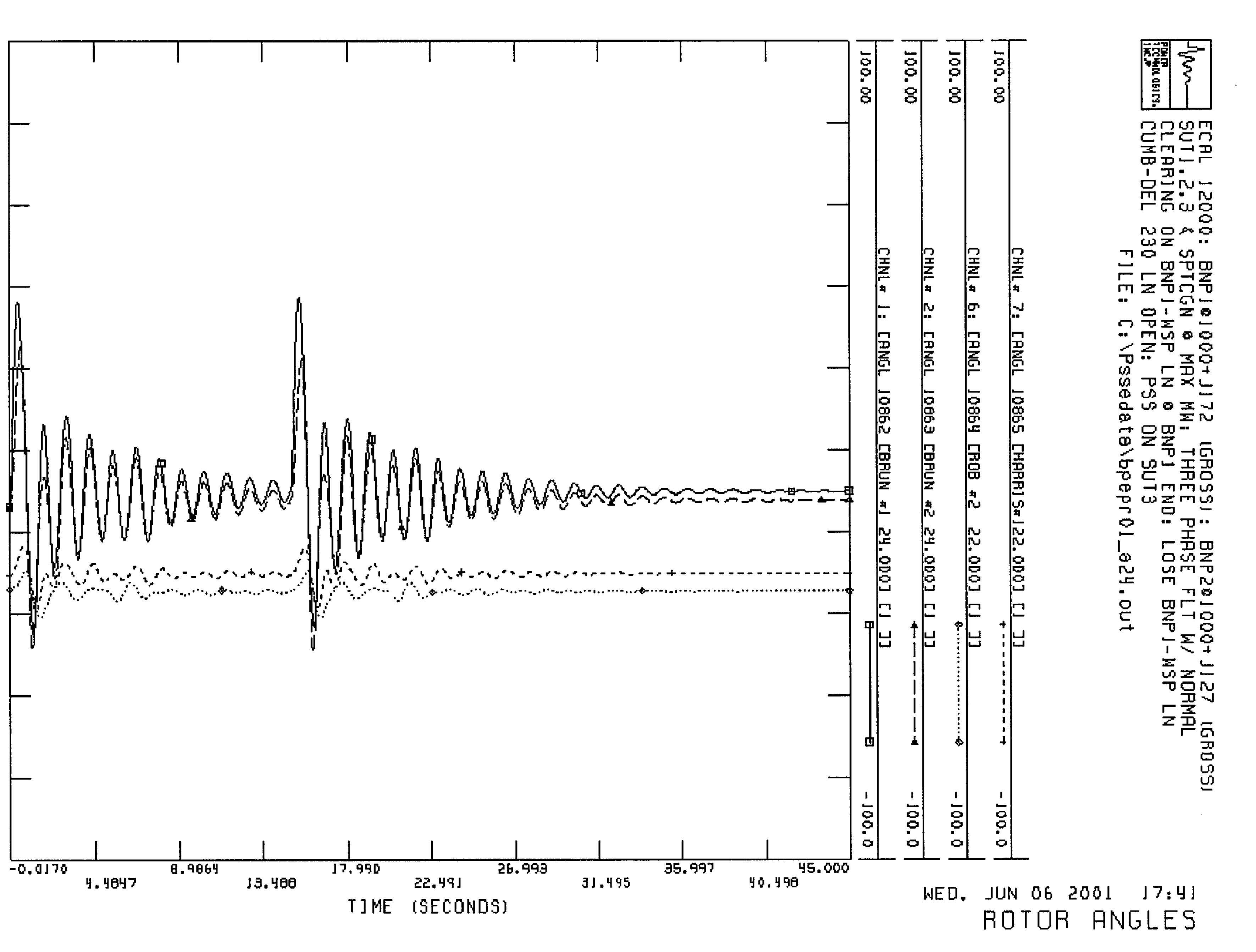
CHNL# 6: [ANGL 10864 [ROB #2 22.000] []]
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] []]
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] []]
100.00
-100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
WED, JUN 06 2001 17:34
ROTOR ANGLES


ECAL 12000: BNP1@1000+J172 (GROSS): BNP2@1000+J127 (GROSS)
SUT1,2,3 & SPTCGN @ MAX MW; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END: LOSE BNP1-WSP LN
CUMB-DEL 230 LN OPEN: PSS ON SUT3
FILE: C:\Pssedata\bpepr01_a24.out
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CHNL# 6: [ANGL 10864 [ROB #2 22.000] []]
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] []]
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] []]
100.00
-100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
26.993
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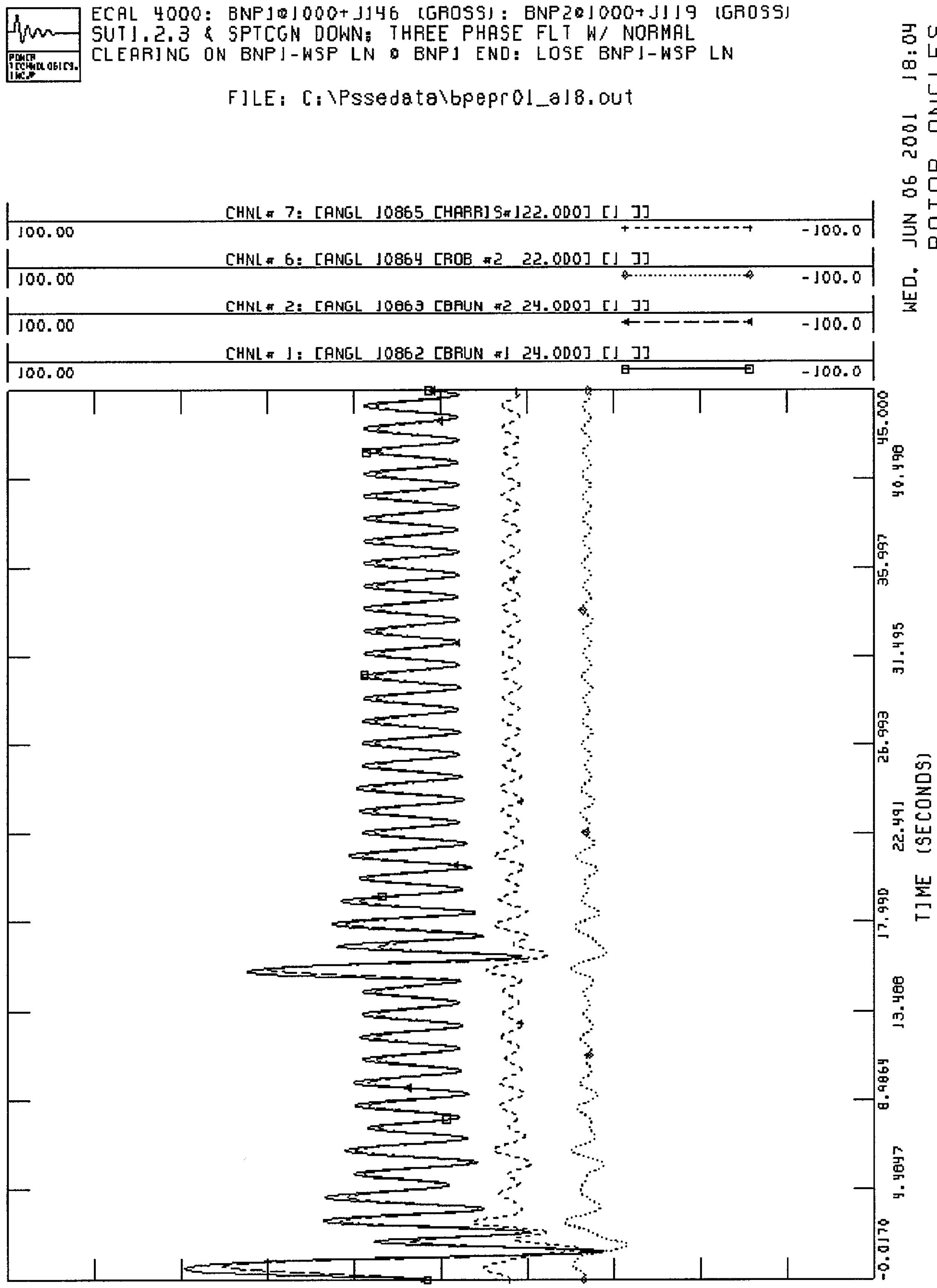
35.997
40.498
45.000
TIME (SECONDS)
WED, JUN 06 2001 17:41
ROTOR ANGLES

Appendix
A4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SUT1,2,3 & SPTCGN DOWN; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END: LOSE BNP1-WSP LN
FILE: C:\Pssedata\bpepr01_a18.out
WED, JUN 06 2001 18:04
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CHNL# 6: [ANGL 10864 [ROB #2 22.000] [1]]
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CHNL# 2: [ANGL 10863 [BRUN #2 24.000] [1]]
100.00
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CHNL# 1: [ANGL 10862 [BRUN #1 24.000] [1]]
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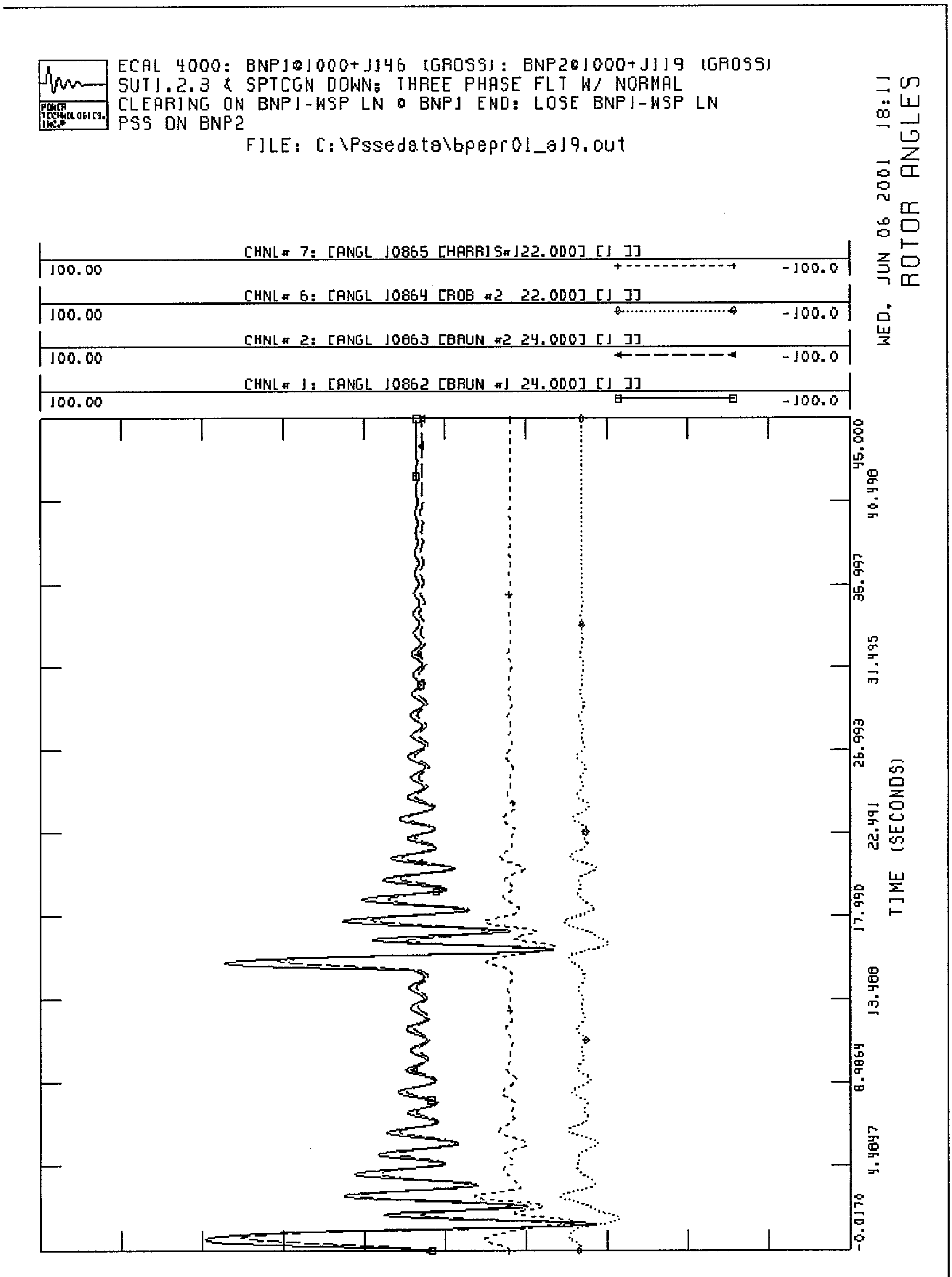
TIME (SECONDS)


ECAL 4000: BNP1@1000+J146 (GROSS): BNP2@1000+J119 (GROSS)
SUT1.2.3 & SPTCGN DOWN; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END: LOSE BNP1-WSP LN
PSS ON BNP2
FILE: C:\Pssedata\bpepr01_a19.out
POWER TECHNOLOGIES, INC.
WED, JUN 06 2001 18:11
ROTOR ANGLES
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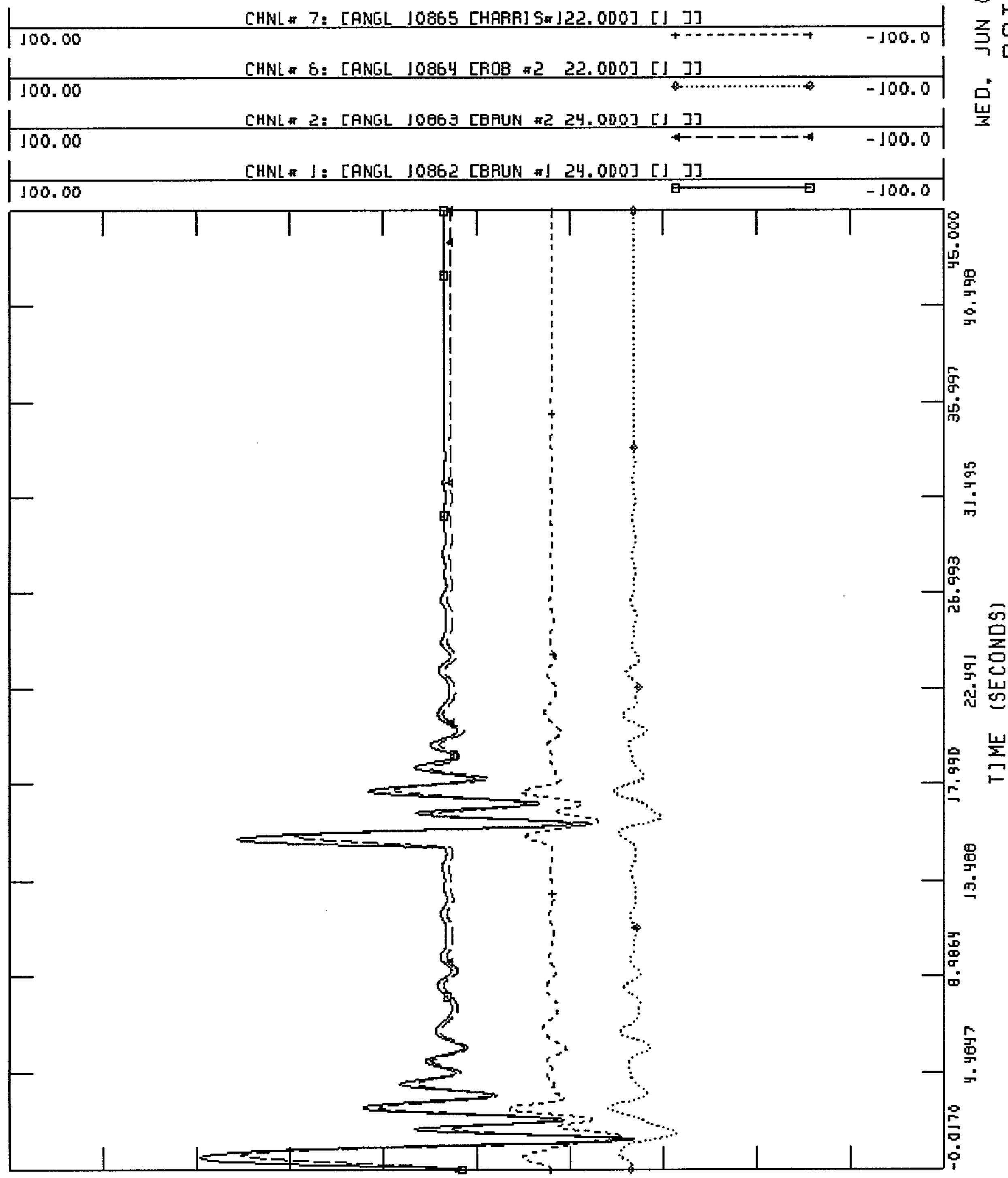
CHNL# 6: [ANGL 10864 [ROB #2 22.000] [1 1]]
100.00
-100.0
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] [1 1]]
100.00
-100.0
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] [1 1]]
100.00
-100.0
45.000
40.498
35.997
31.495
26.993
22.491
17.990
13.488
8.9864
4.4847
-0.0170
TIME (SECONDS)

ECAL 4000: BNP1@1000+J146 (GROSS): BNP2@1000+J119 (GROSS)
SUT1,2,3 & SPTCGN DOWN; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END: LOSE BNP1-WSP LN
PSS ON BNP1&2

FILE: C:\Pssedata\bpepr01_a20.out

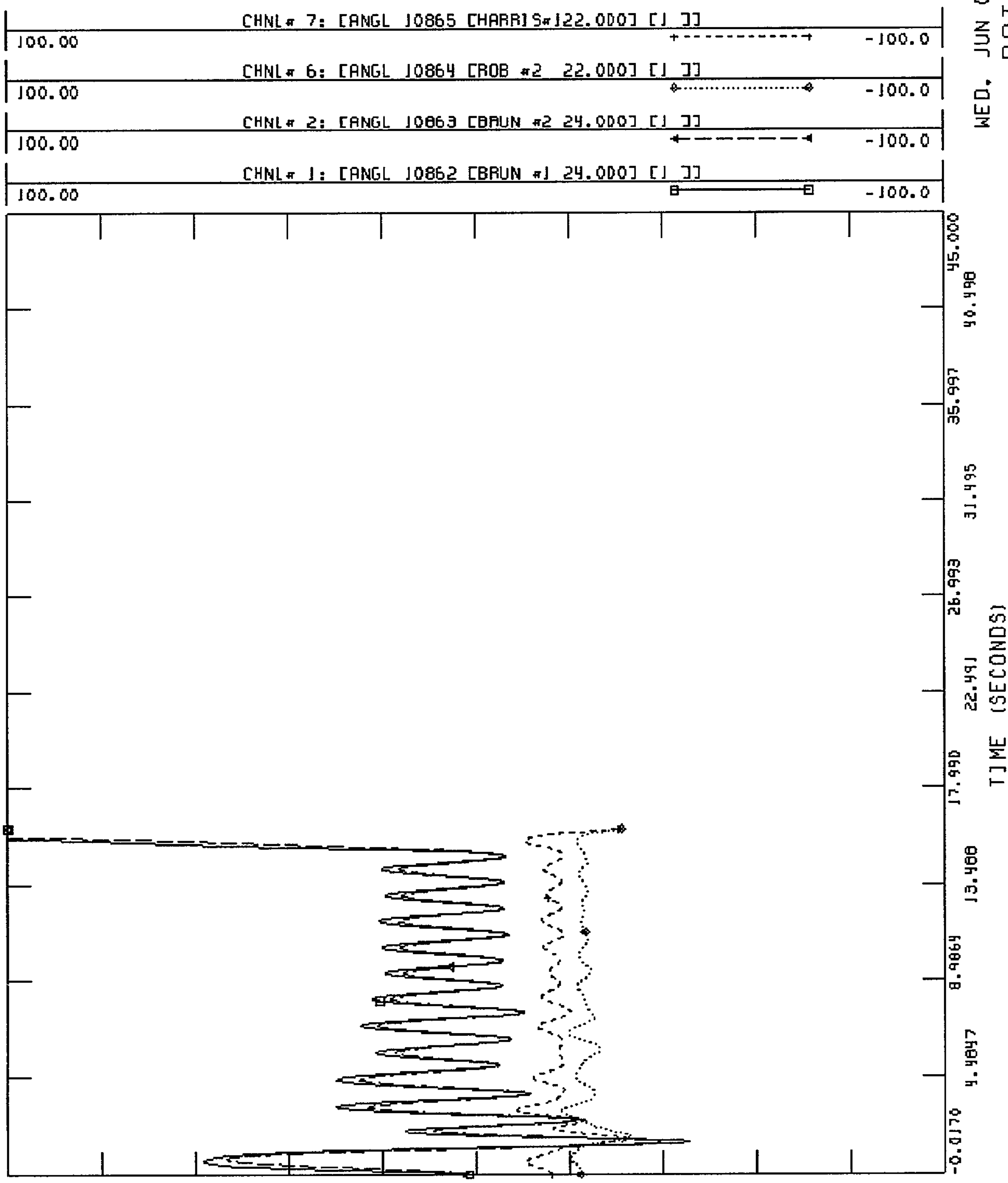
WED, JUN 06 2001 18:17
ROTOR ANGLES

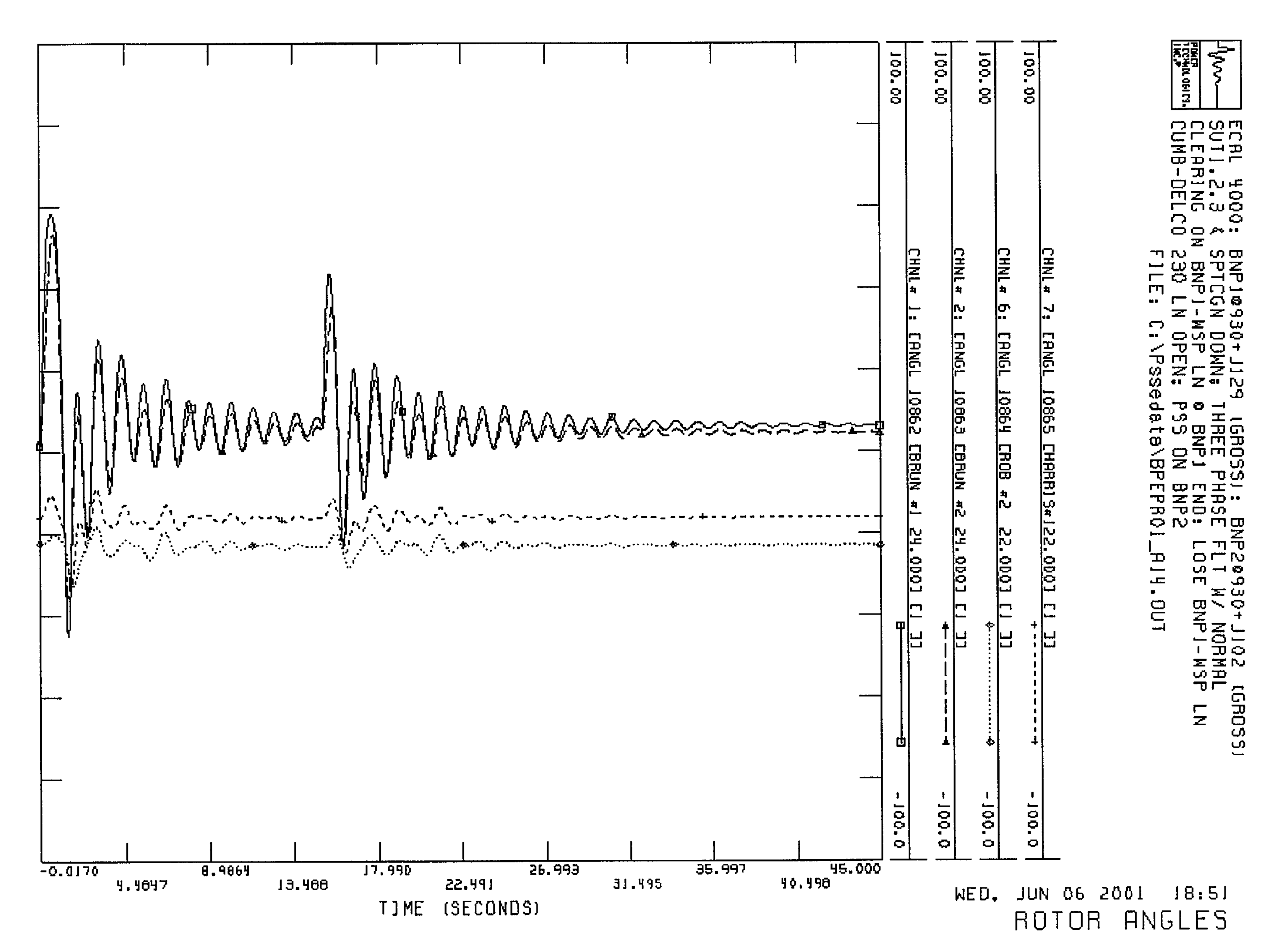


Appendix
A5

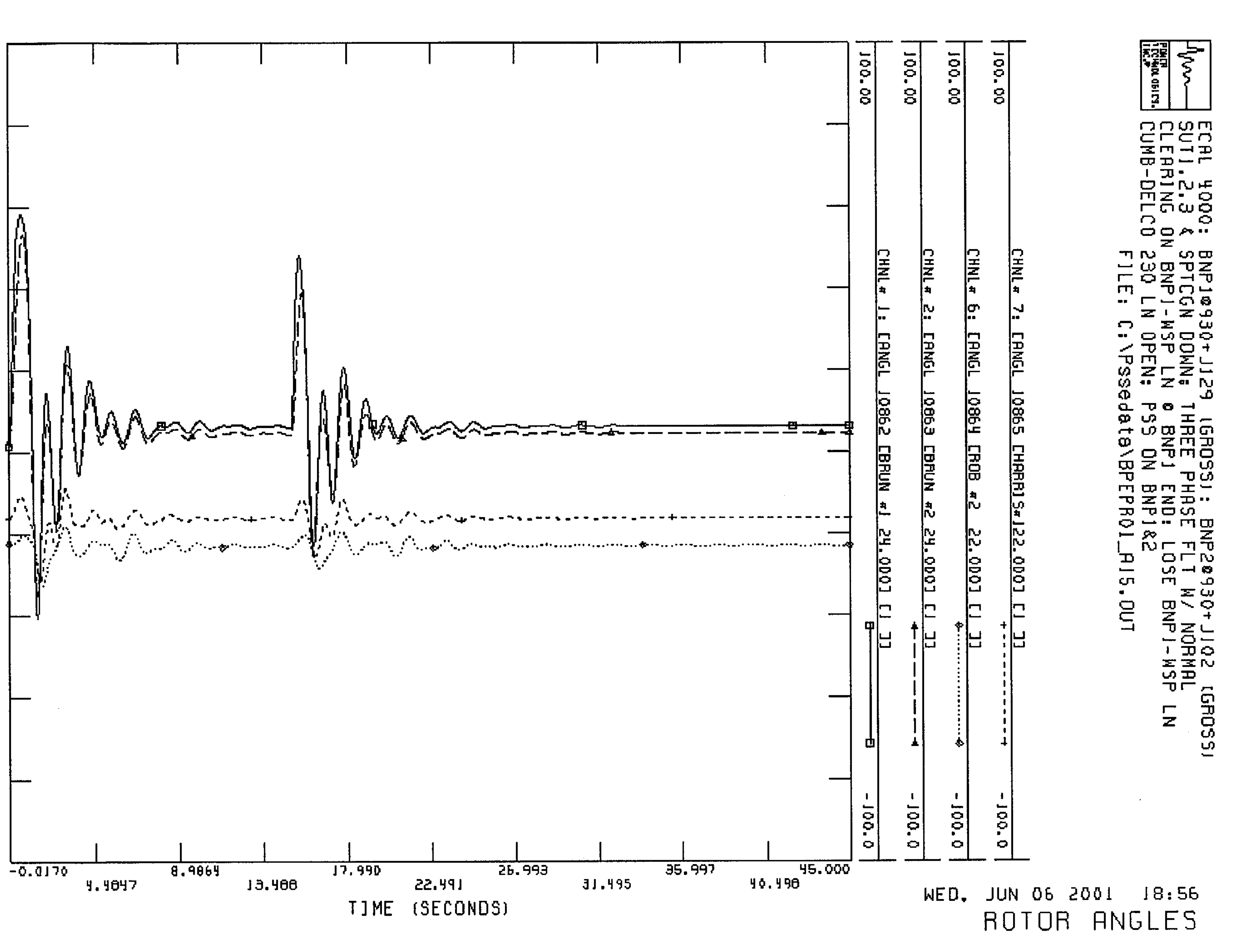
ECAL 4000: BNP1@930+J129 (GROSS): BNP2@930+J102 (GROSS)
SUT1,2,3 & SPTCGN DOWN; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END: LOSE BNP1-WSP LN
CUMB-DELCO 230 LN OPEN
FILE: C:\Pssedata\BPEPR01_A13.OUT

WED, JUN 06 2001 18:32
ROTOR ANGLES

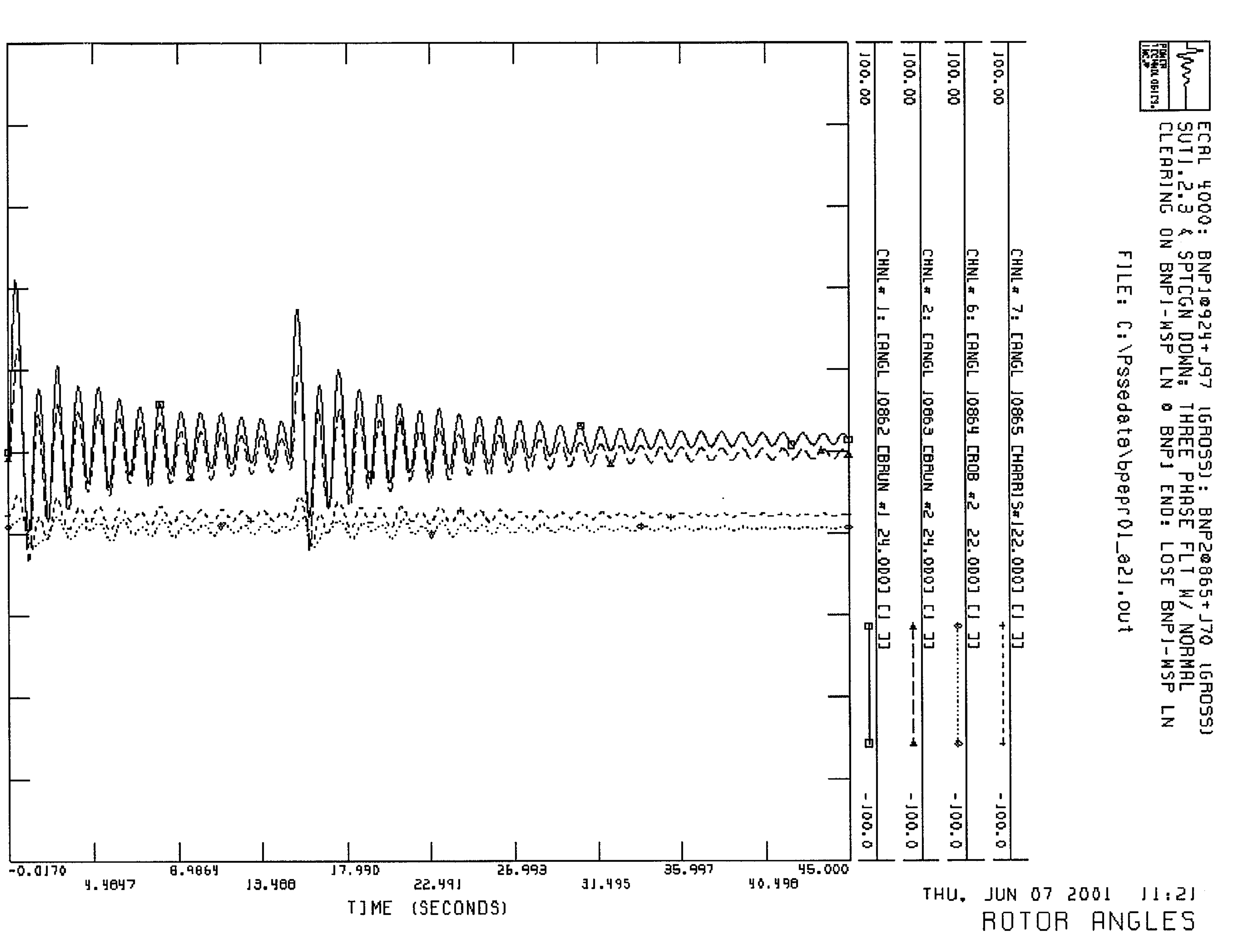




ECAL 4000: BNP1@930+J129 (GROSS): BNP2@930+J102 (GROSS)
SUT1.2.3 & SPTCGN DOWN; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END; LOSE BNP1-WSP LN
CUMB-DELCO 230 LN OPEN; PSS ON BNP2
FILE: C:\Pssedata\BPEPRO1_A14.OUT
CHNL# 7: [ANGL 10865 [HARRIS#1 22.000] [ ]]
CHNL# 6: [ANGL 10864 [ROB #2 22.000] [ ]]
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] [ ]]
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] [ ]]
100.00
-100.0
WED, JUN 06 2001 18:51
ROTOR ANGLES
-0.0170
4.4947
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)

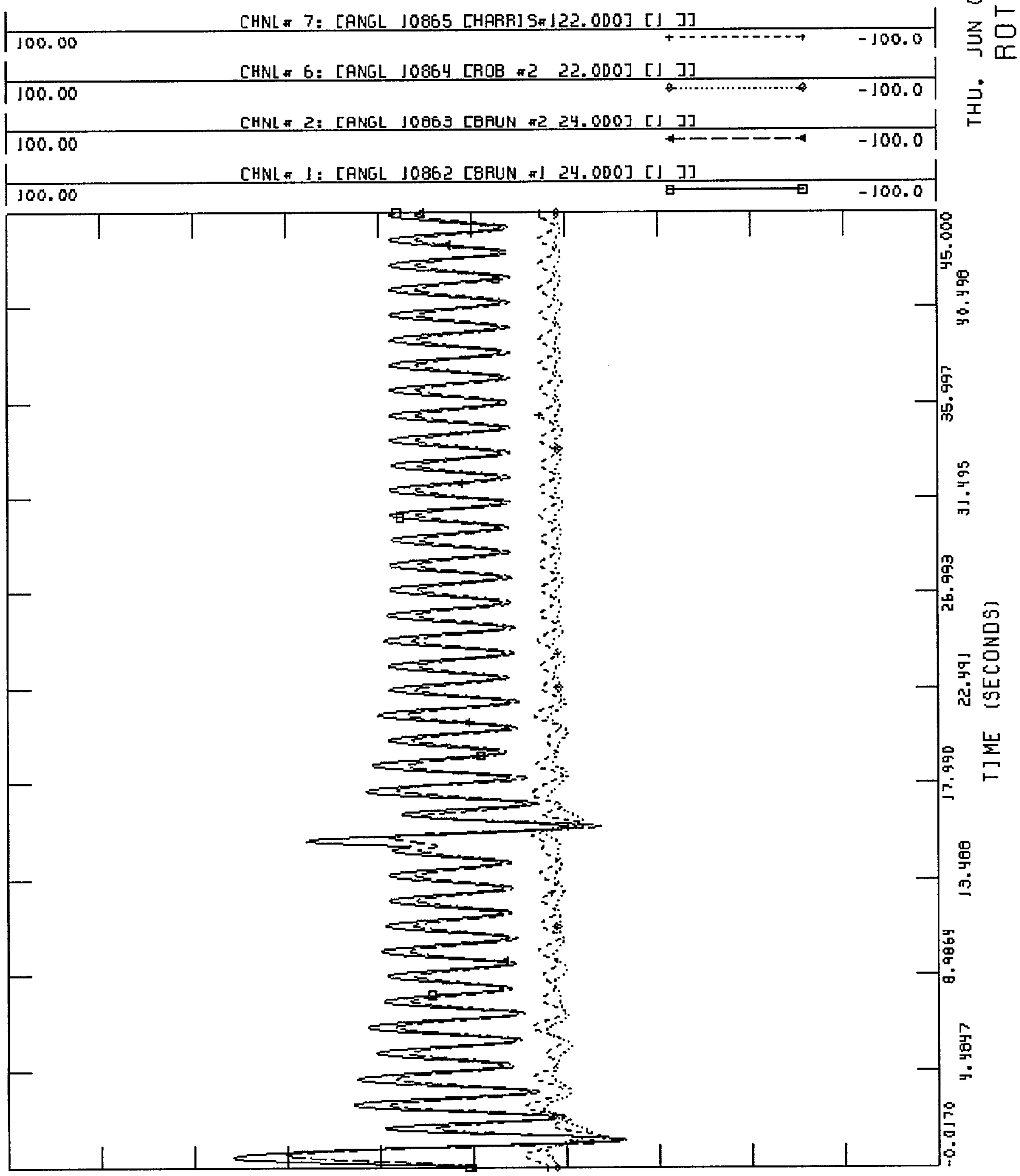

ECAL 4000: BNP1@930+J129 (GROSS): BNP2@930+J102 (GROSS)
SUT1,2,3 & SPTCGN DOWN; THREE PHASE FLT W/ NORMAL
CLEARING ON BNPJ-WSP LN @ BNPJ END; LOSE BNPJ-WSP LN
CUMB-DELCO 230 LN OPEN; PSS ON BNP1&2
FILE: C:\Pssedata\BPEPR01_AI5.OUT
CHNL# 7: [ANGL J0865 [HARRIS#1]22.000] [ ]
CHNL# 6: [ANGL J0864 [ROB #2 22.000] [ ]
CHNL# 2: [ANGL J0863 [BRUN #2 24.000] [ ]
CHNL# 1: [ANGL J0862 [BRUN #1 24.000] [ ]
100.00
-100.0
-0.0170
4.4047
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
WED, JUN 06 2001 18:56
ROTOR ANGLES

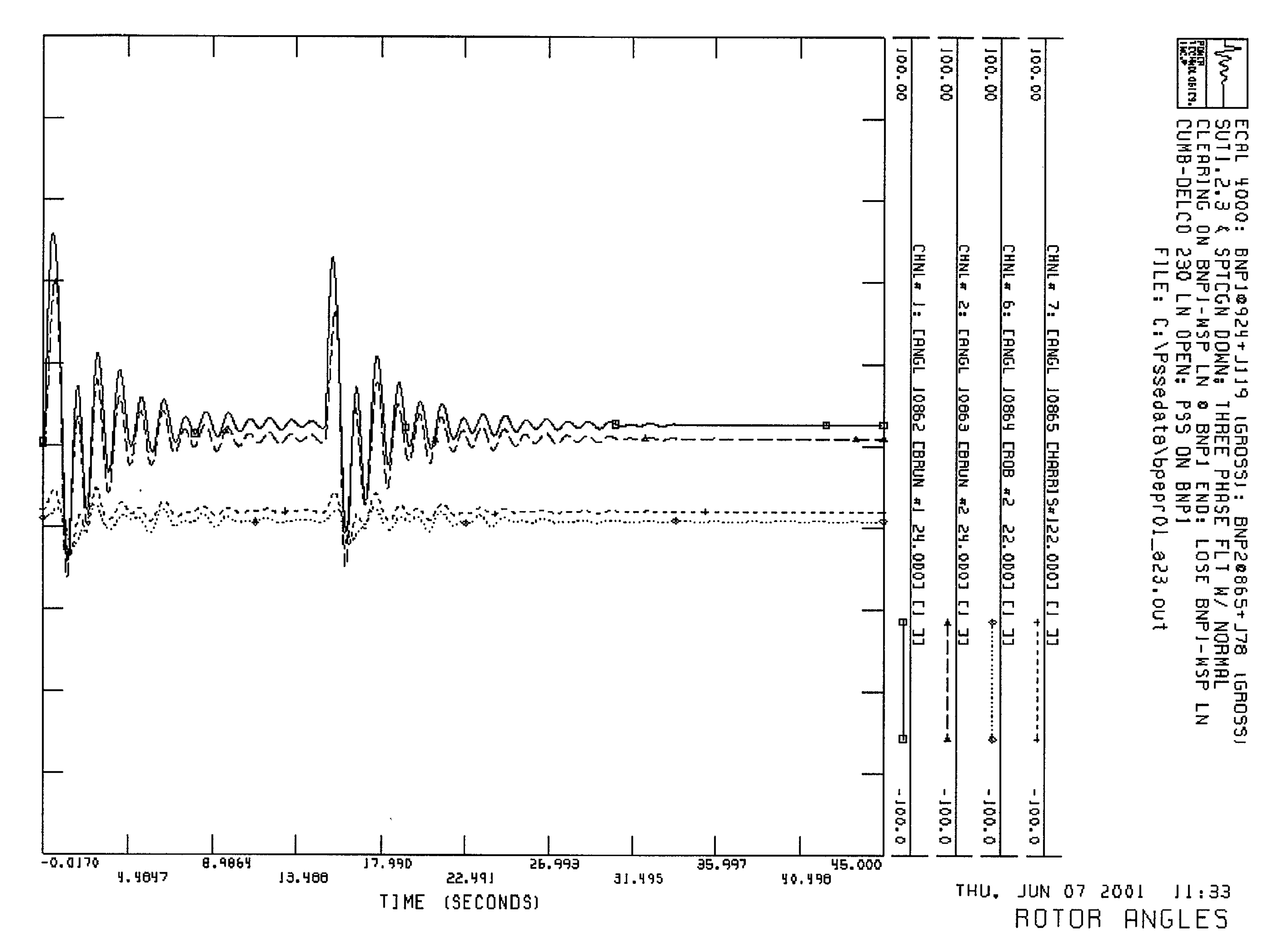
Appendix
A6


ECAL 4000: BNP1@924+J97 (GROSS): BNP2@865+J70 (GROSS)
SUT1.2.3 & SPTCGN DOWN: THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END: LOSE BNP1-WSP LN
FILE: C:\Pssedata\bpepr01_a21.out
CHNL# 7: [ANGL 10865 [HARRIS#1 22.000] []]
CHNL# 6: [ANGL 10864 [ROB #2 22.000] []]
CHNL# 2: [ANGL 10863 [BRUN #2 24.000] []]
CHNL# 1: [ANGL 10862 [BRUN #1 24.000] []]
100.00
-100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
THU, JUN 07 2001 11:21
ROTOR ANGLES

ECAL 4000: BNP1@924+J119 (GROSS): BNP2@865+J78 (GROSS)
SUT1,2,3 & SPTCGN DOWN; THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END: LOSE BNP1-WSP LN
CUMB-DELCO 230 LN OPEN
FILE: C:\Pssedata\bpepr01_a22.out

THU, JUN 07 2001 11:27
ROTOR ANGLES




ECAL 4000: BNP1@924+J119 (GROSS): BNP2@865+J78 (GROSS)
SUT1.2.3 & SPTCGN DOWN: THREE PHASE FLT W/ NORMAL
CLEARING ON BNP1-WSP LN @ BNP1 END: LOSE BNP1-WSP LN
CUMB-DELCO 230 LN OPEN: PSS ON BNP1
FILE: C:\Pssedata\bpepr01_a23.out
CHNL# 7: [ANGL 10865 CHARRIS#1 22.000] [ ]]
CHNL# 6: [ANGL 10864 CROB #2 22.000] [ ]]
CHNL# 2: [ANGL 10863 CBRUN #2 24.000] [ ]]
CHNL# 1: [ANGL 10862 CBRUN #1 24.000] [ ]]
100.00
-100.0
-0.0170
4.4847
8.9864
13.488
17.990
22.491
26.993
31.495
35.997
40.498
45.000
TIME (SECONDS)
THU, JUN 07 2001 11:33
ROTOR ANGLES