SPP Southwest Power Pool

Expedited System Impact Study Addendum for Generation Interconnection Request

GEN-2004-008

SPP Tariff Studies

(#GEN-2004-008-4)

August 2004
Updated September 2005

Executive Summary

<OMITTED TEXT>Customer has requested an Expedited System Impact Study to evaluate a proposal to add up to 900MW of generation in northern Platte County, MO. The requested in-service date is June 1, 2009.

The Customer has proposed the addition of 900MW of coal-fired generation at the site. The unit will be interconnected to the existing Kansas City Power and Light (KCPL) Iatan 345kV substation.

This study addendum addresses network upgrade changes proposed by KCPL in order to interconnect the customer.

The network upgrade requirements include expansion of the Iatan 345kV bus and installation of six (6) new 345kV circuit breakers. This expansion would provide terminals for the unit and for a new 345/161kV 550MVA autotransformer to be located at the Iatan substation. The existing Stranger Creek-Platte City 161kV transmission line would be split, thus allowing two 161kV terminals to be brought into the new Iatan 161kV switchyard. There would also be various terminal equipment replacements on the 345kV and 161kV transmission systems to achieve ratings increases.

The total estimated cost of the required network upgrades for interconnection is $17,295,000.

The Iatan-Nashua 345kV transmission line required by the original Expedited System Impact Study is no longer required.

Short circuit analysis will be performed as part of the Facility Study performed by the Transmission Owner if the customer wishes to proceed.

Transient stability analysis indicates that for more probable disturbances with normal fault clearing times, system stability is maintained. With the occurrence of a less probable, extreme fault condition at the Iatan bus, in which fault clearing is delayed due to stuck breaker conditions, the Iatan and Customer units exhibit poor damping. For this contingency, the terminal voltage of both units oscillates uncontrollably possibly causing the units to trip off-line. Instability appears to be limited to relatively low magnitude, high frequency oscillations. Equipment at the Iatan substation is equipped with independent pole tripping to reduce the likelihood of delayed clearing of the three-phase fault condition. New equipment for the interconnection facilities should include similar operational capability, and out-of-step relaying is recommended for equipment protection.

Transmission Service is not analyzed during the interconnection impact study. ***A separate study analyzing the impacts caused by addition of the generation and the associated transmission service that was previously performed will have to re-studied.***

1. Introduction

1.1 Project Description

<OMITTED TEXT>Customer has requested a System Impact Study to evaluate a proposal to add up to 900MW of generation in northern Platte County, MO. The requested generation addition is for a 900MW coal-fired unit at the customer's site adjacent to the existing KCPL Iatan 345kV substation. The requested in-service date is June 1, 2009. The purpose of this study addendum was to address the network upgrade changes proposed by KCPL to interconnect the customer. These changes included removing the once proposed Nashua-Iatan 345kV line and replacing it with a 345/161kV autotransformer and 161kV switchyard at Iatan.

1.2 Study Methodology

The Interconnection System Impact Study investigates the effect of new generation on system performance during normal and contingency conditions. Deliverability of power to final customers is not analyzed. Those facilities that are affected only by the interconnection of the generation are analyzed in the Interconnection System Impact Study. These costs do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies when the Customer requests transmission service through Southwest Power Pool's OASIS. Separate studies evaluate the impact of deliverability of the plants output.

Comparison of the base case, which excludes the proposed facilities, to the study case, which includes the proposed Customer unit, reveals any system constraints that result from the proposed generation addition. The analysis cases performed by KCPL were the 2010 and 2015 summer peaks to address the different seasonal loading conditions of the system. The proposed plant is modeled at maximum output of 900MW for all study cases.

2. Powerflow Analysis

2.1 2010 Summer Peak

Prior to the addition of the proposed network upgrades, several transmission facilities were overloaded in base case and contingency conditions. After addition of the proposed network upgrades, some overloading still occurs on the SPP transmission system as a result of outages of transmission facilities in the 2010 Summer Peak case.

Facility Name	SIS Rate B	Transfer Case Loading	Solution
IATAN-ST JOSEPH 345KV	956	105.3%	Terminal Upgrades at St Josesph
IATAN-PLATTE CITY 161KV	335	110.0%	Terminal Upgrades at Platte City
JAGGARD-PENTAGON 115Kv	92	112.9%	
IATAN 345/161KV AUTO	605	100.4%	

2.2 2010 Winter Peak

After addition of the proposed network upgrades, overloading still occurs on the SPP transmission system as a result of outages of transmission facilities in the 2010 Winter Peak case.

Facility Name	SIS Rate B	Transfer Case Loading	Solution
IATAN-ST JOSEPH 345KV	956	110.2%	Terminal Upgrades at St Josesph
166th-JAGGARD 115KV	97	108.4%	(Facility base overloaded in 10sp)
STRANGER-CRAIG 345KV	1195	101.1%	
IATAN-PLATTE CITY 161KV	335	120.2%	Terminal Upgrades

2.3 2015 Summer Peak

After addition of the proposed network upgrades, overloading still occurs on the SPP transmission system as a result of outages of transmission facilities in the 2015 Summer Peak case.

Facility Name	SIS Rate B	Case Loading Transfer	Solution
IATAN-ST JOSEPH 345KV	956	100.8%	Terminal Upgrades at St Josesph
IATAN-PLATTE CITY 161KV	335	108.4%	Terminal Upgrades at Platte City
JAGGARD-PENTAGON 115Kv	92	123.3%	
IATAN 345/161KV AUTO	605	107.3%	
JARBALO-STRANGER 115KV	240	102.0%	
STRANGER CREEK-IATAN 345KV	1195	100.5%	
MPS CLINTON-AECI CLINTON	100	106.7%	

3. Interconnection Network Upgrades

3.1 Interconnection Substation

The Customer plant will be interconnected with the 345kV transmission system at the Iatan substation in northern Platte County, MO. The existing 345kV bus will be expanded to accommodate the new generating unit and two (2) unit auxiliary transformers. Six (6) 345kV circuit breakers will be added to accommodate the new unit and a new 345/161kV 550MVA autotransformer that will tie into the existing Stranger Creek-Platte City 161kV line.

3.2 161kV Upgrades

A 161kV switchyard will be built at the Iatan substation. This switchyard will include two 161kV terminals to Stranger Creek and Platte City. The existing Stranger Creek-Platte City 161kV line will be split and the ends will be brought into the new switchyard.

Also included will be the addition of a 6 ohm line reactor on the Iatan-Platte City 161kV line.

The preliminary cost estimates for the network upgrade facilities are listed in Table 1 below. An estimated project schedule will be included in the Facility Study.

Table 1 – Summary of Network Upgrade Costs for Interconnection	
Stand Alone Network Upgrades	
Description	Cost
Iatan 345kV substation facilities and equipment to facilitate interconnection	$4,918,000
Total Stand Alone Network Upgrades	***$4,918,000***

Capacity Upgrades	
Description	Cost
Iatan 345/161kV 550 MVA Autotransformer	$2,200,000
Iatan 161kV substation ring bus	$2,000,000
161kV double circuit line construction from the Iatan 161kV ring bus to the existing Platte City-Stranger 161kV line	$7,127,000
Platte City 161kV reactor	$750,000
Platte City 161kV substation terminal upgrades	$300,000
Total Capacity Upgrades	***$12,377,000***
Total Upgrades	***$17,295,000***

These costs do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies when the Customer requests transmission service through Southwest Power Pool's OASIS. Other facilities may be required depending on the results of the Transmission Service study. The facilities listed above are required only for interconnection and capacity upgrades for the generation facility.

4. Short Circuit Analysis

A short circuit study will be conducted by KCPL as part of the Facility Study to determine if fault current levels exceed equipment ratings at KCPL facilities.

5. Transient Stability Analysis

Transient Stability analysis was performed to verify dynamic system response to disturbances on the system using the 2010 summer peak model and network upgrade changes proposed by KCPL. The customer provided the machine data for the proposed Customer plant. Typical values were provided for a 1000kVA generator with an ESST4B exciter. This data was used to create a PTI dynamics model for the Customer plant.

The machine data for the remaining system was obtained from the current SPP dynamics data files modified to include all previously queued plants proposed for the study period. Selected fault scenarios were applied with clearing times specified in accordance with KCPL Planning Criteria. Single phase and three phase fault conditions were tested at the interconnection point and machines in the KCPL, WERE, MIPU, NPPD, OPPD, and KACY control areas were monitored for stability. Analysis of stuck breaker events was included to examine the effects of extreme disturbances. A list of the faults applied is in Table 4 below.

Table 4 Selected Faults

Fault #	Fault Description
FLT_1_1PH	Single Phase fault at Stranger Creek on the Stranger Creek -- Iatan 345kV line
FLT_1_3PH	Three Phase fault at Stranger Creek on the Stranger Creek -- Iatan 345kV line
FLT_2_1PH	Single Phase fault at St. Joe on the St. Joe -- Iatan 345kV line
FLT_2_3PH	Three Phase fault at St. Joe on the St. Joe -- Iatan 345kV line
FLT_3_1PH	Single Phase fault at Stranger Creek on the Stranger Creek -- Craig 345kV line
FLT_3_3PH	Three Phase fault at Stranger Creek on the Stranger Creek -- Craig 345kV line
FLT_4_1PH	Single Phase fault at Stranger Creek on the Stranger Creek -- Hoyt 345kV line
FLT_4_3PH	Three Phase fault at Stranger Creek on the Stranger Creek -- Hoyt 345kV line
FLT_5_1PH	Single Phase fault at St. Joe on the St. Joe -- Cooper 345kV line
FLT_5_3PH	Three Phase fault at St. Joe on the St. Joe -- Cooper 345kV line
FLT_6_1PH	Single Phase fault at St. Joe on the St. Joe -- Fairport 345kV line
FLT_6_3PH	Three Phase fault at St. Joe on the St. Joe -- Fairport 345kV line
FLT_7_1PH	Single Phase fault at the Midpoint on the Cooper -- Fairport 345kV line
FLT_7_3PH	Three Phase fault at the Midpoint on the Cooper -- Fairport 345kV line
FLT_8_1PH	Single Phase fault at St. Joe on the St. Joe -- Hawthorn 345kV line
FLT_8_3PH	Three Phase fault at St. Joe on the St. Joe -- Hawthorn 345kV line
FLT_9	Trip Iatan Unit #1 (670MW)
FLT_10	Trip Customer Unit at Iatan (900MW)
FLT_11	Trip Jeffrey Energy Center Unit #2 (681MW)
FLT_12_1PH	Single Phase fault at Iatan on the St. Joe -- Iatan 345kV line
FLT_12_3PH	Three Phase fault at Iatan on the St. Joe -- Iatan 345kV line
FLT_12_1PH_stuck	Stuck breaker/delayed clearing -- Single Phase fault at Iatan on the St. Joe -- Iatan 345kV line
FLT_12_3PH_stuck	Stuck breaker/delayed clearing -- Three Phase fault at Iatan on the St. Joe -- Iatan 345kV line

The faults above were applied to the new proposed interconnection configuration. These include the Iatan unit, the Customer unit, the 345/161kV autotransformer, and 161kV switchyard at Iatan. The configuration does not include the Iatan-Nashua 345kV line.

The study indicates that normally cleared single-phase and three-phase fault events do not cause system instability. However, a less probable, extreme disturbance involving a stuck breaker with delayed clearing of a three-phase fault, the Iatan and Customer units become

unstable. The terminal voltage of the plants begins to oscillate uncontrollably. Out-of-synchronism relaying should trip the Iatan and Customer units offline and the remainder of the system should remain stable. Installation of a special protection system utilizing independent pole tripping at the Iatan substation reduces the likelihood of the three-phase delayed clearing condition and is recommended, in addition to out-of-step relaying for generator protection during the extreme disturbance events.

Plots of machine angles and selected 345kV system voltages for all scenarios analyzed are attached in the Appendices to this report.

6. Conclusion

This System Impact Study was requested by Customer to assess the interconnection requirements for the addition of 900MW of new generation in northern Platte County, MO. This addendum studies the impact of the new generation with the network upgrade changes proposed by KCPL.

The addition of 900MW generating capacity at the proposed site results in the overloading of transmission facilities during outages on the 345kV and 161kV system. The existing circuits from the Iatan substation are inadequate for the additional capacity of the plant. A 345/161kV autotransformer and adjacent 161kV switchyard at Iatan substation are required for the interconnection to allow the transfer of full output of the plant from the Iatan site under contingency conditions.

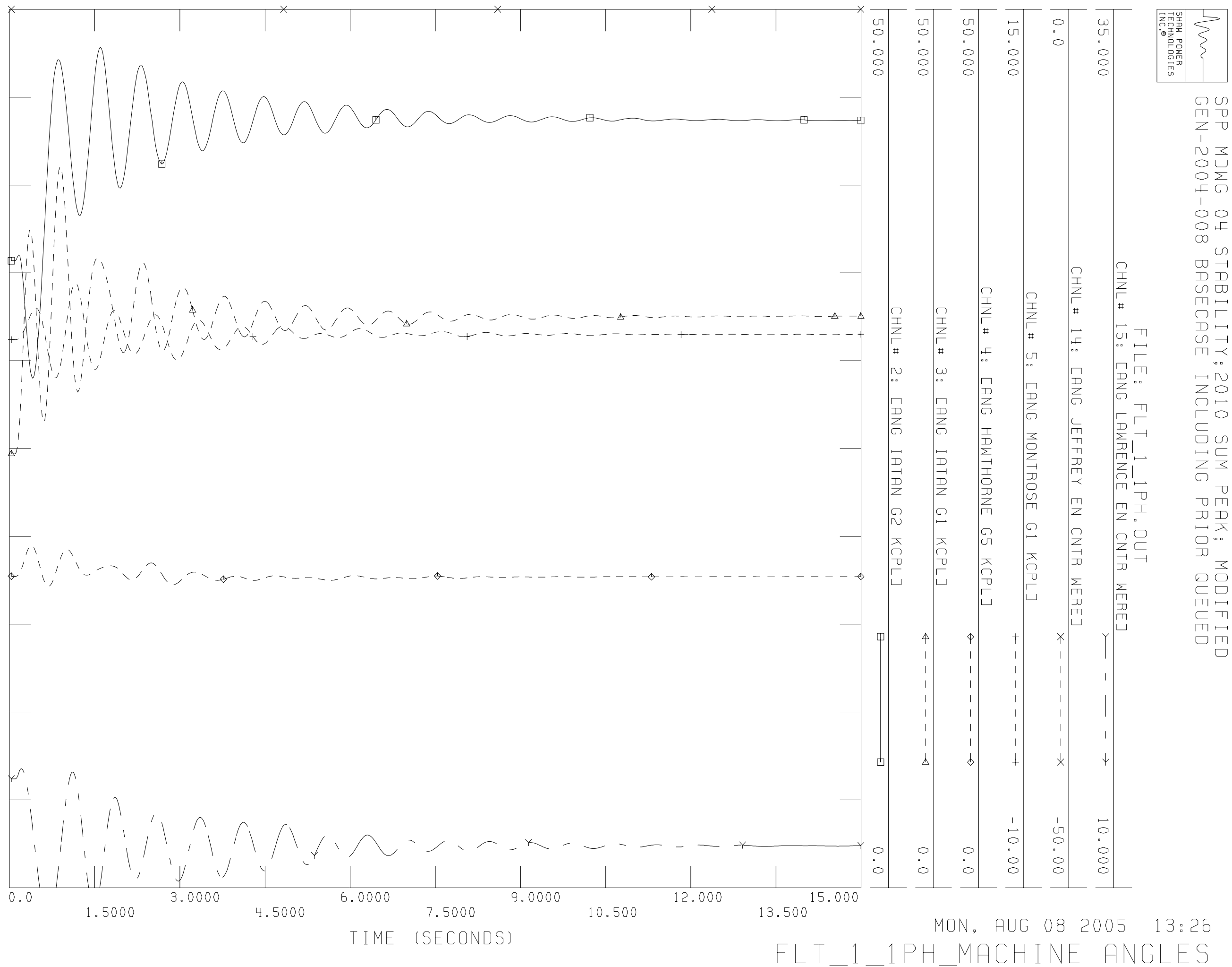
Network upgrades are required at the Iatan substation to accommodate the proposed plant full output. Expansion of the 345kV ring bus and installation of six (6) 345kV circuit breakers is necessary for the new unit terminal and proposed Iatan 345/161kV autotransformer. The total estimated cost for the network upgrades is $17,295,000. An estimated project schedule will be determined during the Facility Study.

Transient Stability analysis shows that the proposed capacity upgrades do not cause system instability and are acceptable.

These costs do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies when the Customer requests transmission service through Southwest Power Pool's OASIS.

APPENDIX A.

SELECTED MACHINE ROTOR ANGLES AND TERMINAL VOLTAGES FROM STABILITY ANALYSIS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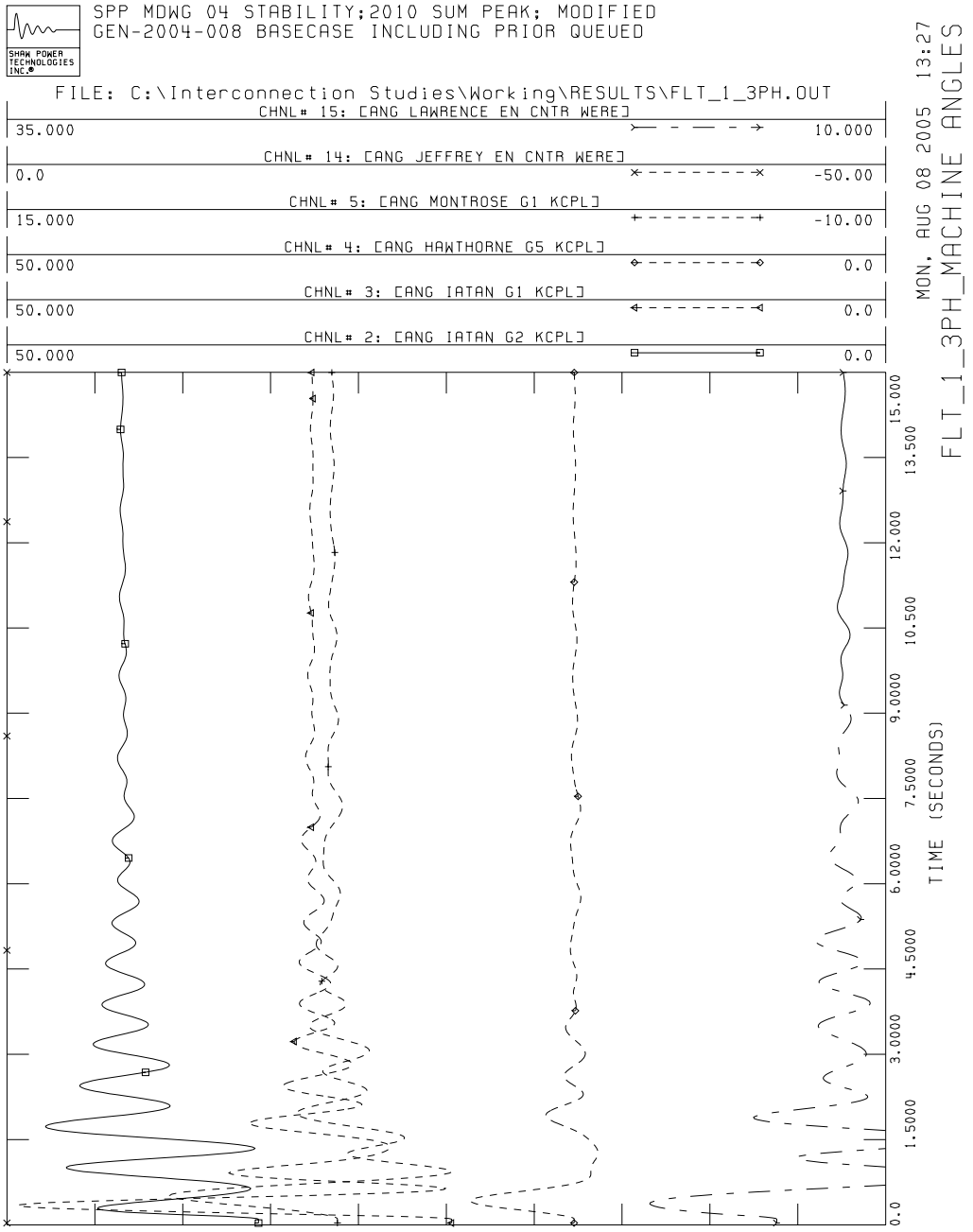
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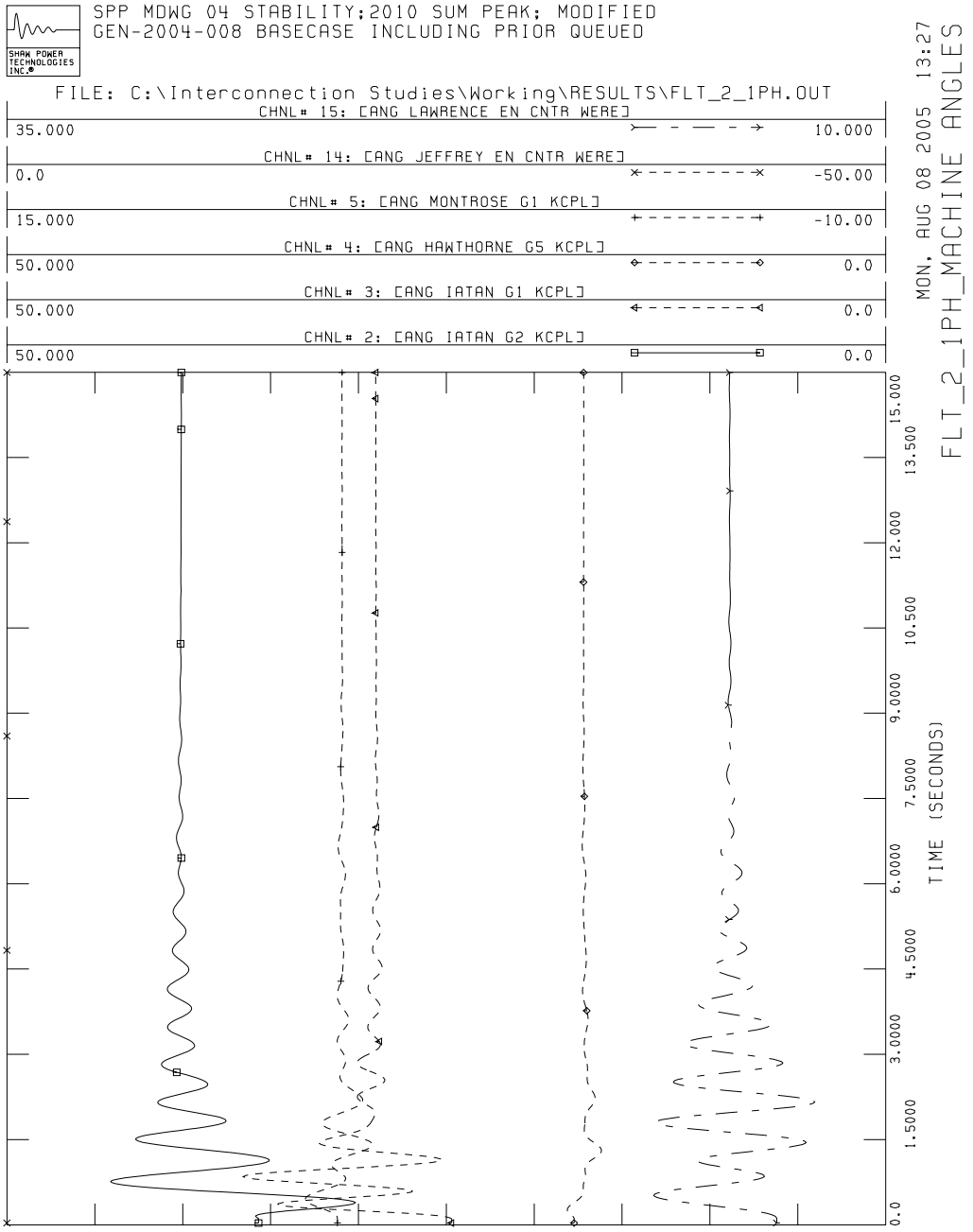
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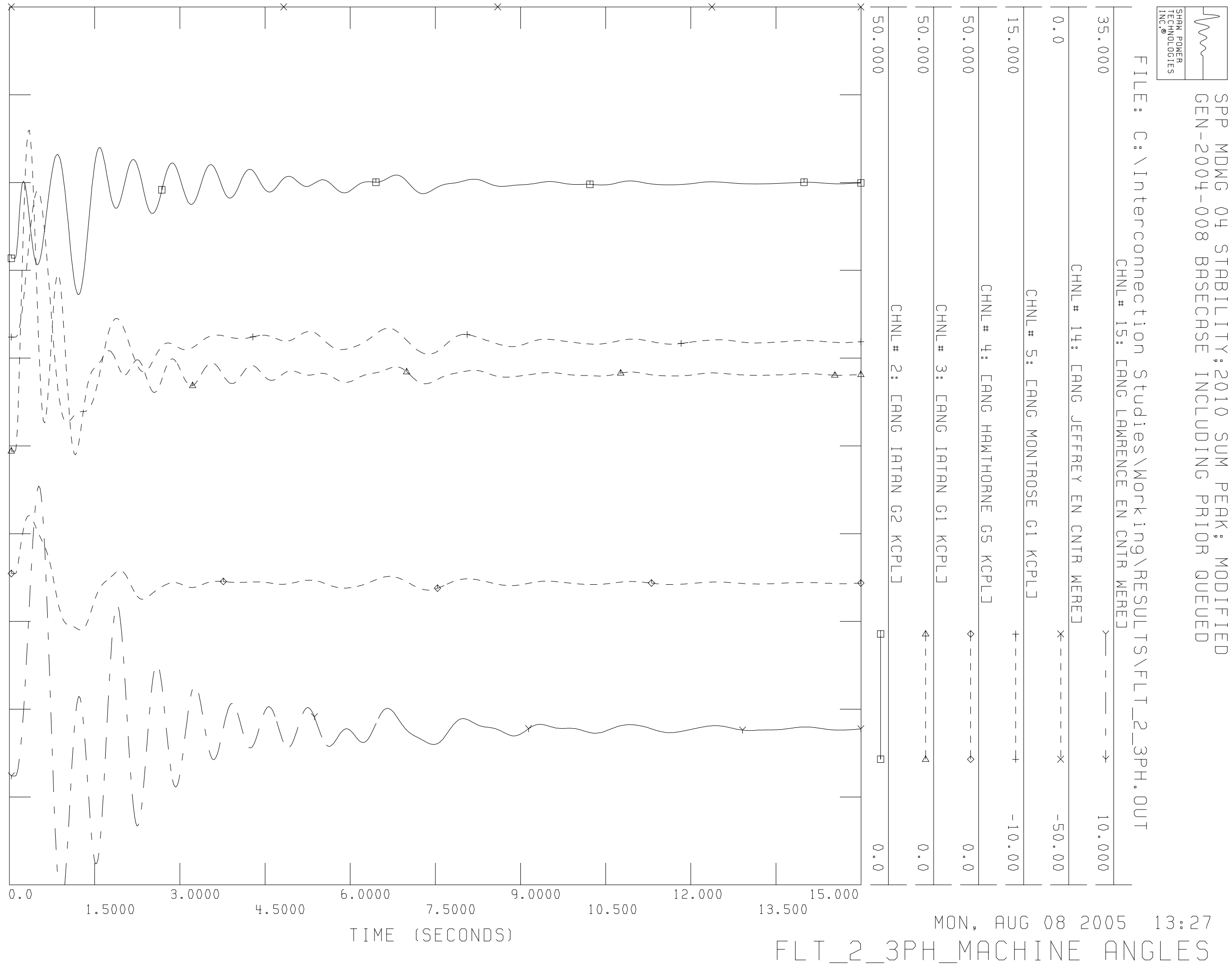
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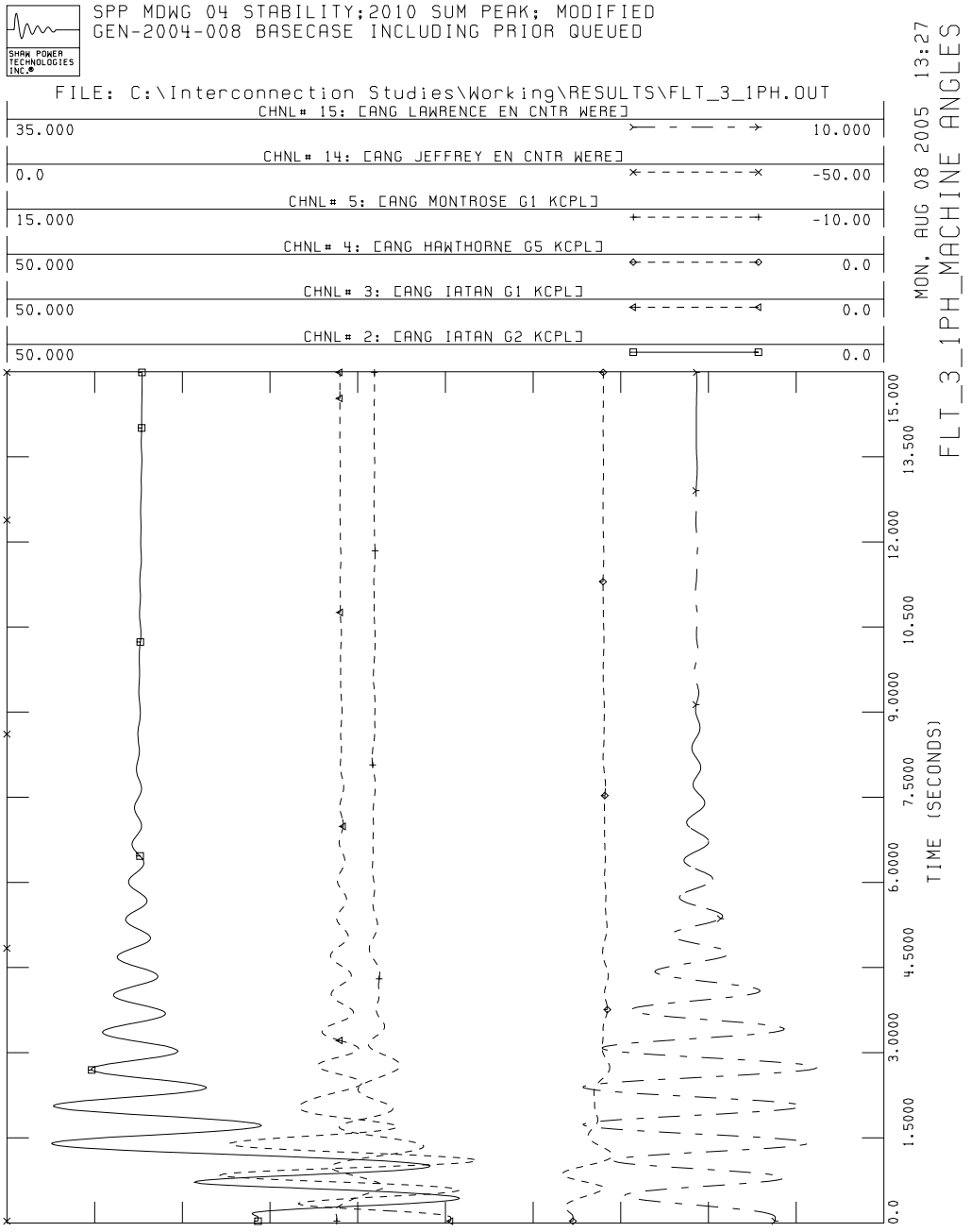
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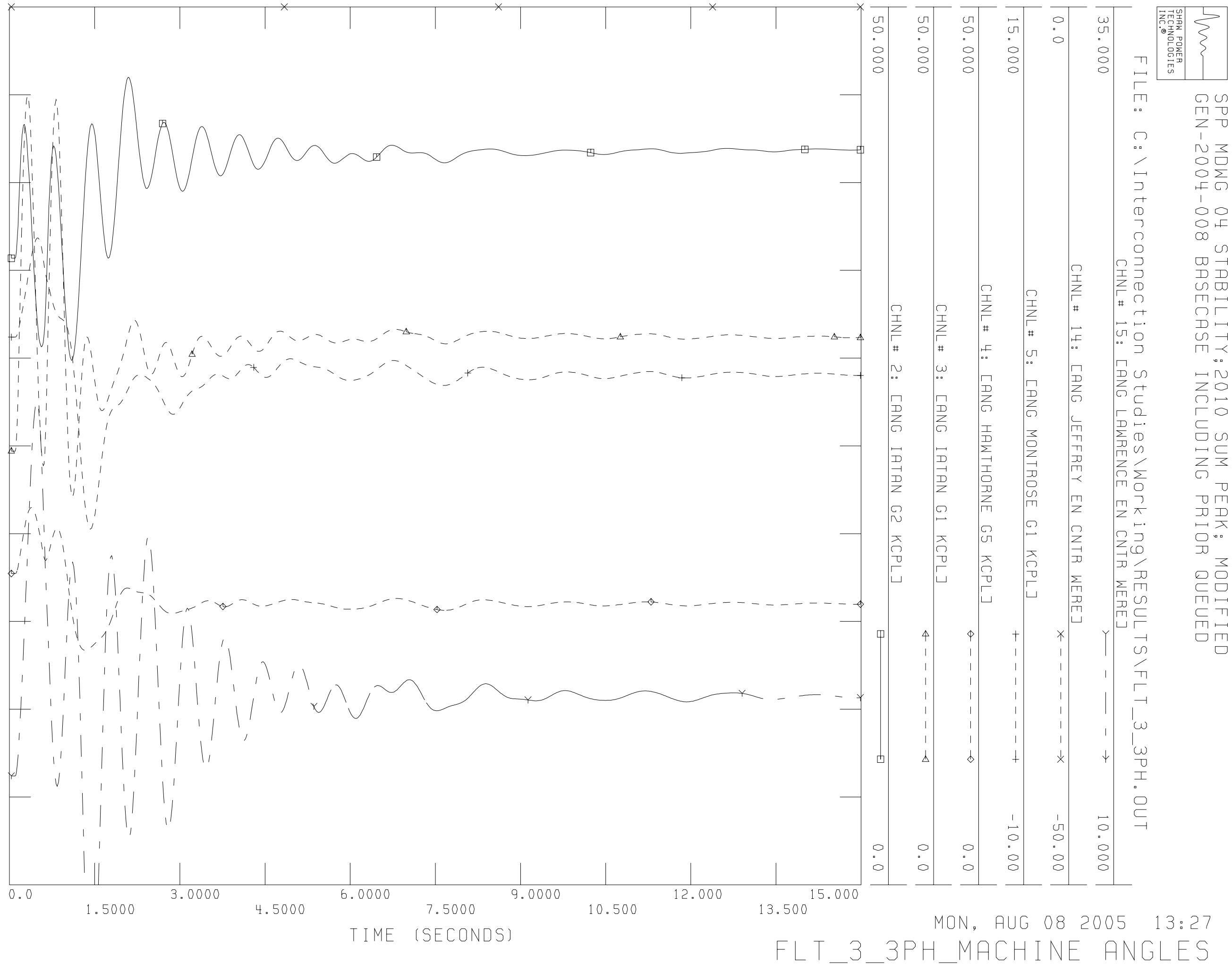
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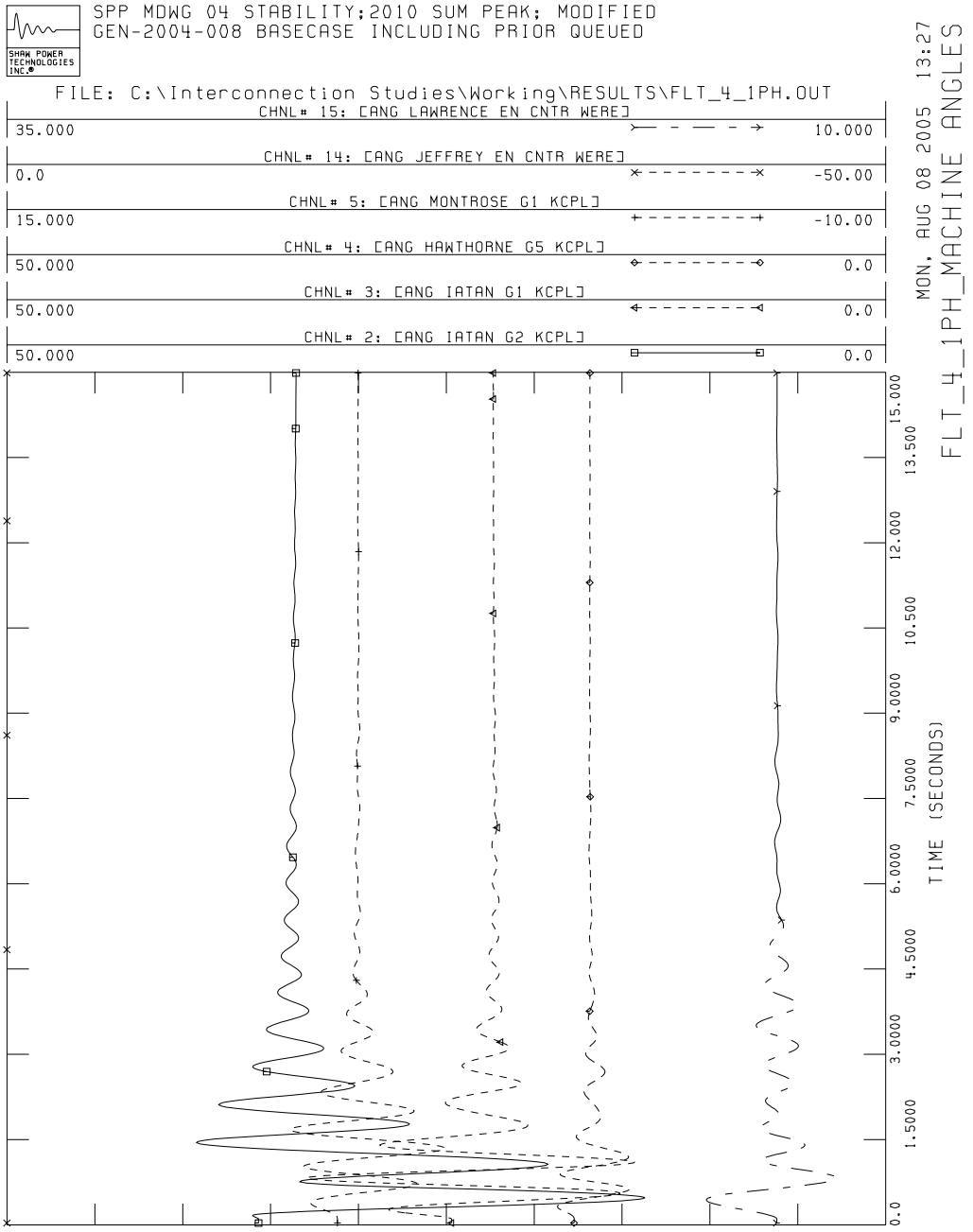
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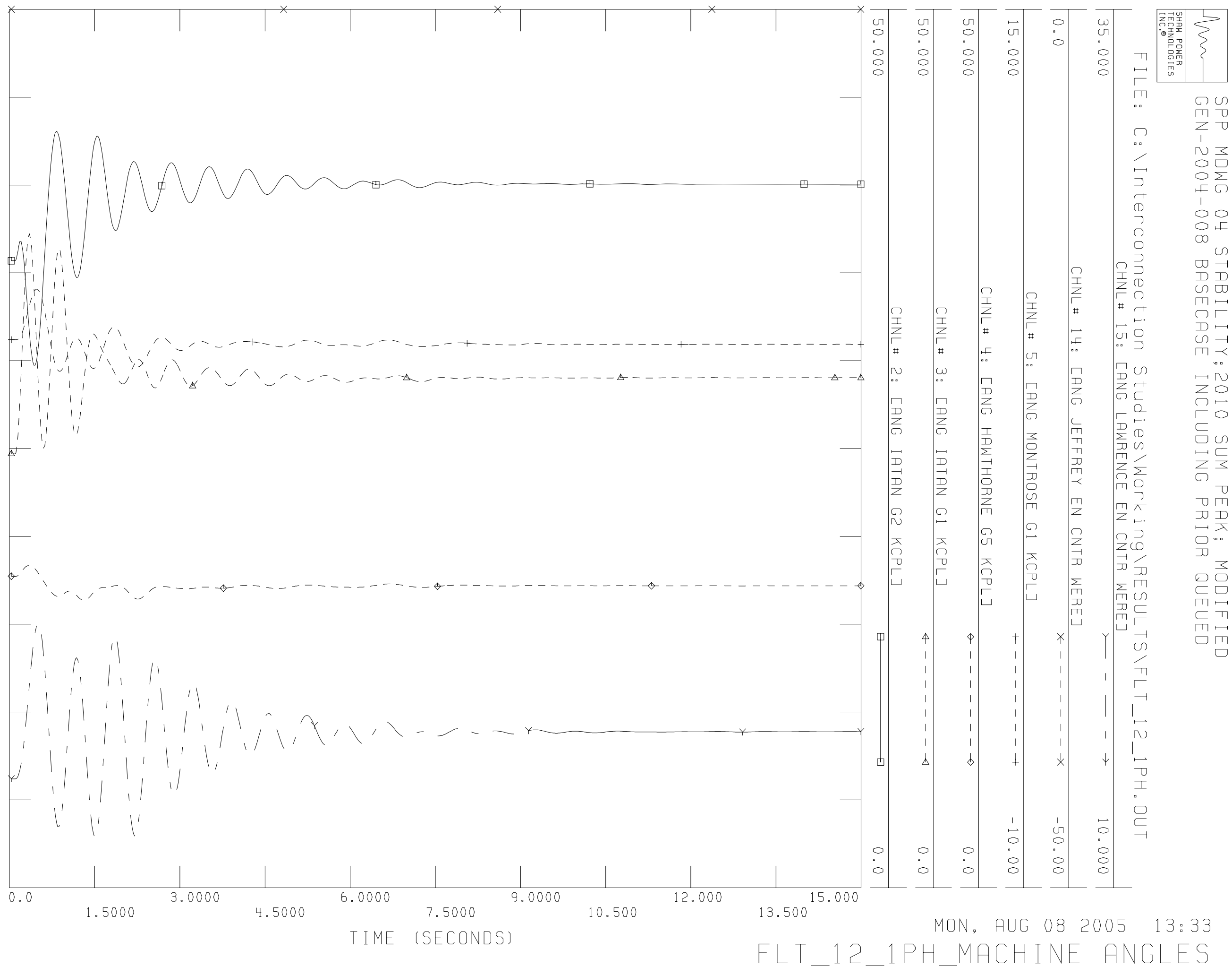
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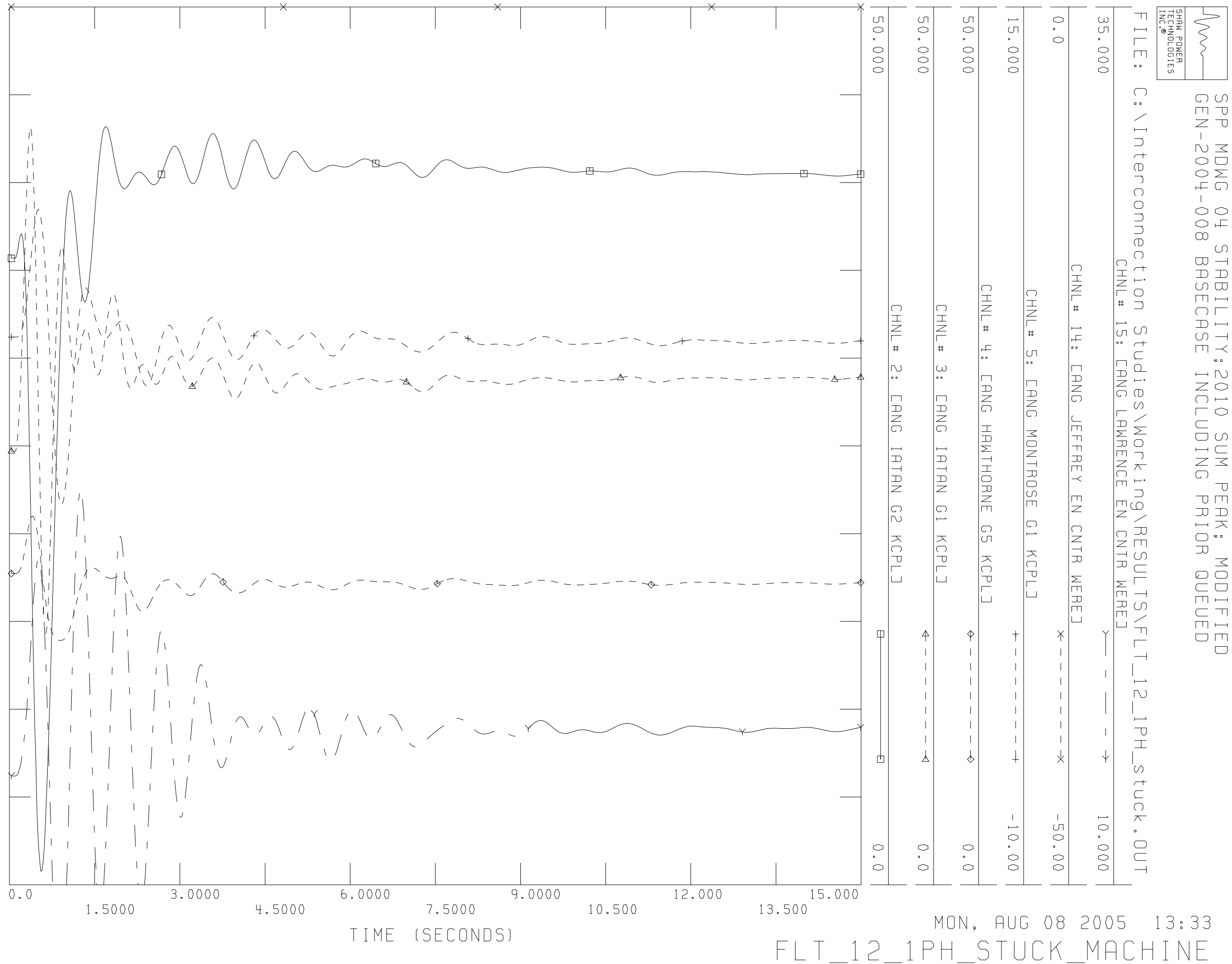
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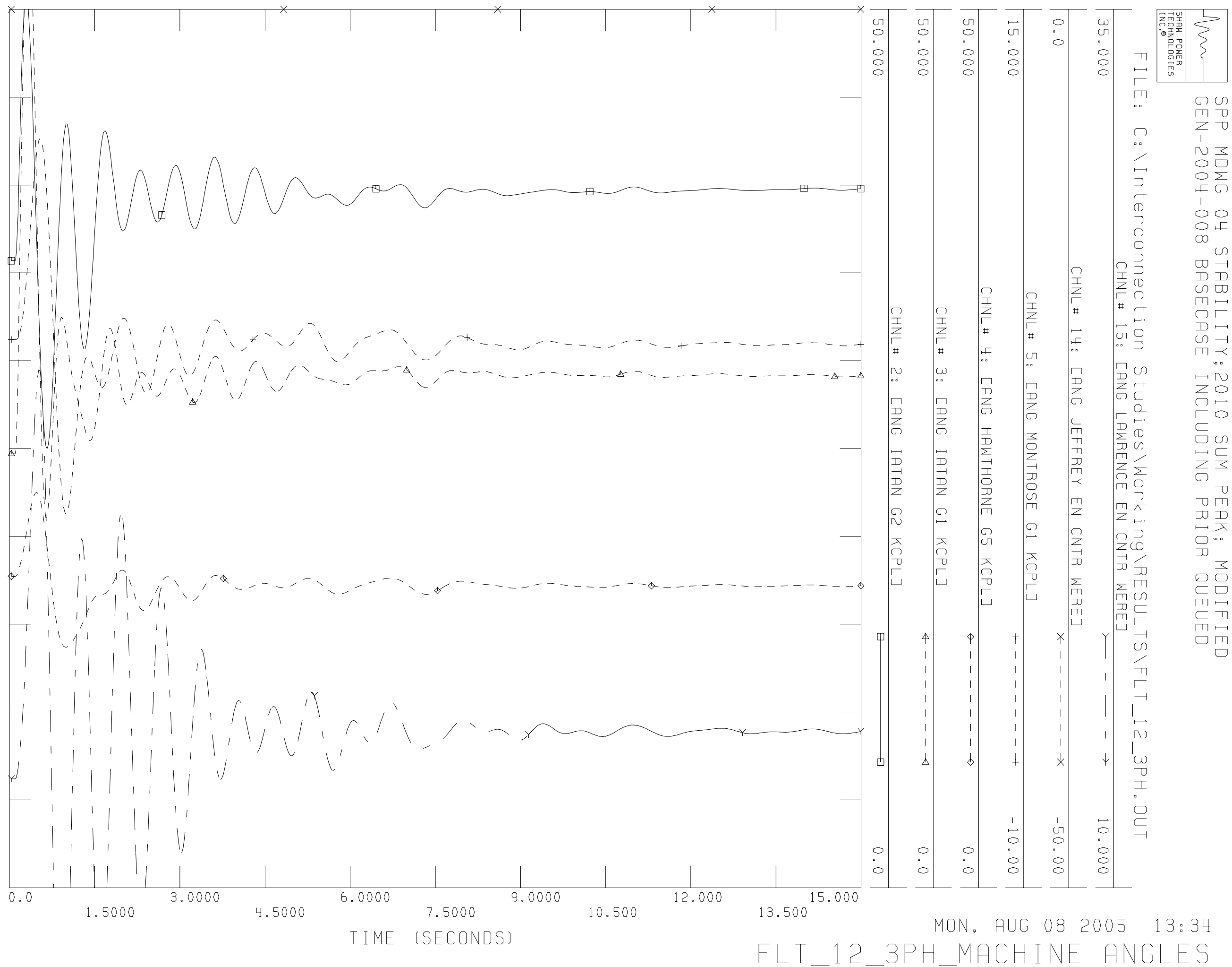
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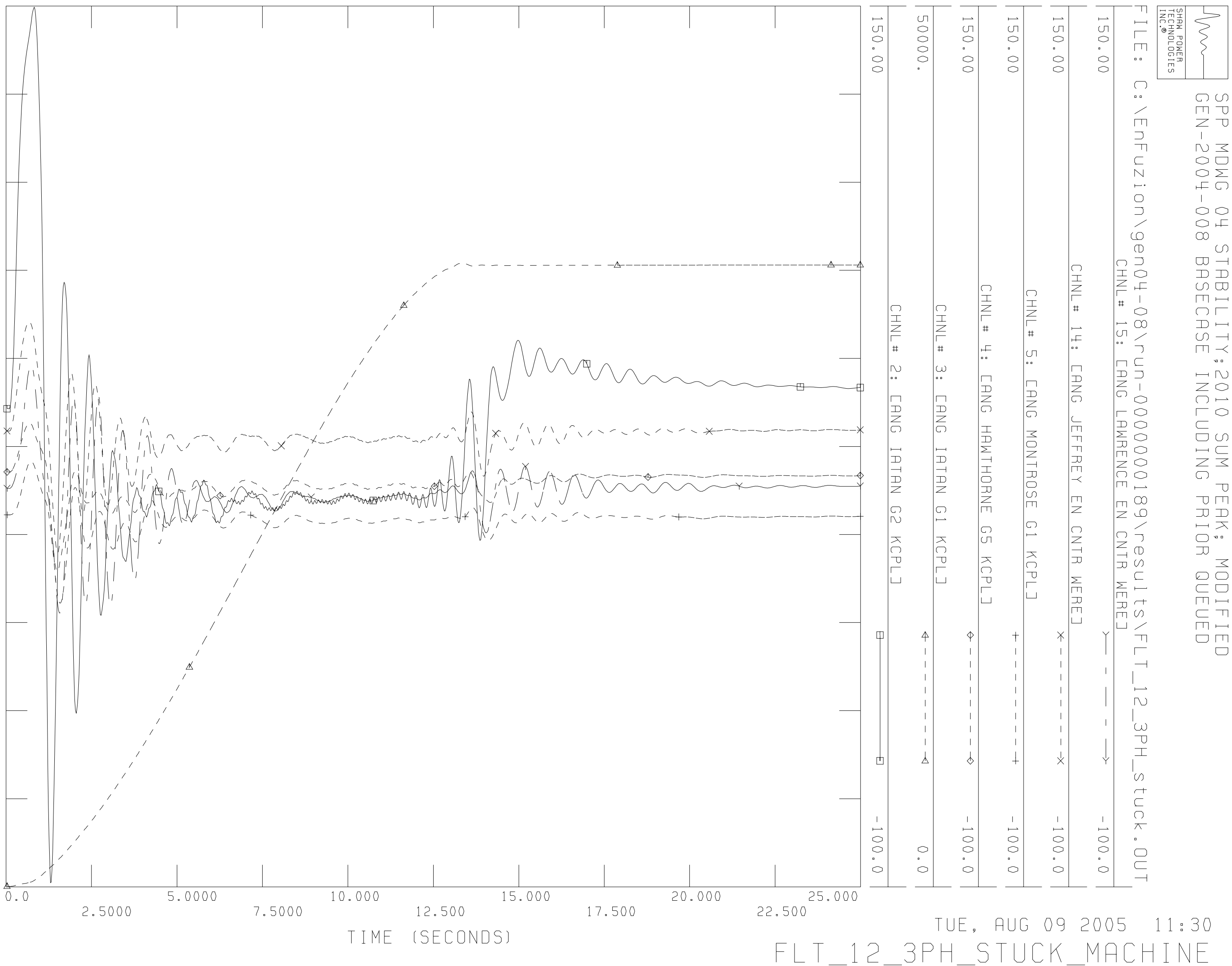

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TUE, AUG 09 2005 11:30
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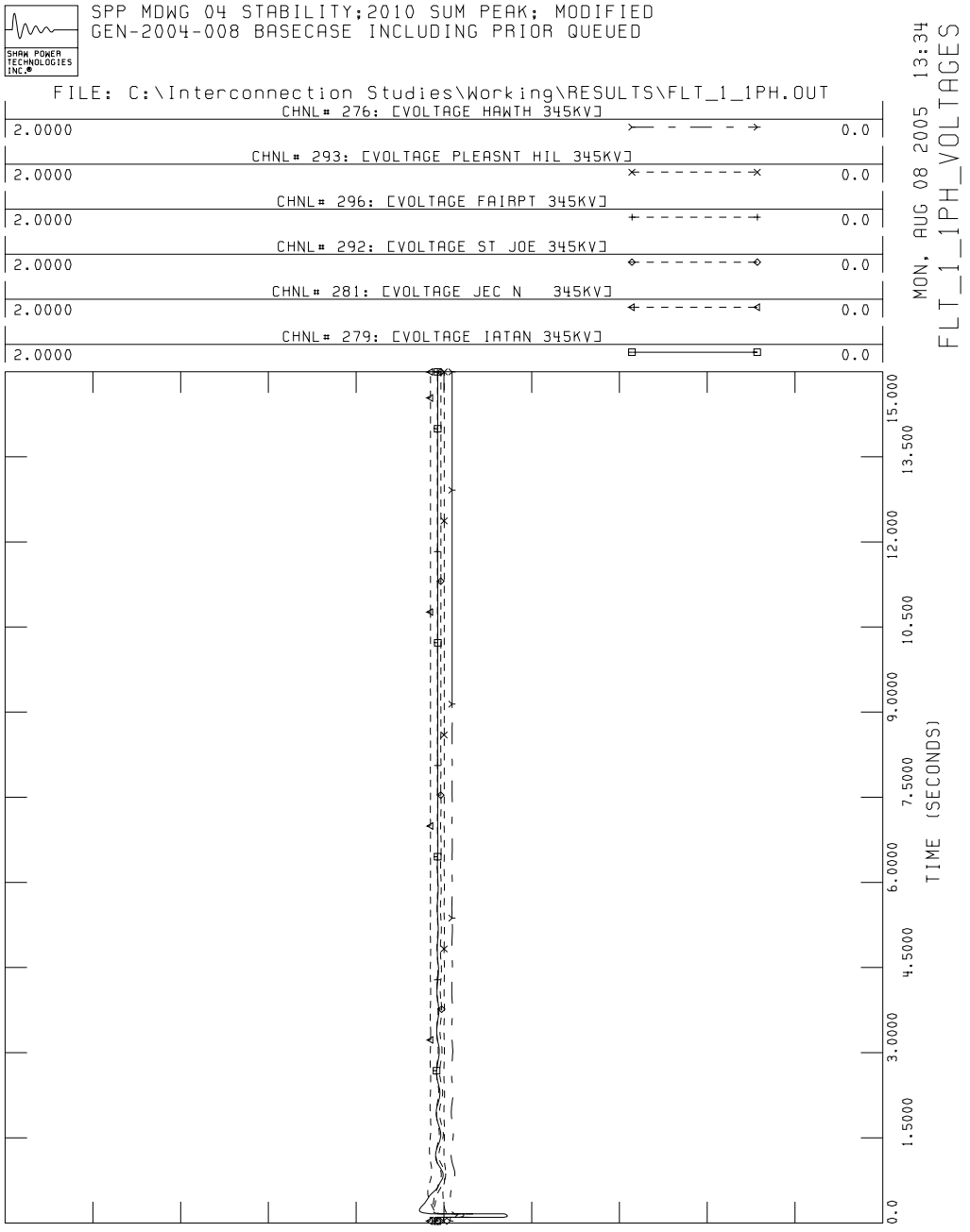
SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-008 BASECASE INCLUDING PRIOR QUEUED
SHAW POWER TECHNOLOGIES INC.
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_1_1PH.OUT
CHNL# 276: [VOLTAGE HAWTH 345KV]
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
CHNL# 296: [VOLTAGE FAIRPT 345KV]
CHNL# 292: [VOLTAGE ST JOE 345KV]
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MON, AUG 08 2005 13:34
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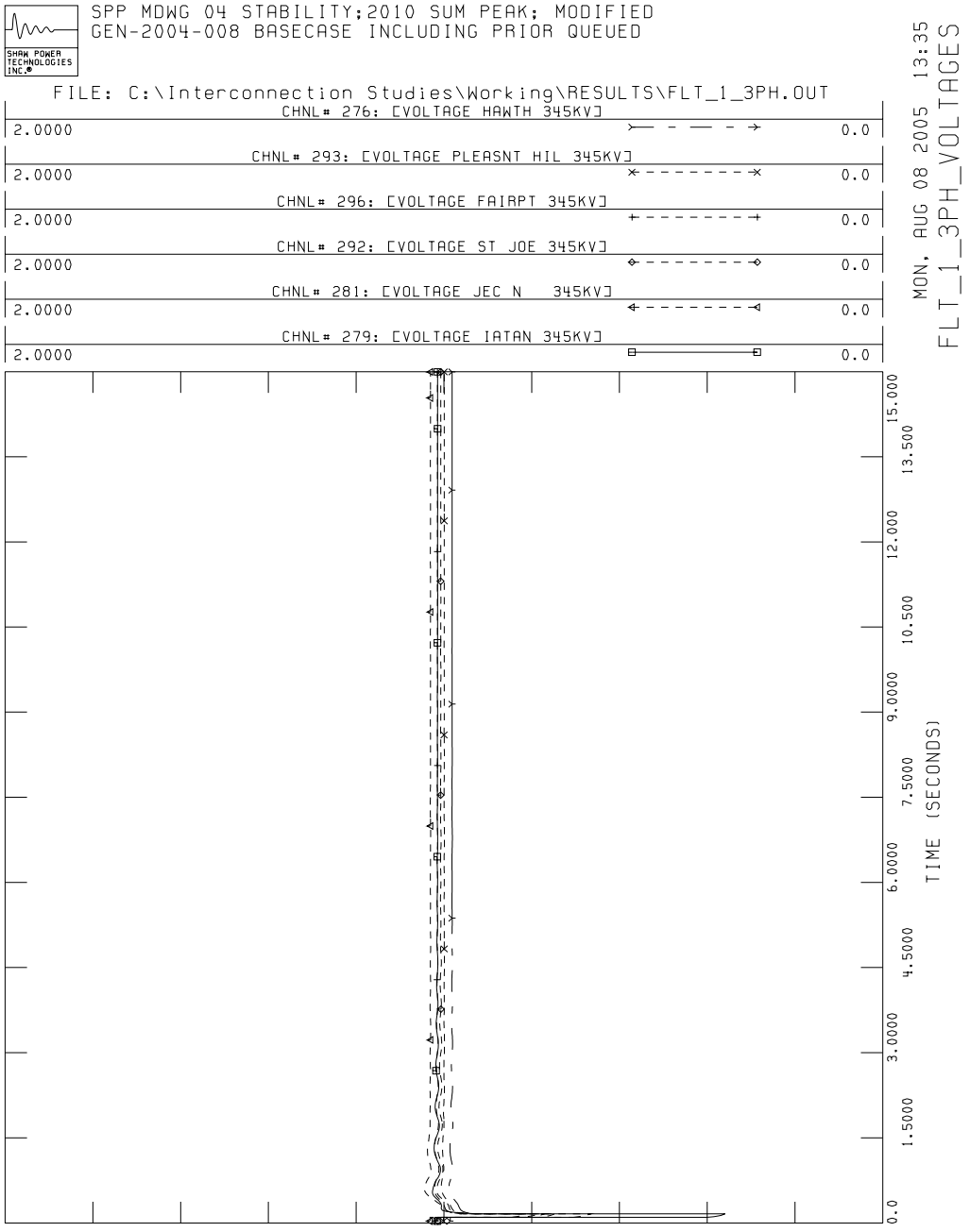
SHAW POWER TECHNOLOGIES INC.
SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-008 BASECASE INCLUDING PRIOR QUEUED
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CHNL# 281: [VOLTAGE JEC N 345KV]
CHNL# 279: [VOLTAGE IATAN 345KV]
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4.5000
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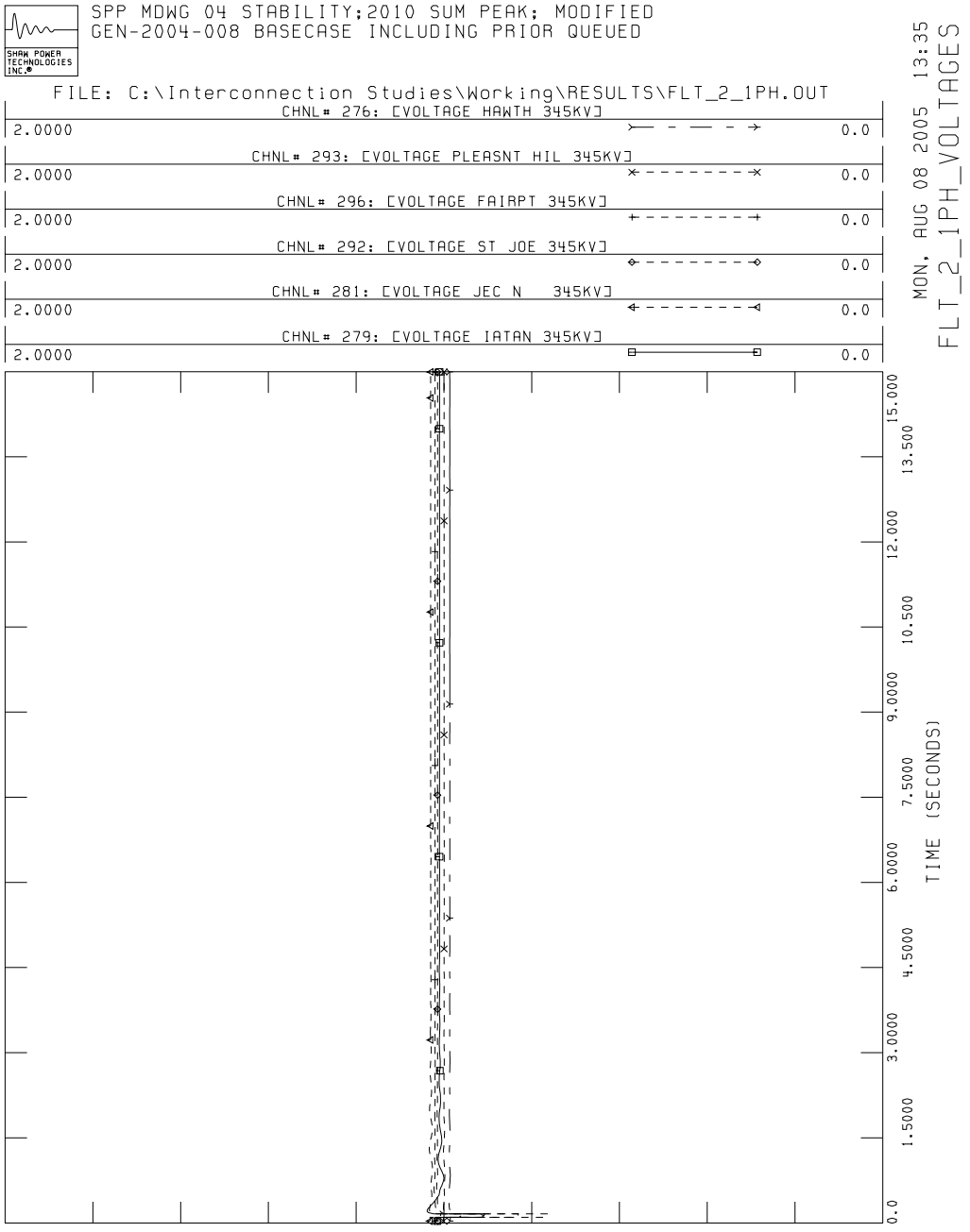
MON, AUG 08 2005 13:35
FLT_1_3PH_VOLTAGES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CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
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CHNL# 279: [VOLTAGE IATAN 345KV]
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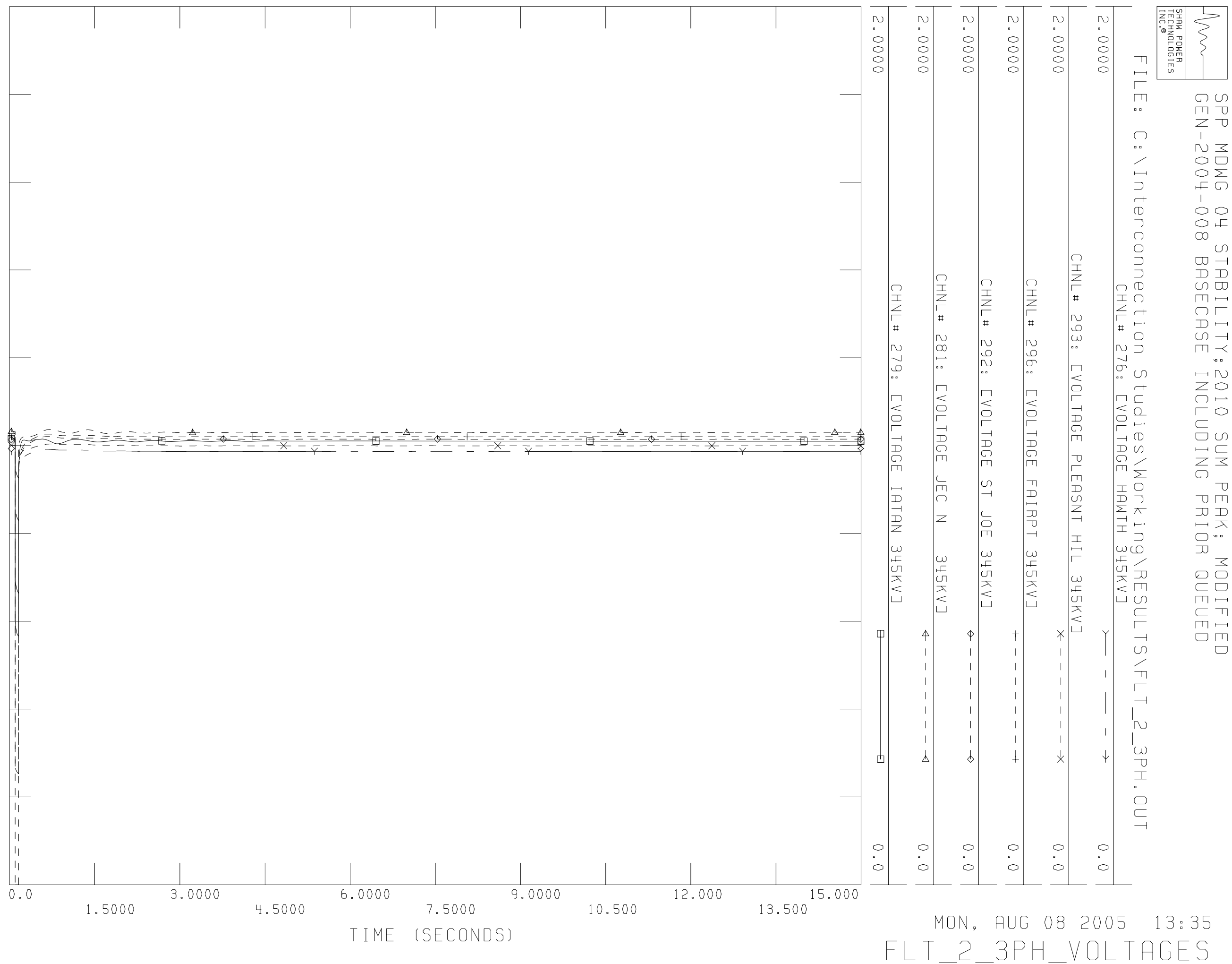
FLT_2_1PH_VOLTAGES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GEN-2004-008 BASECASE INCLUDING PRIOR QUEUED
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SHAW POWER TECHNOLOGIES INC.®
CHNL# 276: [VOLTAGE HAWTH 345KV]
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
CHNL# 296: [VOLTAGE FAIRPT 345KV]
CHNL# 292: [VOLTAGE ST JOE 345KV]
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CHNL# 279: [VOLTAGE IATAN 345KV]
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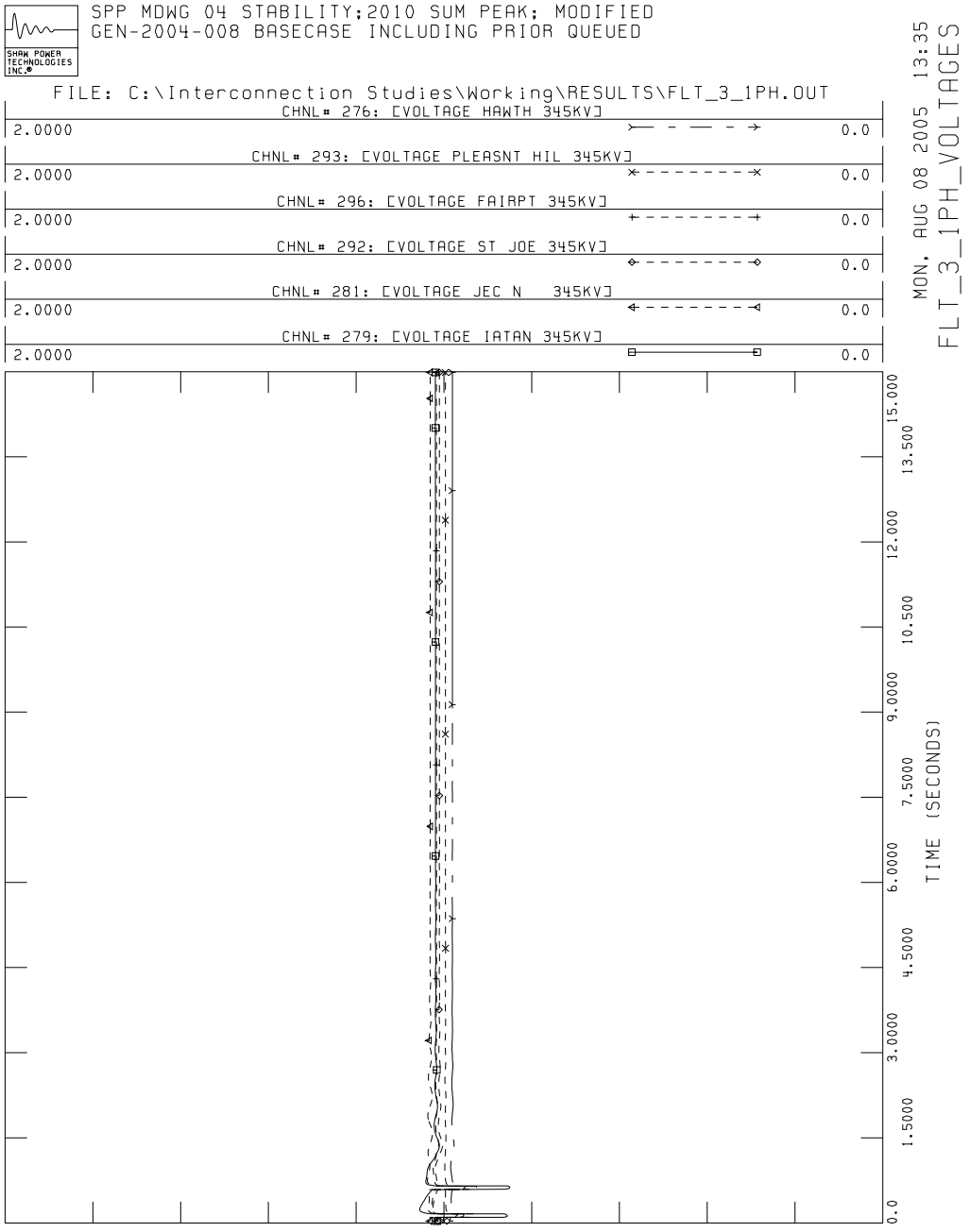
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GEN-2004-008 BASECASE INCLUDING PRIOR QUEUED
SHAW POWER TECHNOLOGIES INC.
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2.0000
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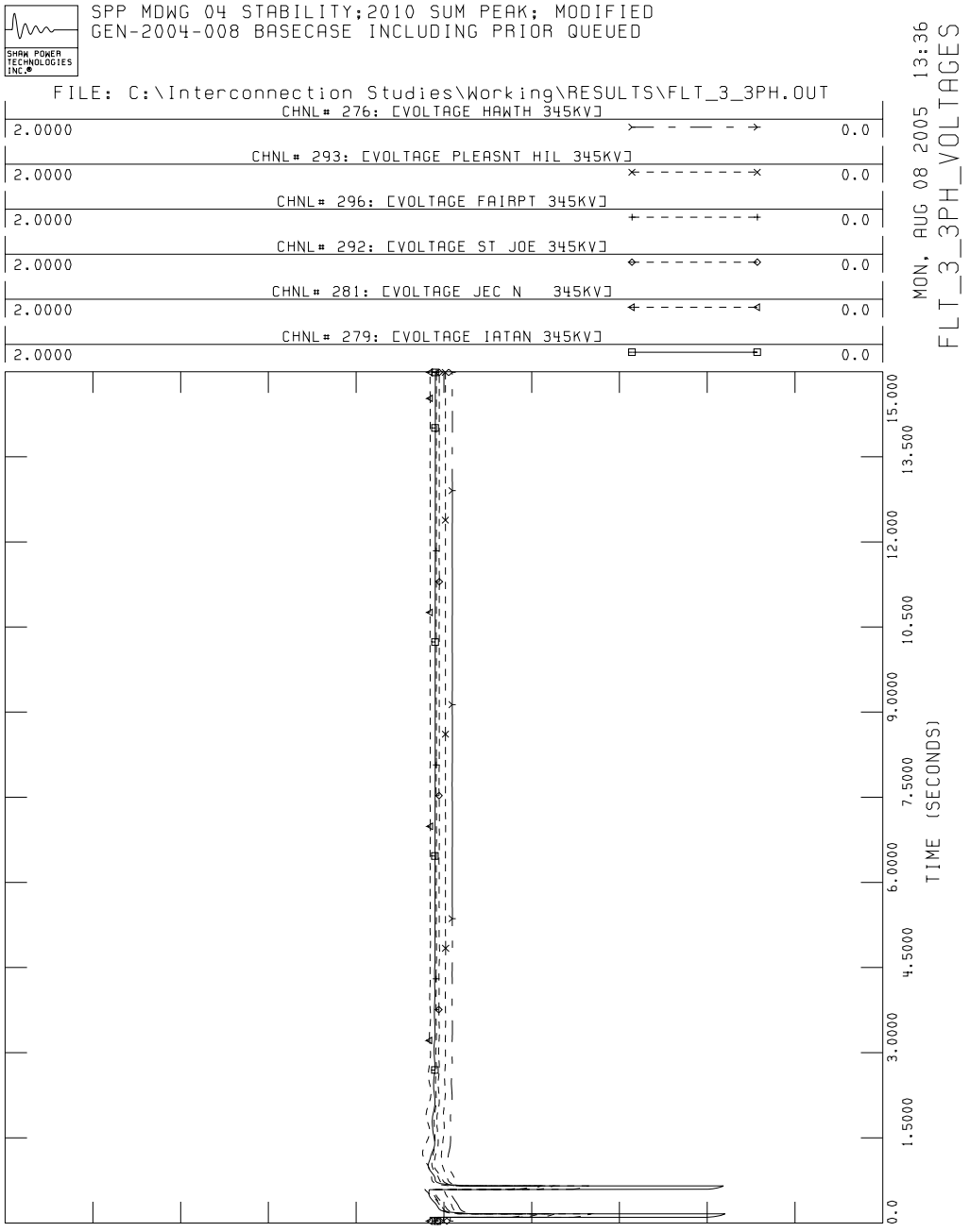
FLT_3_1PH_VOLTAGES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SHAW POWER TECHNOLOGIES INC.
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_3_3PH.OUT
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CHNL# 281: [VOLTAGE JEC N 345KV]
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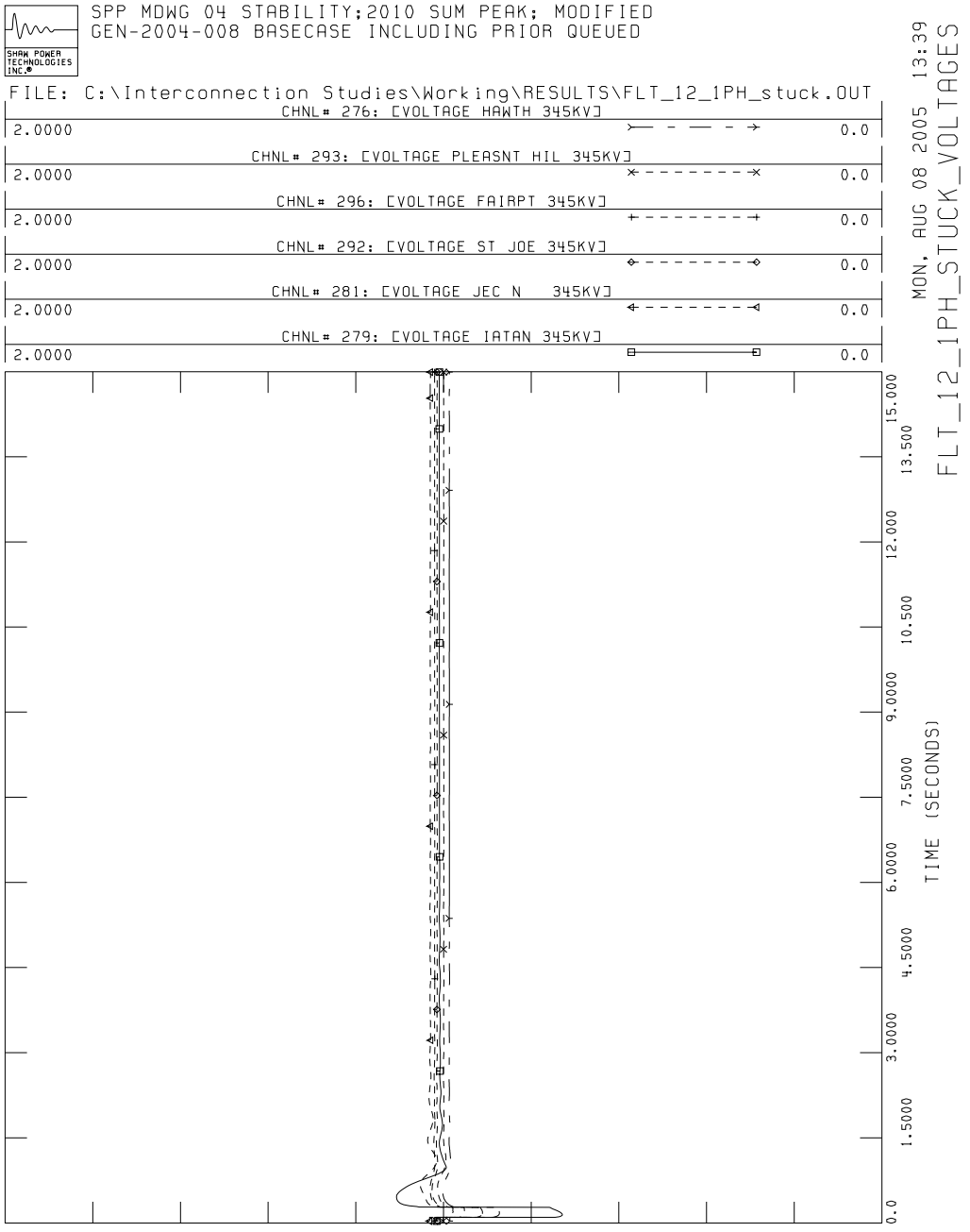
MON, AUG 08 2005 13:36
FLT_3_3PH_VOLTAGES


SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-008 BASECASE INCLUDING PRIOR QUEUED
SHAW POWER TECHNOLOGIES INC.
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_12_1PH_stuck.OUT
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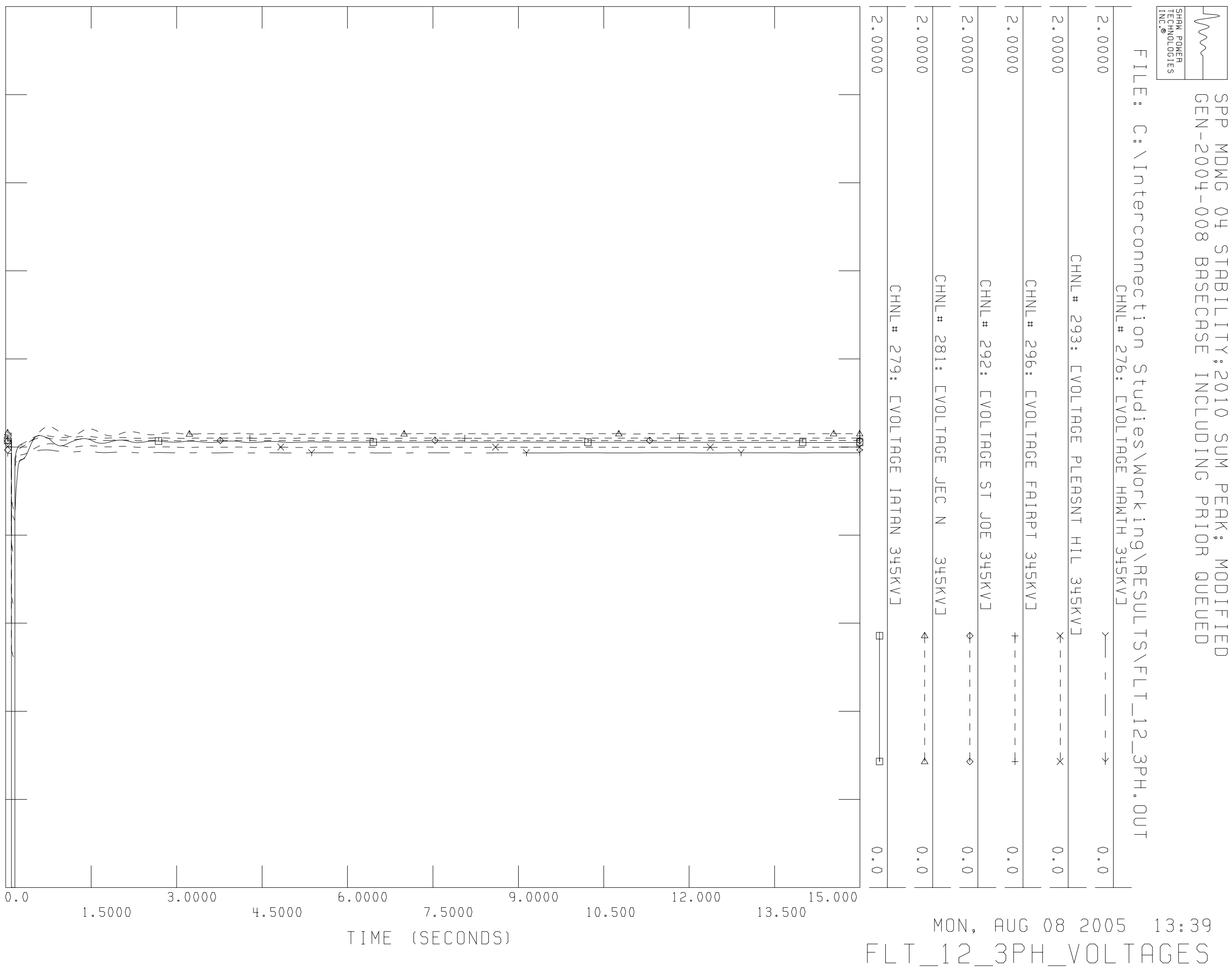
FLT_12_1PH_STUCK_VOLTAGES


SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-008 BASECASE INCLUDING PRIOR QUEUED
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SHAW POWER TECHNOLOGIES INC.
CHNL# 276: [VOLTAGE HAWTH 345KV]
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
CHNL# 296: [VOLTAGE FAIRPT 345KV]
CHNL# 292: [VOLTAGE ST JOE 345KV]
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CHNL# 279: [VOLTAGE IATAN 345KV]
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4.5000
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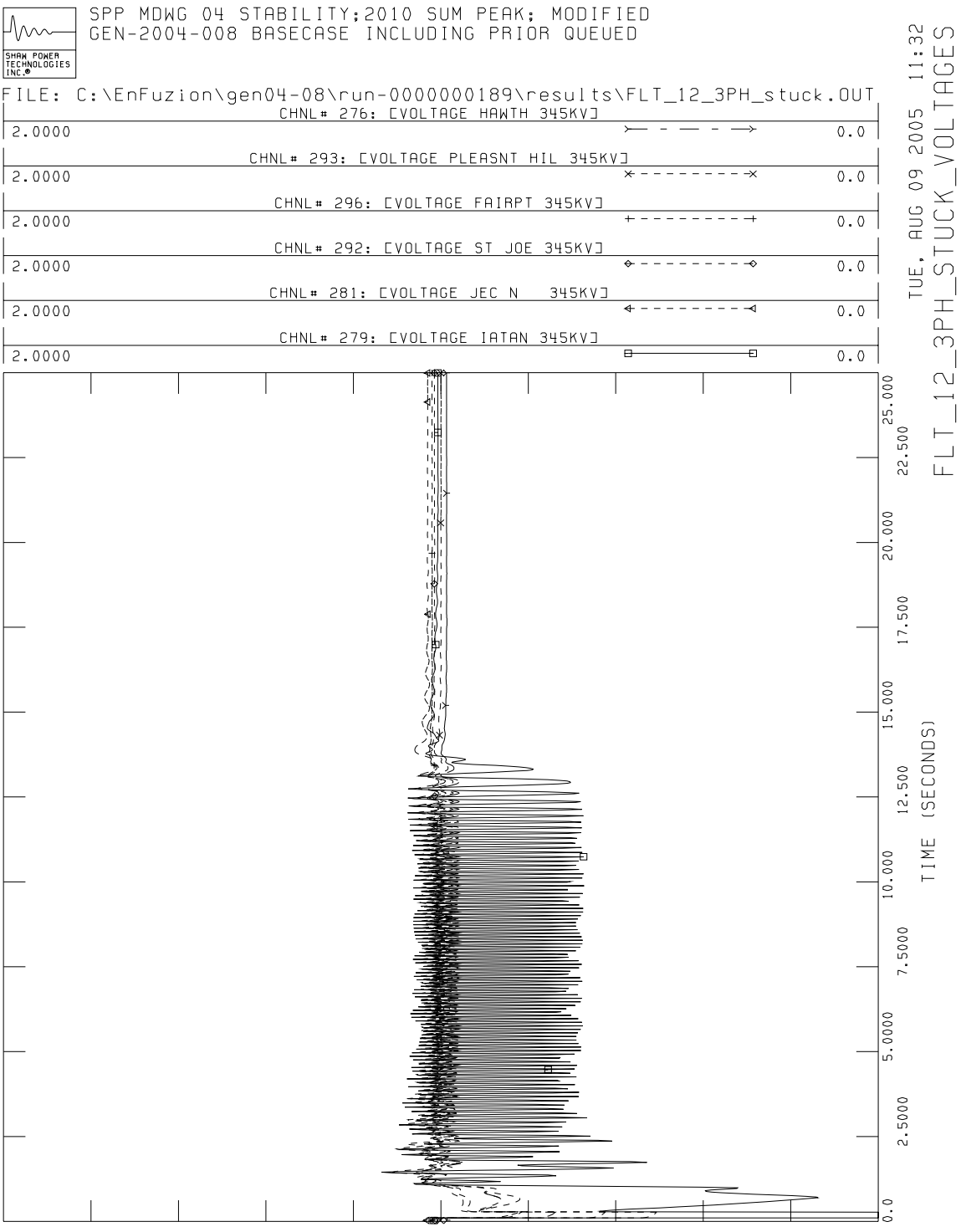
MON, AUG 08 2005 13:39
FLT_12_3PH_VOLTAGES


SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-008 BASECASE INCLUDING PRIOR QUEUED
SHAW POWER TECHNOLOGIES INC.®
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CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
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CHNL# 279: [VOLTAGE IATAN 345KV]
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TUE, AUG 09 2005 11:32
FLT_12_3PH_STUCK_VOLTAGES