
Pointe du Bois Interconnection Evaluation Study

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Executive Summary

An Interconnection Evaluation Study (IES) has been performed to determine the transmission facilities necessary to accommodate a generation increase from 79 MW to either 90 or 120 MW at an existing generating station near Pointe du Bois, Manitoba. The Generator has requested the proposed generation facility be considered a Manitoba Hydro (MH) network resource.

The following alternate developments were evaluated:

Options	Generation (MW)
Decommission the existing plant	0
Rehabilitate with Francis turbines	85 – 90
Repower with 14 Straflo units	120
Redevelop with 4 Vertical axis units	120

The three main options for increasing the output of the generating station are:

- Rehabilitation of the existing plant and replacement of existing turbines with more efficient units or,
- Repowering with new Straflo units or,
- Redevelopment with the construction of a new powerhouse and new generating units.

Dynamic stability simulations determined that Repowering of Pointe du Bois with 14 Straflo units is unacceptable. The low inertia Straflo units separated from the electrical system for moderate disturbances. Equipping these Straflo units with power system stabilizers does not prevent this loss of synchronism. This generation option does not meet the requirements for interconnection and should not be pursued. See report section 5.4.3.

Analysis was performed to determine the necessary transmission requirements to deliver the additional power to domestic load for Rehabilitation and Redevelopment. Detailed analysis was not provided for the Repowering option for reasons given above.

Since the existing Pointe du Bois power output feeds directly into the Winnipeg load centre, an estimate is also made of costs associated with the loss of this facility through decommissioning.

Two transmission alternatives were identified which could satisfy capacity requirements for both Rehabilitation and Redevelopment. These involved converting the 138 kV network around Pointe du Bois into a 115 kV network. This would entail construction of a new 115 kV transmission line from Pointe du Bois to the City of Winnipeg. The transmission alternatives are designated as Rover and Transcona 115 kV alternatives. They differ primarily on the termination point for the new line. The Rover alternative terminates the new line at a new Rover 115 kV station while the Transcona alternative

terminates the line at existing Transcona 115 kV Station. In both cases, the line will re-use existing parallel circuits in the Beausejour area that are presently de-energized.

This report assumes that four new generator transformers will be terminated into a new Pointe du Bois 115 kV ring bus. The Generator will purchase and provide these transformers.

Based on economic and technical considerations, a new single circuit 115 kV line from Pointe du Bois to a new Rover 115 kV station in Winnipeg is recommended. This circuit requires:

- construction of 43 km of new 115kv single circuit transmission line from Pointe Du Bois to the Lac Du Bonnet area
- utilization of the existing GT1/ST2/SG12 115kV circuits between Lac Du Bonnet and Winnipeg
- construction of 17 km of new 115kV line into Rover Station and
- development of a new 115-66kV station at Rover.

In addition, conversion of the Slave Falls – Scotland system to 115kV requires:

- transformer replacements at Scotland Station
- upgrades to existing S1, S2, R1 and R2 138kV circuits between Pointe Du Bois, Slave Falls and Scotland Station to 100C rated capability and
- development of a new 115kV switching station at Pointe Du Bois

The cost of these improvements is \$30.8M in 2004 dollars.

The additional cost to salvage the existing Pointe du Bois – Rover 66 kV lines, a requirement for both transmission alternatives, is \$14.6M.

As a network resource, the impacts of scheduling to MH generation and load were evaluated. MH's load and generation are located entirely within the Province of Manitoba. Therefore, the generation increase will not require the need to increase transfer levels on the Manitoba to Ontario, Saskatchewan or U.S. boundaries.

This study determined the impact of the generation increase on the existing MH transmission system by means of steady-state ac power flow analysis, constrained interface analysis, stability analysis and short circuit analysis.

Both transmission alternatives cause several thermal overloads that require further investigation in an Interconnection Facilities Study (IFS). In addition, conversion of the 138 kV network to 115 kV will increase the reactive power requirements of the Winnipeg Central 66 kV system.

There are no short circuit concerns with the Rover 115 kV alternative. However, the Transcona 115 kV alternative would require the replacement of 10 Winnipeg area circuit breakers.

A detailed evaluation of the capability of the station buses at Rover and Transcona to accommodate the proposed generation increase was not conducted. This study is part of the Interconnection Facilities Study.

The cost of a generation cross trip scheme was also not included. It will be determined in the IFS.

The Rover 115 kV alternative provides a better transmission solution if Rehabilitation of Pointe du Bois generation station (GS) were to proceed. The transmission system is more robust than that resulting from the Transcona 115 kV alternative.

Neither transmission alternative provided significant competitive advantage over the other when combined with Redevelopment at Pointe du Bois GS.

During the course of the study, the following potential risks were identified which could impact the final transmission requirements.

A single new 115 kV line originating at Pointe du Bois has been proposed assuming that the Slave Falls to Scotland 138 kV lines can be adequately upgraded, at a relatively low cost, using a LIDAR/nip-and-tuck program. Confirmation of this assumption was not possible at the time of this report, however it is expected that an economic upgrade will be feasible.

If this assumption is incorrect, then a second new 115 kV line also originating at Pointe du Bois could be required. A second line would likely cost between \$4 million and \$7 million, and could impact the transformation requirements at Scotland and Transcona.

It is assumed that the existing Pointe du Bois 66 kV lines can operate until its scheduled salvage date. For Redevelopment at Pointe du Bois, its salvage date is 2012. If these lines cannot survive until this time, alternate construction plans may be required.

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1.0 Introduction

1.1 Background Information

This report documents the results of an Interconnection Evaluation Study for a generating station near the town of Pointe du Bois, Manitoba. The Generator is proposing to increase the power output of the existing plant from 79 MW to either 90 (Rehabilitation) or 120 MW (Redevelopment). The proposed in-service date is December 2011.

Either generation increase is studied with two competing transmission alternatives. The first alternative provides a new 115 kV transmission line between Pointe du Bois and Transcona. The second alternative is to terminate this 115 kV line at a new Rover 115 kV station, instead of at Transcona. Both alternatives provide for conversion and integration of the 138 kV network connecting Pointe du Bois – Slave Falls – Scotland into the existing MH 115 kV network. Single-line diagrams for both transmission plans are provided in Appendix A.

Appendix A-1 shows the proposed 115 kV Pointe du Bois ring bus layout. Four 115/6.9 kV generator step-up transformers will collect output from either 16 existing generator units (Rehabilitation) or from 4 new units (Redevelopment) similar to those at Kelsey GS. Lines R1 and R2 will operate at 115 kV and connect Pointe du Bois to Slave Falls.

Appendices A-2 and A-3 illustrate the transmission line improvements between Pointe du Bois and Winnipeg. Appendices A-4 and A-5 show the termination of the new 115 kV line from Pointe du Bois at either Transcona or Rover.

The existing Pointe du Bois / Slave Falls transmission system consists of 2-138 kV lines between Pointe du Bois and Slave Falls (R1 and R2), 2-138 kV lines between Slave Falls and Scotland Station (S1 and S2), and the 4-66 kV Pointe Lines. The Pointe Lines have experienced significant deterioration over their lifespan of over 90 years and are quickly approaching the end of their useful life. It was determined in reference [1] to convert and integrate this 138 kV system into the MH 115 kV system and to construct a 115 kV line between Pointe du Bois and Winnipeg to serve as the primary generation outlet line for Pointe du Bois.

1.2 Objectives

The Interconnection Evaluation Study objectives are to determine:

- the voltage level at point of interconnection
- facilities required to electrically connect the generator to the MH electrical system
- adequacy of reactive power facilities
- system reliability limitations (i.e. equipment overloads, voltage violations)
- short circuit impacts (e.g. circuit breaker replacement)
- planning level cost estimates of transmission facilities

If the Generator chooses to proceed, the Interconnection Facilities Study phase will:

- address the system reliability limitations identified in the IES
- determine a good faith cost estimate of all the interconnection facilities
- determine a good faith construction schedule estimate
- determine special protection requirements (e.g. breaker fail, generator cross trip)
- determine communication requirements
- satisfy any requirements of the Regional Transmission Authority

2.0 Steady-State AC Power Flow Analysis (ACCC)

2.1 Introduction

Steady state power flow analysis was performed to examine the system impact of a 41 MW generation increase, associated with Redevelopment, at Pointe du Bois. This should represent the worst case from a facility loading perspective. The implications of a lower level of generation increase, associated with Rehabilitation, are considered where potential system overloads are identified. Generally, such overloads will be less severe due to lower generation output from Pointe du Bois.

The analysis was performed using the AC contingency calculation (ACCC) activity of PSS/E for each transmission alternative.

For discussion purposes in this study section and its associated appendices, Transcona 115 kV transmission alternative is referred to as 2A and Rover 115 kV transmission alternative is referred to as 2B.

A variety of disturbances were considered for the steady state analysis:

- Single element outages in the MH system (this includes all elements in the Winnipeg Central 66 kV network)
- Multi element outages (multi-terminal, common towers) from the MAPP contingency definition for MH

Contingencies of elements involved in the MH DC Reduction Scheme were not included due to some solution convergence problems with high US export cases. These outages could be studied on an individual basis if necessary to allow incorporation of the MH DC Reduction Scheme into the analysis.

Contingency analysis is conducted on the 2014 winter peak, summer peak and summer off-peak 2004 MAPP Series model cases.

2.2 Study Criteria

Steady state power flow analysis monitors element loading and bus voltage.

Transmission line and transformer loadings were compared to 100% of the Rate C (30 minute emergency rating) following a contingency. Bus voltages were monitored for voltages above 110% or below 90% of the base voltage following a contingency. The PSS/E ACCC screening parameters for reporting were set as follows:

- Minimum contingency case flow change for overload report = 0.02
- Minimum contingency case voltage change for range violation = 0.01

In cases where one (or both) of the transmission alternatives results in a post contingency overload, when loading on the element has increased by greater than 2% of the element's Rate C when compared to the base case contingency loading, then possible

remedial action or system improvements are identified. If the increase in element loading with the transmission alternative is less than 2% then the overload is identified but not discussed in any greater detail.

Phase shift adjustments were locked for the ACCC solution process. Voltage tap adjustments were enabled. Post-contingency phase shift adjustments and voltage tap setting adjustments are considered on a case by case basis as required to address potential overloads.

2.3 Power Flow Model

The three base cases studied in the ACCC analysis are a 2014 winter peak, 2014 summer peak and 2014 summer off peak. These three cases were derived from the 2004 Series MAPP models.

A number of modifications were made to each of the MAPP models to create the study's base cases:

1. The Pointe du Bois-Rover 66 kV Line P2 was removed from service to reflect current operating conditions;
2. Phase shift transformers at McPhillips, Scotland and Sherbrook Stations were adjusted to balance power flows into the Winnipeg Central system;
3. MH generation levels were adjusted as discussed below;
4. Exports to the US, SaskPower and Ontario (IMO) were adjusted up to maximum allowable levels to utilize the difference between MH generation and domestic load and losses.

Outputs of MH non-dc collector system generators are adjusted to 2003 accredited levels approved by the MAPP Design Review Subcommittee.

At Pine Falls, Great Falls and Selkirk Generating Stations, outputs are increased further to account for anticipated projects. Study requests for generation increases at these three plants are currently in the MH Transmission System Interconnections Generation Queue and are expected to be in service by 2014. Table 1 lists the MH non-dc collector system generation levels used in the models.

Table 1: Non-DC Collector System Generation Levels

Bus #	Plant	Generation (MW)
67698	Pointe du Bois	120
67686	Selkirk	144.2
67687	Jenpeg	139.8
67689	Kelsey	237.6
67690, 67691, 67676, 67677	Grand Rapids	480
67692, 67950, 67951	Brandon	376.9
67694	Pine Falls	95.6
67695, 68002	Great Falls	139.2
67696	McArthur Falls	56.5
67697	Seven Sisters	165.4
67699	Slave Falls	68.0

68064, 68065, 68066	Wuskwatim	222
67816	St. Leon	99

Interconnection requests ranked higher than Pointe du Bois that are omitted from Table 1 are not expected to materially affect the results of this study. They will be given consideration in the Interconnection Facilities Study.

The dc generation (Limestone, Long Spruce and Kettle) is increased until either the dc system limit (3350 MW) or export limits are reached. In the winter peak case the dc system limit is encountered before the export limit to the US (2175 MW) is reached. In the summer peak case, exports to the US are maximized and the remaining difference between MH generation and domestic load/losses is exported to SaskPower. In the summer off peak case exports to the US, SaskPower and IMO are maximized (2175 MW to US, 300 MW to SaskPower, 200 MW to IMO) before the dc system limit is encountered.

A summary of the three base case models is provided in Table 2. Load flow single line drawings for each of the cases are attached.

Table 2: Base Case Summary

Case	MH Gen (MW)	MH Load (MW)	MH DC Load (MW)	MH>US (MW)	MH>SP (MW)	MH>IMO (MW)	Case Name
2014 Winter Peak	5703	4096	3350	1340	0	0	Base: Case 1 (14wipk) Alt 2A: Case 2 (14wipk-1) Alt 2B: Case 3 (14wipk-2)
2014 Summer Peak	5702	3178	3350	2175	70	0	Base: Case 4 (14supk) Alt 2A: Case 5 (14supk-1) Alt 2B: Case 6 (14supk-2)
2014 Summer Off Peak	5132	2249	2774	2175	300	200	Base: Case 7 (14suop) Alt 2A: Case 8 (14suop-1) Alt 2B: Case 9 (14suop-2)

The additional generation at Pointe du Bois (41 MW) is offset by a reduction in dc collector system generation (Kettle, Long Spruce and Limestone Generating Stations) in the summer off peak models and by an increase in exports in the summer peak and winter peak models.

The facility changes made to the base case models for each of the two transmission alternatives under consideration are summarized in Appendix B-1.

2.4 ACCC Results – Limiting Elements

The ACCC results for the 2014 winter peak, summer peak and summer off peak scenarios are summarized in Appendix B-2, BA-3 and B-4, respectively. The limiting elements related to Pointe du Bois improvements are identified and discussed in detail in this section. Contingencies which cause overloads both in the base case and in one or both of the alternative cases are not included in the detailed discussion unless the required rating change is greater than 2% higher with the alternative than with the base case.

A number of 230 kV system overloads resulting from common tower double contingencies in the Winnipeg area are identified in the ACCC analysis for summer peak case conditions. These overloads are not considered further or discussed in any detail since Pointe du Bois improvements have either little negative (<2%) impact or positive impact on the overloads. Future System Planning studies are required to address these issues.

2.4.1 McPhillips 115-66 kV Phase Shifting Transformer Banks 8 & 9

The two 80 MVA phase shifting transformers at McPhillips supply the Winnipeg Central (formerly Winnipeg Hydro) 66 kV network. This 66 kV network is also supplied by a 125 MVA phase shifting bank at Sherbrook, an 80 MVA phase shifting bank at Scotland, two 40 MVA non-phase shifting banks at Scotland, two 63.5 kV transmission lines (BA10 & TA11) and the Pointe du Bois and Slave Falls generating stations.

The worst case overloads for these banks occur under summer peak case conditions. An outage of either of the two banks results in overloads of the remaining bank of 111.4%, 118.1% and 115.6% of Rate C with the base case and Alternatives 2A and 2B respectively. These banks also overload in all three cases after a common tower outage involving 115 kV lines XS49 and HS5. These outages also cause overloads under winter peak case conditions but the magnitude of the overloads is smaller.

Recent Planning studies have identified the need to upgrade these transformers in the near future based on system scenarios not directly related to Pointe du Bois improvements. Preliminary work indicates that the rating of these two banks could be increased from 80 MVA to 92 MVA with fan upgrades, which would eliminate all the above mentioned overloads. These bank upgrades (or other equivalent upgrades) should be in place before Pointe du Bois improvements are completed.

2.4.2 Scotland 115-66 kV Phase Shifting Transformer Bank 7

An outage of the 125 MVA phase shifting transformer at Sherbrook under summer peak case conditions results in an overload on Scotland Bank 7 (80 MVA) of 113.6% and 105.8% of Rate C with Alternatives 2A and 2B respectively. This outage also causes a 101.8% overload on Scotland Bank 7 with Alternative 2A under winter peak load conditions. Further, with Alternative 2A, an outage of Harrow-Scotland 115 kV Line HS5 (supplies Scotland 115-66 kV non-phase shifting Banks 8 & 10) results in an overload of 104.9% of Rate C on Scotland Bank 9.

Recent Planning studies have identified the need to upgrade this transformer in the near future based on system scenarios not directly related to Pointe du Bois improvements. Preliminary work indicates that the rating of this bank could be increased from 80 MVA to 100 MVA with fan upgrades, which would eliminate the above mentioned overloads. These bank upgrades (or other equivalent upgrades) should be in place before Pointe du Bois improvements are completed.

2.4.3 Mohawk-St. Vital 115 kV Line XV39

Line XY39 is the single 115 kV tie between St. Vital and Mohawk Stations, and together with 115 kV lines YX47 (Laverendrye-Mohawk-Wilkes) and YX48 (Laverendrye-Mohawk-St. James), supply Mohawk and, via 115 kV Line XS49, Scotland Station. This line also supplies one of two transformers at Dakota Station via a tap (no breakers). With the winter peak, summer peak and summer off peak cases, a common tower outage involving 115 kV lines YX47 and YX48 results in an overload on XV39. This double circuit outage eliminates flows between Laverendrye and Mohawk and significantly increases flows between St. Vital and Mohawk. The two alternatives under consideration tend to worsen this situation, although the impact under winter peak and summer off peak conditions is less than 2%.

The XV39 overloads after this outage are considerably worse under summer peak case conditions. The YX47/YX48 double circuit outage results in overloads of 149.6%, 156.2% and 152.4% of Rate C in the base case and with Alternatives 2A and 2B respectively. The limitations associated with 115 kV double circuit outages in the Winnipeg area have already been identified and a Planning study has been initiated to address these issues. Recommendations from this report should help eliminate these overloads. Additional analysis will be required once these plans are finalized to determine if incremental improvements will be required to accommodate Redevelopment at Pointe du Bois. Rehabilitation will likely require fewer incremental upgrades.

Another double circuit outage which causes an overload on XV39 under summer peak case conditions is a common tower outage involving Dorsey-Laverendrye 230 kV Lines D11Y and D15Y. This double circuit outage reduces flows between Laverendrye and Mohawk and increases flows between St. Vital and Mohawk. It results in overloads on XV39 of 101.2%, 107.4% and 105.4% in the base case and with Alternatives 2A and 2B respectively. These overloads can be eliminated by adjusting phase shifters in the Winnipeg area to reduce flows into the Sherbrook and, to a greater extent, Scotland phase shifting transformers.

Finally, an outage of RS51 with the summer peak cases results in XV39 overloads of 101.3% and 107% in the base case and with Alternatives 2A respectively. Again, these overloads can be eliminated by adjusting phase shifters in the Winnipeg area.

2.4.4 Selkirk-Mercy 115 kV Line SM26

Line SM26 is one of two lines between Selkirk Generating Station and the Parkdale/Selkirk load centre. Under summer peak base case conditions (no Pointe du Bois improvements), a GP1 (Great Falls-Pine Falls 115 kV) / PR2 (McArthur Falls-Pine Falls 115 kV) double circuit outage or a PC3 (Pine Falls-Parkdale 115 kV) / PC4 (Pine Falls-Parkdale 115 kV) double circuit outage result in just under 100% loading on SM26. Both of these double circuit outages effectively remove two of the main circuits between the Great Falls and McArthur Falls Generating Stations and the Parkdale/Selkirk load centre. Power flow is diverted through Selkirk via the Great Falls-Selkirk 115 kV transmission.

Both alternatives under consideration slightly increase loading on SM26 for these outages, although for Alternative 2B, the increase is less than 2%. For Alternative 2A, the maximum overload on SM26 for these two double circuit outages is 101.8%. These double contingency related overloads could be addressed by reducing Selkirk generation.

2.4.5 Great Falls-Pine Falls 115 kV Line GP1

Under summer peak base case conditions (no Pointe du Bois improvements), a common tower outage of the Great Falls-Selkirk GS 115 kV lines GS21 and GS22 diverts some flows from the Winnipeg River generators to the Selkirk/Parkdale load centre through Pine Falls and results in a 108.2% (Rate C) overload on GP1. Alternatives 2A and 2B increase this overload to 113.3% and 112% of Rate C respectively. These double contingency related overloads could be eliminated by either re-dispatching some Winnipeg River generation or by upgrading GP1 from 70C to 100C.

2.4.6 Ridgeway-Transcona 66 kV Line R94

Line R94 is one of two 66 kV lines in Winnipeg East between Ridgeway, which has 230-66 kV transformation and Transcona, which has 115-66 kV transformation. With the summer peak case base case (no Pointe du Bois improvements), an outage of R95, the second 66 kV line between Ridgeway and Transcona, results in a 109.2% (Rate C) overload on R94. Alternative 2A, by delivering Pointe du Bois/Slave Falls generation into Transcona (instead of into Rover at 66 kV) and replacing the four existing banks at Transcona with two larger banks, increases this overload to 126.4% of Rate C. The extent of this overload would depend in part on the magnitude of the impedances of the two new transformers.

A number of current problems on the Winnipeg East 66 kV system unrelated to Pointe du Bois improvements have been identified in past System Planning work and a study is underway to address these issues. Limitations associated with Line R94 will be considered in this study. The requirements related specifically to Pointe du Bois Redevelopment or Rehabilitation should be re-examined once plans to address these issues are in place.

2.4.7 Transcona-Dawson Road 66 kV Line TD3

Line TD3 is one of two 66 kV lines between Transcona and Dawson Road and an important part of the 66 kV network between Transcona and Amy Station (former Winnipeg Hydro system). This line also supplies Atwood Station via a tap (no breakers). A number of outages result in significant overloads on this circuit under summer peak base case conditions (no Pointe du Bois improvements). Alternative 2A increases these overloads significantly since Pointe du Bois/Slave Falls generation is delivered to Transcona instead of directly to Rover.

The worst case is an outage of TD2, the other 66 kV line between Transcona and Dawson Road. The overload on TD3 for this outage is 132.7% (Rate C) with the base case and 153.3% (Rate C) with Alternative 2A. This outage also results in an overload with Alternative 2B but the magnitude of the overload is less than it is with the base case. Significant TD3 overloads also occur with the base case and Alternative 2A for an outage involving 115 kV Lines HS5 and XS49 (the two 115 kV supply lines into Scotland) and Transcona-Amy 66 kV Line TA11. Further, with Alternative 2A, loading on TD3 is 101.6% of Rate C with no contingency outages.

A number of current problems on the Winnipeg East 66 kV system unrelated to Pointe du Bois improvements have been identified in past System Planning work and a study is underway to address these issues. Limitations associated with Line TD3 will be considered in this study. The requirements related specifically to Pointe du Bois Redevelopment or Rehabilitation should be re-examined once plans to address these issues are in place.

2.4.8 Rover-Charles 66 kV Line W4

Line W4 (Rover-Charles) is part of the former Winnipeg Hydro system and is one of two 66 kV circuits out of Rover. Under summer off peak case conditions, an outage of W13 (Rover-Amy), the other 66 kV circuit out of Rover, results in a 106.2% overload on W4 (Rover-Charles) with Alternative 2B. This overload does not occur under winter peak or summer peak conditions since a larger portion of the Pointe du Bois/ Slave Falls generation delivered to Rover is consumed at Rover.

Distribution Planning is currently studying a number of options for new stations in the north east corner of the former Winnipeg Hydro service territory which will required a new 66 kV supply line out of Rover. This new line may run parallel to the exiting W4 (Rover-Charles) circuit or, more likely, will replace the aging cable. This system improvement is expected to be in place before Pointe du Bois improvements are completed.

2.4.9 Rover-Amy 66 kV Line W13

Line W13 (Rover-Amy) is part of the former Winnipeg Hydro system and is one of two 66 kV circuits out of Rover. Amy Station is located in downtown Winnipeg and this circuit generally carries the majority of the power flowing out of to Rover into the Winnipeg Central 66 kV system.

For a common tower outage of Slave Falls-Scotland Lines S1 and S2 with either Alternatives 2A or 2B, the new 115 kV line between Pointe du Bois and the Winnipeg area (either Transcona or Rover) would carry the full amount of generation from Pointe du Bois and Slave Falls. With Alternative 2B, the majority of this power would flow through the Rover transformer and then out of Rover on Line W13 (Rover-Amy). This results in a 164% overload on this circuit using the summer off peak case. The overloads are lower in the winter peak and summer peak cases since station loads, particularly at Rover, are higher. These overloads could be eliminated by reducing Slave Falls generation for this particular double contingency or by tripping the new line or new 115-66 kV bank at Rover.

2.4.10 New Rover 115-66 kV Transformer

In this study the size of the new Rover 115-66 kV transformer used for Alternative 2B is assumed to be 125 MVA. This size is consistent with the largest 115-66 kV bank currently supplying the Winnipeg 66 kV network and is likely close to the largest amount of power with the Rover load and the two 66 kV lines out of Rover could accommodate.

For a common tower outage of Slave Falls-Scotland Lines S1 and S2 with Alternative 2B, the new 115 kV line between Pointe du Bois and Rover carries the full amount of generation from Pointe du Bois and Slave Falls. This results in a 138% overload on this bank using either the summer peak or summer off peak cases. This overload could be eliminated by reducing Slave Falls generation for this particular double contingency or by tripping the new line or new 115-66 kV bank at Rover.

2.4.11 New Pointe du Bois-Transcona or Pointe du Bois-Rover 115 kV Line

The new Pointe du Bois-Transcona and Pointe du Bois-Rover 115 kV Lines of Alternatives 2A and 2B respectively will consist of newly constructed line as well as a portion of an existing 266.8 MCM double circuit 115 kV line between the Winnipeg River and Winnipeg (GT1 & ST2). This existing double circuit is currently sagged for 75C.

For a common tower outage of Slave Falls-Scotland Lines S1 and S2 with both alternatives, this new 115 kV line carries the full amount of generation from Pointe du Bois and Slave Falls. This results in a significant overload on the new line based on the 75C Rate C currently in the MAPP model. These overloads could be eliminated by upgrading the existing double circuit portion of this line to 100C.

2.5 Conclusions

Overloads on the McPhillips, Scotland and Sherbrook 115-66 kV phase shifting transformers occur in the 2014 summer peak base case with no Pointe du Bois redevelopment. The phase shifting banks at McPhillips (Banks 8 & 9) and Scotland (Bank 7) will have to be upgraded to 92 MVA and 100 MVA respectively before 2014 with or without Pointe du Bois improvements.

Both transmission alternatives under consideration with Redevelopment can have a negative impact on McPhillips, Scotland and Sherbrook 115-66 kV transformation overloads after contingencies, particularly under summer peak conditions. With Alternative 2A the direct connection between Pointe du Bois and the Winnipeg Central 66 kV network (Rover Station) is removed. Further, the conversion of the Slave Falls transmission from 138 kV to 115 kV increases the reactive power requirements of this system. The additional reactive power (a difference of about 11 MVA_r compared to the summer peak base case) must flow from the MH 115 kV system, through the 66 kV network and to the Slave Falls transmission terminated at Scotland.

With Alternative 2B, the reactive power for both the Slave Falls transmission and the new Pointe du Bois transmission (a difference of about 18.8 MVA_r compared to summer peak base case) must flow through the 66 kV network increasing the reactive power flows seen by the 115-66 kV transformation. This indicates that capacitor additions (likely at 66 kV voltage level) should be considered for both alternatives.

Overloads on Transcona-Dawson Road 66 kV Line TD3 occur for a number of contingencies with the 2014 summer peak base case. System Planning should address these base case overloads in future work. Alternative 2A has a negative impact on this situation since some of the power delivered to Transcona from Pointe du Bois flows through this network increasing the overloads. Due to the magnitude of the increase in overloads, incremental improvements to this 66 kV network could be required to accommodate Alternative 2A. The impact of this alternative should be reexamined once plans to address the base case contingency overloads are developed.

Overloads on St. Vital-Mohawk 115 kV Line XY39 occur for a number of common tower double contingencies with and without changes Pointe du Bois. System Planning should investigate these base case overloads as part of an ongoing study on common tower outages on the Winnipeg area 115 kV transmission system. The impact of Pointe du Bois improvements on this part of the system should be reexamined once this study's recommendations are known. Alternative 2A increases XY39 overloads more than Alternative 2B since Alternative 2B delivers Pointe du Bois/Slave Falls power directly to the Winnipeg Central 66 kV network.

Alternative 2A results in slight overloads on Selkirk-Mercy 115 kV Line SM26 for two common tower outages. The increase in loading on SM26 for these outages when compared to the base case (no Pointe du Bois improvements) is slightly greater than 2%.

Selkirk or Winnipeg River generation would have to be reduced to eliminate the overloads from these common tower outages. Alternative 2B results in less than a 2% increase of loading on SM26 for these outages.

System Planning should consider upgrading Great Falls-Pine Falls 115 kV Line GP1 to 100C (currently 70C) to eliminate a potential overload for a common tower outages of Great Falls-Selkirk 115 kV Lines GS21 & GS22. This upgrade would also eliminate the overloads with both alternatives for this common tower outage.

3.0 Constrained Interface Analysis

3.1 Introduction

Constrained interface analysis is typically used to investigate the impact that long-term firm point-to-point transactions have on constrained interfaces within MAPP and MISO and to determine if there is sufficient non-recallable available transmission capacity to accommodate the request. In this case, the Generator has requested the hydraulic plant be considered a MH network resource. The impact of re-dispatching output from this plant to generation within Manitoba on constrained interfaces is calculated.

3.2 Study Procedure

It was not necessary to conduct two separate studies into the impact of both Rehabilitation and Redevelopment on constrained interface flows. Rehabilitation is expected to at most contribute an additional 11 MW output, while Redevelopment can provide an additional 41 MW. Since Redevelopment is the more limiting case, it is sufficient evidence to demonstrate that adequate transmission is available for this option.

For each transmission alternative, system intact cases (summer off-peak, summer peak and winter peak) are modified to include the additional 41 MW output from Pointe du Bois. Four different power flow cases are created for each seasonal case, in which the generation increase was scheduled to Dorsey DC, Brandon CT and Grand Rapids generation and Manitoba seasonal load.

The net change in power flow across a constrained interface is divided by the amount of new generation. This quantity is called the distribution factor (DF). Four different sets of DFs were calculated for each power flow in order to see any effects of varying the Manitoba Hydro slack bus. Area interchange was enabled in the creation of the pre- and post-Pointe du Bois generation increase power flows.

A PSS/E IPLAN program was run to compare the flows on MAPP constrained interfaces in the pre- and post-Pointe du Bois generation increase cases. If the DF (incremental loading as a percent of the generation schedule) is greater than 5%, investigation of long-term non-recallable transmission capacity (NATC) is required.

3.3 Discussion - Results

In all cases, the entire generation increase transaction stays within Manitoba's boundaries, and therefore does not directly cross any of MAPP's constrained interfaces. Loop flows through Saskatchewan and Ontario do not result, due to phase-shifting transformers being present at Boundary Dam on the Saskatchewan-North Dakota 230 kV interconnection and at Whiteshell on the Manitoba-Ontario 230 kV interconnection.

There is virtually no impact on Manitoba – U.S. tie line sharing for either Rover or Transcona 115 kV alternative. The highest increased distribution factors for each alternative are discussed below. Decreased flow on a constrained path is considered to be a positive impact.

3.3.1 Rover 115 kV Alternative

The highest positive distribution factor for the 41 MW generation addition is 2.8% and occurs for the NDEX interface (North Dakota) during the 2014 summer peak case. Since the impact is less than 5%, no additional investigation of NATC is needed.

3.3.2 Transcona 115 kV Alternative

The highest positive distribution factor for the 41 MW generation addition is 3.5% and occurs for the NDEX interface (North Dakota) during the 2014 summer off-peak case. Since the impact is less than 5%, no additional investigation of NATC is needed.

The MHEX_S+ interface shows a reduction of flow of 3.2% across its boundary.

3.4 Conclusions

Either Rover or Transcona 115 kV transmission alternative can redispatch the 41 MW generation addition to Manitoba Hydro generation and load without impacting any MAPP constrained interface. There is negligible impact on Manitoba – U.S. tie sharing.

4.0 Short Circuit Analysis

4.1 Introduction

The addition of generation at Pointe du Bois may expose existing facilities to an increase in fault current. Fault analysis has been performed to determine the impact of a 41 MW increase on existing equipment connected to the Manitoba Hydro network. As it is expected that Redevelopment will provide a more conservative assessment, no fault analysis was conducted for the Rehabilitation option.

4.2 Fault Study Model

The study model was based on the System Planning 2004 short circuit model, but encompassed a number of additions to incorporate the Redevelopment of the Pointe du Bois generating station and either Rover or Transcona 115 kV transmission alternatives. These additions include but are not limited to:

1. The redevelopment of Pointe du Bois generating station, increasing capacity to 140 MVA (120 MW at 0.85 pf).
2. The conversion of the existing 138 kV lines between Pointe and Slave Falls and Slave Falls and Scotland to 115 kV operation.
3. The replacement of the existing 121/66 kV banks 11 to 14 at Scotland station with 2-125 MVA units.
4. The utilization of a portion of the existing 115 kV GT1/ST2 double circuit line, with terminations at either Transcona or Rover.
5. The replacement of the existing 115/66 kV banks 2, 3 and 4 at Transcona station with 2-125 MVA units.
6. The addition of a 125 MVA 115/66 kV transformer at Rover station.

A two stage study methodology was conducted as follows:

1. An initial overview of fault levels, breaker capacities, and percent increases for both transmission alternatives. This overview used less stringent criteria to identify the stations requiring more detailed examination.
2. An individual circuit breaker detailed examination of all stations flagged in the overview assessment was then completed.

4.3 Criteria Used in the Evaluation

4.3.1 Station Fault Level Overview

Three phase and single-line-ground fault levels were calculated at 35 Winnipeg area stations. The results were developed and evaluated under the following criteria:

1. “Flat Classical” analysis was used in all fault calculations. The base kV was then adjusted to produce fault levels that reflect nominal system voltages.
2. Station symmetrical fault levels were directly compared to the lowest rated breaker(s) at a particular location, i.e. an individual breaker is required to interrupt the entire fault kA or MVA produced by a “close in” fault. No consideration was given for location, circuit breaker duty or individual equipment contribution.
3. All busses in the major transmission system were analyzed in their normal¹ operating condition.
4. All busses in the sub-transmission system were analyzed in a minimal networked² operating condition.
5. Stations that contain circuit breakers with an interrupting capability at or above 90% of the full three phase or S-L-G bus fault current and exhibit a 2.0% or greater increase in fault levels due to the Pointe du Bois Redevelopment with the transmission alternatives, were identified for detailed analysis.

4.3.2 Circuit Breaker Detailed Examination Criteria

A total of 22 circuit breakers at 3 individual stations were identified by the overview examination and found to require additional analysis under the following criteria:

1. Faults on both sides of the circuit breaker were considered with the location providing the highest fault current used in determining breaker capability.
2. The breaker in question was assumed to be the last breaker to clear the fault. This was accomplished by performing an “open end” fault calculation where the remote line end breaker is assumed open prior to the application of the fault. In the case of a transformer circuit breaker,

¹ This is the “normal operating” model of the 2004 Manitoba Hydro system; all N/O points in use during non-emergency operation are represented.

² “Minimal Networked” fault levels allow for a maximum of two switch closures thus linking as many as three supply stations. All other N/O points are consistent with normal operation

- the transformer was assumed out-of-service before the fault value as seen by the breaker was calculated.
3. The highest typical operating voltage was considered when calculating the fault current.
 4. To account for the asymmetrical (ac and dc decay) component of the fault current the system X1/R1 ratio was calculated from the Thevenin impedance at the fault location. A value exceeding 17 (L/R time constant = 45ms) required a multiplying factor to be applied to the fault value. None of the circuit breakers under study required an X1/R1 multiplying factor.
 5. If an individual circuit breaker has a symmetrical interrupting rating at or beyond its resulting detailed fault calculation value, it was considered a candidate for replacement.

4.4 Study Results

4.4.1 Overview Examination

Three phase and single-line-ground fault levels were calculated for both Rover and Transcona alternatives at 35 area stations. Transcona 115 kV alternative yielded a total of 22 circuit breakers at 3 individual stations. On the other hand, Rover 115 kV alternative did not identify any breakers beyond the assessment criteria. Therefore, the detailed examination discussion will consider only the Transcona 115 kV alternative.

4.4.2 Detailed Examination

Two 115 kV breakers were identified at the Transcona 115 kV station as requiring further study. By applying the detailed examination criteria to each individual breaker, it was determined that both breakers be recommended for replacement due to the impact of Redevelopment with the Transcona 115 kV alternative.

Eight 66 kV breakers were identified at the Transcona 66 kV station as requiring further study. By applying the detailed examination criteria to each individual breaker, it was determined that all eight be recommended for replacement due to the impact of Redevelopment with the Transcona 115 kV alternative.

Seven 66 kV breakers were identified at the Dawson Road 66 kV station as requiring further study. By applying the detailed examination criteria to each individual breaker, it was determined that none of the 7 be recommended for replacement.

Five 66 kV breakers were identified at the Des Meurons 66 kV station as requiring further study. By applying the detailed examination criteria to each individual breaker, it was determined that none of the 5 be recommended for replacement.

4.5 Conclusions

Redevelopment with the Transcona 115 kV alternative will increase the fault level interrupting requirements of 10 Winnipeg area circuit breakers up to or beyond their rated short circuit interrupting capacity. The Rover 115 kV alternative does not increase the fault level interrupting requirements beyond the circuit breaker capacity of any of the 35 stations evaluated.

5.0 Stability Analysis

5.1 Introduction

Transient stability involves major disturbances such as sudden loss of generation, line-switching operations, faults or sudden load changes. Following a disturbance, synchronous machine frequencies undergo transient deviations from synchronous frequency and machine power angles change. The objective of a transient study is to determine whether or not the machines will return to synchronous frequency at a new steady-state power angle. Changes in power flows and bus voltages are also a concern. Stability analysis is performed using the summer study package developed by the MAPP Transmission Reliability Assessment Working Group (TRAWG) to monitor bus voltages, rotor angles, relay margins, power flows and other system variables during critical disturbances.

5.2 Study Criteria

MAPP has specific voltage criteria for buses during system disturbances. This criteria ensures that power system performance is within NERC guidelines. The default transient voltage criteria within MAPP requires that voltages do not swing below 0.70 per unit or above 1.20 per unit voltage after a disturbance clears. Specific buses defined in the *MAPP Operating Studies Manual* have voltage limits outside of those defined by the MAPP default criteria and were applied in this study.

5.3 Study Models

The summer study package developed by the MAPP Transmission Reliability Assessment Working Group (TRAWG) was used for summer stability assessment. It is based on a 2002 MAPP model series, year 2012 case.

The load flow case from the study package was subsequently expanded to include upgrades at Great Falls GS and Pine Falls GS to be completed in 2004 and 2008, respectively. These two projects precede Pointe du Bois development in the Interconnection Generation Queue and are included in this study to provide a more accurate snapshot of the Winnipeg River area around 2011.

Great Falls unit 3 was refurbished in 2003, resulting in a capacity increase from 21 to 28.5 MVA. Refurbishment of unit 4 was scheduled to be completed in 2004 and should also increase its capacity to 28.5 MVA. The refurbishment of units 3 and 4 results in 8 MW of additional generating capacity from Great Falls GS.

There are also plans to re-runner units 1 and 2 at Pine Falls. This work would be completed in 2008 and increase the rating of each unit from 15.5 MVA to 20.5 MVA.

The re-running of units 1 and 2 results in 6 MW of additional generating capacity from Pine Falls GS.

One summer off-peak case from the TRAWG study package provided the base case:

<u>Load</u>	<u>Prior outage</u>	<u>loadflow</u>
Summer off-peak	none	b00-so12aa.uymV4V4.sav

This base case was updated to include aforementioned upgrades at Great Falls and Pine Falls. Derived load flow cases for the different scenarios are summarized in Table 3.

Stability analysis of the Repowering option was conducted separately with the TRAWG study package because of its unique application of low-inertia Stralfo units. Refer to section 5.4.3 for a detailed discussion and conclusions.

Table 3: System Intact base cases – Stability Analysis

<u>Load Flow</u>	<u>Generation Option</u>	<u>Transmission Alternative</u>	----- Power Transfer -----		
			<u>MH>US</u>	<u>NDEX</u>	<u>SP>US</u>
p1r-so12aa.uymV4V4	Rehabilitate	Rover	2173	1958	164
p1t-so12aa.uymV4V4	Rehabilitate	Transcona	2173	1958	165
p2r-so12aa.uymV4V4	Redevelop	Rover	2174	1958	165
p2t-so12aa.uymV4V4	Redevelop	Transcona	2174	1958	165

The Rehabilitation option re-uses existing machine models and increases PDB generation from 78 MW to 90 MW. The Redevelopment option employs new machine models and increases PDB generation from 78 MW to 120 MW. From each base case in Table 3, two prior outage load flow cases were developed. The following prior outages were used:

- Prior outage 1: Pointe du Bois – Rover (Transcona) 115 kV line
- Prior outage 2: Slave Falls – Scotland S1 line

For discussion purposes in this study section, Prior outage 1 (or the line itself) may be referred to as PR or PT, depending on the transmission alternative being referenced.

Table 4 provides a summary of prior outage cases.

Table 4: Prior outage cases – Stability Analysis

<u>Load Flow</u>	<u>Generation Option</u>	<u>Transmission Alternative</u>	<u>Prior Outage</u>
p1r-so12s1.uymV4V4	Rehabilitate	Rover	S1
p1r-so12pr.uymV4V4	Rehabilitate	Rover	PR
p1t-so12s1.uymV4V4	Rehabilitate	Transcona	S1
p1t-so12pt.uymV4V4	Rehabilitate	Transcona	PT
p2r-so12s1.uymV4V4	Redevelop	Rover	S1

p2r-so12pr.uymV4V4	Redevelop	Rover	PR
p2t-so12s1.uymV4V4	Redevelop	Transcona	S1
p2t-so12pt.uymV4V4	Redevelop	Transcona	PT

5.3.1 Stability Models

Great Falls units 3 & 4

The dynamic models and parameters for refurbished unit 3 were taken from reference [2]. As new data from refurbishment of unit 4 is not available, it is assumed that its new dynamic models and parameters are the same as those for unit 3. Stability data sheets are provided in Appendix C-1.

Pine Falls units 1 & 2

Re-running of units 1 and 2 at Pine Falls will change the unsaturated d-axis reactances of the generators. No further information was available. See Appendix C-2 for dynamic models.

Rehabilitated Pointe du Bois

Data was not provided by the Generator to account for possible changes to dynamic models from the Rehabilitation process. It was assumed that the existing dynamic models for Pointe du Bois would not change.

Redeveloped Pointe du Bois - new units

Redevelopment of Pointe du Bois GS will see the existing plant replaced with a new powerhouse outfitted with four new vertical shaft units, likely similar to those at Kelsey GS. Generator machine and governor models like those at Kelsey were used. A static exciter model and power system stabilizer model were tuned for use at the redeveloped plant. See Appendix C-3 for dynamic models.

5.3.2 Disturbance List

Two types of local disturbances were simulated to assess the performance of each generation option and transmission alternative pair:

- Single line to ground stuck breaker (slow clearing) fault with system intact
- 3-phase normal clearing fault with prior line outage

Cross tripping of generation is required for most of the studied prior outage disturbances. The Pointe du Bois / Slave Falls “collector system” will have three outlet lines: S1, S2, and PR/PT. Generally, loss of any two outlet lines will require generation reduction to prevent overloading the remaining line. The amount of generation that is cross tripped

depends on the combined power output at Pointe du Bois and Slave Falls, and on the transmission capacity of either 115 kV transmission alternative.

For simplification, all generation cross tripping is assumed to occur at Pointe du Bois. It is assumed that suitable communication facilities will be established between Pointe du Bois and Slave Falls to achieve this cross trip scheme and that breaker-fail protection will be installed at Pointe du Bois. The cost to provide this cross trip scheme is estimated to be \$ 1 million. It will be determined in the Interconnection Facilities Study.

Since the transmission network changes for each Pointe du Bois generation and transmission pair, a fair comparison for each scenario could not be made against the existing system configuration. As such, efforts were directed at assessing the performance of each proposed development scenario, rather than at evaluating the performance of the present system.

Standard Northern MAPP limiting disturbances were not simulated because Pointe du Bois GS is located further within Manitoba Hydro's boundaries and its generation increase is not expected to significantly impact neighbouring utilities.

Rehabilitated plant – Rover alternative

Prior Outage 1 - PR

- p1s 6 cycles 3 phase fault at Slave Falls end of Slave Falls-Scotland S2 line and subsequent cross tripping of PDB units 1-4
- p2s 6 cycles 3 phase fault at PDB end of PDB-Slave Falls R2 line and subsequent cross tripping of PDB units 1-4

Prior Outage 2 – S1

- p3s 6 cycles 3 phase fault at PDB end of PDB-Rover 115 kV line and subsequent cross tripping of PDB units 1-4
- p4s 6 cycles 3 phase fault at Slave Falls end of Slave Falls-Scotland S2 line and subsequent cross tripping of PDB units 1-4

System Intact

- c4s 16 cycles SLG 115 kV fault at PDB end of PDB-Rover 115 kV line. Stuck breaker and subsequent loss of units 13-16 (26 MVA reduction)

Rehabilitated plant – Transcona alternative

Prior Outage 1 - PT

- p1s 6 cycles 3 phase fault at Slave Falls end of Slave Falls-Scotland S2 line and subsequent cross tripping of PDB units 1-4
- p2s 6 cycles 3 phase fault at PDB end of PDB-Slave Falls R2 line and subsequent cross tripping of PDB units 1-4

Prior Outage 2 – S1

p5s 6 cycles 3 phase fault at PDB end of PDB-Transcona 115 kV line and subsequent cross tripping of PDB units 1-4

p6s 6 cycles 3 phase fault at Slave Falls end of Slave Falls-Scotland S2 line

System Intact

a4s 16 cycles SLG 115 kV fault at PDB end of PDB-Transcona 115 kV line. Stuck breaker and subsequent loss of units 13-16 (26 MVA reduction)

Redeveloped plant – Rover alternative

Prior Outage 1 - PR

p7s 6 cycles 3 phase fault at Slave Falls end of Slave Falls-Scotland S2 line and subsequent cross tripping of two 37.5 MVA units at PDB

p8s 6 cycles 3 phase fault at PDB end of PDB-Slave Falls R2 line and subsequent cross tripping of two 37.5 MVA units at PDB

Prior Outage 2 – S1

p9s 6 cycles 3 phase fault at PDB end of PDB-Rover 115 kV line and subsequent cross tripping of of 2, 37.5 MVA units at PDB

pas 6 cycles 3 phase fault at Slave Falls end of Slave Falls-Scotland S2 line and subsequent cross tripping of three 37.5 MVA units at PDB

System Intact

c3s 16 cycles SLG 115 kV fault at PDB end of PDB-Rover 115 kV line. Stuck breaker and subsequent loss of one 37.5 MVA unit at PDB

Redeveloped plant – Transcona alternative

Prior Outage 1 - PT

p7s 6 cycles 3 phase fault at Slave Falls end of Slave Falls-Scotland S2 line and subsequent cross tripping of two 37.5 MVA units at PDB

p8s 6 cycles 3 phase fault at PDB end of PDB-Slave Falls R2 line and subsequent cross tripping of two 37.5 MVA units at PDB

Prior Outage 2 – S1

pbs 6 cycles 3 phase fault at PDB end of PDB-Transcona 115 kV line and subsequent cross tripping of two 37.5 MVA units at PDB

pcs 6 cycles 3 phase fault at Slave Falls end of Slave Falls-Scotland S2 line and subsequent cross tripping of one 37.5 MVA unit at PDB

System Intact

a3s 16 cycles SLG 115 kV fault at PDB end of PDB-Transcona 115 kV line. Stuck breaker and subsequent loss of one 37.5 MVA unit at PDB

5.4 Discussion – Stability Results

Stability summary data is tabulated in Appendix D.

Cross trip time delays of 8, 10, 12, and 14 cycles were tested for several disturbances. It was determined that cross tripping of generation should occur within 10 cycles after the initial fault application for each disturbance. Generally, transient instability was observed if either 12 or 14 cycle time delays were used.

5.4.1 Rehabilitation

Both Rover and Transcona alternatives demonstrated transient stability following disturbance p1s. The 115 kV bus voltages at Slave Falls and Pointe du Bois fall close to 0.7 p.u. during the initial voltage swing, but quickly recover to within normal operating range. See Appendix D-1 and D-2. After 10 seconds of simulation, minor oscillations can still be observed. Damping is only marginally satisfactory with Rehabilitation.

The Rehabilitation option with the Transcona alternative was unstable for disturbance p5s. In Appendix D-3, the rotor angles for Pointe du Bois and Slave Falls units fall out of synchronism with units at other Winnipeg River plants. High frequency oscillations can also be observed with 115 kV bus voltages at Slave Falls and Pointe du Bois. The post-disturbance power flows along intact line S2 oscillate at the same frequency as the Slave Falls bus voltage.

Transient stability could be achieved if the pre-contingency output at Pointe du Bois is reduced below 90 MW to the existing output of 78 MW. However, as the objective of Rehabilitation is to increase the output at Pointe du Bois to a maximum of 90 MW, the implication is it is not desirable to combine the Rehabilitation option with the Transcona 115 kV transmission alternative.

Transient instability was not observed for the equivalent Rover alternative disturbance p3s. Its stability plots are similar to those already given in Appendix D-1. However, the Rover alternative requires more generation to be cross tripped to prevent overloading the new Rover 115/66 kV bank that is rated 125 MVA. This also mitigates overloading the Rover – Amy 66 kV outlet line.

For illustration, compare Appendix D-4 for Rover alternative and Appendix D-5 for Transcona alternative. The latter shows that with S1 and S2 out of service, the 115 kV from Pointe du Bois to Transcona can carry the full output of Pointe du Bois and Slave Falls. This is not possible with the Rover alternative; it requires generation to be cross tripped, as shown by the reduced line flows in D-4.

If Rehabilitation was implemented at Pointe du Bois, the Rover 115 kV alternative would provide a more robust transmission outlet from a stability perspective.

5.4.2 Redevelopment

With the Redevelopment option, there was no appreciable difference between the transient performance of the system with either Rover or Transcona alternative. Good transient damping is achieved with the power system stabilizer at Pointe du Bois. No instability was observed. See Appendix D-6 for the Rover alternative and Appendix D-7 for the Transcona alternative.

The Redevelopment option would be preferred over Rehabilitation from a stability perspective; this can be attributed to the application of power system stabilizers.

5.4.3 Repowering

The Repowering option would provide for the installation of new Straflo generating units to replace existing units with Francis type turbines. It is expected that a total of 14 Straflo units would ultimately be in-service at Pointe du Bois, with a total output of 120 MW.

The replacement of Pointe du Bois generators with Straflo units was previously studied in 1999 [3]. The study concluded that new Straflo units will lose synchronism for certain faults while conventional units would not. This is due to the following:

- Straflo units have only half the inertia of conventional units
- Reactances for these units are 50 to 200% higher than those for conventional units

The 1999 study did not consider the impact of power system stabilizers (PSS) on system stability.

This IES study expanded the study of Straflo units by considering the impact of PSS on system stability. It was assumed that static exciters along with dual input, integral-of-accelerating power stabilizers would be installed. The SCRX static exciter model and IEEE standard PSS2A stabilizer model were used in this study.

The Rover 115 kV transmission alternative was studied in conjunction with this Repowering option. Fourteen Straflo units are considered to be in-service.

Stability results show that the Straflo units will separate from the electrical system for 3-phase bus faults at Pointe du Bois with clearing times exceeding 8 cycles. Power system stabilizers do not prevent this loss of synchronism. More severe disturbances that consider line or generating unit trips, prior outages and slower clearing times (stuck breaker) will increase the risk of system instability.

The loss of the entire Pointe du Bois plant for moderate disturbances is not acceptable. Mitigation measures which would overcome this shortcoming may be available, but were

not studied as part of this report. If required, the Interconnection Facilities Study could give consideration to such measures.

5.5 Conclusions

Repowering at Pointe du Bois is unacceptable and not recommended, as described in section 5.4.3.

Redevelopment of Pointe du Bois Generating Station should not negatively impact the transient stability of the transmission network. Both Pointe du Bois 115 kV transmission alternatives did not exhibit instability problems when combined with the Redevelopment option.

However, more generation cross tripping (after prior outage contingency) was required for the Rover alternative to prevent overloading the new Rover 115/66 kV transformer bank and the Rover – Amy 66 kV outlet line. The bank will be rated 125 MVA.

Redevelopment of Pointe du Bois GS will require the installation of power system stabilizers to damp out rotor angle oscillations following severe transient disturbances. The stabilizers require proper tuning to effectively damp out system swings.

The Rehabilitation option at full rated generation output (90 MW) was unstable for one prior outage contingency when combined with the Transcona 115 kV alternative. Transient stability for this prior outage contingency could be achieved if Pointe du Bois output was reduced below 90 MW to its existing output of 78 MW.

No transient instabilities were observed for the Rehabilitation option when combined with the Rover 115 kV alternative.

From a stability standpoint, the Rover 115 kV alternative provides a more robust transmission solution for the Rehabilitation option at Pointe du Bois GS. However, the Redevelopment option is preferred over Rehabilitation due to improved damping performance and disturbance recovery. This is true for both Transcona and Rover 115 kV alternatives.

6.0 Transmission Facility Costs

6.1 Introduction

The transmission facility costs for either Transcona or Rover 115 kV alternative are calculated to meet Level I requirements (+/- 50 %). They are applicable whether Rehabilitation or Redevelopment proceeds at Pointe du Bois.

If Pointe du Bois was decommissioned, the cost to advance future capacity increase to the Winnipeg Central area is estimated to be \$3 million in 2004 dollars. It is assumed that the next capacity increase would be a new 66 kV line between Ridgeway and Rover stations.

6.2 Cost Comparison

A cost breakdown for each transmission alternative is provided below in Table 5.

Table 5: Cost Breakdown for Transcona (2A) and Rover (2B) 115 kV Alternatives

		Cost Estimate
2A	- Establish 115 kV single circuit line between Pointe du Bois and GT1/ST2 tap	\$ 8,350,106
	- Reterminate TR5, SV23 & GT1 at Transcona (completes PDB-Transcona line)	\$ 1,086,201
	- Install 1-115 kV breaker at Transcona ¹	\$ 831,224
	- Install 8-115 kV breakers at Pointe Du Bois ²	\$ 5,971,429
	- Replace Transcona Banks 2, 3 & 4 with 2-125 MVA banks	\$ 6,033,249
	- Upgrade Slave & River lines to 100C	\$ 500,000*
	- Replace Scotland Banks 11, 12, 13 & 14 with 2 x 125 MVA banks	\$ 7,174,382
	- Salvage existing Pointe du Bois 138-66 kV station	\$ 650,459
	- Replace 10 circuit breakers in Winnipeg area	\$ 3,000,000
Total:⁴	\$ 33,597,050	
2B	- Establish 115 kV single circuit line between Pointe du Bois and GT1/ST2 tap	\$ 8,350,106
	- Establish 115 kV single circuit line between GT1 and Rover	\$ 3,778,272
	- Install 1-115 kV breaker and 1-125 MVA, 115-66 kV transformer at Rover ³	\$ 4,330,807
	- Install 8-115 kV breakers to Pointe Du Bois ²	\$ 5,971,429
	- Upgrade Slave & River lines to 100C	\$ 500,000*
	- Replace Scotland Banks 11, 12, 13 & 14 with 2 x 125 MVA banks	\$ 7,174,382
	- Salvage existing Pointe du Bois 138-66 kV station	\$ 650,459
	Total:⁴	\$ 30,755,455

* Feasibility of upgrades & cost to be determined in 2005.

Notes:

[1] Includes cost of one new bay.

[2] Requires expansion of switchyard for two additional bays. May have further site improvement costs.

[3] Includes cost of one 66 kV breaker and one 40 MVA ground bank.

[4] Does not include cost of generation cross trip scheme.

All costs in Table 5 are based on 2004 dollars. Interest and escalation are not included. It is anticipated that Manitoba Hydro's Transmission & Distribution division will cover the cost (\$ 14,646,531) to salvage the existing Pointe du Bois – Rover 66 kV lines. As the Generator will provide the four new generator transformers at Pointe du Bois, their costs are not included in Table 5.

In general, it is assumed that the existing right-of-way from Pointe du Bois to Winnipeg will be utilized as much as possible to reduce the potential environmental impact a new transmission line may have on the Whiteshell / Winnipeg River area.

It is also assumed that the existing Pointe du Bois – Rover 66 kV transmission lines can be salvaged in advance of any new line construction activities. If the existing lines remain in-service prior to new transmission line construction, additional cost will be incurred for the selection and approval of a new transmission line route.

Transmission costs for both alternatives could increase substantially if it is not possible to upgrade Slave Falls lines S1 and S2 to 100C rating. The 100C rating will permit S1 and S2 to accommodate the entire maximum output of Pointe du Bois (120 MW) and Slave Falls (68 MW) should the new 115 kV line between Pointe du Bois and Winnipeg (Transcona or Rover termination) be out-of-service. If this firm transmission capacity is not available, then it will be necessary to construct an additional 115 kV circuit from Pointe du Bois. This additional 115 kV circuit can be terminated at Transcona or Rover station. Refer to the following section for a brief discussion.

6.3 Additional Considerations

The Transcona 115 kV alternative will increase the fault level interrupting requirements of 10 Winnipeg area circuit breakers up to or beyond their rated short circuit interrupting capacity. The minimum cost to replace all 10 circuit breakers is estimated to be \$ 3,000,000. This cost is noted in Table 5.

The incremental cost for a second 115 kV circuit between Pointe du Bois and Transcona is \$ 4,290,289. This includes the cost for a second bay expansion at Transcona and associated line terminations.

The incremental circuit cost for a second 115 kV circuit between Pointe du Bois and Rover is \$ 4,922,792. This excludes the cost of a second 115-66 kV bank, which would be required. In this case, it is uncertain whether sufficient space exists in the Rover switchyard to terminate another 115 kV circuit and therefore, termination and bay costs have not yet been included.

Technical studies were not conducted to evaluate the merits of a second 115 kV circuit.

6.4 High Level Schedule

The Generator needs to determine which generating option it wishes to pursue. Once a commitment is made to proceed by the Generator, Manitoba Hydro will require several years lead time to conduct transmission system improvements in advance of generation changes at Pointe du Bois.

The following system improvements are expected:

<u>In-service</u>	<u>Transmission Improvement</u>
2005/06	Upgrade Slave Falls lines S1 and S2, River lines R1 and R2 to 100C
2006/07	Increase interchange capacity into Winnipeg Central load centre by upgrading phase-shifting transformers (this is required independent of Pointe du Bois development)
2009/10	Replace Scotland banks 11-14 with 2, 125 MVA banks; this includes construction of Scotland 115 kV ring bus and conversion of the 138 kV Slave Falls – Scotland system to 115 kV operation
2010/11	Salvage Pointe du Bois 66 kV lines. Construct of new 115 kV line & station facilities at Rover Station.

Conversion of the Pointe du Bois switchyard to 115 kV rating is expected to be completed in several stages for either generation option. The existing 66 and 138 kV buses will be modified for 115 kV operation one bay at a time. This work will be coordinated with transfer of generating units off the existing 66 kV and 138 kV step-up transformers to the new 115 kV step-up transformers.

The exact sequencing of the conversion will depend on the generation option selected by the Generator. Outage time estimates will be provided after this is decided.

Salvage of the existing Pointe du Bois 66 kV lines and construction of the new 115 kV line between Pointe du Bois and Rover should occur after Pointe du Bois station has fully migrated to the 115 kV system linking Slave Falls and Scotland. Rover 115 kV station can be constructed in parallel with the new 115 kV line. At this stage, the output from Pointe du Bois can be diverted through to Scotland 115 kV station and the aging 66 kV lines can be salvaged without bottling up generation. A 2-year time frame is allotted for this work.

The estimated in-service dates and construction timeline are subject to change depending on how generation changes proceed at Pointe du Bois. Moreover, if the Pointe du Bois 66 kV lines cannot survive until its scheduled salvage, alternate plans may be required.

7.0 References

- [1] B.C. Jorowski, “Preliminary Report on Pointe du Bois Transmission Upgrades”, Inter-Office Memorandum to W. Pyl, System Planning technical memorandum TM04/13, 2004 07 23
- [2] B.A. Archer, “Great Falls Unit 3 Stability Models”, Inter-Office Memorandum to J.B. Davies, System Planning technical memorandum TM03/22, 2003 09 05
- [3] D.R. Allan, “Replacement of Pointe du Bois Generators”, Inter-Office Memorandum to B.A. Archer, System Planning technical memorandum TM99-2, 1999 03 30

Appendices

Appendix A: Single-line Diagrams of Transmission Alternatives

- A-1 Pointe du Bois 115 kV Station
- A-2 PDB – Transcona 115 kV
- A-3 PDB – Rover 115 kV
- A-4 Transcona 115 kV Line Termination
- A-5 Rover 115 kV Line Termination

Appendix B: Steady State Analysis Tables

- B-1 Changes to Base Case
- B-2 ACCC Summary for Winter Peak
- B-3 ACCC Summary for Summer Peak
- B-4 ACCC Summary for Summer Off Peak

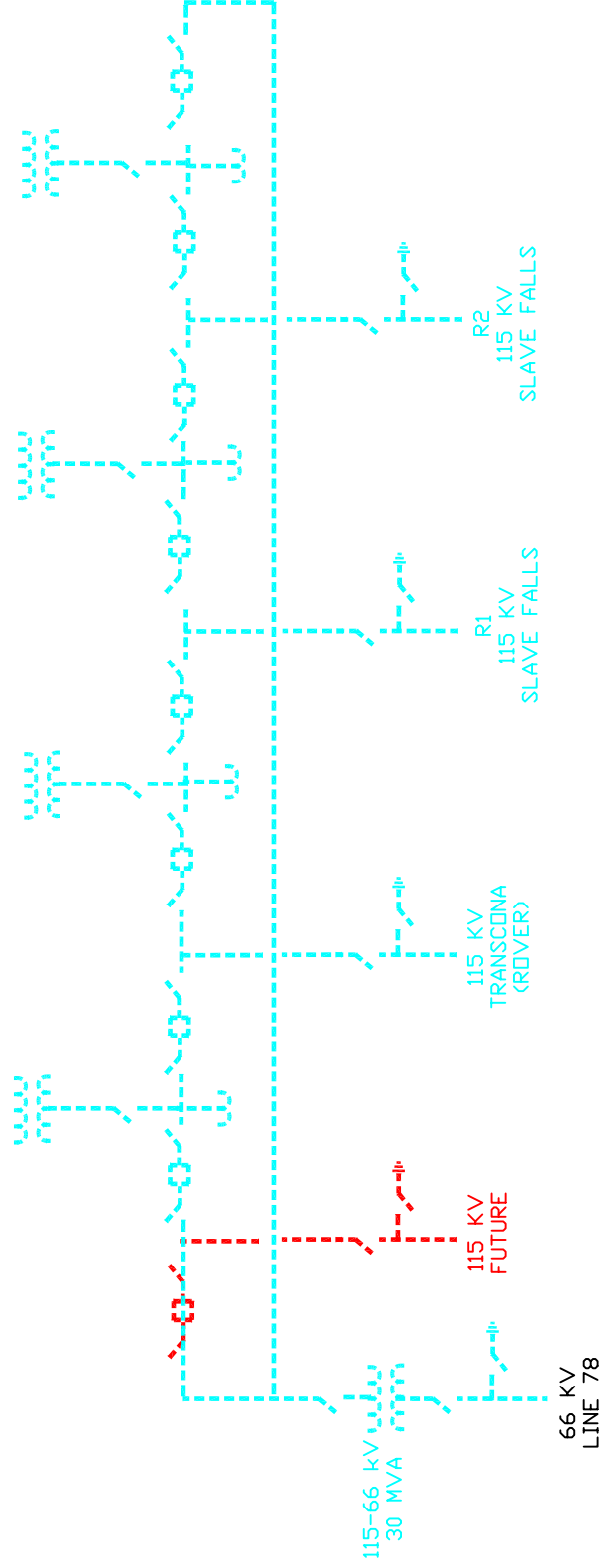
Appendix C: Great Falls, Pine Falls, Pointe du Bois Machine Parameters

- C-1 Great Falls
- C-2 Pine Falls
- C-3 Pointe du Bois (Redevelopment)


Appendix D: Stability Analysis Tables & Plots

- D Power Flow and Stability Summary Table
- D-1 p1s disturbance plots (Rehabilitation - Rover)
- D-2 p1s disturbance plots (Rehabilitation - Transcona)
- D-3 p5s disturbance plots (Rehabilitation - Transcona)
- D-4 p4s disturbance plots (Rehabilitation - Rover)
- D-5 p6s disturbance plots (Rehabilitation - Transcona)
- D-6 p9s disturbance plots (Redevelopment - Rover)
- D-7 pbs disturbance plots (Redevelopment - Transcona)

GENERATOR TRANSFORMERS (LOCATED IN POWER HOUSE)



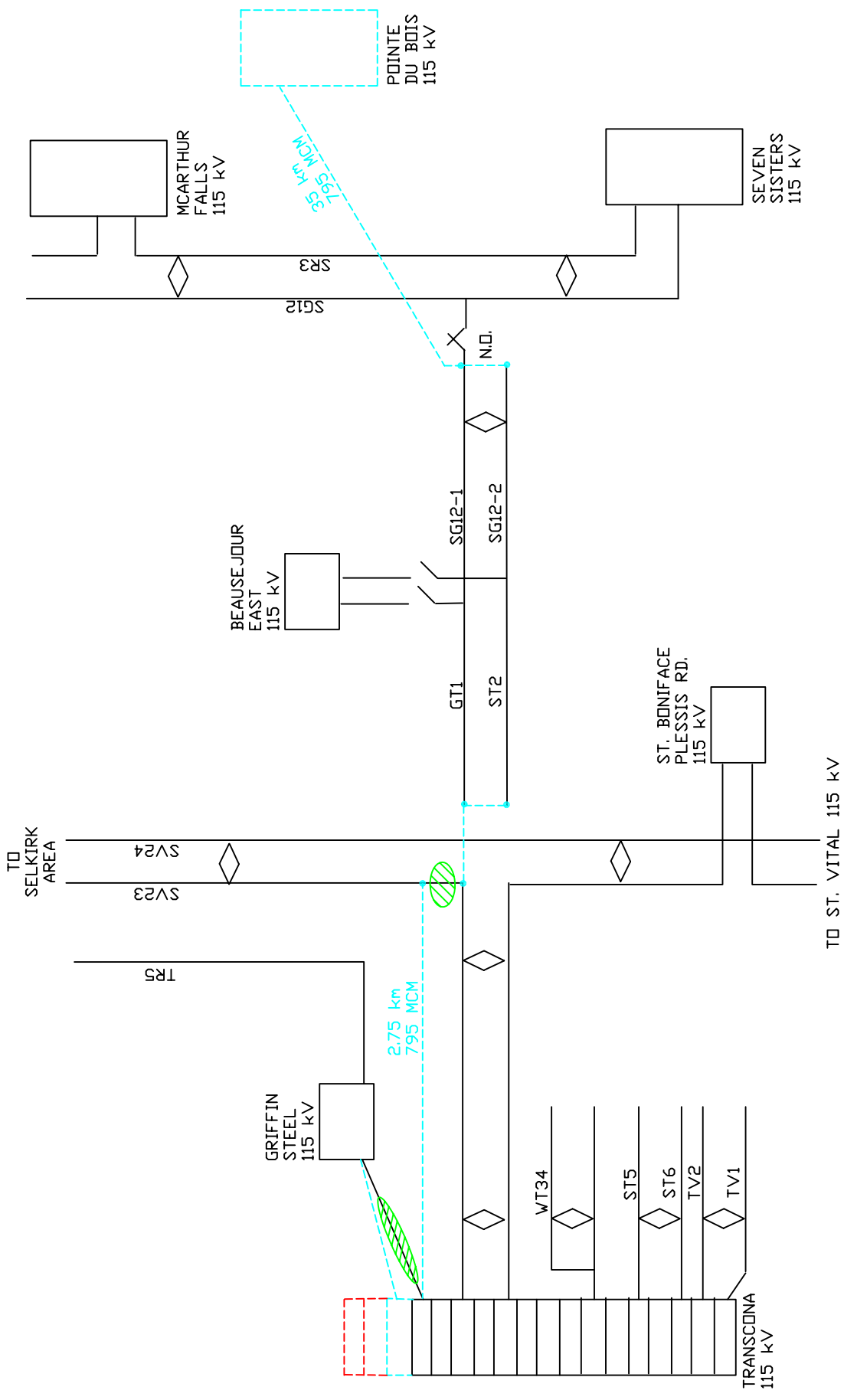
LEGEND

- EXISTING ———
- PROPOSED - - - - -
- FUTURE ———
- SALVAGE 

CONCEPTUAL DIAGRAM

ROVER & TRANSCONA 115 KV ALTERNATIVES – POINTE DU BOIS STN.

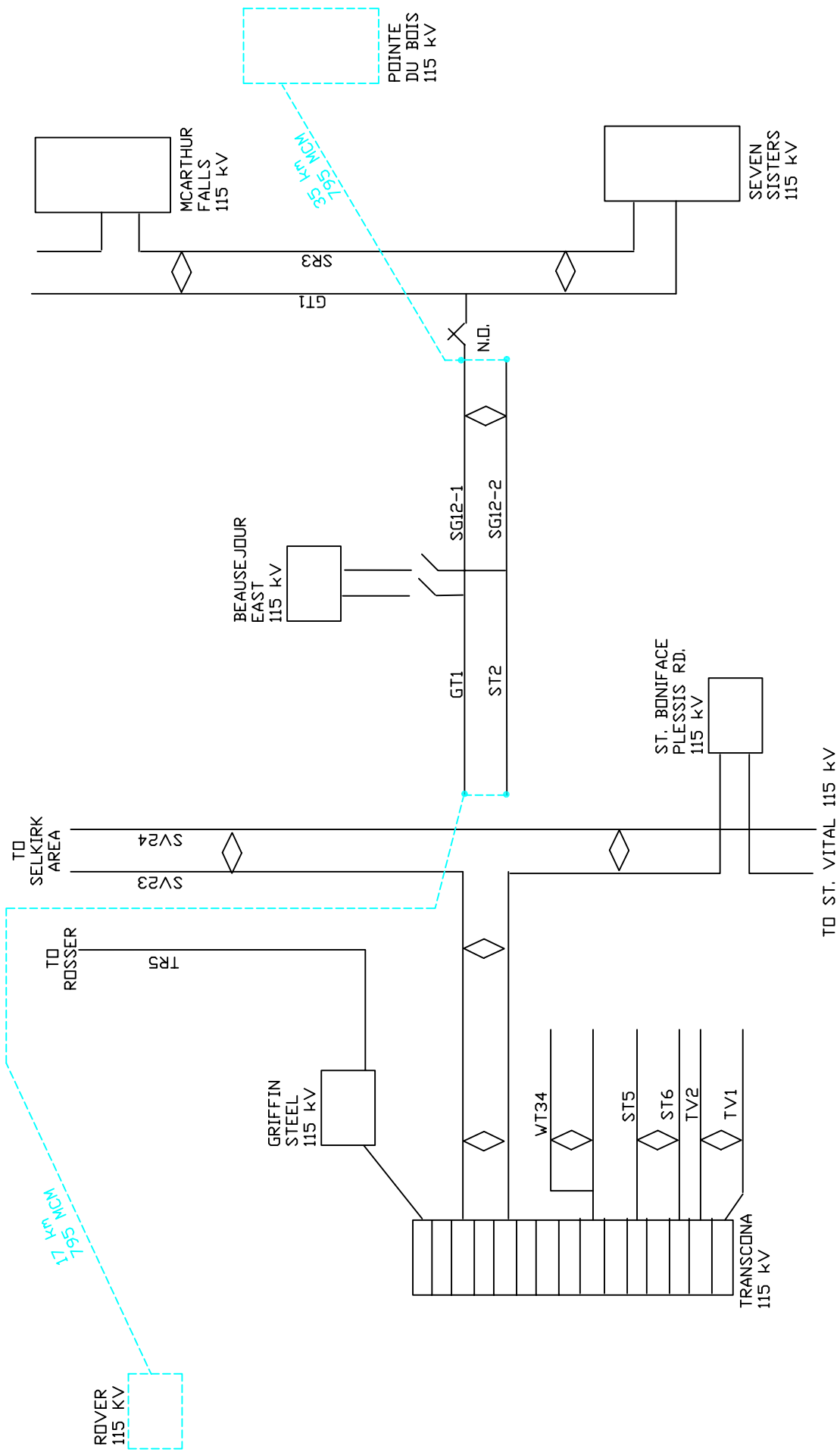
REVISED: 2004 03 10	ISSUED BY: BCJ
APPENDIX A-1	



CONCEPTUAL DIAGRAM
ALTERNATIVE 2A
POINTE DU BOIS-TRANSCONA 115KV
 REVISED: 2004 03 10 ISSUED BY: BCJ/TY
 APPENDIX A-2

LEGEND

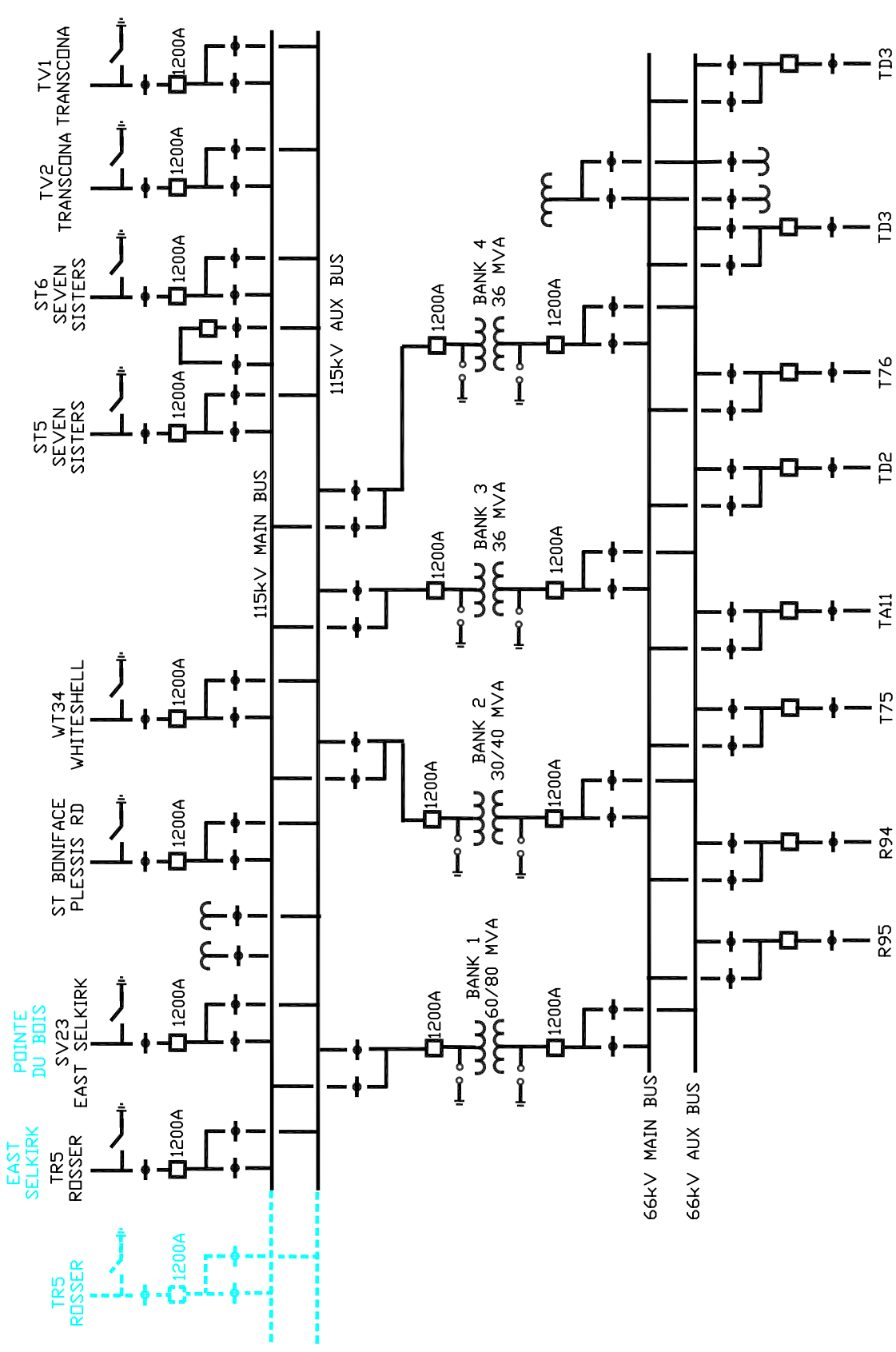
EXISTING	—
PROPOSED	- - -
FUTURE	—
SALVAGE	▨



CONCEPTUAL DIAGRAM
ALTERNATIVE 2B
POINTE DU BOIS-ROVER 115KV
 REVISED: 2004 03 10 ISSUED BY: BCJ/TY
 APPENDIX A-3

LEGEND

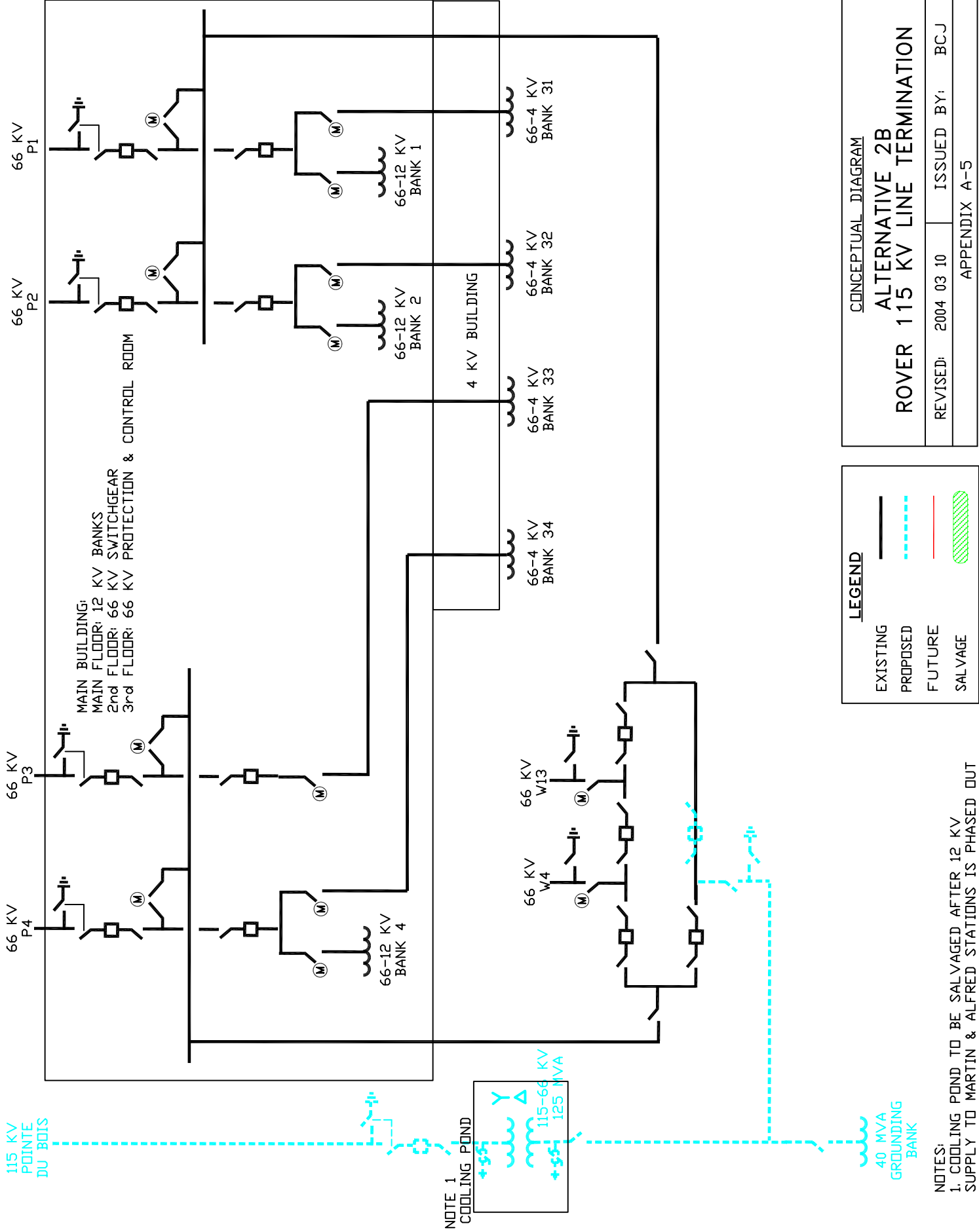
- EXISTING: Solid black line
- PROPOSED: Dashed cyan line
- FUTURE: Dotted red line
- SALVAGE: Green hatched area



CONCEPTUAL DIAGRAM
ALTERNATIVE 2A
TRANSCONA 115KV LINE TERMINATION
 REVISED: 2004 03 10 ISSUED BY: BCJ
 APPENDIX A-4

LEGEND

EXISTING	—
PROPOSED	- - -
FUTURE	---
SALVAGE	▨



CONCEPTUAL DIAGRAM
ALTERNATIVE 2B
ROVER 115 KV LINE TERMINATION

REVISED: 2004 03 10 ISSUED BY: BCJ

APPENDIX A-5

NOTES:
 1. COOLING POND TO BE SALVAGED AFTER 12 KV SUPPLY TO MARTIN & ALFRED STATIONS IS PHASED OUT



	Base Case Alterations	PSS/E Case Revisions
Transcona 115 kV Alternative 2A	Establish new PDB 110 kV bus & 120 MW Plant	Establish new 110 kV bus 67993. Connect bus 67698 (PDB Units 5-16 generator bus) to bus 67993 via a transformer branch. Change generator data for 67698 to reflect 120 MW plant. Extract bus 67679 (PDB Units 1-4 generator bus).
	Connect PDB-Slave Falls Lines (River Lines R1 and R2) to new 110 kV bus.	Connect 67648 (PDB end of R1) to new bus 67993 via a zero impedance branch. Re-terminate branch between buses 67553 (PDB end of R2) & 67554 (Slave Falls) from bus 67553 to bus 67993. Change Base kV of buses 67554, 67679 and 67555 (Scotland) to 110 kV. Change impedances of the above branches and the two circuits between buses 67554 & 67555 to reflect the new base. Tap ratio of Slave Falls transformer can be left as is due to change of tap position and change of base.
	Remove GT1/ST2 tap (to Beausejour East) from Seven Sisters-Great Falls 115 kV Line	Remove branch between buses 67697 (Seven Sisters) & 67774 and between buses 67774 & 67539 (Lac Du Bonnet) and add new branch between buses 67697 & 67539.
	Establish PDB-Transcona 115 kV line using existing GT1/ST2 double circuit	Add new branch between buses 67993 (PDB) & 67774, and between buses 67775 (Beausejour East tap) & 67540 (Transcona 115 kV)
	Replace Transcona Banks 2, 3 and 4 with two 75/100/125 MVA banks. Remove Bank 1 from service under normal conditions.	Change status of transformers 1 & 4 between buses 67540 & 67547. Change transformer data for circuits 2 & 3 between 67540 & 67547 to reflect new 75/100/125 MVA (use Transcona Bank 1 impedance)
	Replace Scotland Banks 11, 12, 13 & 14 with two 75/100/125 MVA banks.	Remove transformers 1, 2, 3 & 4 between buses 67545 & 67555 from the case. Replace with two new 75/100/125 MVA banks (use Transcona Bank 1 impedance)

Appendix B-1: Changes to Base Case for Transmission Alternatives

	Base Case Alteration	PSS/E Case Revisions
Rover 115 kV Alternative 2B	Establish new PDB 110 kV bus & 120 MW Plant	Establish new 110 kV bus 67993. Connect bus 67698 (PDB Units 5-16 generator bus) to bus 67993 via a transformer branch. Change generator data for 67698 to reflect 120 MW plant. Extract bus 67679 (PDB Units 1-4 generator bus).
	Connect PDB-Slave Falls Lines (River Lines R1 and R2) to new 110 kV bus.	Connect 67648 (PDB end of R1) to new bus 67993 via a zero impedance branch. Re-terminate branch between buses 67553 (PDB end of R2) & 67554 (Slave Falls) from bus 67553 to bus 67993. Change Base kV of buses 67554, 67679 and 67555 (Scotland) to 110 kV. Change impedances of the above branches and the two circuits between buses 67554 & 67555 to reflect the new base. Tap ratio of Slave Falls transformer can be left as is due to change of tap position and change of base.
	Remove GT1/ST2 tap (to Beausejour East) from Seven Sisters-Great Falls 115 kV Line	Remove branch between buses 67697 (Seven Sisters) & 67774 and between buses 67774 & 67539 (Lac Du Bonnet) and add new branch between buses 67697 & 67539.
	Establish PDB-Rover 115 kV line using existing GT1/ST2 double circuit	Add new branch between buses 67993 (PDB) & 67774, and between buses 67775 (Beausejour East tap) & new bus 67999 (Rover 115 kV)
	Install 115-66 kV Transformer at Rover.	Add 75/100/125 MVA transformer between bus 67551 (Rover 66 kV) & new bus 67999 (use Transcona Bank 1 impedance)
	Replace Scotland Banks 11, 12, 13 & 14 with two 75/100/125 MVA banks.	Remove transformers 1, 2, 3 & 4 between buses 67545 & 67555 from the case. Replace with two new 75/100/125 MVA banks (use Transcona Bank 1 impedance)

Appendix B-1 (cont.): Changes to Base Case for Transmission Alternatives

Facility	Thermal Rating (deg C)	Rate C (MVA)	Contingency	14wipk Overload (% Rate C)	14wipk-2A Overload (% Rate C)	14wipk-2B Overload (% Rate C)	(% Diff)	Remedial Action	Required Improvements
BP6	75	47.3	BX18 / BX19 dbl cct	103.1	103.2	103.2	0.1	Rate C is 68.2 MVA (358 A), not 47.3 MVA	None required
BP7	75	47.3	BX18 / BX19 dbl cct	106.4	106.4	106.4	0	Rate C is 68.2 MVA (358 A), not 47.3 MVA	None required
McPhillips Bank 8 (or Bank 9)		80	McPhillips Bank 9	100	104.2	101.3	4.2		Increase rating of McPhillips Banks 8 to 92 MVA w/ fan upgrade
		80	HS5 / XS49 dbl cct	102.8	103.1	100.5	0.3		Increase rating of McPhillips Banks 8 to 92 MVA w/ fan upgrade
RS51	100	152.4	YX47 / YX48 dbl cct		100			Adjust phase shifters in W/pg.	
XV39	100	143.7	YX47 / YX48 dbl cct	106.3	107.1	106.6	0.8		System Planning study underway
Scotland Bank 7		80	SB14		101.8				Increase rating of Scotland Bank 7 to 100 MVA w/ fan upgrade
Sherbrook Bank 9		125	HS5 / XS49 dbl cct		100.8			Adjust phase shifters in W/pg.	Increase rating of McPhillips Banks 8 & 9 to 92 MVA w/ fan upgrade
Rover 115-66 kV Bank		125	S1 / S2 dbl cct			128		Reduce Slave Falls generation	
W13 (Rover-Amy)		88	S1 / S2 dbl cct			105		Reduce Slave Falls generation	

Appendix B-2: ACCC Summary for Winter Peak

BCJ 2004 08 03

Facility	Thermal Rating (deg C)	Rate C (MVA)	Contingency	14supk Load (% Rate C)	14supk-2A Overload (% Rate C)	14supk-2B Overload (% Rate C)	(% Diff)	Remedial Action	Required System Improvements
D72V			R23R / D36R dbl cct	106.4	103.3	102.4	-3.1	-4	Further study required
D55Y			D11Y / D15Y dbl cct	111.8	110.7	110	-1.1	-1.8	Further study required
R23R			D36R / D72V dbl cct	102.7	101.4		-1.3		Further study required
L20D			BK41 BK41 / BD52 dbl cct	100.6	100.3	100.4	-0.3	-0.2	Further study required
SC25	100	69.9	SM26	99.3	102.4	102	3.1	None - Rate C is actually 80 MVA (420 A)	
SM26	100	93	GP1 / PR2 dbi cct	99	101.8	100.8	2.8	1.8 Reduce Selkirk generation	
RS51	100	152.4	PC3 / PC4 dbi cct YX48 YX47 / YX48 dbl cct	98	100.6		2.6	Reduce Selkirk generation	
RL1	100	93.2	RL3 / RL4 dbl cct	102.3	101.3	107.8	-1		
McPhillips Bank 8 (or Bank 9)		80	SB14 (or Sherbrook Bank 9) McPhillips Bank 9	108.2	104.4	104.5	-3.8		
			HS5 / XS49 dbl cct	109	109.1	115.6	0.1	Adjust voltage tap settings & phase shifters in Wpg.	Increase rating of McPhillips Bank 8 to 92 MVA w/ fan upgrade
GP1	70	69.7	GS21 / GS22 dbl cct	111.4	118.1	112	6.7	2.9 Adjust phase shifters in Wpg.	Upgrade GP1 to 100C (93.2 MVA)
WT34	75	120.6	ST5 / ST6 dbl cct	105.9	115.4	101.8	9.5	3.8	Upgrade Transcona termination (Line rating is 164 MVA)

BCJ 2004 08 06

Appendix B-3: ACCC Summary for Summer Peak

Facility	Thermal Rating (deg C)	Rate C (MVA)	Contingency	14supk Load (% Rate C)	14supk-2A Overload (% Rate C) (% Diff)	14supk-2B Overload (% Rate C) (% Diff)	Remedial Action	Required System Improvements
XV39	100	110.1	RS51 VH1 / VH2 dbl cct	101.3	107	5.7	Adjust phase shifters in Wpg.	
			D11Y / D15Y dbl cct	101.2	107.4	6.2	Adjust phase shifters in Wpg.	
			YX47 / YX48 dbl cct	149.6	156.2	6.6	Adjust phase shifters in Wpg.	Planning study underway
Scotland Bank 7		80	SB14 (or Sherbrook Bank 9)		113.6	105.8		Increase rating of Scotland Bank 7 to 100 MVA w/ fan upgrade
TD2			HS5		104.9			Increase rating of Scotland Bank 7 to 100 MVA w/ fan upgrade
Sherbrook Bank 9			TD3		112.1		Adjust phase shifters in Wpg.	
			HS5 / XS49 dbl cct	105.7	107.4	1.7		
R94	75	46.2	Transcona Bank 2 or 3		102.1		Adjust phase shifters in Wpg.	
			R95	109.2	126.4	17.2		Planning study underway
TD3	75	46.2	None	100.6			Adjust phase shifters in Wpg.	
			TD2	132.7	153.3	20.6		Upgrade TD3
			HS5 / XS49 dbl cct	109.5	122.3	12.8		Upgrade TD3
			TA11	101.8	119.2	17.4		Upgrade TD3
			SB14 (or Sherbrook Bank 9)		110.8			Upgrade TD3
			All other contingencies		<110		Adjust phase shifters in Wpg.	
Transcona Bank 2		40	Transcona Bank 1	115.6		112.8		
Transcona Bank 3		36	Transcona Bank 1	109.9		107.2		
Transcona Bank 4		36	Transcona Bank 1	106.9		104.3		
PDB- Transcona 115 kV		139.4	S1 / S2 dbl cct		124			Upgrade GT1 / ST2 to 100C
PDB-Rover 115 kV		139.4	S1 / S2 dbl cct			130		Upgrade GT1 / ST2 to 100C
Rover 115-66 kV Bank		125	S1 / S2 dbl cct			138	Reduce Slave Falls generation	
W13 (Rover- Amy)		88	S1 / S2 dbl cct			138	Reduce Slave Falls generation	

Appendix B-3 (cont.): ACCC Summary for Summer Peak

Facility	Thermal Rating (deg C)	Rate C (MVA)	Contingency	14suop Overload (% Rate C)	14suop-2A Overload (% Rate C)	(% Diff)	14suop-2B Overload (% Rate C)	(% Diff)	Remedial Action	Required Improvements
P52E	75	287.6	F10M	101.5	101.5	0	101.5	0	Reduce exports to SaskPower	
			G1A	101.4	101.4	0	101.4	0	Reduce exports to SaskPower	
			G2A	101.4	101.4	0	101.4	0	Reduce exports to SaskPower	
			G8P	103.2	103.2	0	103.2	0	Reduce exports to SaskPower	
			R25Y	106.5	106.5	0	106.5	0	Reduce exports to SaskPower	
			V57R	108	108	0	108	0	Reduce exports to SaskPower	
			I1F / I2F dbi cct	105.6	105.6	0	105.6	0	Reduce exports to SaskPower	
XV39	100	287.6	YX47 / YX48 dbi cct	105.6	106.5	0.9	106.2	0.6		System Planning study underway
W4 (Rover-Charles)			W13 (Rover-Amy)				106.2			Replace W4 (Rover-Charles)
PDB-Transcon a 115 kV					122					Upgrade GT1 / ST2 to 100C
PDB-Rover 115 kV										Upgrade GT1 / ST2 to 100C
Rover 115 66 kV Bank		139.4	S1 / S2 dbi cct				128			
W13 (Rover-Amy)		125	S1 / S2 dbi cct				138		Reduce Slave Falls generation	
		88	S1 / S2 dbi cct				164		Reduce Slave Falls generation	

Appendix B-4: ACCC Summary for Summer Off Peak

Appendix C.1 Great Falls Dynamic Models

GREAT FALLS MACHINE PARAMETERS FOR ALL LOAD FLOW CASES

GREAT FALLS UNITS 1,2,5,6 NET

PLANT MODELS

REPORT FOR ALL MODELS

BUS 67695 [GTFNET4G11.0]

** GENSL ** BUS NAME BSKV MACH C O N S S T A T E S
 67695 GTFNET4G 11.0 1 32700-32711 14274-14278

MBASE Z S O R C E X T R A N G E N T A P
 98.4 0.00530+J 0.22000 0.00000+J 0.00000 1.00000

T'D0 T'D0 T'Q0 H DAMP XD XQ X'D X'D XL
 4.000 0.053 0.108 2.42 0.00 0.9860 0.8240 0.3100 0.2200 0.1667

S(1.0) S(1.2)
 0.2100 0.6500

** IEEET5 ** BUS NAME BSKV MACH C O N S S T A T E S VAR
 67695 GTFNET4G 11.0 1 79875-79884 31962-31963 3649

TRH KV VRMAX VRMIN TE KE
 20.000 0.050 4.030 0.000 1.840 1.031

E1 S(E1) E2 S(E2) KE VAR
 2.2000 0.0900 2.9200 0.3500 0.0000

** IEEESGO ** BUS NAME BSKV MACH C O N S S T A T E S VAR
 67695 GTFNET4G 11.0 1 111022-111032 42366-42370 6585

T1 T2 T3 T4 T5 T6 K1 K2 K3 PMAX PMIN
 0.320 3.290 33.150 0.000 0.42 0.00 17.9 3.00 0.00 1.07 0.00

Appendix C.1 Great Falls Dynamic Models

GREAT FALLS UNIT 3

PLANT MODELS

REPORT FOR ALL MODELS

BUS 68002 [GTFL 3G 11.0]

** GENSAL ** BUS NAME BSKV MACH CONS STAES
68002 GTFL 3G 11.0 3 121888-121899 44935-44939

MBASE ZSORE XTRAN GENTAP
28.5 0.00520+J 0.35800 0.00000+J 0.00000 1.00000

T'D0 T'Q0 H DAMP XD XQ X'D X'D XL
4.000 0.053 0.108 2.49 0.00 1.2930 0.8020 0.4250 0.3580 0.1622

S(1.0) S(1.2)
0.2100 0.6500

** PSS2A ** BUS NAME BSKV MAC CONS STAES VARS ICONS
68002 GTFL 3G 11.0 3 121900-121916 44940-44955 10408-10411 7479-7484

IC1 REMBUS1 IC2 REMBUS2 M N
1 0 3 0 3 1

TW1 TW2 T6 TW3 TW4 T7 KS2 KS3
2.000 2.000 0.020 2.000 0.000 2.000 0.402 1.000

T8 T9 KS1 T1 T2 T3 T4 VSTMAX VSTMIN
0.030 0.012 6.000 0.180 0.110 0.110 0.040 0.050 -0.050

** EXST1 ** BUS NAME BSKV MACH CONS STAES
68002 GTFL 3G 11.0 3 121917-121928 44956-44959

TR VIMAX VIMIN TC TB KA TA
0.020 0.260 -0.180 1.000 1.000 350.0 0.000

VRMAX VRMIN KC KF TF
7.830 -5.480 0.000 0.000 0.020

Appendix C.1 Great Falls Dynamic Models

GREAT FALLS UNIT 4

 PLANT MODELS

REPORT FOR ALL MODELS

BUS 68003 [GTFL 4G 11.0]

** GENSAL ** BUS NAME BSKV MACH C O N S S T A T E S
 68003 GTFL 4G 11.0 4 121929-121940 44960-44964

MBASE Z S O R C E X T R A N G E N T A P
 28.5 0.00520+J 0.35800 0.00000+J 0.00000 1.00000

T'D0 T'I'Q0 H DAMP XD XQ X'D X'I'D XL
 4.000 0.053 0.108 2.49 0.00 1.2930 0.8020 0.4250 0.3580 0.1622

S(1.0) S(1.2)
 0.2100 0.6500

** PSS2A ** BUS NAME BSKV MAC C O N S S T A T E S V A R S I C O N S
 68003 GTFL 4G 11.0 4 121941-121957 44965-44980 10412-10415 7485-7490

IC1 REMBUS1 IC2 REMBUS2 M N
 1 0 3 0 3 1

TW1 TW2 T6 TW3 TW4 T7 KS2 KS3
 2.000 2.000 0.020 2.000 0.000 2.000 0.402 1.000

T8 T9 KS1 T1 T2 T3 T4 VSTMAX VSTMIN
 0.030 0.012 6.000 0.180 0.110 0.110 0.040 0.050 -0.050

** EXST1 ** BUS NAME BSKV MACH C O N S S T A T E S
 68003 GTFL 4G 11.0 4 121958-121969 44981-44984

TR VIMAX VIMIN TC TB KA TA
 0.020 0.260 -0.180 1.000 1.000 350.0 0.000

VRMAX VRMIN KC KF TF
 7.830 -5.480 0.000 0.000 0.020

Appendix C.2 Pine Falls Dynamic Models

PINE FALLS MACHINE PARAMETERS FOR ALL LOAD FLOW CASES

PINE FALLS UNITS 3,4,5,6 NET

 PLANT MODELS

REPORT FOR ALL MODELS

BUS 67694 [PNFL3-6G13.8]

** GENSL ** BUS NAME BSKV MACH C O N S S T A T E S
 67694 PNFL3-6G 13.8 1 32688-32699 14269-14273

MBASE Z S O R C E X T R A N G E N T A P
 67.2 0.00630+J 0.27400 0.00000+J 0.00000 1.00000

T'D0 T''Q0 H DAMP XD XQ X'D X''D XL
 1.970 0.058 0.069 2.72 0.00 1.0010 0.6147 0.3760 0.2740 0.1600

S(1.0) S(1.2)
 0.1230 0.4000

** IEEET1 ** BUS NAME BSKV MACH C O N S S T A T E S VAR
 67694 PNFL3-6G 13.8 1 79861-79874 31958-31961 3648

TR KA TA VRMAX VRMIN KE TE KF TF SWITCH
 0.000 6.50 0.200 1.000 -1.000 0.000 0.250 0.150 1.000 0.0

E1 S(E1) E2 S(E2) KE VAR
 2.4272 0.1300 3.2362 0.3590 0.0000

** IEEESGO ** BUS NAME BSKV MACH C O N S S T A T E S VAR
 67694 PNFL3-6G 13.8 1 111011-111021 42361-42365 6584

T1 T2 T3 T4 T5 T6 K1 K2 K3 PMAX PMIN
 0.300 5.880 94.440 0.000 0.70 0.00 27.6 3.00 0.00 1.00 0.00

Appendix C.2 Pine Falls Dynamic Models

PINE FALLS UNIT 1

PLANT MODELS

REPORT FOR ALL MODELS

BUS 68000 [PNFL 1G 13.8]

** GENSAI ** BUS NAME BSKV MACH C O N S S T A T E S
 68000 PNFL 1G 13.8 1 121970-121981 44985-44989

MBASE Z S O R C E X T R A N G E N T A P
 20.5 0.00630+J 0.36200 0.00000+J 0.00000 1.00000

T'D0 T'I'Q0 H DAMP XD XQ X'D X'I'D XL
 1.970 0.058 0.069 2.72 0.00 1.3240 0.6147 0.4970 0.3620 0.1600

S(1.0) S(1.2)
 0.1230 0.4000

** IEEET1 ** BUS NAME BSKV MACH C O N S S T A T E S VAR
 68000 PNFL 1G 13.8 1 121982-121995 44990-44993 10416

TR KA TA VRMAX VRMIN KE TE KE KF TF SWITCH
 0.000 6.50 0.200 1.000 -1.000 0.000 0.250 0.150 1.000 0.0

E1 S(E1) E2 S(E2) KE VAR
 2.4272 0.1300 3.2362 0.3590 0.0000

** IEEESGO ** BUS NAME BSKV MACH C O N S S T A T E S VAR
 68000 PNFL 1G 13.8 1 121996-122006 44994-44998 10417

T1 T2 T3 T4 T5 T6 K1 K2 K3 PMAX PMIN
 0.300 5.880 94.440 0.000 0.70 0.00 27.6 3.00 0.00 1.00 0.00

Appendix C.2 Pine Falls Dynamic Models

PINE FALLS UNIT 2

 PLANT MODELS

REPORT FOR ALL MODELS BUS 68001 [PNFL 2G 13.8]

** GENSAI ** BUS NAME BSKV MACH C O N S S T A T E S
 68001 PNFL 2G 13.8 2 122007-122018 44999-45003

MBASE Z S O R C E X T R A N G E N T A P
 20.5 0.00630+J 0.36200 0.00000+J 0.00000 1.00000

T'D0 T'I'Q0 H DAMP XD XQ X'D X'I'D XL
 1.970 0.058 0.069 2.72 0.00 1.3240 0.6147 0.4970 0.3620 0.1600

S(1.0) S(1.2)
 0.1230 0.4000

** IEEET1 ** BUS NAME BSKV MACH C O N S S T A T E S VAR
 68001 PNFL 2G 13.8 2 122019-122032 45004-45007 10418

TR KA TA VRMAX VRMIN KE TE KE KF TF SWITCH
 0.000 6.50 0.200 1.000 -1.000 0.000 0.250 0.150 1.000 0.0

E1 S(E1) E2 S(E2) KE VAR
 2.4272 0.1300 3.2362 0.3590 0.0000

** IEEESGO ** BUS NAME BSKV MACH C O N S S T A T E S VAR
 68001 PNFL 2G 13.8 2 122033-122043 45008-45012 10419

T1 T2 T3 T4 T5 T6 K1 K2 K3 PMAX PMIN
 0.300 5.880 94.440 0.000 0.70 0.00 27.6 3.00 0.00 1.00 0.00

Appendix C.3 Pointe du Bois Dynamic Models (Redevelopment Only)

POINTE DU BOIS MACHINE PARAMETERS FOR REDEVELOPMENT CASES

POINTE DU BOIS UNITS 1,2,3,4

PLANT MODELS

REPORT FOR ALL MODELS

BUS 67698 [PDB1-4G 6.90]

** GENSAL ** BUS NAME BSKV MACH C O N S S T A T E S
 67698 PDB1-4G 6.90 1 122044-122055 45013-45017

MBASE Z S O R C E X T R A N G E N T A P
 150.0 0.00200+J 0.16240 0.00000+J 0.00000 1.00000

T'D0 T'D0 T'Q0 H DAMP XD XQ X'D X'D XL
 3.600 0.050 0.076 4.10 0.00 0.9150 0.5411 0.2440 0.1624 0.1333

S(1.0) S(1.2)
 0.1600 0.5200

** PSS2A ** BUS NAME BSKV MAC C O N S S T A T E S V A R S I C O N S
 67698 PDB1-4G 6.90 1 122056-122072 45018-45033 10420-10423 7491-7496

IC1 REMBUS1 IC2 REMBUS2 M N
 1 0 3 0 5 1

TW1 TW2 TW3 TW4 TW7 KS2 KS3
 10.000 0.000 0.000 10.000 0.000 10.000 1.219 1.000
 T8 T9 T1 T2 T3 T4 VSTMAX VSTMIN
 0.500 0.100 20.000 0.055 0.025 0.075 0.025 0.050 0.050 -0.050

** SCRX ** BUS NAME BSKV MACH C O N S S T A T E S BUS
 67698 PDB1-4G 6.90 1 122073-122080 45034-45035 FED

TA/TB TB K TE EMIN EMAX SWITCH RC/RFD
 1.000 0.100 117.0 0.025 -5.00 6.00 0.0 10.00

Appendix C.3 Pointe du Bois Dynamic Models (Redevelopment Only)

```
** IEESGO ** BUS NAME BSKV MACH C O N S S T A T E S VAR
67698 PDB1-4G 6.90 1 122081-122091 45036-45040 10424

T1 T2 T3 T4 T5 T6 K1 K2 K3 PMAX PMIN
0.440 6.710 74.400 0.000 0.63 0.00 24.4 3.00 0.00 0.92 0.00
```

POWER FLOW AND STABILITY SUMMARY TABLE

Case No.	1	2	3	4
Case Name	p1r-so12pr.uymV4V4-p1s	p1r-so12pr.uymV4V4-p2s	p1r-so12s1.uymV4V4-p3s	p1r-so12s1.uymV4V4-p4s
Disturbance	p1s	p2s	p3s	p4s
Prior Outage	pr	pr	s1	s1
Date/Time	AUG 23 2004 14:46	AUG 23 2004 15:26	AUG 23 2004 16:05	AUG 24 2004 8:21
Comments				
Steady State Flows				
NDEX / EAST BIAS	1958 / 269	1958 / 269	1958 / 269	1958 / 269
MHEX / L20D	2169 / 259	2169 / 259	2171 / 259	2171 / 259
ECL-ARP / PRI-BYN	516 / 528	516 / 528	516 / 528	516 / 528
MWSI / MNEX	1044 / 1466	1044 / 1466	1044 / 1466	1044 / 1466
D602F / F601C	1726 / 1193	1726 / 1193	1727 / 1194	1727 / 1194
B10T / MH>SPC	164 / 67	164 / 67	164 / 67	164 / 67
OH E-W / OH>MH	-197 / -195	-197 / -195	-197 / -196	-197 / -196
R50M / OH>MP	148 / 150	148 / 150	148 / 150	148 / 150
G82R	35	35	35	35
Dorsey BP1 / BP2	1418 / 1605	1418 / 1605	1418 / 1605	1418 / 1605
Dorsey Reserve / Wtrtn SVC	812 / -8	812 / -8	830 / -8	830 / -8
Forbes SVC / MSC	43 / 600	43 / 600	44 / 600	44 / 600
Steady State Vltgs				
Dorsey 500/Dorsey 230	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045
Roseau 500/Forbes 500	1.035 / 1.014	1.035 / 1.014	1.034 / 1.014	1.034 / 1.014
Chisago 500/EauClaire 345	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026
Int Falls 115/Badoura 115	1.003 / 1.017	1.003 / 1.017	1.003 / 1.017	1.003 / 1.017
Drayton 230/Groton 345	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006
SS OS Relay Margins				
D602F at Forbes/Dorsey	245% / 417%	245% / 417%	245% / 416%	245% / 416%
B2R at Rugby/L20D at Drayton	999% / 761%	999% / 761%	999% / 760%	999% / 760%
R50M/F3M	911% / 313%	911% / 313%	910% / 313%	910% / 313%
B10T	331%	331%	331%	331%
Min/MaxTransientVltg				
Arrowhd 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Boise 115	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.01
Dorsey 230	1.04 1.05	1.04 1.05	1.03 1.05	1.04 1.05
Forbes 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Riverton 230	1.02 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Coal Creek 230	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Dickinson 345	1.01 1.01	1.01 1.02	1.01 1.01	1.01 1.02
Drayton 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Groton 345	1.01 1.01	1.01 1.01	1.01 1.01	1.01 1.01
Tioga 230	1.02 1.03	1.02 1.02	1.02 1.02	1.02 1.03
Wahpeton 115	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Watertown 345	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03
Dynamic Voltage Warnings				
	none	none	none	none
Worst Case Angle Damping				
	KING 3 / 54.53%	KING 3 / 49.27%	ANTEL3 / 65.90%	KING 3 / 31.43%
Dorsey SUVV / UdHold				
Forbes DC Red (DCAR)	496%	493%	495%	494%
K22W (max +dP @ t, d-ang)	12.8@(0.15000,-0.6)	12.1@(0.15000,-0.5)	14.8@(0.14167,-0.6)	14.4@(0.14167,-0.6)
K22W (max -dP @ t, d-ang)	0.0@(0.08333,0.0)	5.2@(1.35000,-0.9)	0.0@(0.25000,-0.3)	3.1@(1.43333,-1.7)
K22W (max d-ang @ t, dP)	-2.1@(2.00000,3.4)	-1.4@(1.98333,2.3)	-2.0@(1.92500,3.5)	-2.2@(2.13333,3.5)
OS Rel Trip / Marg				
MH - OH				
D602F at Forbes/Dorsey	245% / 417%	242% / 411%	244% / 414%	244% / 414%
B2R at Rugby/L20D at Drayton	999% / 761%	999% / 750%	999% / 760%	999% / 757%
R50M / F3M	911% / 312%	895% / 312%	906% / 311%	901% / 311%
B10T	331%	330%	330%	331%
FSCAPS (SS/Unav/Final)				
Balta 230	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)
Eau Cl 345 / Park Lk 115	(3 3 3) / (0 0 0)	(3 3 3) / (0 0 0)	(3 3 3) / (0 0 0)	(3 3 3) / (0 0 0)
Prairie 115 / Ramsey 230	(1 1 1) / (0 0 0)	(1 1 1) / (0 0 0)	(1 1 1) / (0 0 0)	(1 1 1) / (0 0 0)
Roseau 230 / Running 230	(0 0 0) / (3 3 3)	(0 0 0) / (3 3 3)	(0 0 0) / (3 3 3)	(0 0 0) / (3 3 3)
Shey 115 / Split Rock 115	(0 0 0) / (0 0 0)	(0 0 0) / (0 0 0)	(0 0 0) / (0 0 0)	(0 0 0) / (0 0 0)

POWER FLOW AND STABILITY SUMMARY TABLE

Case No.	5	6	7	8
Case Name	p1r-so12aa.uymV4V4-c4s	p1t-so12pt.uymV4V4-p1s	p1t-so12pt.uymV4V4-p2s	p1t-so12s1.uymV4V4-p5s
Disturbance	c4s	p1s	p2s	p5s
Prior Outage	None	pt	pt	s1
Date/Time	AUG 24 2004 9:19	AUG 25 2004 11:02	AUG 24 2004 10:25	AUG 24 2004 11:07
Comments				
Steady State Flows				
NDEX / EAST BIAS	1958 / 269	1958 / 269	1958 / 269	1958 / 269
MHEX / L20D	2173 / 259	2168 / 259	2168 / 258	2171 / 259
ECL-ARP / PRI-BYN	516 / 529	516 / 528	516 / 528	516 / 529
MWSI / MNEX	1045 / 1467	1044 / 1466	1044 / 1466	1045 / 1467
D602F / F601C	1729 / 1195	1726 / 1193	1725 / 1193	1727 / 1195
B10T / MH>SPC	164 / 67	164 / 67	164 / 67	164 / 67
OH E-W / OH>MH	-197 / -196	-197 / -196	-197 / -196	-197 / -196
R50M / OH>MP	148 / 150	148 / 150	148 / 150	148 / 150
G82R	35	35	35	35
Dorsey BP1 / BP2	1418 / 1605	1417 / 1605	1417 / 1605	1417 / 1605
Dorsey Reserve / Wtrtn SVC	844 / -7	805 / -8	811 / -8	824 / -7
Forbes SVC / MSC	46 / 600	43 / 600	43 / 600	45 / 600
Steady State Vltgs				
Dorsey 500/Dorsey 230	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045
Roseau 500/Forbes 500	1.034 / 1.014	1.035 / 1.014	1.035 / 1.014	1.034 / 1.014
Chisago 500/EauClaire 345	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026
Int Falls 115/Badoura 115	1.003 / 1.017	1.005 / 1.016	1.005 / 1.016	1.006 / 1.016
Drayton 230/Groton 345	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006
SS OS Relay Margins				
D602F at Forbes/Dorsey	245% / 415%	246% / 417%	246% / 417%	245% / 416%
B2R at Rugby/L20D at Drayton	999% / 758%	999% / 761%	999% / 761%	999% / 759%
R50M/F3M	908% / 313%	913% / 316%	913% / 316%	911% / 316%
B10T	330%	331%	331%	331%
Min/MaxTransientVltg				
Arrowhd 230	1.01 1.02	1.01 1.01	1.01 1.01	1.01 1.02
Boise 115	1.00 1.01	1.00 1.01	1.00 1.01	1.00 1.02
Dorsey 230	1.04 1.05	1.04 1.05	1.04 1.05	1.02 1.06
Forbes 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.03
Riverton 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Coal Creek 230	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Dickinson 345	1.01 1.02	1.01 1.01	1.01 1.01	1.01 1.02
Drayton 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.03
Groton 345	1.01 1.01	1.01 1.01	1.01 1.01	1.01 1.01
Tioga 230	1.02 1.02	1.02 1.03	1.02 1.02	1.02 1.03
Wahpeton 115	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Watertown 345	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03
Dynamic Voltage Warnings				
	none	none	none	none
Worst Case Angle Damping				
	ANTEL3 / 55.97%	KING 3 / 53.19%	KING 3 / 48.76%	KING 3 / 29.73%
Dorsey SUVV / UdHold				
Forbes DC Red (DCAR)	498%	496%	493%	492%
K22W (max +dP @ t, d-ang)	9.6@(1.86666,-0.9)	12.6@(0.15000,-0.6)	11.7@(0.15000,-0.5)	26.3@(0.14167,-1.0)
K22W (max -dP @ t, d-ang)	7.2@(1.46666,-0.7)	0.0@(0.00000,0.0)	5.2@(1.35000,-0.9)	0.0@(0.00833,0.0)
K22W (max d-ang @ t, dP)	-1.3@(2.06666,2.9)	-2.1@(2.01666,3.4)	-1.4@(2.00000,2.1)	-8.3@(9.97488,19.0)
OS Rel Trip / Marg				
MH - OH				
D602F at Forbes/Dorsey	239% / 406%	246% / 417%	242% / 411%	245% / 415%
B2R at Rugby/L20D at Drayton	999% / 739%	999% / 761%	999% / 750%	999% / 759%
R50M / F3M	881% / 310%	913% / 314%	896% / 314%	905% / 315%
B10T	327%	331%	330%	330%
FSCAPS (SS/Unav/Final)				
Balta 230	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)
Eau Cl 345 / Park Lk 115	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)
Prairie 115 / Ramsey 230	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)
Roseau 230 / Running 230	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)
Shey 115 / Split Rock 115	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)

POWER FLOW AND STABILITY SUMMARY TABLE

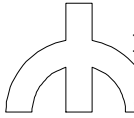
Case No.	9	10	11	12
Case Name	p1t-so12s1.uymV4V4-p6s	p1t-so12aa.uymV4V4-a4s	p2r-so12pr.uymV4V4-p7s	p2r-so12pr.uymV4V4-p8s
Disturbance	p6s	a4s	p7s	p8s
Prior Outage	s1	None	pr	pr
Date/Time	AUG 24 2004 12:30	AUG 24 2004 13:11	AUG 24 2004 13:39	AUG 24 2004 14:03
Comments				
Steady State Flows				
NDEX / EAST BIAS	1958 / 269	1958 / 269	1957 / 269	1957 / 269
MHEX / L20D	2171 / 259	2173 / 259	2166 / 258	2166 / 258
ECL-ARP / PRI-BYN	516 / 529	516 / 529	515 / 528	515 / 528
MWSI / MNEX	1045 / 1467	1045 / 1468	1043 / 1465	1043 / 1465
D602F / F601C	1727 / 1195	1728 / 1196	1724 / 1192	1724 / 1192
B10T / MH>SPC	164 / 67	165 / 67	164 / 66	164 / 66
OH E-W / OH>MH	-197 / -196	-197 / -196	-196 / -195	-196 / -195
R50M / OH>MP	148 / 150	148 / 150	148 / 150	148 / 150
G82R	35	35	35	35
Dorsey BP1 / BP2	1417 / 1605	1417 / 1605	1406 / 1592	1406 / 1592
Dorsey Reserve / Wtrtn SVC	824 / -7	841 / -7	827 / -8	827 / -8
Forbes SVC / MSC	45 / 600	46 / 600	41 / 600	41 / 600
Steady State Vltgs				
Dorsey 500/Dorsey 230	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045
Roseau 500/Forbes 500	1.034 / 1.014	1.034 / 1.014	1.035 / 1.014	1.035 / 1.014
Chisago 500/EauClaire 345	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026
Int Falls 115/Badoura 115	1.006 / 1.016	1.005 / 1.016	1.006 / 1.017	1.006 / 1.017
Drayton 230/Groton 345	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006
SS OS Relay Margins				
D602F at Forbes/Dorsey	245% / 416%	245% / 415%	246% / 418%	246% / 418%
B2R at Rugby/L20D at Drayton	999% / 759%	999% / 758%	999% / 761%	999% / 761%
R50M/F3M	911% / 316%	909% / 315%	912% / 317%	912% / 317%
B10T	331%	330%	333%	333%
Min/MaxTransientVltg				
Arrowhd 230	1.01 1.01	1.01 1.01	1.01 1.02	1.01 1.02
Boise 115	1.00 1.01	1.00 1.01	1.01 1.01	1.01 1.01
Dorsey 230	1.04 1.05	1.04 1.05	1.04 1.05	1.04 1.05
Forbes 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Riverton 230	1.01 1.02	1.01 1.02	1.02 1.02	1.02 1.02
Coal Creek 230	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Dickinson 345	1.01 1.01	1.01 1.02	1.01 1.02	1.01 1.02
Drayton 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Groton 345	1.01 1.01	1.01 1.01	1.01 1.01	1.01 1.01
Tioga 230	1.02 1.02	1.02 1.02	1.02 1.03	1.02 1.03
Wahpeton 115	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Watertown 345	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03
Dynamic Voltage Warnings				
	none	none	none	none
Worst Case Angle Damping	ANTEL3 / 60.16%	ANTEL3 / 52.24%	KING 3 / 46.68%	KING 3 / 42.33%
Dorsey SUVP / UdHold				
Forbes DC Red (DCAR)	490%	498%	497%	494%
K22W (max +dP @ t, d-ang)	24.4@(0.14167,-0.9)	11.8@(0.13333,-0.4)	13.2@(0.15833,-0.6)	12.6@(1.70000,-2.7)
K22W (max -dP @ t, d-ang)	8.2@(1.35000,0.2)	5.5@(1.48333,-1.0)	2.0@(0.68333,-1.4)	6.2@(1.27500,-2.6)
K22W (max d-ang @ t, dP)	-1.0@(0.20000,22.9)	-1.6@(2.09999,3.6)	-3.5@(1.35833,2.7)	-3.2@(1.94166,4.2)
OS Rel Trip / Marg				
MH - OH				
D602F at Forbes/Dorsey	239% / 406%	239% / 406%	246% / 418%	246% / 417%
B2R at Rugby/L20D at Drayton	999% / 740%	999% / 740%	999% / 761%	999% / 761%
R50M / F3M	884% / 309%	879% / 314%	912% / 315%	905% / 316%
B10T	327%	327%	333%	333%
FSCAPS (SS/Unav/Final)				
Balta 230	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)
Eau Cl 345 / Park Lk 115	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)
Prairie 115 / Ramsey 230	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)
Roseau 230 / Running 230	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)
Shey 115 / Split Rock 115	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)

POWER FLOW AND STABILITY SUMMARY TABLE

1	Case No.	13	14	15	16
2	Case Name	p2r-so12s1.uymV4V4-p9s	p2r-so12s1.uymV4V4-pas	p2r-so12aa.uymV4V4-c3s	p2t-so12pt.uymV4V4-p7s
3	Disturbance	p9s	pas	c3s	p7s
4	Prior Outage	s1	s1	None	pt
5	Date/Time	AUG 24 2004 14:22	AUG 24 2004 14:40	AUG 24 2004 15:05	AUG 25 2004 9:59
6	Comments				
7					
8	Steady State Flows				
9	NDEX / EAST BIAS	1958 / 269	1958 / 269	1958 / 269	1958 / 269
10	MHEX / L20D	2171 / 259	2171 / 259	2174 / 260	2165 / 258
11	ECL-ARP / PRI-BYN	515 / 528	515 / 528	516 / 529	515 / 527
12	MWSI / MNEX	1044 / 1467	1044 / 1467	1045 / 1468	1043 / 1464
13	D602F / F601C	1727 / 1194	1727 / 1194	1729 / 1196	1723 / 1192
14	B10T / MH>SPC	164 / 67	164 / 67	165 / 67	164 / 67
15	OH E-W / OH>MH	-196 / -196	-196 / -196	-197 / -196	-197 / -196
16	R50M / OH>MP	148 / 150	148 / 150	149 / 150	147 / 150
17	G82R	35	35	36	35
18	Dorsey BP1 / BP2	1406 / 1592	1406 / 1592	1406 / 1592	1406 / 1592
19	Dorsey Reserve / Wtrtn SVC	845 / -7	845 / -7	863 / -7	814 / -8
20	Forbes SVC / MSC	44 / 600	44 / 600	46 / 600	40 / 600
21	Steady State Vltgs				
22	Dorsey 500/Dorsey 230	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045
23	Roseau 500/Forbes 500	1.034 / 1.014	1.034 / 1.014	1.034 / 1.014	1.035 / 1.014
24	Chisago 500/EauClaire 345	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026
25	Int Falls 115/Badoura 115	1.006 / 1.016	1.006 / 1.016	1.006 / 1.016	1.007 / 1.017
26	Drayton 230/Groton 345	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006
27	SS OS Relay Margins				
28	D602F at Forbes/Dorsey	245% / 416%	245% / 416%	245% / 415%	246% / 418%
29	B2R at Rugby/L20D at Drayton	999% / 759%	999% / 759%	999% / 756%	999% / 762%
30	R50M/F3M	909% / 317%	909% / 317%	906% / 316%	913% / 317%
31	B10T	331%	331%	330%	331%
32	Min/MaxTransientVltg				
33	Arrowhd 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
34	Boise 115	1.00 1.01	1.01 1.01	1.00 1.01	1.01 1.01
35	Dorsey 230	1.04 1.05	1.04 1.05	1.04 1.05	1.04 1.05
36	Forbes 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
37	Riverton 230	1.02 1.02	1.02 1.02	1.01 1.02	1.02 1.02
38	Coal Creek 230	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
39	Dickinson 345	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
40	Drayton 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
41	Groton 345	1.01 1.01	1.01 1.01	1.01 1.01	1.01 1.01
42	Tioga 230	1.02 1.03	1.02 1.03	1.02 1.02	1.02 1.03
43	Wahpeton 115	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
44	Watertown 345	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03
45	Dynamic Voltage Warnings				
46		none	none	none	none
47					
48					
49					
50					
51					
52					
53	Worst Case Angle Damping	KING 3 / 44.60%	KING 3 / 39.68%	KING 3 / 58.69%	KING 3 / 46.31%
54	Dorsey SUVV / UdHold				
55	Forbes DC Red (DCAR)	496%	496%	497%	496%
56	K22W (max +dP @ t, d-ang)	15.4@(0.14167,-0.6)	14.9@(1.71666,-4.3)	11.4@(1.06666,-1.2)	13.3@(0.15833,-0.6)
57	K22W (max -dP @ t, d-ang)	1.3@(0.69166,-1.4)	2.0@(1.30000,-3.8)	7.0@(1.48333,-1.6)	2.1@(0.68333,-1.4)
58	K22W (max d-ang @ t, dP)	-3.4@(1.40000,2.6)	-5.0@(10.00821,7.1)	-2.0@(1.29166,1.4)	-3.5@(1.35833,2.4)
59	OS Rel Trip / Marg				
60	MH - OH				
61	D602F at Forbes/Dorsey	245% / 416%	245% / 416%	239% / 406%	246% / 418%
62	B2R at Rugby/L20D at Drayton	999% / 759%	999% / 759%	999% / 739%	999% / 762%
63	R50M / F3M	909% / 315%	909% / 315%	879% / 313%	913% / 315%
64	B10T	331%	331%	328%	331%
65	FSCAPS (SS/Unav/Final)				
66	Balta 230	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)
67	Eau Cl 345 / Park Lk 115	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)
68	Prairie 115 / Ramsey 230	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)
69	Roseau 230 / Running 230	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)
70	Shey 115 / Split Rock 115	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)

POWER FLOW AND STABILITY SUMMARY TABLE

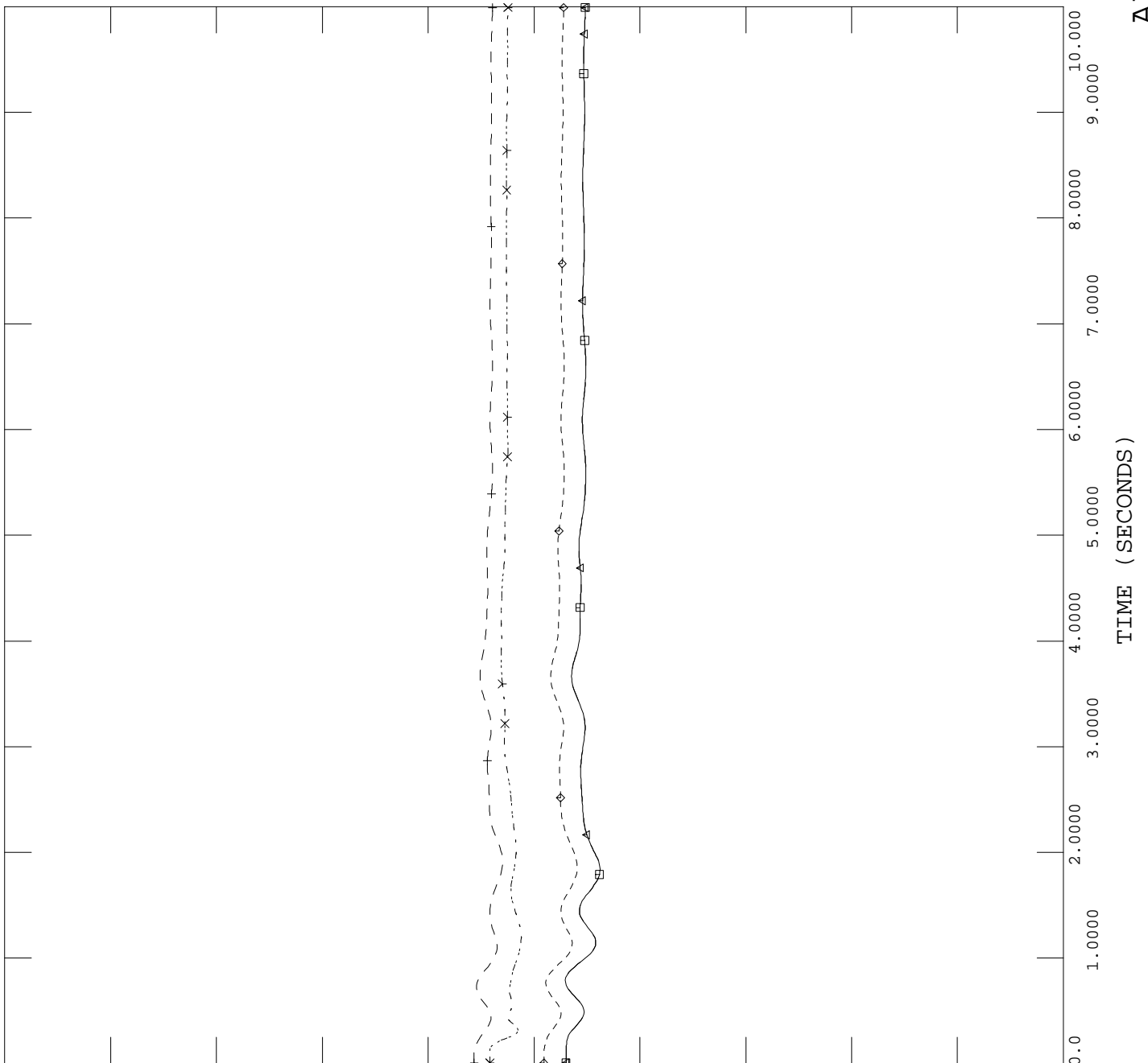
Case No.	17	18	19	20
Case Name	p2t-so12pt.uymV4V4-p8s	p2t-so12s1.uymV4V4-pbs	p2t-so12s1.uymV4V4-pcs	p2t-so12aa.uymV4V4-a3s
Disturbance	p8s	pbs	pcs	a3s
Prior Outage	pt	s1	s1	None
Date/Time	AUG 25 2004 10:24	AUG 24 2004 16:11	AUG 25 2004 8:42	AUG 25 2004 10:43
Comments				
Steady State Flows				
NDEX / EAST BIAS	1958 / 269	1958 / 269	1958 / 269	1958 / 269
MHEX / L20D	2165 / 258	2172 / 259	2172 / 259	2175 / 260
ECL-ARP / PRI-BYN	515 / 527	515 / 529	515 / 529	516 / 529
MWSI / MNEX	1043 / 1464	1045 / 1467	1045 / 1467	1045 / 1468
D602F / F601C	1723 / 1192	1728 / 1195	1728 / 1195	1729 / 1196
B10T / MH>SPC	164 / 67	164 / 67	164 / 67	165 / 67
OH E-W / OH>MH	-197 / -196	-196 / -196	-196 / -196	-197 / -196
R50M / OH>MP	147 / 150	148 / 150	148 / 150	148 / 150
G82R	35	36	36	36
Dorsey BP1 / BP2	1406 / 1592	1406 / 1592	1406 / 1592	1406 / 1592
Dorsey Reserve / Wtrtn SVC	814 / -8	836 / -7	836 / -7	850 / -7
Forbes SVC / MSC	40 / 600	46 / 600	46 / 600	47 / 600
Steady State Vltgs				
Dorsey 500/Dorsey 230	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045	1.037 / 1.045
Roseau 500/Forbes 500	1.035 / 1.014	1.034 / 1.014	1.034 / 1.014	1.034 / 1.014
Chisago 500/EauClaire 345	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026	1.016 / 1.026
Int Falls 115/Badoura 115	1.007 / 1.017	1.007 / 1.016	1.007 / 1.016	1.007 / 1.016
Drayton 230/Groton 345	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006	1.014 / 1.006
SS OS Relay Margins				
D602F at Forbes/Dorsey	246% / 418%	245% / 416%	245% / 416%	244% / 415%
B2R at Rugby/L20D at Drayton	999% / 762%	999% / 757%	999% / 757%	999% / 756%
R50M/F3M	913% / 317%	907% / 317%	907% / 317%	904% / 317%
B10T	331%	331%	331%	330%
Min/MaxTransientVltg				
Arrowhd 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Boise 115	1.01 1.01	1.01 1.01	1.00 1.01	1.01 1.01
Dorsey 230	1.04 1.05	1.03 1.05	1.04 1.05	1.04 1.05
Forbes 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Riverton 230	1.01 1.02	1.02 1.02	1.01 1.02	1.01 1.02
Coal Creek 230	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Dickinson 345	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Drayton 230	1.01 1.02	1.01 1.02	1.01 1.02	1.01 1.02
Groton 345	1.01 1.01	1.01 1.01	1.01 1.01	1.01 1.01
Tioga 230	1.02 1.03	1.02 1.03	1.02 1.03	1.02 1.03
Wahpeton 115	1.03 1.04	1.03 1.04	1.03 1.04	1.03 1.04
Watertown 345	1.03 1.03	1.03 1.03	1.03 1.03	1.03 1.03
Dynamic Voltage Warnings				
	none	none	none	none
Worst Case Angle Damping				
	KING 3 / 41.51%	KING 3 / 43.32%	KING 3 / 43.65%	KING 3 / 55.43%
Dorsey SUVV / UdHold				
Forbes DC Red (DCAR)	494%	492%	489%	496%
K22W (max +dP @ t, d-ang)	12.6@(0.16667,-0.6)	27.4@(0.15000,-1.1)	25.4@(0.15000,-1.0)	13.0@(1.08333,-1.7)
K22W (max -dP @ t, d-ang)	6.0@(1.27500,-2.6)	1.9@(0.70833,-2.2)	6.3@(1.29166,-1.5)	4.8@(0.70000,-0.7)
K22W (max d-ang @ t, dP)	-3.2@(9.98321,4.3)	-3.9@(1.40000,5.7)	-1.8@(1.10833,0.9)	-2.3@(1.29166,4.3)
OS Rel Trip / Marg				
MH - OH				
D602F at Forbes/Dorsey	246% / 417%	245% / 416%	241% / 410%	239% / 406%
B2R at Rugby/L20D at Drayton	999% / 761%	999% / 757%	999% / 748%	999% / 739%
R50M / F3M	906% / 315%	905% / 317%	891% / 312%	874% / 316%
B10T	331%	331%	329%	328%
FSCAPS (SS/Unav/Final)				
Balta 230	(0 0 0)	(0 0 0)	(0 0 0)	(0 0 0)
Eau Cl 345 / Park Lk 115	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)	(3 3 3)/(0 0 0)
Prairie 115 / Ramsey 230	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)	(1 1 1)/(0 0 0)
Roseau 230 / Running 230	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)	(0 0 0)/(3 3 3)
Shey 115 / Split Rock 115	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)	(0 0 0)/(0 0 0)



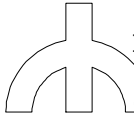
P1R-SO12PR.UYMV4V4.SAV;SUMMER;OP LD;PDB-ROV 110KV O/S :
ND=1958,MH=2169,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

FILE: plr-sol2pr.uymV4V4-pls.bin

150.00	CHNL# 1088: [ANG1GTFL-4G]	→ - - - - - →	50.000
150.00	CHNL# 1087: [ANG1GTFL-3G]	× - - - - - ×	50.000
150.00	CHNL# 1086: [ANG1GTFLNET4G]	+ - - - - - +	50.000
150.00	CHNL# 1085: [ANG1PNFL3-6G]	◇ - - - - - ◇	50.000
150.00	CHNL# 1084: [ANG1PNFL-2G]	← - - - - - →	50.000
150.00	CHNL# 1083: [ANG1PNFL-1G]	□ - - - - - □	50.000



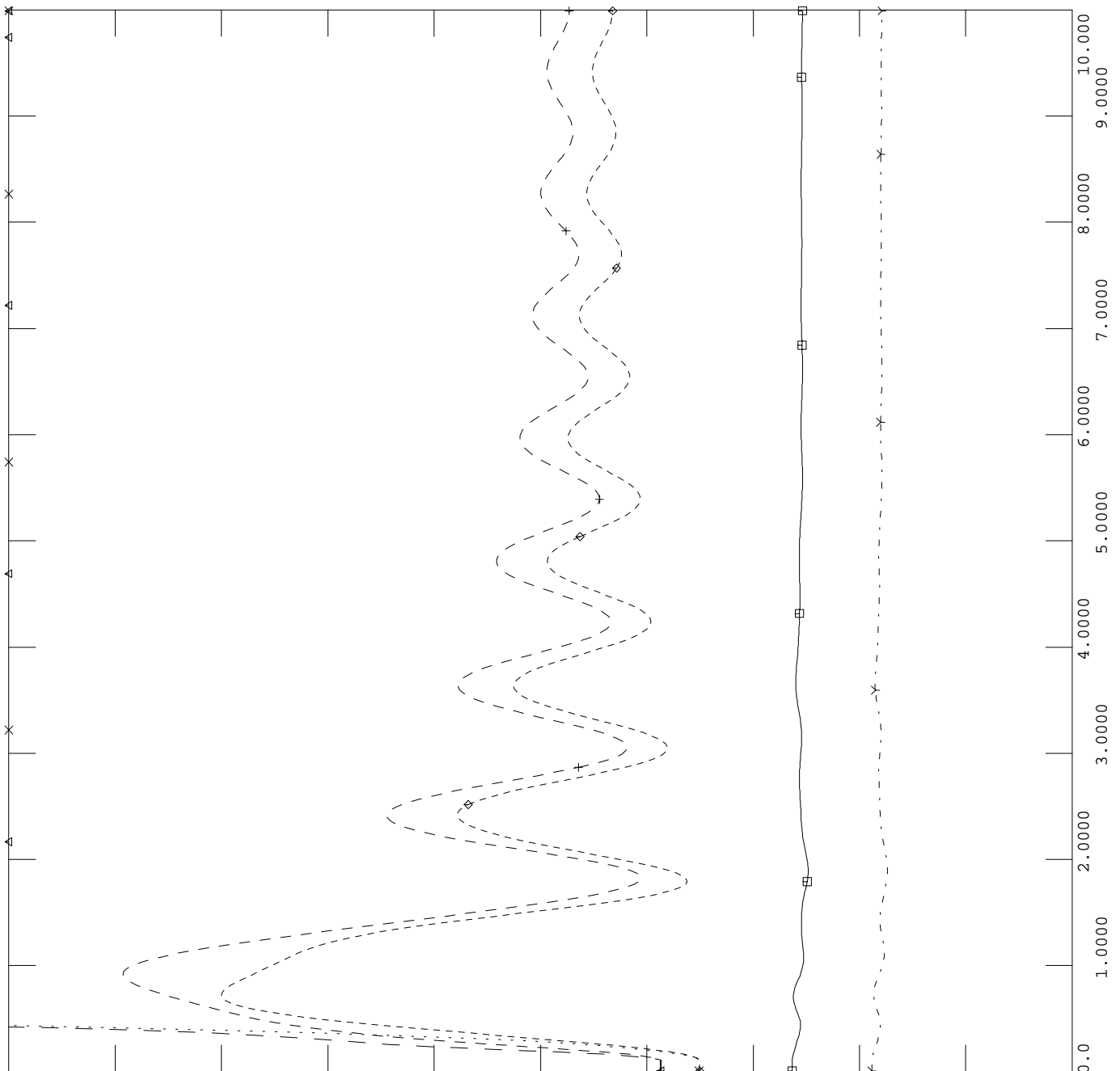
MON, AUG 30 2004 11:08
APPENDIX D.1A ANGLE1



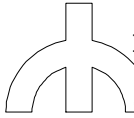
P1R-SO12PR.UYMV4V4.SAV;SUMMER;OP LD;PDB-ROV 110KV O/S :
ND=1958,MH=2169,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

FILE: plr-sol2pr.uymV4V4-pls.bin

Value	Channel	Marker	Value
230.00	CHNL# 44: [ANG17SIS1-6G]	→ - - - - - →	50.000
230.00	CHNL# 1093: [ANG1PDB2-4G]	× - - - - - ×	50.000
230.00	CHNL# 1092: [ANG1SLFL1-8G]	+ - - - - - +	50.000
230.00	CHNL# 1091: [ANG1PDB5-16G]	◇ - - - - - ◇	50.000
230.00	CHNL# 1090: [ANG1PDB-1GSTRAF]	← - - - - - →	50.000
230.00	CHNL# 1089: [ANG1MCA1-8G]	□ - - - - - □	50.000



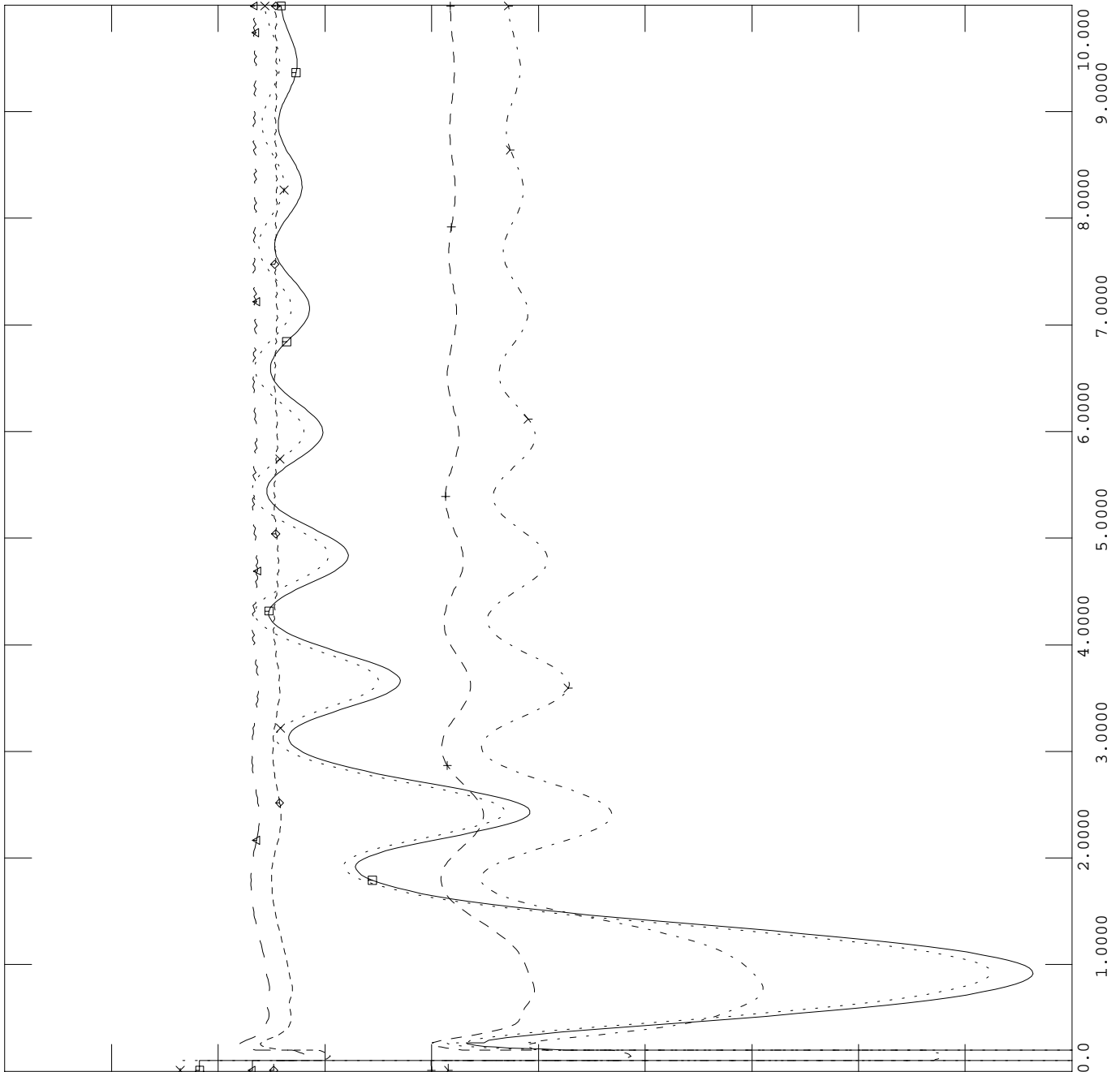
MON, AUG 30 2004 11:08
APPENDIX D.1B ANGLE2



P1R-SO12PR.UYMV4V4.SAV;SUMMER;OP LD;PDB-ROV 110KV O/S :
ND=1958,MH=2169,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

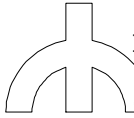
FILE: plr-sol2pr.uymV4V4-pls.bin
CHNL# 1102: [V-67555 SCOTLAND 110]

1.2000	>----->	0.70000
	CHNL# 1101: [V-67993 PDB 110]	
1.2000	x-----x	0.70000
	CHNL# 1100: [V-67999 ROVER 110]	
1.2000	+-----+	0.70000
	CHNL# 1098: [V-67535 PINEFL 110]	
1.2000	◇-----◇	0.70000
	CHNL# 1097: [V-67536 GREATFL 110]	
1.2000	←-----→	0.70000
	CHNL# 1094: [V-67554 SLFL 121]	
1.2000	▣-----▣	0.70000



MON, AUG 30 2004 11:08
APPENDIX D.1C VOLTAGE

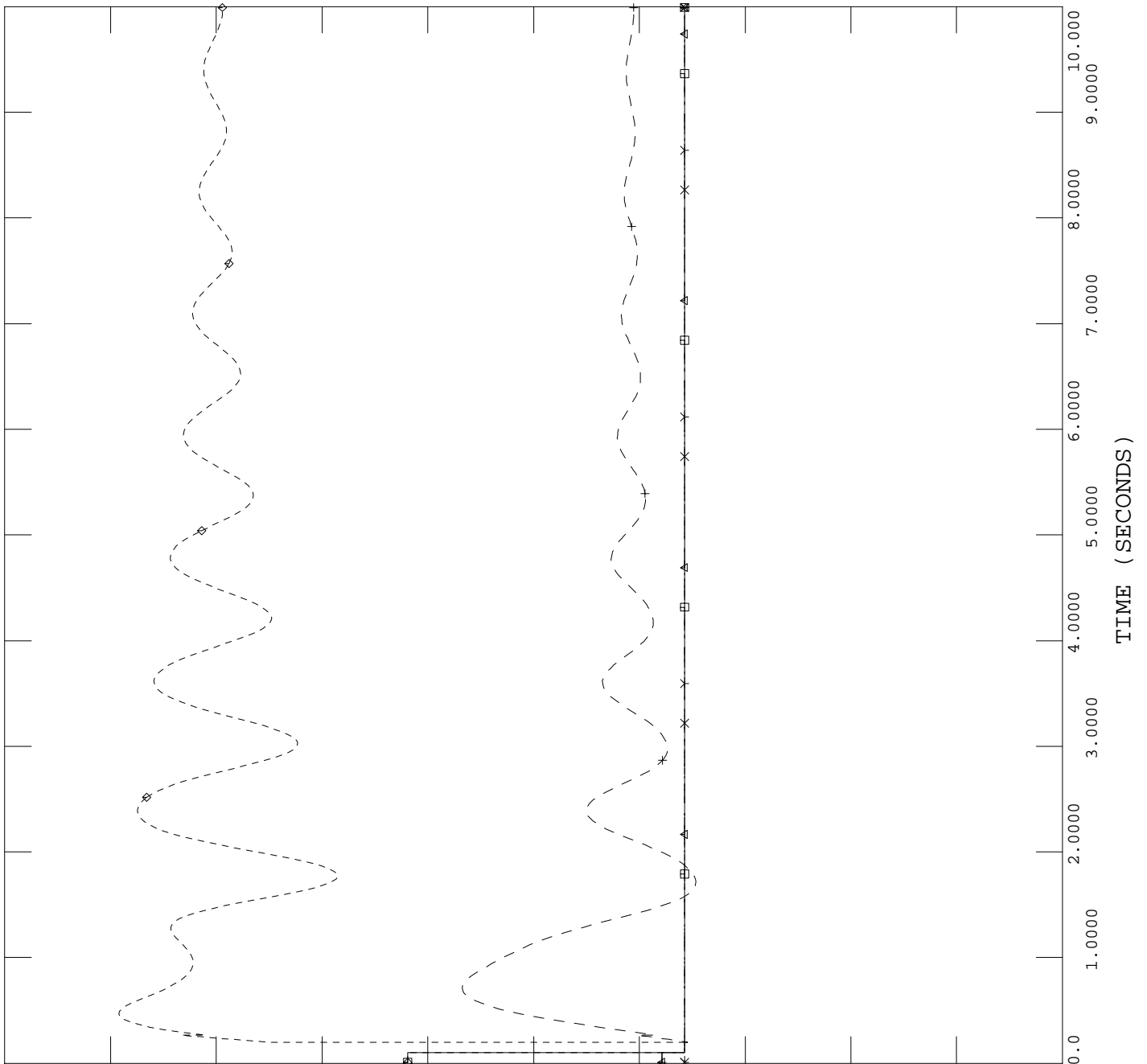
TIME (SECONDS)

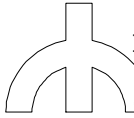


P1R-SO12PR.UYMV4V4.SAV;SUMMER;OP LD;PDB-ROV 110KV O/S :
ND=1958,MH=2169,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

FILE: plr-sol2pr.uymV4V4-pls.bin
CHNL# 1108: [Q-PDB-SG12TAP (TO ROVER)]

180.00	>----->	-100.0
180.00	X-----X	-100.0
180.00	+-----+	-100.0
180.00	◇-----◇	-100.0
180.00	←-----△	-100.0
180.00	▣-----▣	-100.0

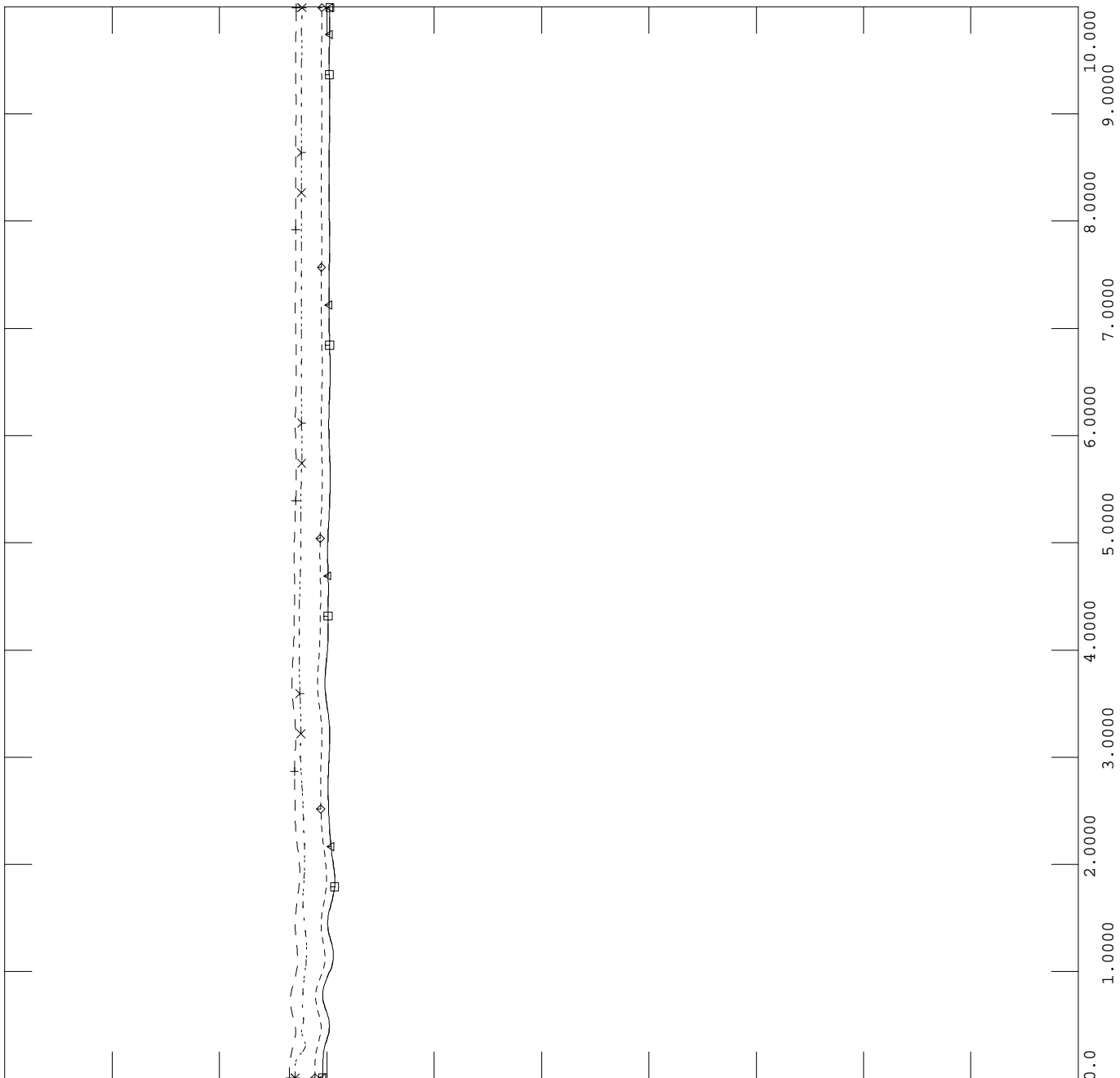




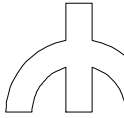
P1T-S012PT.UYMV4V4.SAV;SUMMER;OP LD;PDB-TRN 110KV O/S :
ND=1958,MH=2168,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

FILE: plt-sol2pt.uymV4V4-pls.bin

180.00	CHNL# 1088: [ANG1GTFL-4G]	➤-----➤	-100.0
180.00	CHNL# 1087: [ANG1GTFL-3G]	×-----×	-100.0
180.00	CHNL# 1086: [ANG1GTFLNET4G]	+-----+	-100.0
180.00	CHNL# 1085: [ANG1PNFL3-6G]	◇-----◇	-100.0
180.00	CHNL# 1084: [ANG1PNFL-2G]	←-----→	-100.0
180.00	CHNL# 1083: [ANG1PNFL-1G]	▣-----▣	-100.0



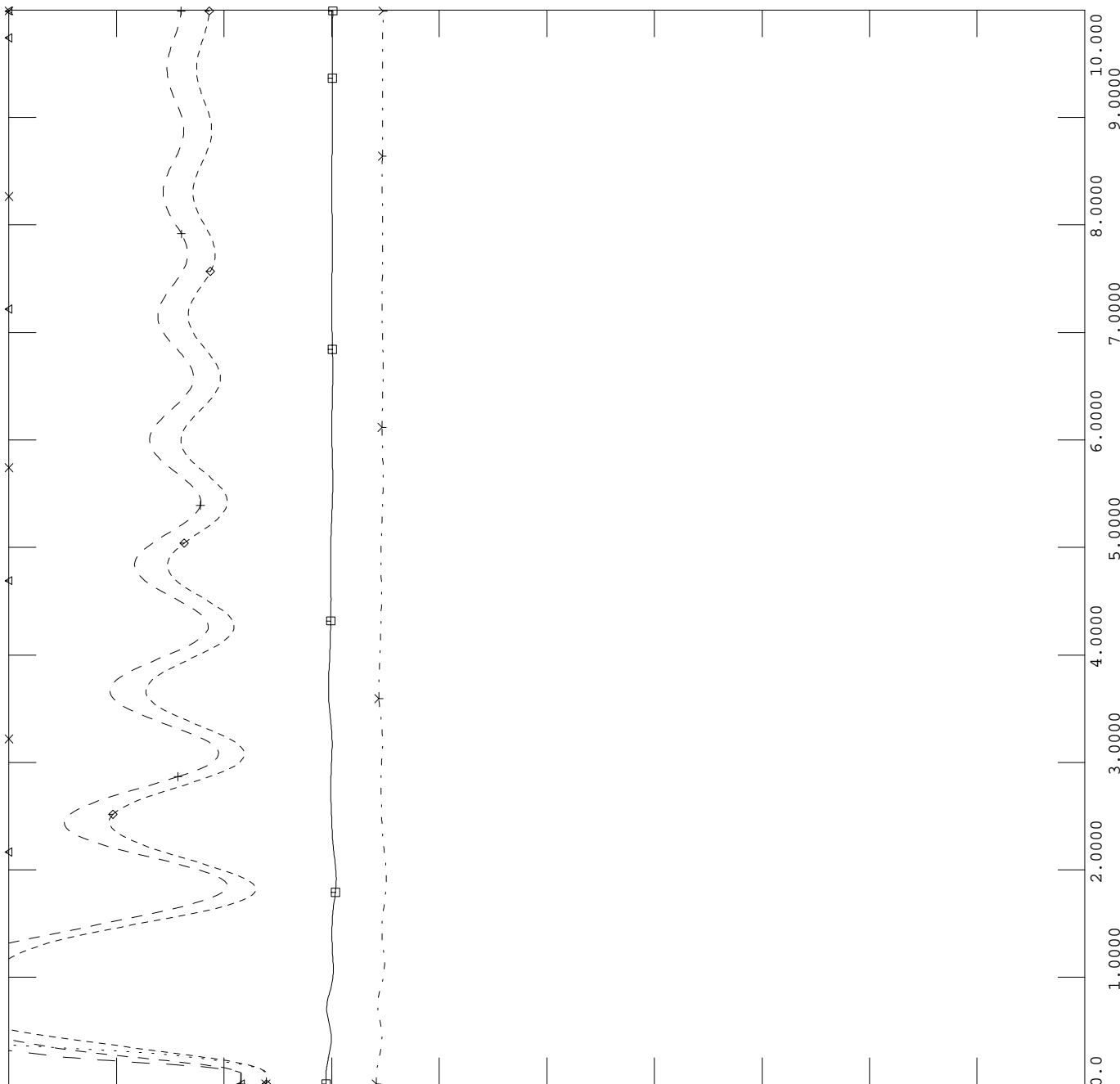
MON, AUG 30 2004 11:13
APPENDIX D.2A - ANGLES 1



P1T-S012PT.UYMV4V4.SAV;SUMMER;OP LD;PDB-TRN 110KV O/S :
ND=1958,MH=2168,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

FILE: plt-sol2pt.uymV4V4-pls.bin

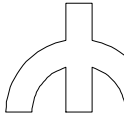
Channel ID	Channel Name	Start Value	End Value
CHNL# 44	[ANG17SIS1-6G]	180.00	-100.0
CHNL# 1093	[ANG1PDB2-4G]	180.00	-100.0
CHNL# 1092	[ANG1SLFL1-8G]	180.00	-100.0
CHNL# 1091	[ANG1PDB5-16G]	180.00	-100.0
CHNL# 1090	[ANG1PDB-1GSTRAF]	180.00	-100.0
CHNL# 1089	[ANG1MCA1-8G]	180.00	-100.0



MON, AUG 30 2004 11:13

APPENDIX D.2B - ANGLES 2

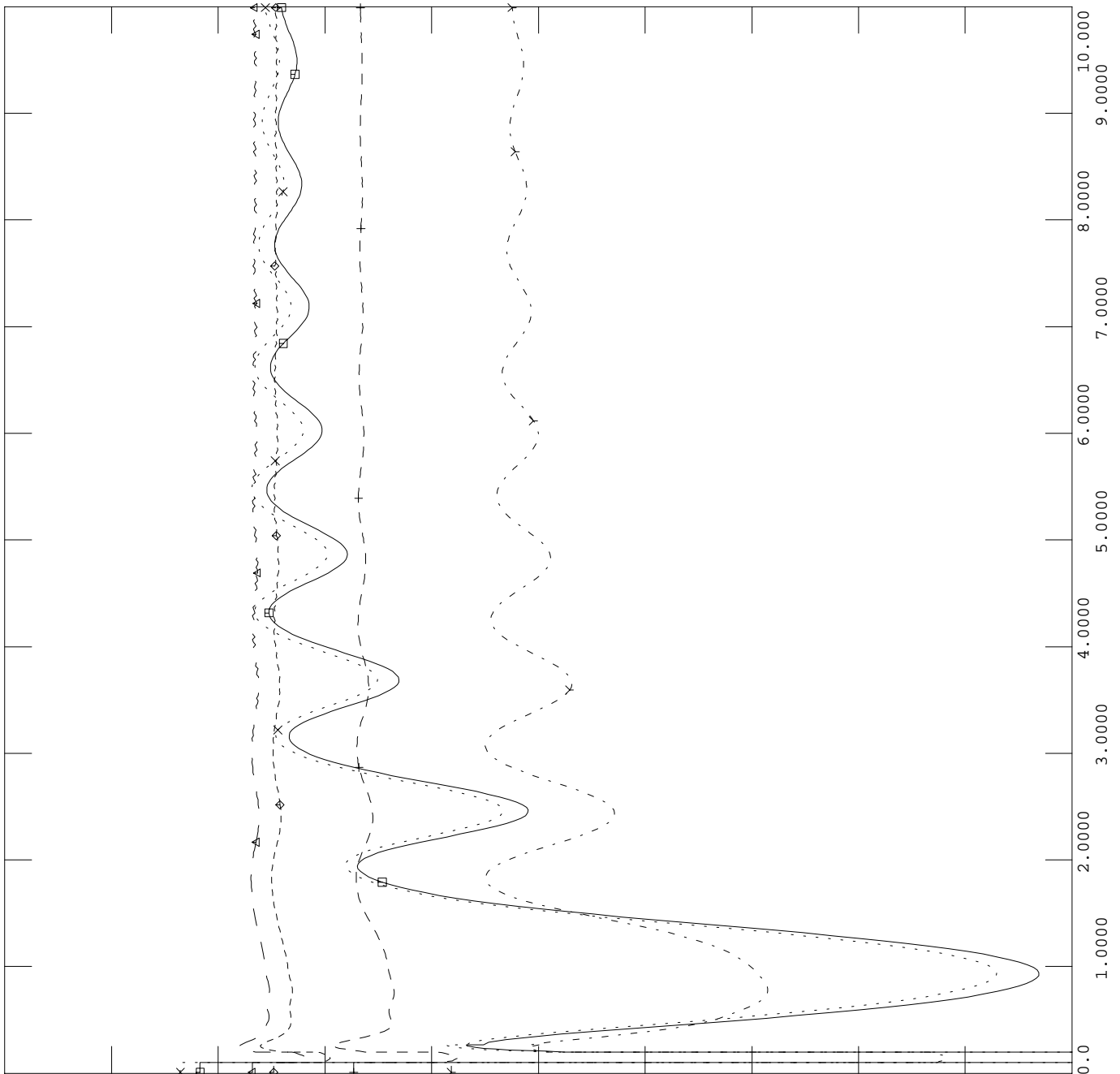
TIME (SECONDS)



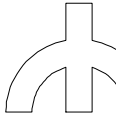
P1T-SO12PT.UYMV4V4.SAV;SUMMER;OP LD;PDB-TRN 110KV O/S :
ND=1958,MH=2168,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

FILE: plt-sol2pt.uymV4V4-pls.bin

1.2000	CHNL# 1102: [V-67555 SCOTLAND 110]	→ - - - - - →	0.70000
1.2000	CHNL# 1101: [V-67993 PDB 110]	× - - - - - ×	0.70000
1.2000	CHNL# 1100: [V-67540 TRANSCONA 110]	+ - - - - - +	0.70000
1.2000	CHNL# 1098: [V-67535 PINEFL 110]	◇ - - - - - ◇	0.70000
1.2000	CHNL# 1097: [V-67536 GREATFL 110]	← - - - - - →	0.70000
1.2000	CHNL# 1094: [V-67554 SLFL 121]	▣ - - - - - ▣	0.70000



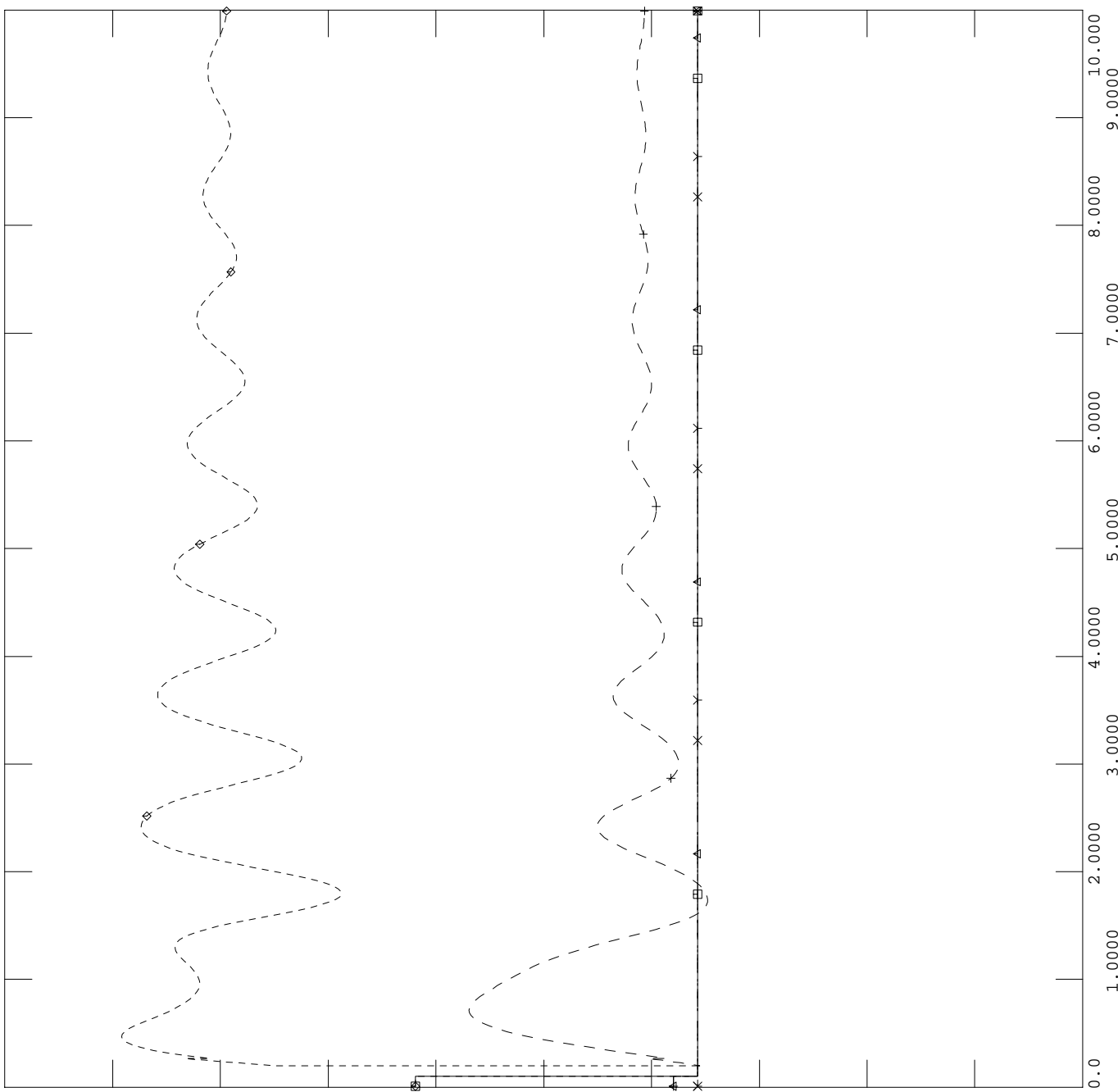
MON, AUG 30 2004 11:13
APPENDIX D.2C - VOLTAGES



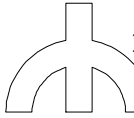
P1T-S012PT.UYMV4V4.SAV;SUMMER;OP LD;PDB-TRN 110KV O/S :
ND=1958,MH=2168,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

FILE: plt-sol2pt.uymV4V4-pls.bin
CHNL# 1108: [Q-PDB-SG12TAP (TO TRANSCONA)]

180.00	>----->	-100.0
CHNL# 1107: [P-PDB-SG12TAP (TO TRANSCONA)]		
180.00	x-----x	-100.0
CHNL# 1106: [Q-SFALLS-SCOT-S1]		
180.00	+-----+	-100.0
CHNL# 1105: [P-SFALLS-SCOT-S1]		
180.00	◇-----◇	-100.0
CHNL# 1104: [Q-SFALLS-SCOT-S2]		
180.00	←-----→	-100.0
CHNL# 1103: [P-SFALLS-SCOT-S2]		
180.00	▣-----▣	-100.0



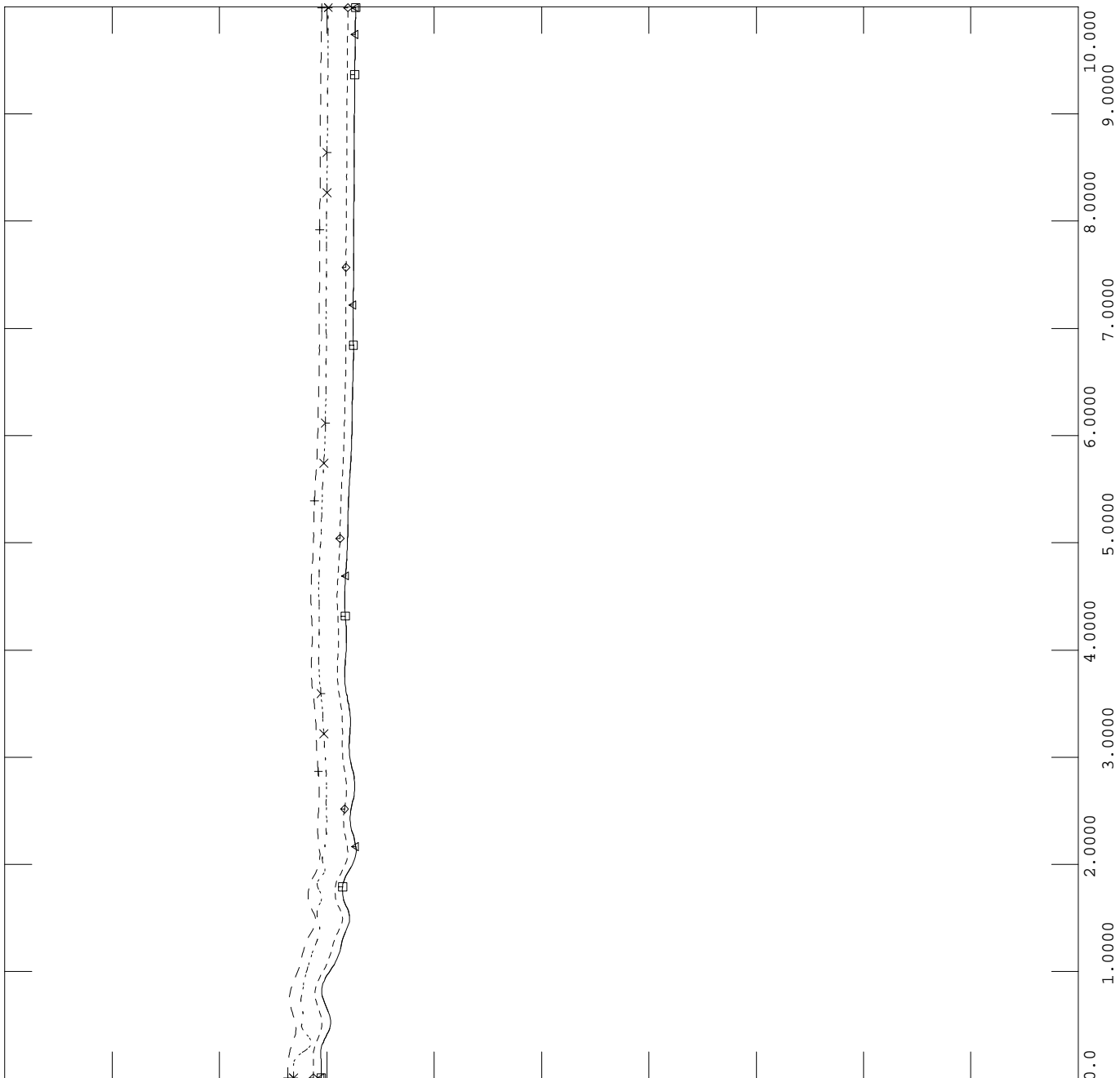
MON, AUG 30 2004 11:13
APPENDIX D.2D - LINE FLOW



P1T-S012S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT PDB-TRANSCONA 115 KV.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

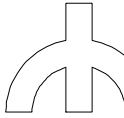
FILE: plt-sol2s1.uymV4V4-p5s.bin

180.00	CHNL# 1088: [ANG1GTFL-4G]	➤-----➤	-100.0
180.00	CHNL# 1087: [ANG1GTFL-3G]	×-----×	-100.0
180.00	CHNL# 1086: [ANG1GTFLNET4G]	+-----+	-100.0
180.00	CHNL# 1085: [ANG1PNFL3-6G]	◇-----◇	-100.0
180.00	CHNL# 1084: [ANG1PNFL-2G]	←-----→	-100.0
180.00	CHNL# 1083: [ANG1PNFL-1G]	▣-----▣	-100.0



MON, AUG 30 2004 11:16
APPENDIX D.3A - ANGLES 1

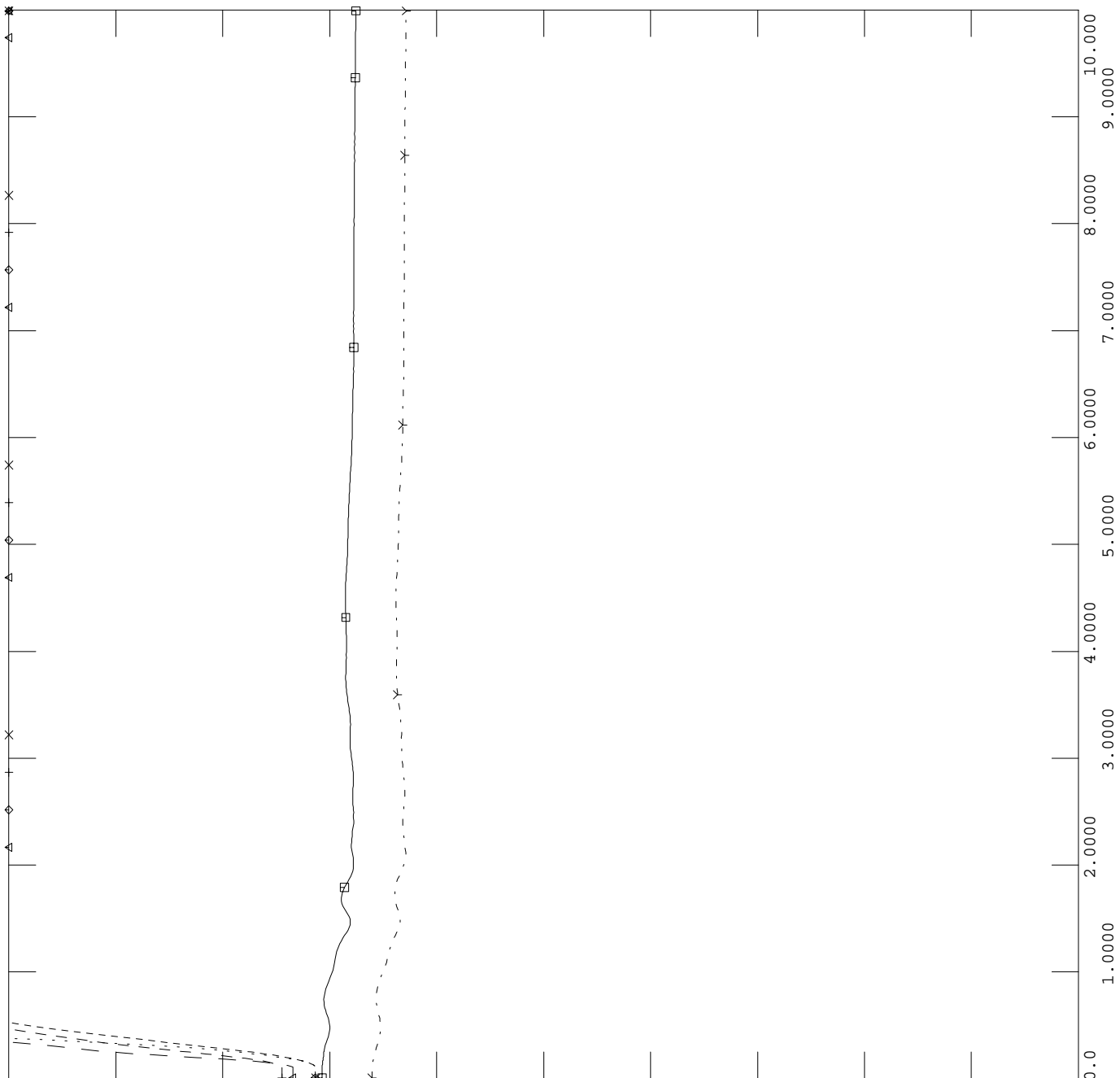
TIME (SECONDS)



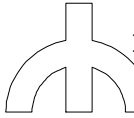
P1T-S012S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT PDB-TRANSCONA 115 KV.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

FILE: plt-sol2s1.uymV4V4-p5s.bin

Channel ID	Channel Name	Symbol	Value
CHNL# 44	[ANG17SIS1-6G]	>----->	-100.0
CHNL# 1093	[ANG1PDB2-4G]	x-----x	-100.0
CHNL# 1092	[ANG1SLFL1-8G]	+-----+	-100.0
CHNL# 1091	[ANG1PDB5-16G]	◇-----◇	-100.0
CHNL# 1090	[ANG1PDB-1GSTRAF]	←-----→	-100.0
CHNL# 1089	[ANG1MCA1-8G]	▣-----▣	-100.0



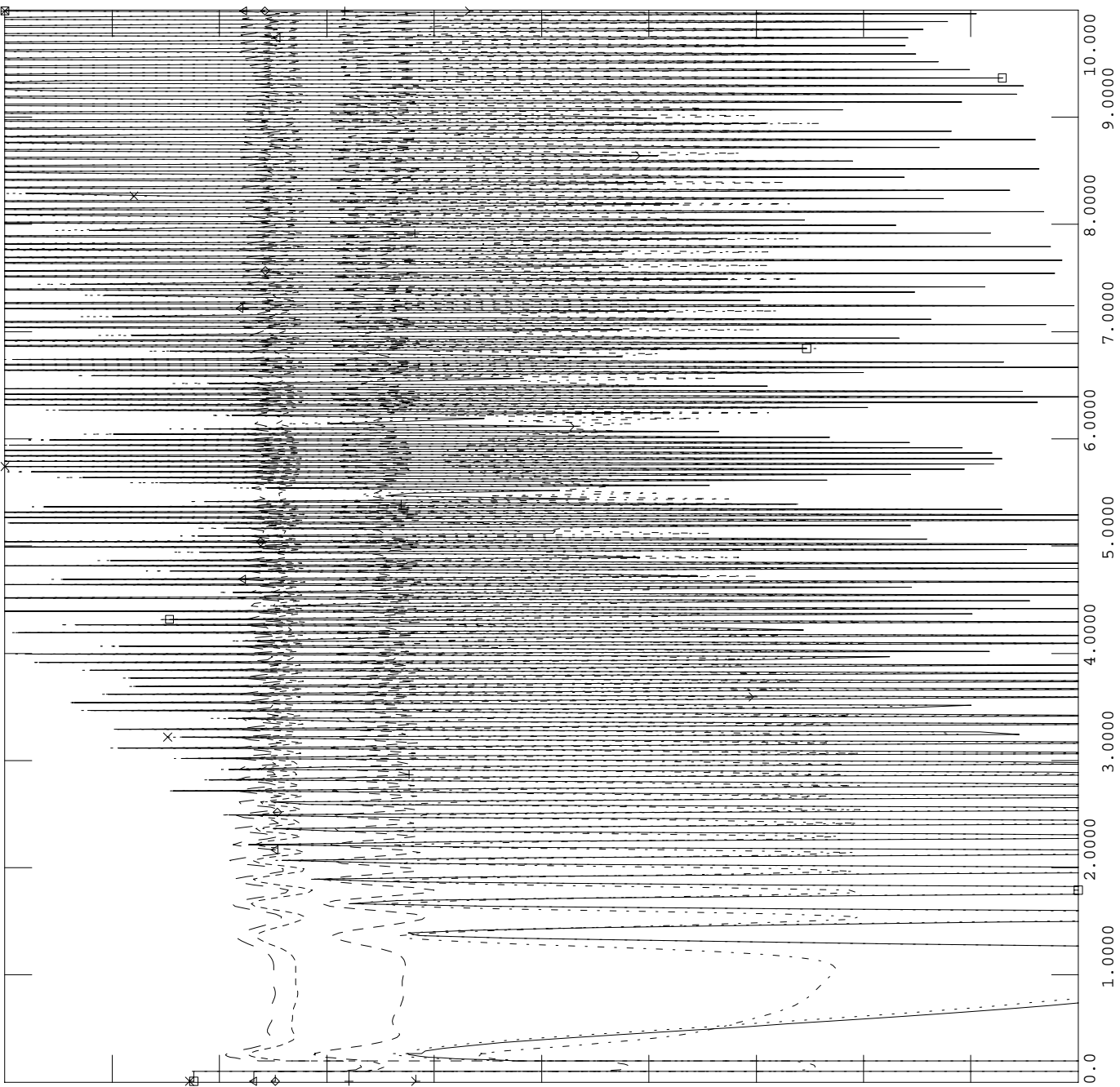
MON, AUG 30 2004 11:16
APPENDIX D.3B - ANGLES 2



P1T-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT PDB-TRANSCONA 115 KV.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

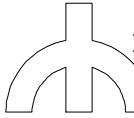
FILE: plt-sol2s1.uymV4V4-p5s.bin
CHNL# 1102: [V-67555 SCOTLAND 110]

1.2000	CHNL# 1101: [V-67993 PDB 110]	0.70000
1.2000	CHNL# 1100: [V-67540 TRANSCONA 110]	0.70000
1.2000	CHNL# 1098: [V-67535 PINEFL 110]	0.70000
1.2000	CHNL# 1097: [V-67536 GREATFL 110]	0.70000
1.2000	CHNL# 1094: [V-67554 SLFL 121]	0.70000



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APPENDIX D.3C - VOLTAGES

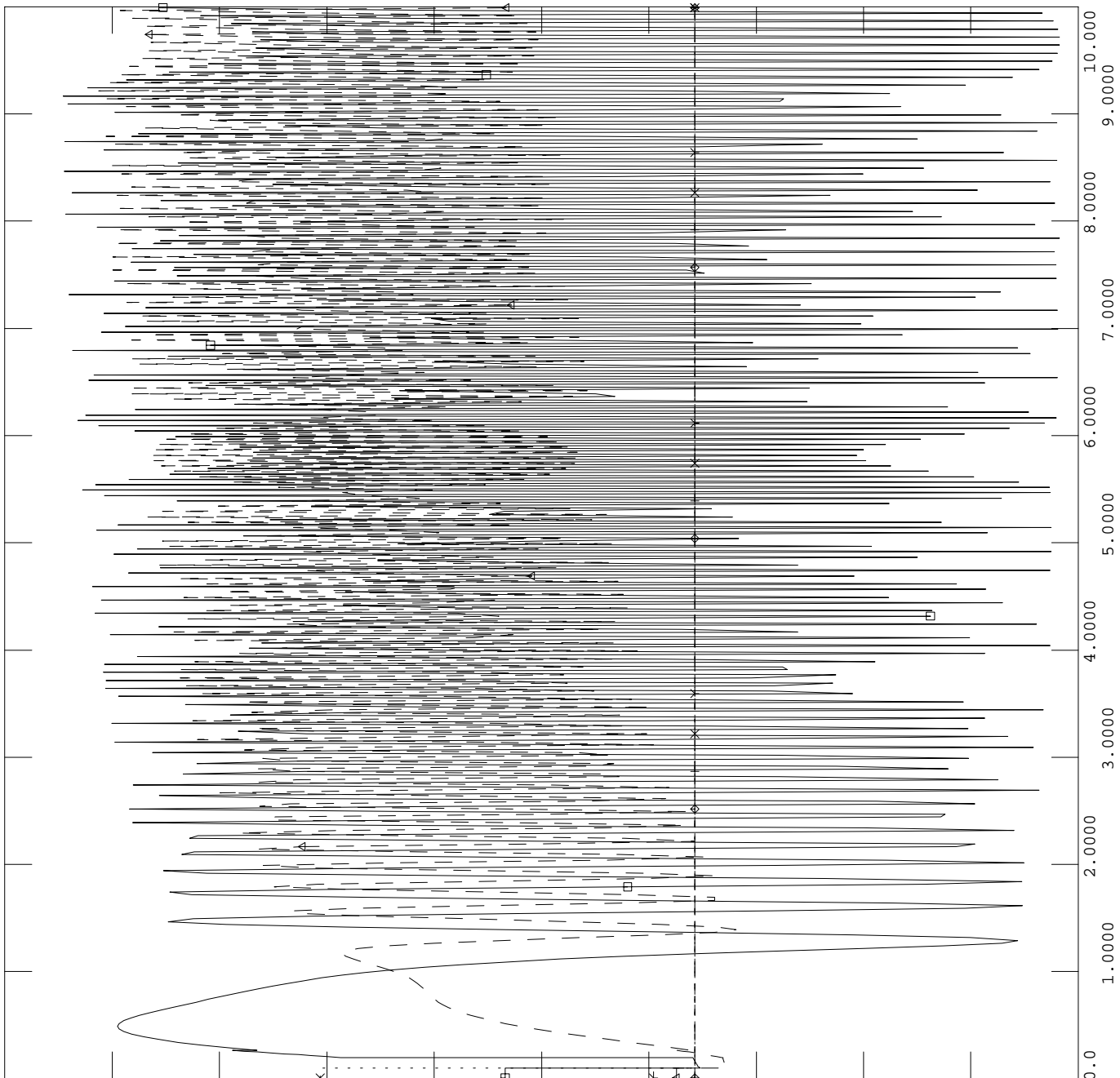
TIME (SECONDS)



P1T-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT PDB-TRANSCONA 115 KV.
CROSS TRIP UNITS 1-4 AT P.D.BOIS.

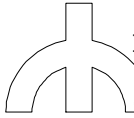
FILE: plt-sol2s1.uymV4V4-p5s.bin

180.00	CHNL# 1108: [Q-PDB-SG12TAP (TO TRANSCONA)]	>----->	-100.0
180.00	CHNL# 1107: [P-PDB-SG12TAP (TO TRANSCONA)]	x-----x	-100.0
180.00	CHNL# 1106: [Q-SFALLS-SCOT-S1]	+-----+	-100.0
180.00	CHNL# 1105: [P-SFALLS-SCOT-S1]	◇-----◇	-100.0
180.00	CHNL# 1104: [Q-SFALLS-SCOT-S2]	←-----△	-100.0
180.00	CHNL# 1103: [P-SFALLS-SCOT-S2]	□-----□	-100.0



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APPENDIX D.3D - LINE FLOW

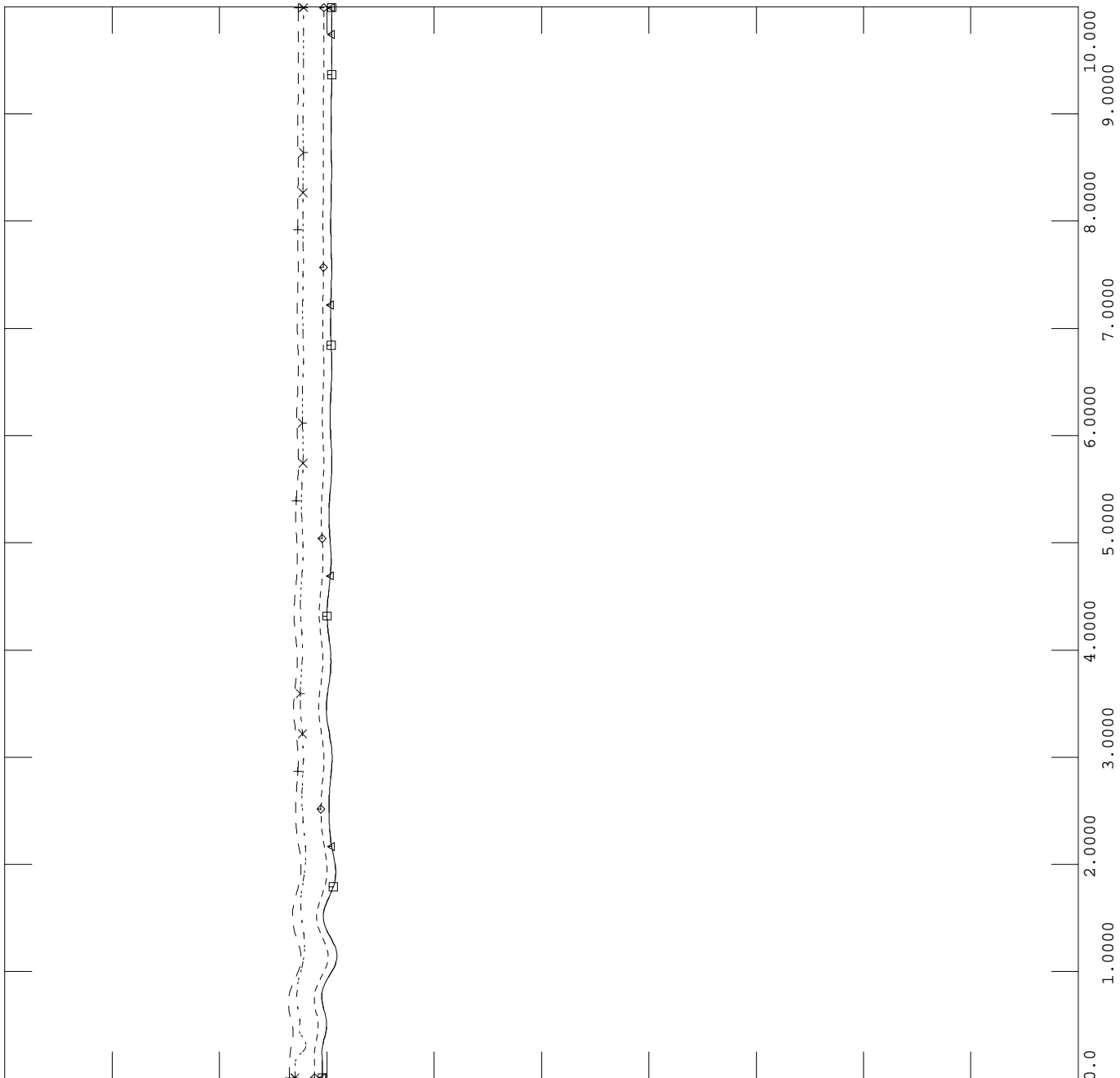
TIME (SECONDS)



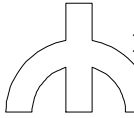
P1R-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4, 14-16 AT P.D.BOIS.

FILE: plr-sol2s1.uymV4V4-p4s.bin

180.00	CHNL# 1088: [ANG1GTFL-4G]	➤-----➤	-100.0
180.00	CHNL# 1087: [ANG1GTFL-3G]	×-----×	-100.0
180.00	CHNL# 1086: [ANG1GTFLNET4G]	+-----+	-100.0
180.00	CHNL# 1085: [ANG1PNFL3-6G]	◇-----◇	-100.0
180.00	CHNL# 1084: [ANG1PNFL-2G]	←-----→	-100.0
180.00	CHNL# 1083: [ANG1PNFL-1G]	▣-----▣	-100.0



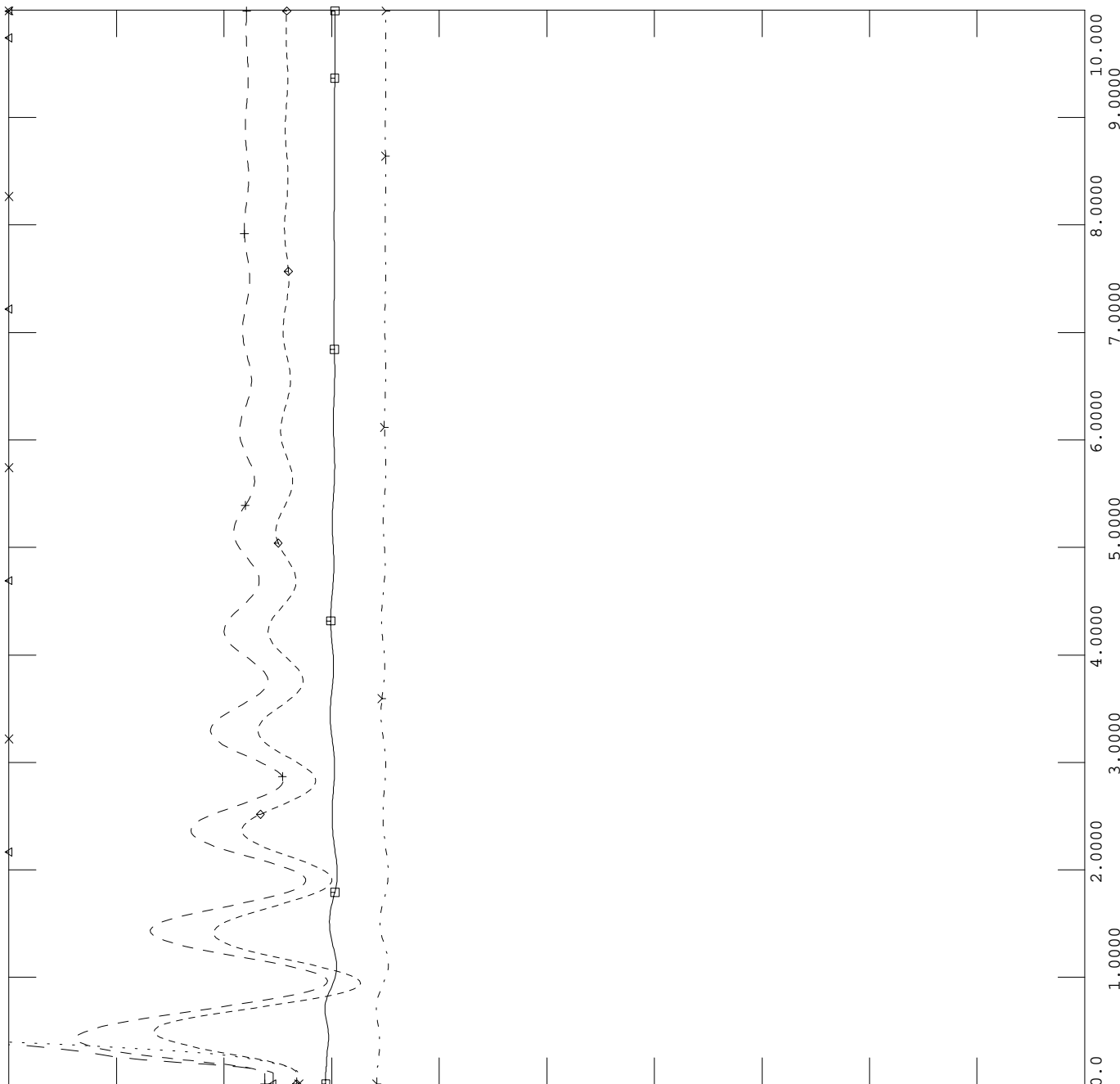
MON, AUG 30 2004 11:21
APPENDIX D.4A - ANGLES 1



P1R-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4, 14-16 AT P.D.BOIS.

FILE: plr-sol2s1.uymV4V4-p4s.bin

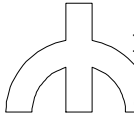
Channel ID	Symbol	Value
CHNL# 44: [ANG17SIS1-6G]	➤-----➤	-100.0
CHNL# 1093: [ANG1PDB2-4G]	×-----×	-100.0
CHNL# 1092: [ANG1SLFL1-8G]	+-----+	-100.0
CHNL# 1091: [ANG1PDB5-16G]	◇-----◇	-100.0
CHNL# 1090: [ANG1PDB-1GSTRAF]	←-----→	-100.0
CHNL# 1089: [ANG1MCA1-8G]	▣-----▣	-100.0



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APPENDIX D.4B - ANGLES 2

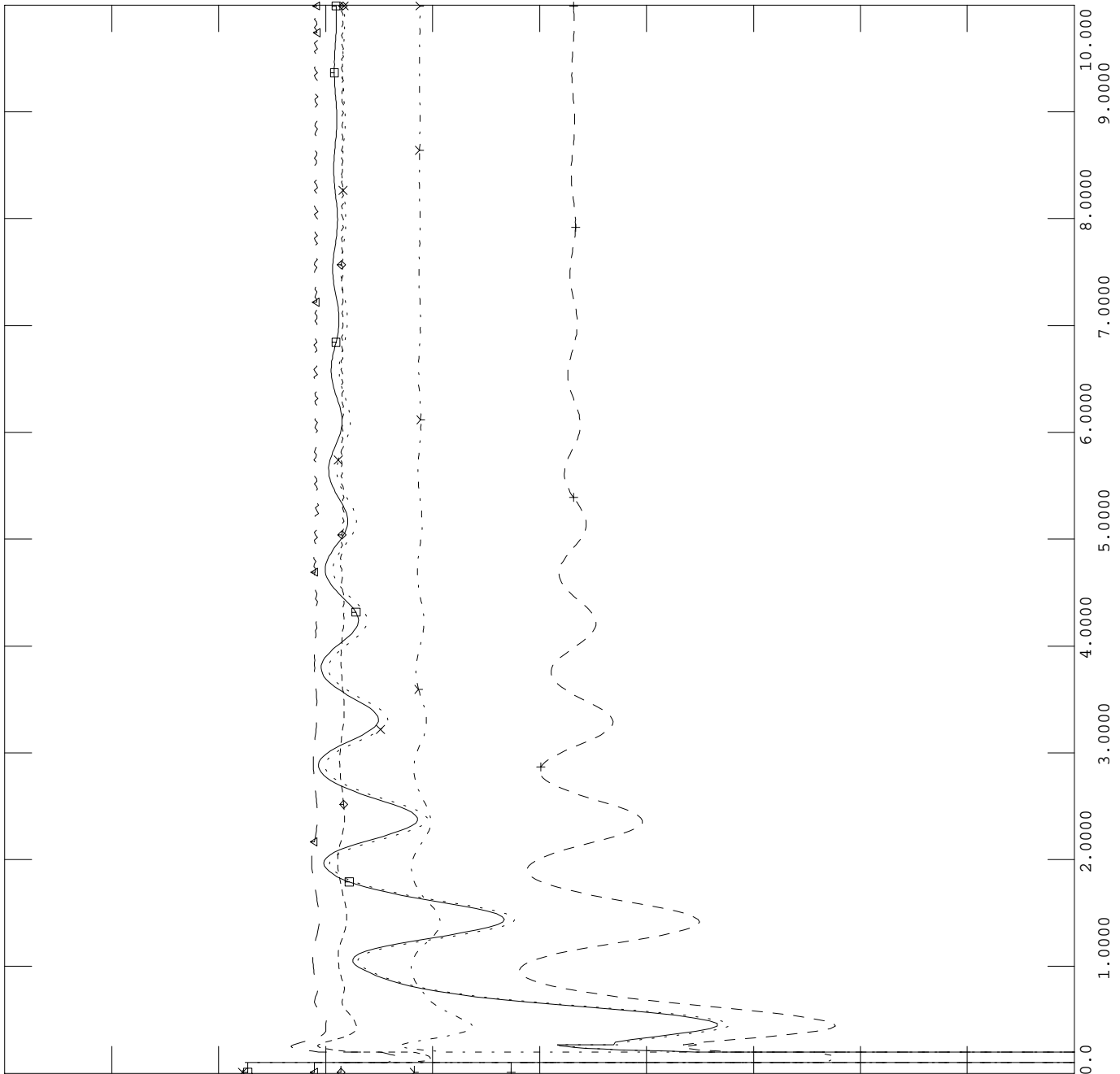
TIME (SECONDS)



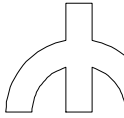
P1R-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4, 14-16 AT P.D.BOIS.

FILE: plr-sol2s1.uymV4V4-p4s.bin
CHNL# 1102: [V-67555 SCOTLAND 110]

1.2000	CHNL# 1101: [V-67993 PDB 110]	0.70000
1.2000	CHNL# 1100: [V-67999 ROVER 110]	0.80000
1.2000	CHNL# 1098: [V-67535 PINEFL 110]	0.80000
1.2000	CHNL# 1097: [V-67536 GREATFL 110]	0.80000
1.2000	CHNL# 1094: [V-67554 SLFL 121]	0.80000



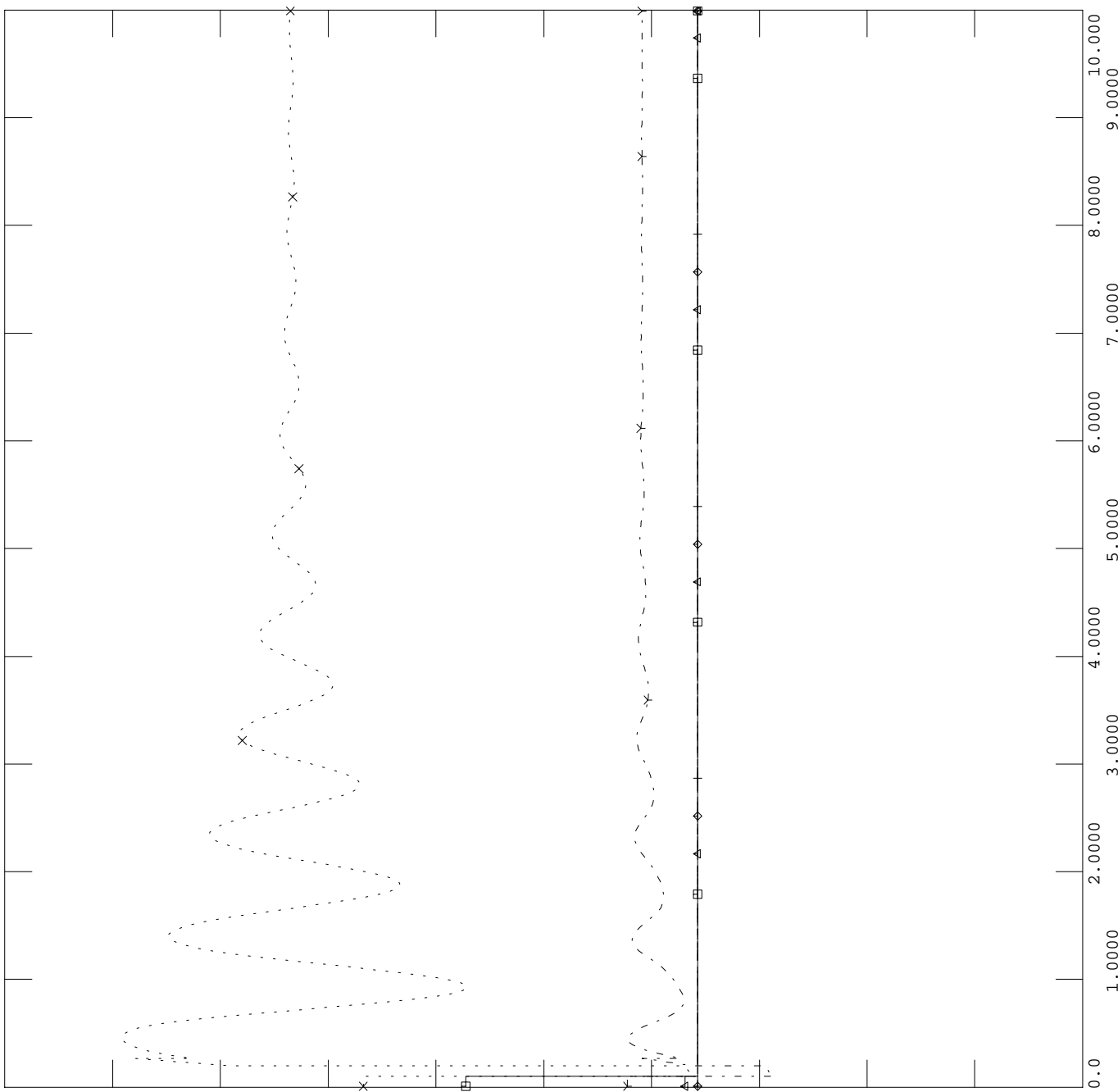
MON, AUG 30 2004 11:22
APPENDIX D.4C - VOLTAGES



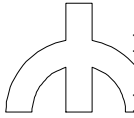
P1R-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
CROSS TRIP UNITS 1-4, 14-16 AT P.D.BOIS.

FILE: plr-sol2s1.uymV4V4-p4s.bin
CHNL# 1108: [Q-PDB-SG12TAP (TO ROVER)]

180.00	>----->	-100.0
CHNL# 1107: [P-PDB-SG12TAP (TO ROVER)]		
180.00	x-----x	-100.0
CHNL# 1106: [Q-SFALLS-SCOT-S1]		
180.00	+-----+	-100.0
CHNL# 1105: [P-SFALLS-SCOT-S1]		
180.00	◇-----◇	-100.0
CHNL# 1104: [Q-SFALLS-SCOT-S2]		
180.00	←-----→	-100.0
CHNL# 1103: [P-SFALLS-SCOT-S2]		
180.00	▣-----▣	-100.0



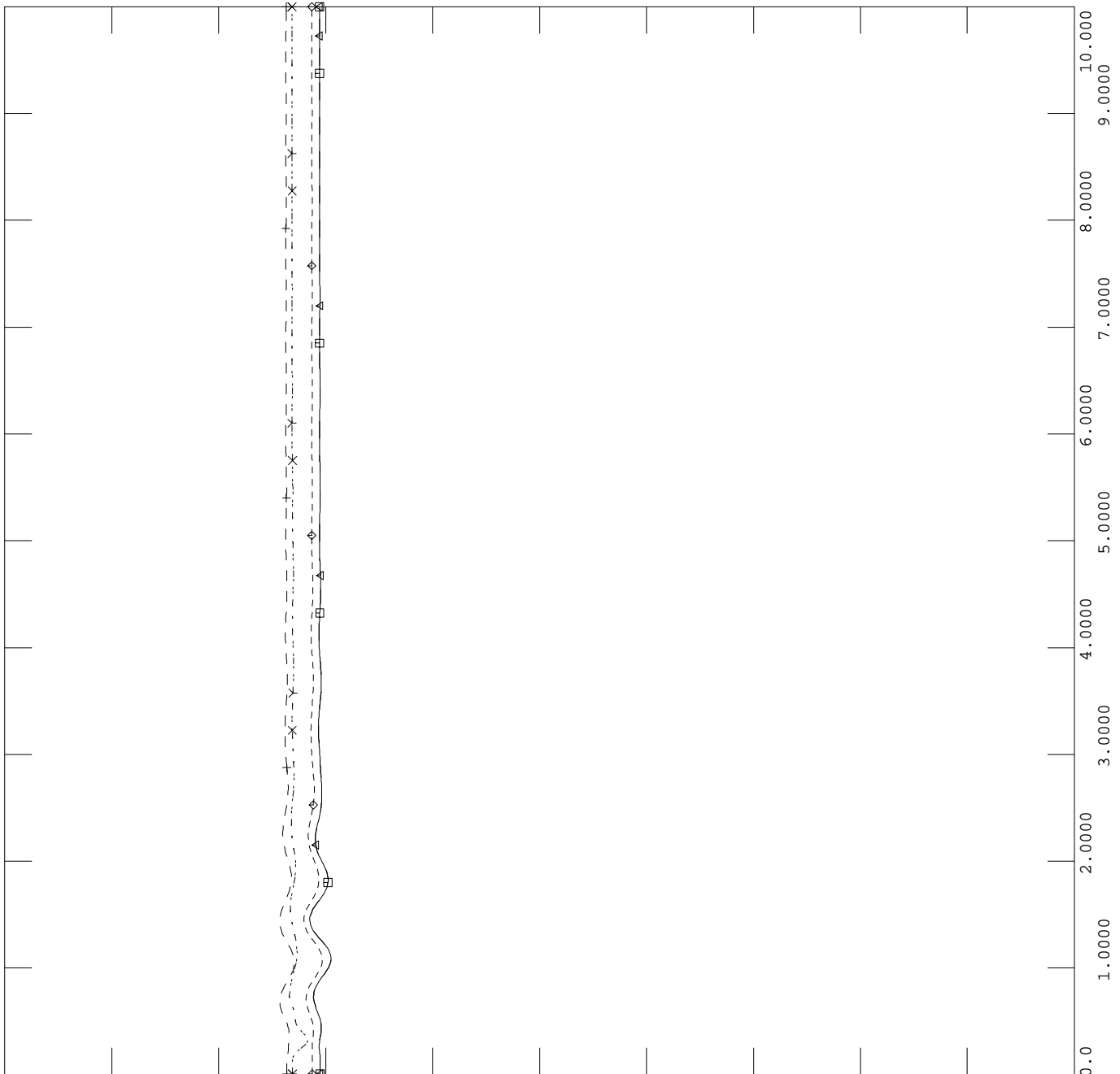
MON, AUG 30 2004 11:22
APPENDIX D.4D - LINE FLOW



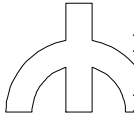
P1T-S012S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
NO GENERATION CROSS TRIP.

FILE: plt-sol2s1.uymV4V4-p6s.bin

Channel #	Channel Name	Value
180.00	CHNL# 1088: [ANG1GTFL-4G]	-100.0
180.00	CHNL# 1087: [ANG1GTFL-3G]	-100.0
180.00	CHNL# 1086: [ANG1GTFLNET4G]	-100.0
180.00	CHNL# 1085: [ANG1PNFL3-6G]	-100.0
180.00	CHNL# 1084: [ANG1PNFL-2G]	-100.0
180.00	CHNL# 1083: [ANG1PNFL-1G]	-100.0



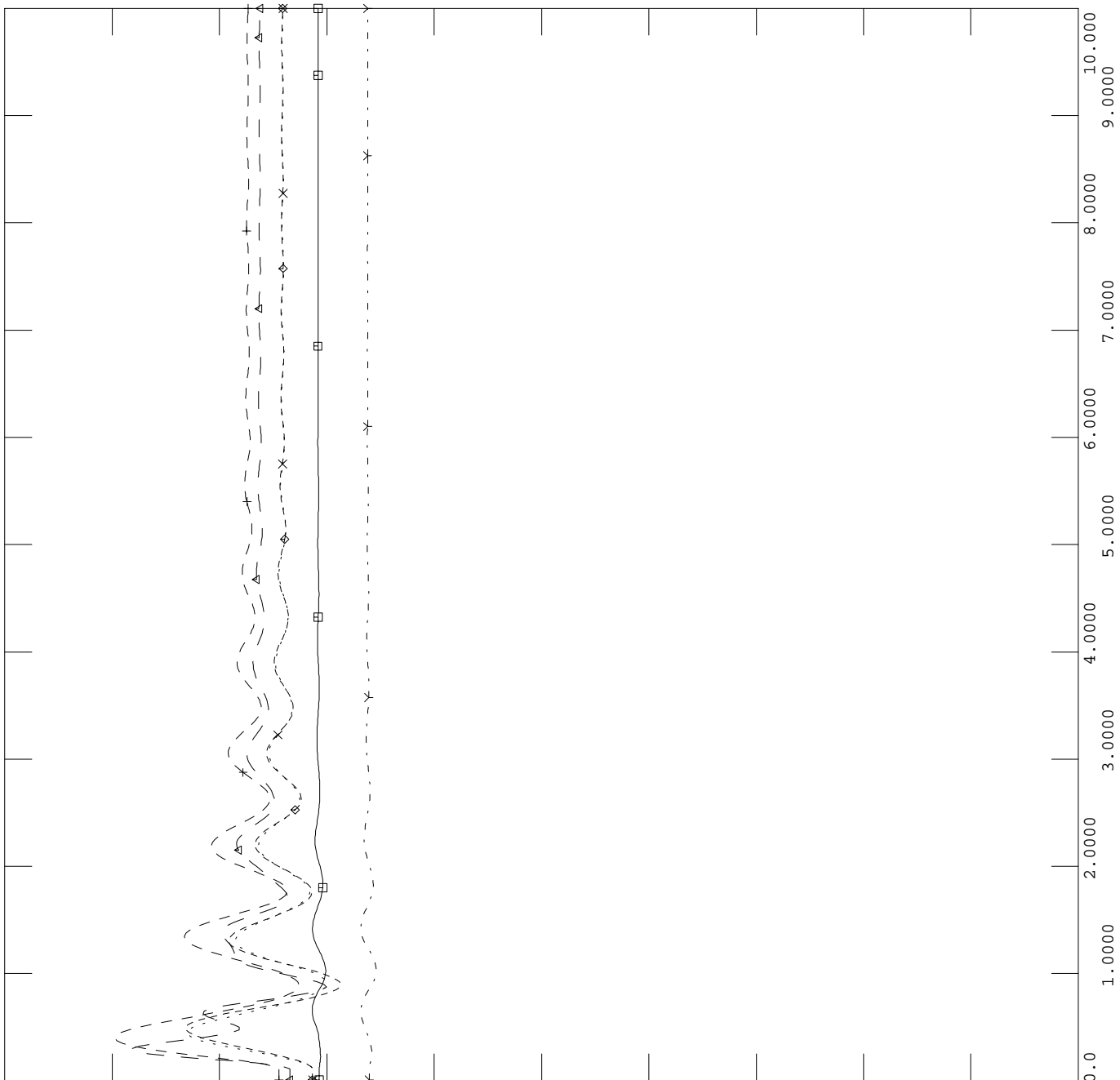
MON, AUG 30 2004 11:24
APPENDIX D.5A - ANGLES 1



P1T-S012S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
NO GENERATION CROSS TRIP.

FILE: plt-sol2s1.uymV4V4-p6s.bin

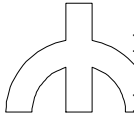
Time (s)	Channel	Value
180.00	CHNL# 44: [ANG17SIS1-6G]	-100.0
180.00	CHNL# 1093: [ANG1PDB2-4G]	-100.0
180.00	CHNL# 1092: [ANG1SLFL1-8G]	-100.0
180.00	CHNL# 1091: [ANG1PDB5-16G]	-100.0
180.00	CHNL# 1090: [ANG1PDB-1GSTRAF]	-100.0
180.00	CHNL# 1089: [ANG1MCA1-8G]	-100.0



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APPENDIX D.5B - ANGLES 2

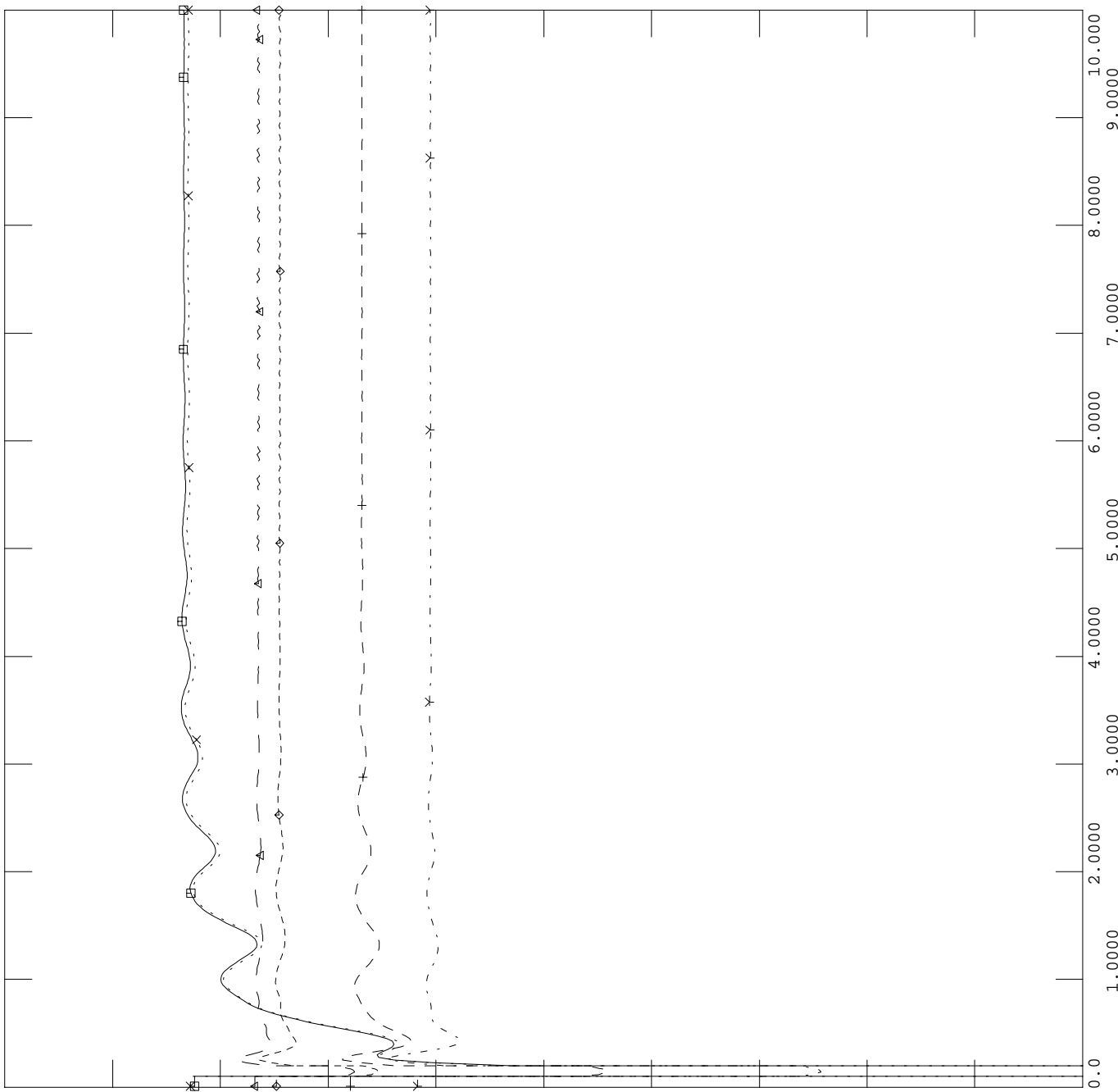
TIME (SECONDS)



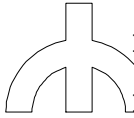
P1T-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
NO GENERATION CROSS TRIP.

FILE: plt-sol2s1.uymV4V4-p6s.bin
CHNL# 1102: [V-67555 SCOTLAND 110]

1.2000	>----->	0.70000
	CHNL# 1101: [V-67993 PDB 110]	
1.2000	x-----x	0.70000
	CHNL# 1100: [V-67540 TRANSCONA 110]	
1.2000	+-----+	0.70000
	CHNL# 1098: [V-67535 PINEFL 110]	
1.2000	◇-----◇	0.70000
	CHNL# 1097: [V-67536 GREATFL 110]	
1.2000	←-----→	0.70000
	CHNL# 1094: [V-67554 SLFL 121]	
1.2000	▣-----▣	0.70000



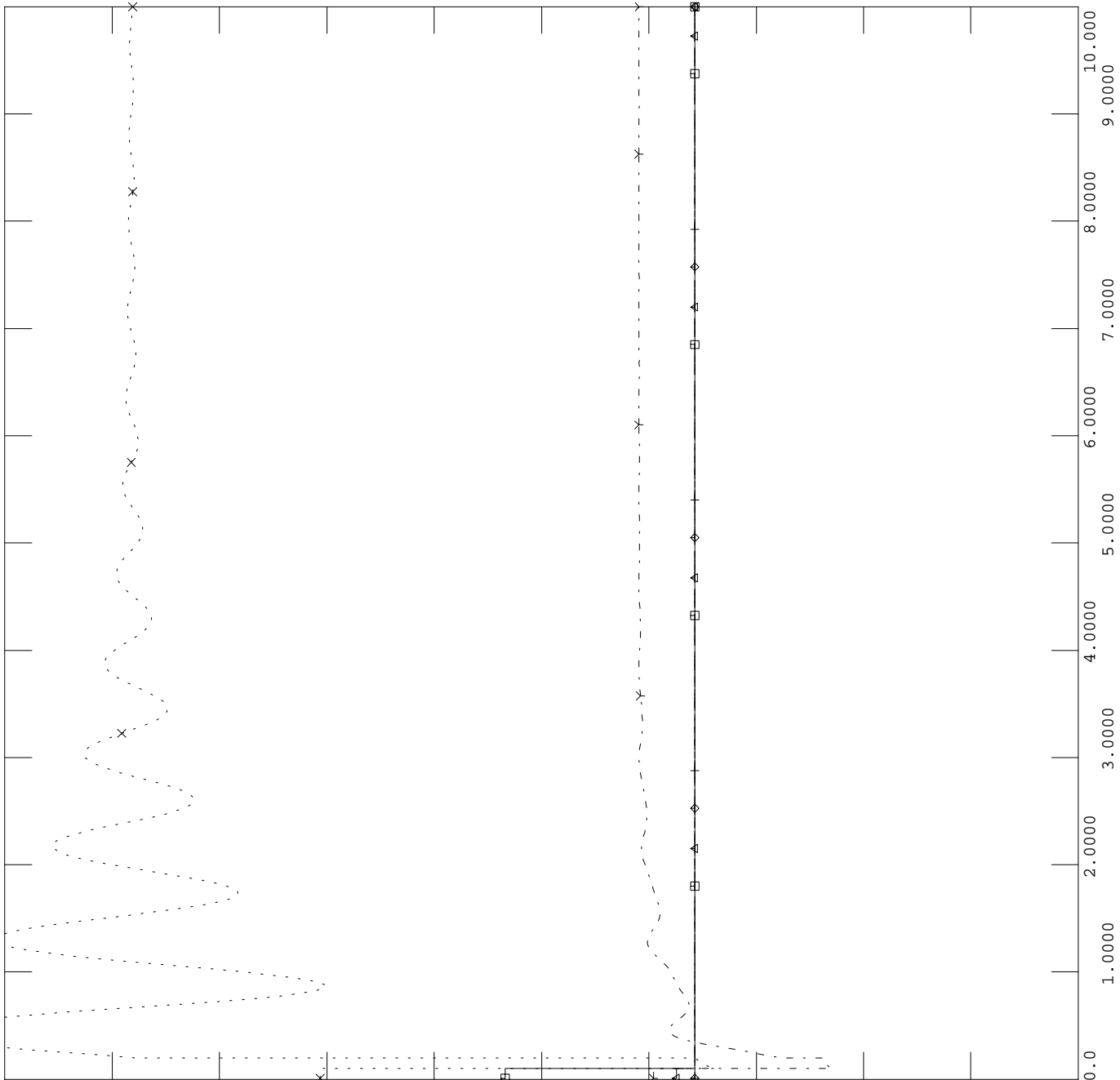
MON, AUG 30 2004 11:24
APPENDIX D.5C - VOLTAGES



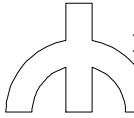
P1T-S012S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1045,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT AT SLAVE FALLS END OF S2.
NO GENERATION CROSS TRIP.

FILE: plt-sol2s1.uymV4V4-p6s.bin
CHNL# 1108: [Q-PDB-SG12TAP (TO TRANSCONA)]

180.00	>----->	-100.0
180.00	x-----x	-100.0
180.00	+-----+	-100.0
180.00	◇-----◇	-100.0
180.00	←-----→	-100.0
180.00	□-----□	-100.0



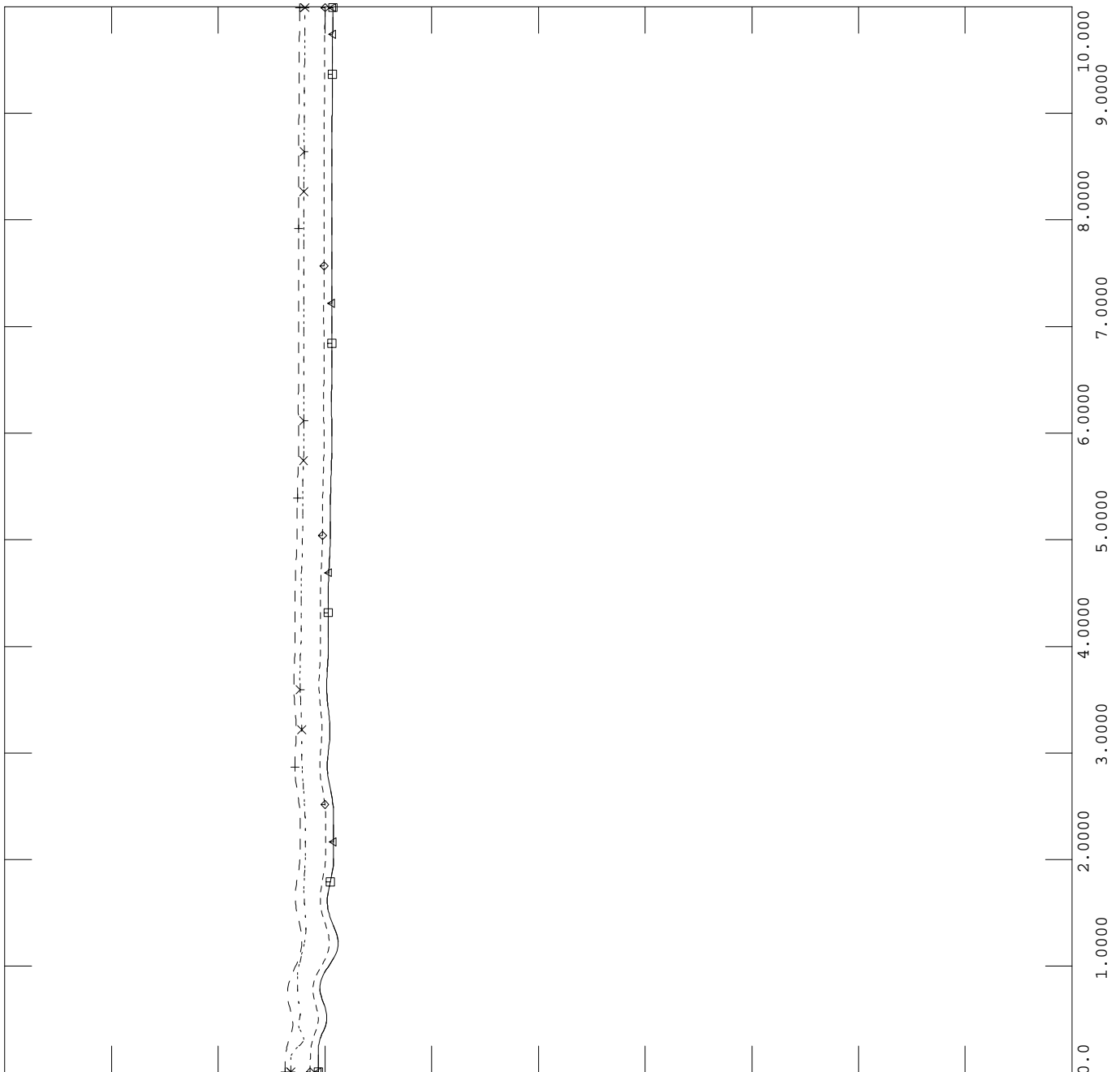
MON, AUG 30 2004 11:24
APPENDIX D.5D - LINE FLOW



P2R-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT TO PDB-ROVER 115 KV.
CROSS TRIP 2, 37.5 MVA UNITS AT P.D.BOIS.

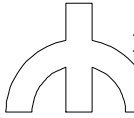
FILE: p2r-sol2s1.uymV4V4-p9s.bin

180.00	CHNL# 1088: [ANG1GTFL-4G]	➤-----➤	-100.0
180.00	CHNL# 1087: [ANG1GTFL-3G]	×-----×	-100.0
180.00	CHNL# 1086: [ANG1GTFLNET4G]	+-----+	-100.0
180.00	CHNL# 1085: [ANG1PNFL3-6G]	◇-----◇	-100.0
180.00	CHNL# 1084: [ANG1PNFL-2G]	←-----→	-100.0
180.00	CHNL# 1083: [ANG1PNFL-1G]	▣-----▣	-100.0



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APPENDIX D.6A - ANGLES 1

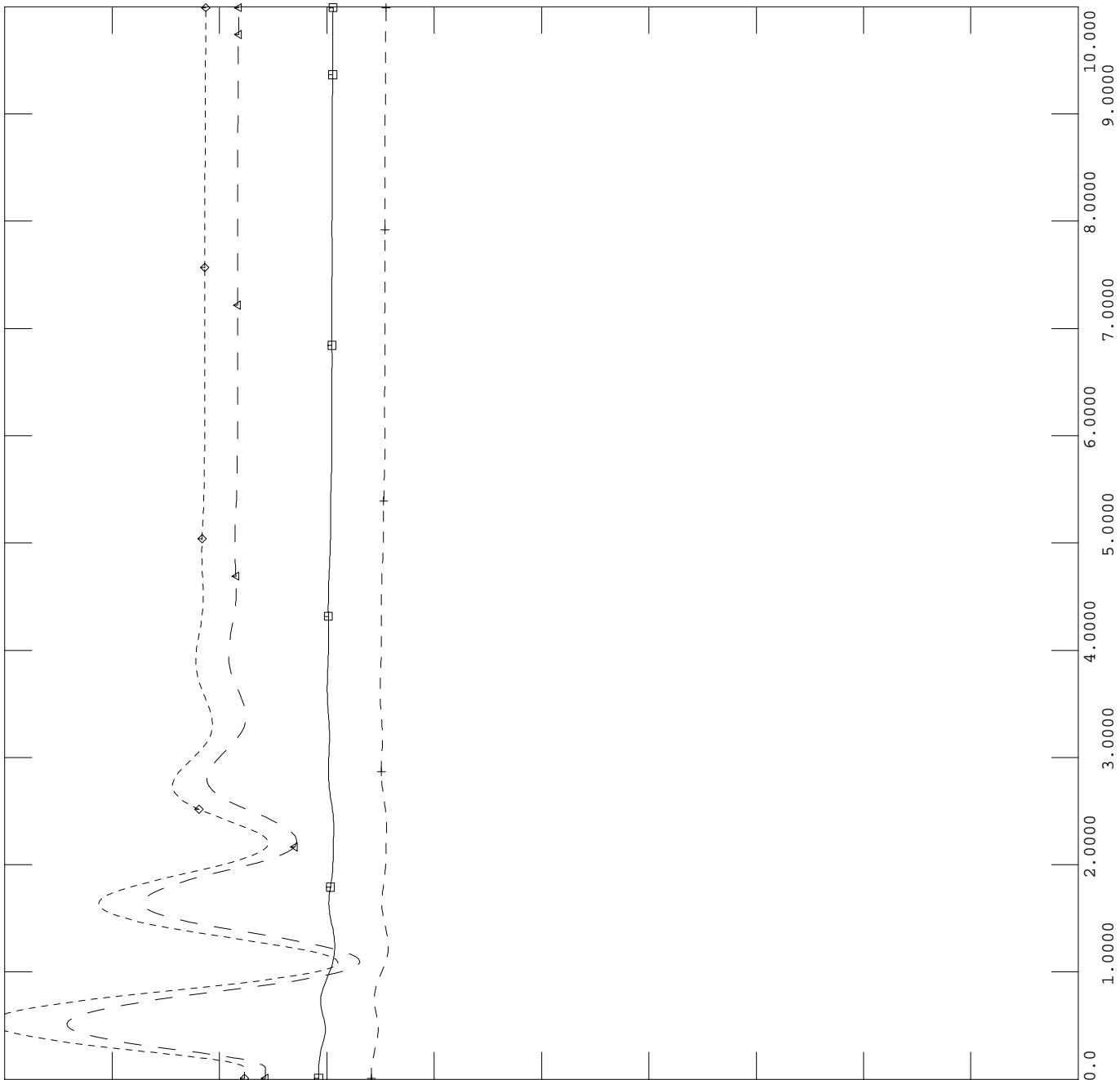
TIME (SECONDS)



P2R-S012S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT TO PDB-ROVER 115 KV.
CROSS TRIP 2, 37.5 MVA UNITS AT P.D.BOIS.

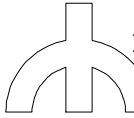
FILE: p2r-sol2s1.uyMV4V4-p9s.bin

Channel	Marker	Value
CHNL# 44: [ANG17SIS1-6G]	+ - - - - +	-100.0
CHNL# 1091: [ANG1SLFL1-8G]	◇ - - - - ◇	-100.0
CHNL# 1090: [ANG1PDBNEW1-4G]	← - - - - ▸	-100.0
CHNL# 1089: [ANG1MCA1-8G]	□ - - - - □	-100.0



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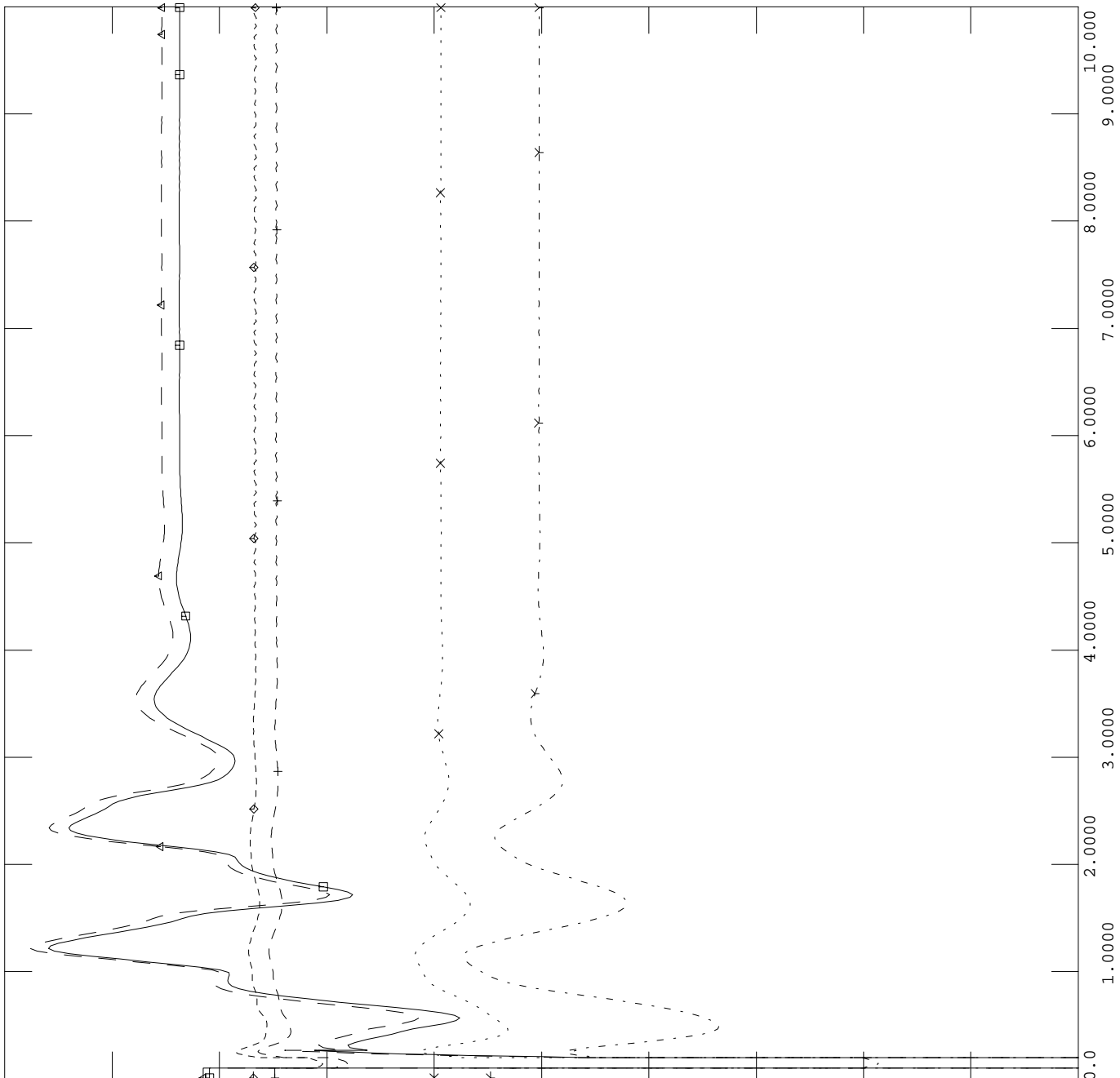
APPENDIX D.6B - ANGLES 2



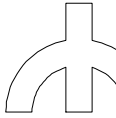
P2R-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT TO PDB-ROVER 115 KV.
CROSS TRIP 2, 37.5 MVA UNITS AT P.D.BOIS.

FILE: p2r-sol2s1.uymV4V4-p9s.bin
CHNL# 1098: [V-67555 SCOTLAND 110]

1.2000	CHNL# 1097: [V-67999 ROVER 110]	0.70000
1.2000	CHNL# 1095: [V-67535 PINEFL 110]	0.70000
1.2000	CHNL# 1094: [V-67536 GREATFL 110]	0.70000
1.2000	CHNL# 1093: [V-67993 PDB 110]	0.70000
1.2000	CHNL# 1092: [V-67554 SLFL 110]	0.70000



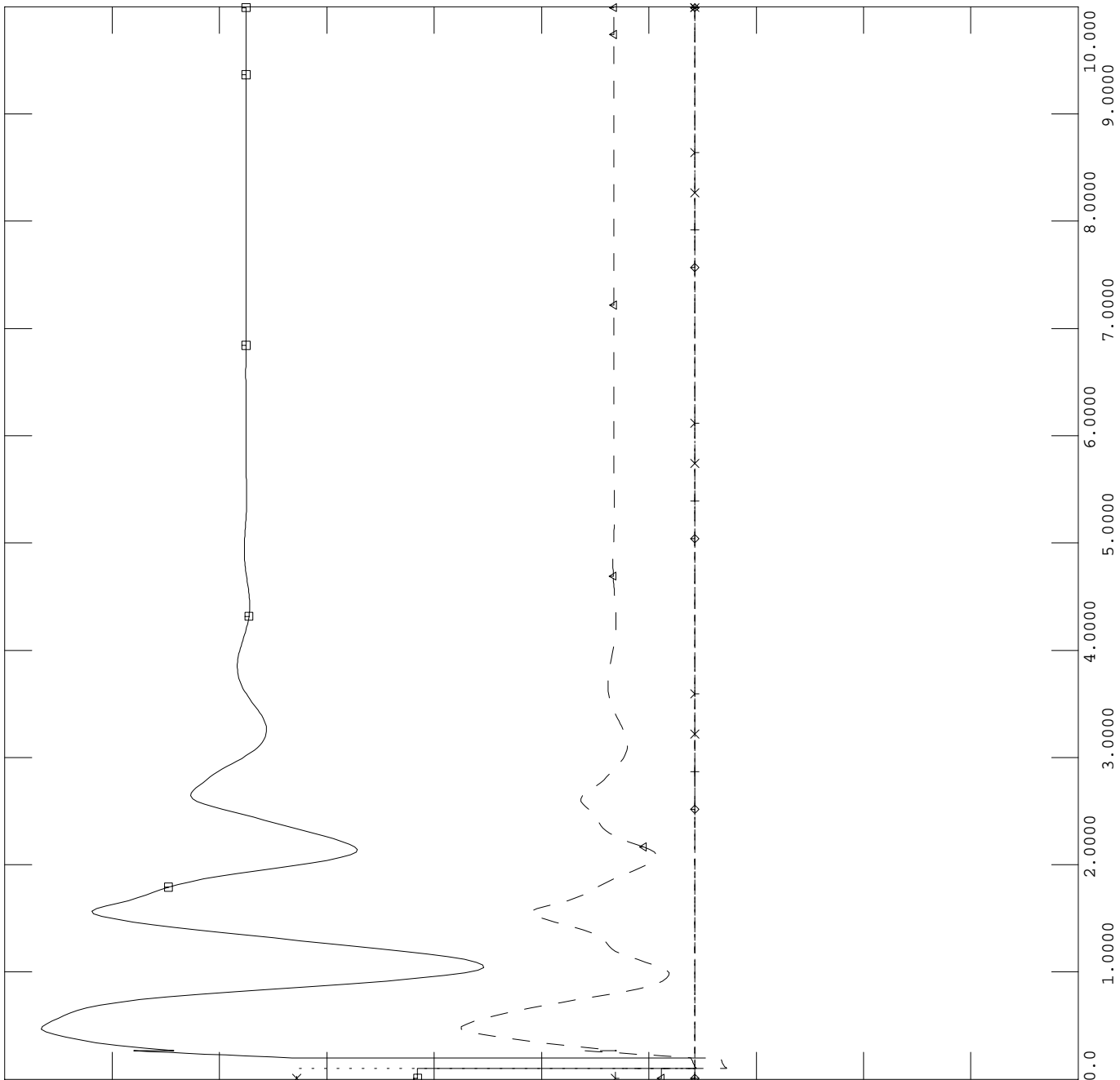
MON, AUG 30 2004 11:27
APPENDIX D.6C - VOLTAGES



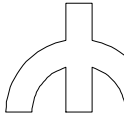
P2R-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1044,OHMH=-196,OHMP=150,EWTW=-197,BD=164
3 PHASE FAULT TO PDB-ROVER 115 KV.
CROSS TRIP 2, 37.5 MVA UNITS AT P.D.BOIS.

FILE: p2r-sol2s1.uymv4v4-p9s.bin
CHNL# 1104: [Q-PDB-SG12TAP (TO ROVER)]

180.00	CHNL# 1104: [Q-PDB-SG12TAP (TO ROVER)]	-100.0
180.00	CHNL# 1103: [P-PDB-SG12TAP (TO ROVER)]	-100.0
180.00	CHNL# 1102: [Q-SFALLS-SCOT-S1]	-100.0
180.00	CHNL# 1101: [P-SFALLS-SCOT-S1]	-100.0
180.00	CHNL# 1100: [Q-SFALLS-SCOT-S2]	-100.0
180.00	CHNL# 1099: [P-SFALLS-SCOT-S2]	-100.0



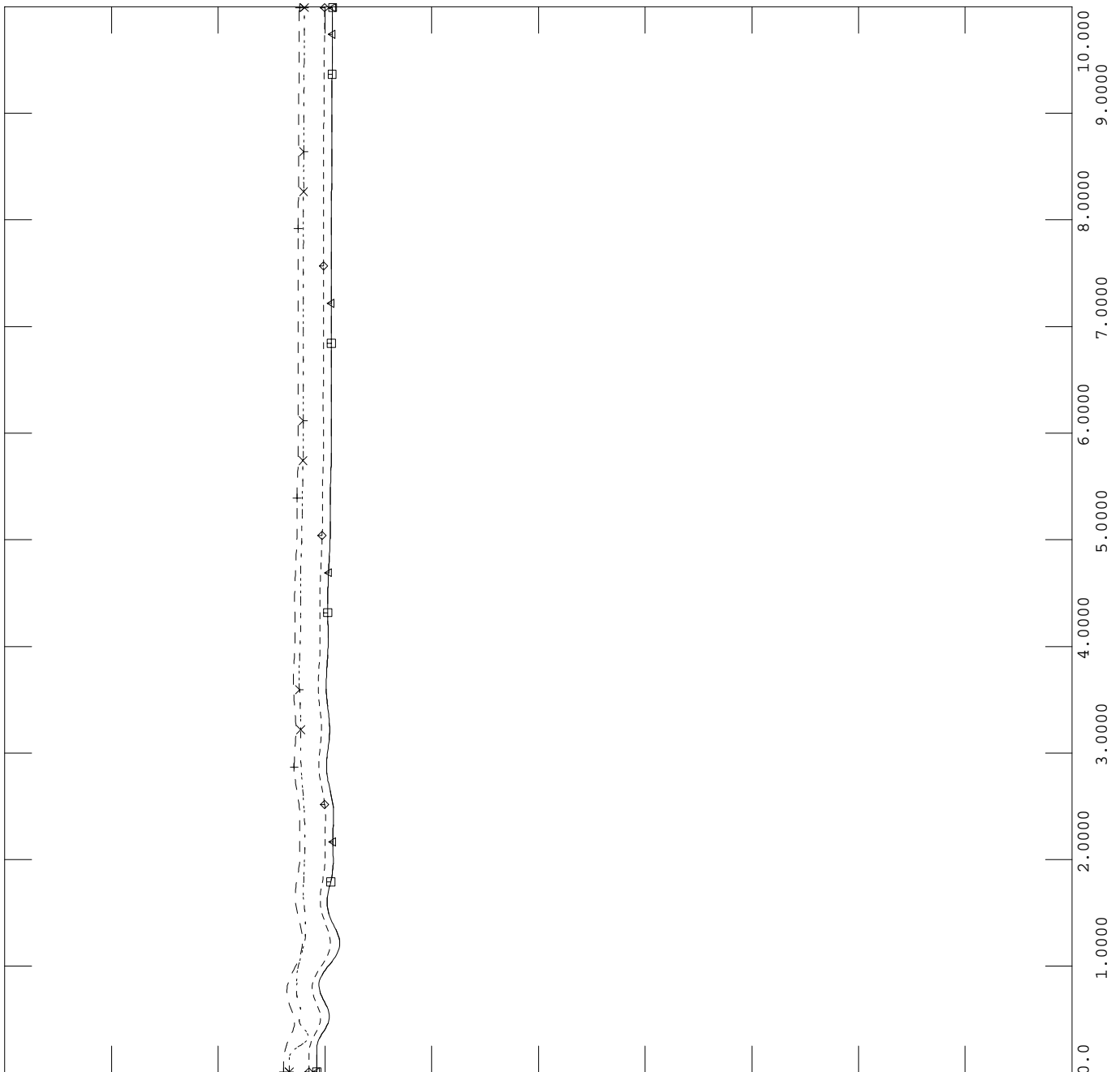
MON, AUG 30 2004 11:27
APPENDIX D.6D - LINE FLOW



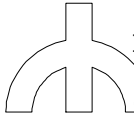
P2T-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1044,OHMH=-196,OHMP=150,EWTW=-196,BD=164
3 PHASE FAULT PDB-TRANSCONA 115 KV.
CROSS TRIP 2, 37.5 MVA UNITS AT P.D.BOIS.

FILE: p2t-sol2s1.uymV4V4-pbs.bin

180.00	CHNL# 1088: [ANG1GTFL-4G]	➤-----➤	-100.0
180.00	CHNL# 1087: [ANG1GTFL-3G]	×-----×	-100.0
180.00	CHNL# 1086: [ANG1GTFLNET4G]	+-----+	-100.0
180.00	CHNL# 1085: [ANG1PNFL3-6G]	◇-----◇	-100.0
180.00	CHNL# 1084: [ANG1PNFL-2G]	←-----→	-100.0
180.00	CHNL# 1083: [ANG1PNFL-1G]	▣-----▣	-100.0



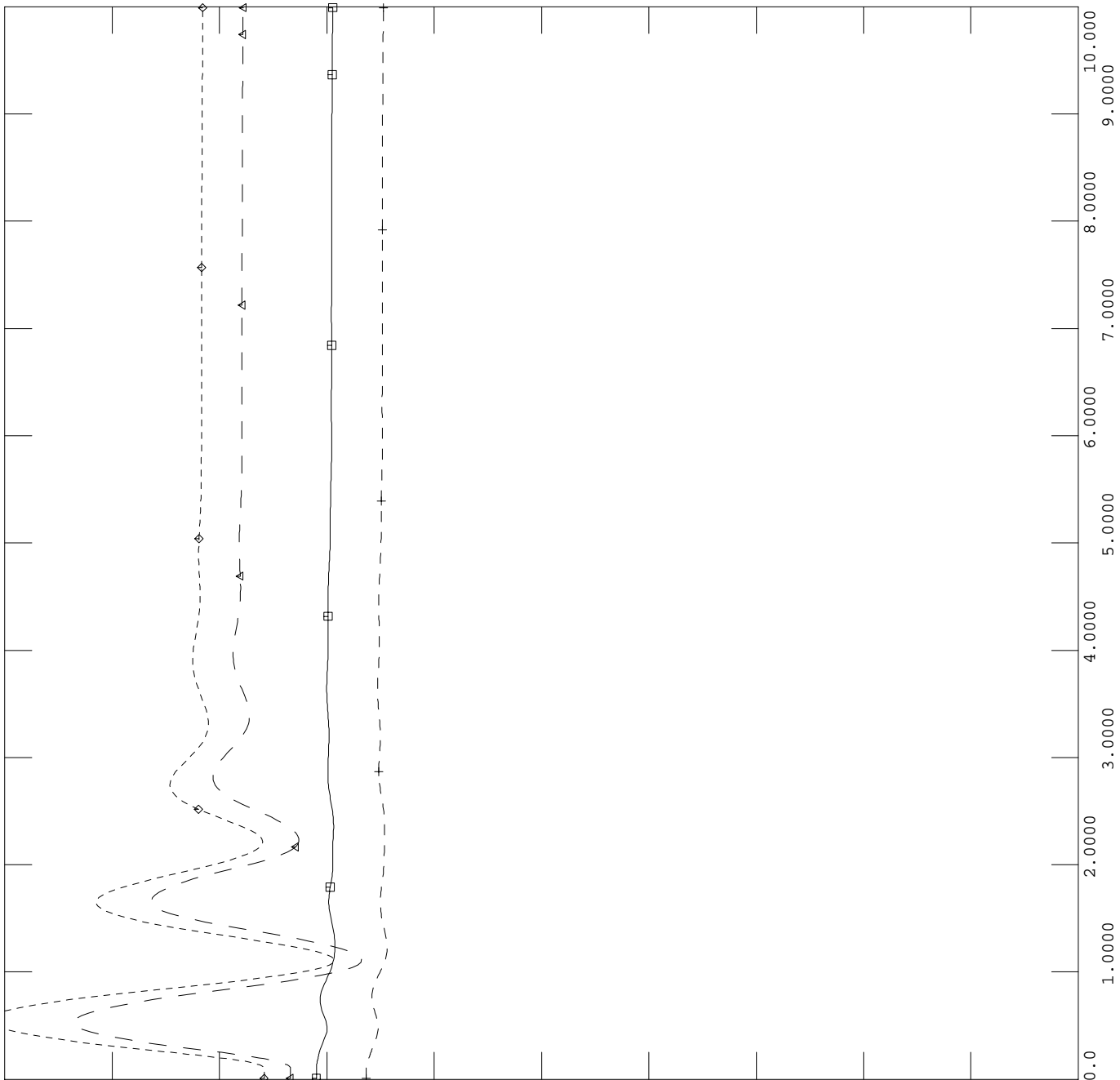
MON, AUG 30 2004 11:29
APPENDIX D.7A - ANGLES 1



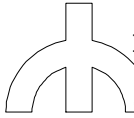
P2T-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1044,OHMH=-196,OHMP=150,EWTW=-196,BD=164
3 PHASE FAULT PDB-TRANSCONA 115 KV.
CROSS TRIP 2, 37.5 MVA UNITS AT P.D.BOIS.

FILE: p2t-sol2s1.uyMV4V4-pbs.bin

Channel	Legend	Value
CHNL# 44: [ANG17SIS1-6G]	+ - - - - +	-100.0
CHNL# 1091: [ANG1SLFL1-8G]	◇ - - - - ◇	-100.0
CHNL# 1090: [ANG1PDBNEW1-4G]	← - - - - ▸	-100.0
CHNL# 1089: [ANG1MCA1-8G]	□ - - - - □	-100.0



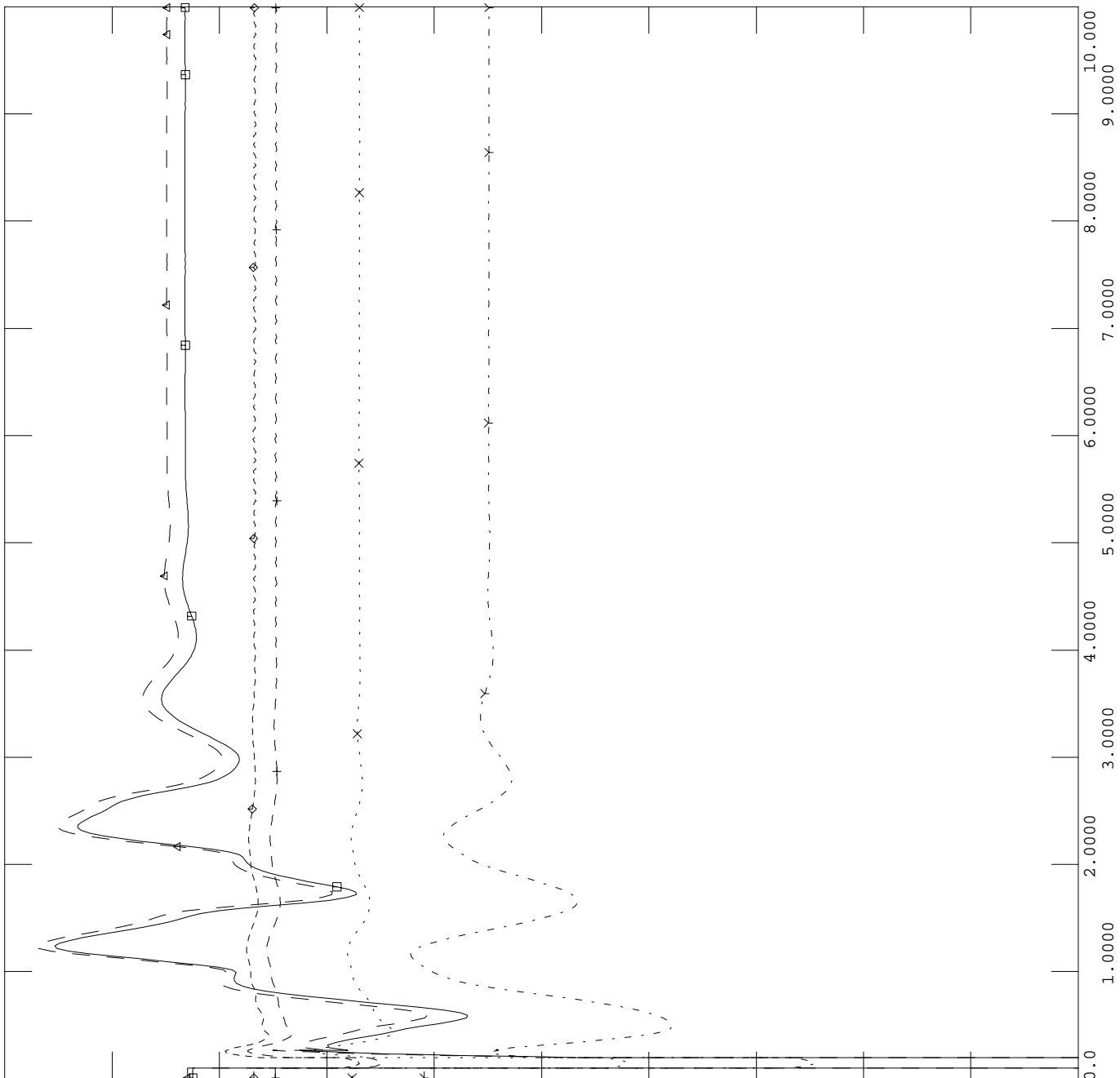
MON, AUG 30 2004 11:29
APPENDIX D.7B - ANGLES 2



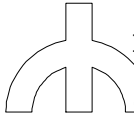
P2T-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1044,OHMH=-196,OHMP=150,EWTW=-196,BD=164
3 PHASE FAULT PDB-TRANSCONA 115 KV.
CROSS TRIP 2, 37.5 MVA UNITS AT P.D.BOIS.

FILE: p2t-sol2s1.uymV4V4-pbs.bin
CHNL# 1097: [V-67555 SCOTLAND 110]

1.2000	CHNL# 1096: [V-67540 TRANSCONA 110]	>----->	0.70000
1.2000	CHNL# 1095: [V-67535 PINEFL 110]	x-----x	0.70000
1.2000	CHNL# 1094: [V-67536 GREATFL 110]	+-----+	0.70000
1.2000	CHNL# 1093: [V-67993 PDB 110]	◇-----◇	0.70000
1.2000	CHNL# 1092: [V-67554 SLFL 110]	←-----△	0.70000
1.2000		▣-----▣	0.70000



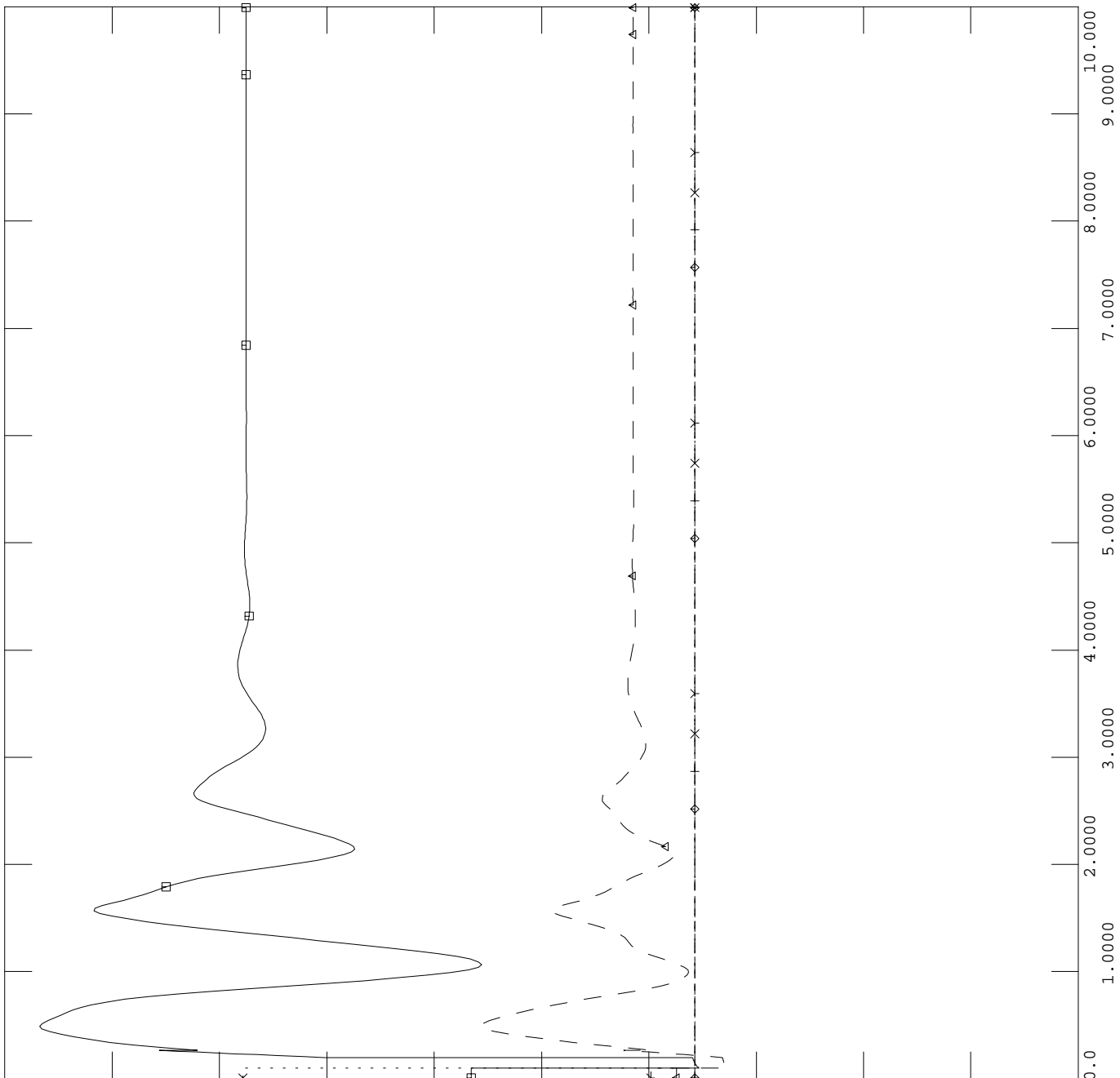
MON, AUG 30 2004 11:29
APPENDIX D.7C - VOLTAGES



P2T-SO12S1.UYMV4V4.SAV;SUMMER;OP LD;SFALLS-SCOT 110KV O/S :
ND=1958,MH=2171,MW=1044,OHMH=-196,OHMP=150,EWTW=-196,BD=164
3 PHASE FAULT PDB-TRANSCONA 115 KV.
CROSS TRIP 2, 37.5 MVA UNITS AT P.D.BOIS.

FILE: p2t-sol2s1.uymV4V4-pbs.bin
CHNL# 1103: [Q-PDB-SG12TAP (TO TRANSCONA)]

180.00	CHNL# 1103: [Q-PDB-SG12TAP (TO TRANSCONA)]	-100.0
180.00	CHNL# 1102: [P-PDB-SG12TAP (TO TRANSCONA)]	-100.0
180.00	CHNL# 1101: [Q-SFALLS-SCOT-S1]	-100.0
180.00	CHNL# 1100: [P-SFALLS-SCOT-S1]	-100.0
180.00	CHNL# 1099: [Q-SFALLS-SCOT-S2]	-100.0
180.00	CHNL# 1098: [P-SFALLS-SCOT-S2]	-100.0



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APPENDIX D.7D - LINE FLOW