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Southwest Transmission COOPERATIVE, INC

TEN YEAR PLAN

2002 - 2011

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN YEAR PLAN

2002 - 2011

Prepared for the

Arizona Corporation Commission

TRANSMISSION PLANNING

JANUARY 2002

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

TEN-YEAR PLAN

GENERAL INFORMATION:

This report is submitted to satisfy the requirements of section 40-360.02 of the Arizona Revised Statutes (ARS) relating to power plant and transmission line siting requirements. It outlines the plans of Southwest Transmission Cooperative, Inc. (SWTC) to install electric facilities required to meet anticipated system growth.

This report contains projects that SWTC anticipates will be started by 2011. This report is divided into two sections. Section I covers planned transmission lines whose nominal rating is equal to or greater than one hundred fifteen thousand volts (115 kV). The Winchester Interconnect Project is listed in this Section. Section II contains the Winchester Interconnect Project Report, to satisfy the requirements of paragraph C7 of section 40-360.02 of the ARS.

In August 2001, the Arizona Electric Cooperative, Inc. (AEPCO) restructured into three separate cooperatives, with AEPCO remaining as a generation company only, Southwest Transmission Cooperative, Inc. (SWTC) as a transmission only company, and Sierra Southwest Cooperative Services, Inc. (Sierra) as a service provider company.

The January 2001 AEPCO Ten Year Plan Filing stated that no new transmission facilities above 115 kV were planned for the Plan Filing period. Since that report, SWTC has determined the need for the Winchester Interconnect Project, which was formally introduced to the ACC Staff on August 23, 2001. The Winchester Project was then announced to the Central Arizona Transmission System (CATS) Study Group on October 5, 2001.

SWTC continues to work closely with the electric utilities in the state, and other interested parties, through the CATS effort, to provide for a more reliable transmission network in the state. Reference should be made to the Salt River Project Ten Year Plan Filing for additional details regarding the CATS Study Group effort.

SECTION I - PLANNED TRANSMISSION FACILITIES:

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

10 YEAR PLAN

TRANSMISSION FACILITIES

Line Designation		Apache Station to Winchester Substation
Size		
a)	Voltage	230 kV
b)	Capacity	450 MVA
c)	Point of Origin	Apache Generating Station Sec. 10 T16S R24E
d)	Point of Termination	Winchester Substation Sec. 28 T14S R21E
e)	Length	23 Miles
Routing		Parallel to existing Apache Station to Hayden line
Purpose		To provide for an addition 230 kV line out of Apache Generating Station for increased reliability under N-1 conditions
Date		
a)	Construction Start	Proposed September 2003
b)	In-Service Date	Proposed February 2004
Is Certificate Necessary?		Yes

SECTION II – WINCHESTER PROJECT INTERCONNECT REPORT

WINCHESTER INTERCONNECT

PROJECT REPORT

SUBMITTED TO THE ARIZONA CORPORATION COMMISSION IN FULFILLMENT OF A.R.S. §40-360.02 ¶C.7

Prepared By

Southwest Transmission Cooperative, Inc.
Transmission Planning

January 2002

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EXECUTIVE SUMMARY

The Winchester Interconnect Project has been developed as part of the efforts of the Southwest Transmission Cooperative, Inc. (SWTC) to enhance the reliability of the SWTC transmission System. It provides an additional 230 kV line that exits the existing Apache Station Substation to a new interconnection point with Tucson Electric Power's (TEP's) 345 kV line from Greenlee to Vail. A diagram of the existing and proposed transmission system is included in Appendix A.

The Winchester Interconnect Project allows the SWTC transmission system to withstand various critical outages and decreases the need for Remedial Action Scheme's (RAS's). It also increases the SWTC transmission system import and export capability by over 400 MW, which represents an approximate 70% improvement over the current system.

INTRODUCTION

SWTC's existing backbone transmission system consists of two 230 kV lines which exit Apache Station going east and west. The 230 kV lines interconnect to Tucson Electric Power (TEP) at Greenlee Substation to the east and Vail Substation to the west. SWTC also owns a 115 kV line that exits Apache Station and goes north to interconnect with Salt River Project (SRP) at Hayden Substation. The Western Area Power Administration (Western) owns a 115 kV line that also exits Apache Station and goes west. A diagram of the existing transmission system is included in Appendix A.

To meet Western Systems Coordinating Council (WSCC) reliability criteria the SWTC transmission system must be able to withstand any single element outage, also know as N-1 conditions. On the current SWTC transmission system, the most severe single element outage is the loss of the Apache to Redtail 230 kV line. During this 230 kV line outage, the 345/230 kV transformer at Bicknell Substation and the remaining 230 kV line becomes heavily loaded.

Based on previous planning studies there was forecasted a need for a second 345/230 kV transformer at Bicknell Substation in the year 2002 to avoid overload of the existing transformer under critical outage situations. SWTC's previous ten year planning included placing a second 345/230 kV transformer at the Bicknell Substation to be placed in service in 2002.

Arizona Electric Power Cooperative, Inc. (AEPCO) has announced plans to place a new 40 MW LM6000 gas turbine at Apache Station in late 2002 to accommodate increased load growth. Increased generation at Apache Station further increases the loading on the remaining 230 kV line, from Apache to Bicknell, during critical outages.

To meet WSCC reliability criteria under any multiple element outage (N-2) the SWTC transmission system must be able to avoid cascading outages. Overloads during N-2 events can be avoided by planned load shedding and/or generation reduction. SWTC's transmission system currently operates with a RAS that will reduce Apache generation

when one of the 230 kV lines is out of service and the other 230 kV line has an unplanned outage.

To mitigate facility overloads under N–1 conditions and to minimize RAS's under multiple contingency events, three options were evaluated. The first option was to upgrade to 230 kV operation a portion of the existing Apache to Hayden 115 kV line from Apache Station to a new interconnection point with TEP's 345 kV system (Winchester Interconnect Project). The second option was to upgrade a portion of the existing Apache to Bicknell 230 kV line from 795 ACSR to 1272 ACSR and add a second 345/230 kV transformer at Bicknell Substation. The third option was to construct a third line from Apache Station to a new interconnection point with TEP's 345 kV system which follows the existing right-of-way of the Apache to Dos Condados 230 kV line.

PROJECT JUSTIFICATION

Power Flow Analysis

General Electric's Positive Sequence Load Flow (GE PSLF) program was used to examine the interconnected influences of loads and generation on the transmission system and its elements. Performance standards were based on WSCC Reliability Criteria for Transmission System Planning and Good Utility Practices as required by the SWTC Open Access Transmission Tariff.

The Central Arizona Transmission System (CATS) Study Phase I Base Case was used for the analysis. This case originated from the WSCC 2002 LS1 case. SWTC Class A Member loads were modeled using 2002 peak values from the recently approved 2000 Power Requirements Study. System configurations were evaluated with all facilities in service (N-0), under single (N-1) and under multiple (N-2) contingency conditions. Generation at Apache Station was modeled at maximum output to simulate the highest level of stress on the SWTC transmission system. Figure 1 summarizes the power flow results for the existing transmission system, with and without the new AEPCO 40 MW generator.

Case Description	Additional Apache Generation – MW	System Results
All Lines in Service (N-0)	0	No Overloads
All Lines in Service (N-0)	40	No Overloads
Apache-Redtail Out (N-1)	0	Bicknell 345/230 kV 103% Loaded Apache to Butterfield Line 89% Loaded
Apache-Redtail Out (N-1)	40	Bicknell 345/230 kV 114% Loaded Apache to Butterfield Line 96% Loaded
Apache-Redtail-Butterfield Out (N-2)	0	Apache Generation Must be Reduced to 212 MW to Avoid System Overloads.

Figure 1 – Power Flow Analysis Results

The worst case N-1 outage is the loss of the Apache to Redtail line. Under this condition the Bicknell 345/230 kV transformer becomes overloaded. This overload is exacerbated by the addition of generation at Apache Station. Also during this N-1 condition the 230 kV line from Apache to Butterfield becomes heavily loaded. During the most severe N-2 scenario on the existing system a RAS must be utilized to drop Apache Station generation to below 212 MW to avoid tripping facilities, which would produce a cascading outage situation.

To mitigate overloads on the existing system and to reduce RAS's that are necessary, three options were considered. Option 1 the Winchester Interconnect Project proposes a new Winchester Substation, a upgraded 230 kV line from Apache Station to Winchester Substation and Apache Station 230 kV switch-yard upgrades. The upgraded 230 kV line would be constructed from Apache Station to a new interconnection point with TEP's 345 kV system. The shortest distance from Apache Station to interconnect with TEP (23 miles) follows a portion of SWTC's existing 115 kV line corridor from Apache Station to Hayden. The proposed Winchester Substation would be built at the new interconnection point. The upgraded line between Apache Station and the Winchester Substation would consist of a single structure double circuit line energized to 230 kV on one side, the Apache to Winchester line, and to 115 kV on the other side, the Apache to Hayden line.

Option 2 would be to add a second 345/230 kV transformer at the Bicknell Substation and upgrade the existing 230 kV line from Apache to Butterfield from 795 ACSR to 1272 ACSR. Although this option will remove overload problems experienced under critical N-1 conditions it will not provide any reduction in the RAS that are necessary under multiple contingency events. For this system configuration the existing system RAS will need to be expanded to include the 115 kV lines from Apache to Hayden and Apache to Nogales Tap, when the 40 MW additional generation is added at Apache Station.

Option 3 was to construct a new 230 kV line from Apache Station to a new interconnection point with TEP's 345 kV system that follows the existing right-of-way of the Apache to Dos Condados 230 kV line. A new substation, Redtail2, would be constructed at the TEP interconnection point. The new 230 kV line would extend 34 miles from Apache Station to the new Redtail2 substation. Apache 230 kV switchyard facility upgrades would also be necessary to accommodate the new line. This option has an additional reliability concern, as two of SWTC's critical 230 kV lines out of Apache Station would be in the same right-of-way and outages caused by fire, storms or other disasters could remove both 230 kV lines from service at the same time. This option was not considered further because of the 230 kV line common corridor issue and due to the 11 miles of additional line extension necessary to make this interconnection over the Winchester Interconnect Project (Option 1).

The most severe single element outage for the transmission system with the Winchester Interconnect Project in place is the loss of the Apache to Winchester 230 kV line. Figure 2 summarizes the power flow results for the SWTC transmission system with the Winchester facility upgrades. Load flow plots of the existing system and N-1 conditions with and without the Winchester Interconnect Project are included in Appendix B.

Case Description	Additional Apache Generation – MW	System Results
All Lines in Service (N-0)	0	No Overloads
All Lines in Service (N-0)	40	No Overloads
Apache-Winchester Out (N-1)	0	No Overloads
Apache-Winchester Out (N-1)	40	No Overloads
Apache-Winchester-Redtail Out (N-2)	0	Apache Generation Must be Reduced to 508 MW to Avoid Overloads

Figure 2 – Power Flow Analysis Results With the Winchester Interconnect

The Winchester Interconnect Project allows the SWTC transmission system to withstand any N-1 condition and decreases the need for RAS for double and multiple contingency events. The Winchester Interconnect Project also increases the SWTC transmission system import and export capability by over 400 MW, which represents an approximate 70% improvement over the current system. This enables SWTC to provide uninterrupted service to customers during critical outage events.

Dynamic Stability Analysis

Dynamic stability or transient stability is the ability of the power system to maintain synchronism when subjected to a severe transient disturbance such as a fault on a transmission facility. The system response to such disturbances involves large excursions of generator rotor angles, power flows, bus voltages, and other system variables. Stability is influenced by the nonlinear characteristics of the power system. If the resulting angular separation between the machines in the system remains within certain bounds, the system maintains synchronism. The WSCC reliability criteria for transmission operations states that the interconnected power system shall be operated at all times so that general system instability, uncontrolled separation, cascading outages, or voltage collapse will not occur as a result of any single contingency or multiple contingencies of sufficiently high likelihood.

The transient stability of a generator is dependent on fault-clearing time, system conditions, and generator operating criteria. For this analysis the fault-clearing time was determined under various system conditions. A dynamics database compatible with the power flow case was prepared for this stability analysis. Vendor generator data for a G.E. LM6000 unit was used for the new AEPCO 40 MW unit. Fault-clearing time was determined for the existing system and the system with the Winchester Interconnection Project. Figure 5 summarizes the results of the stability analyses. Appropriate stability plots are included in Appendix C.

Additional Generation MW	Existing System Cycles	Winchester Interconnect Cycles
0	12	15
40	12	15

Figure 5 – Stability Fault Clearing Times - Cycles

The system with the Winchester Interconnect Project increased the time a fault had to clear by 25%. The fault clearing times on the existing system are close to the operating

time of breaker failure backup protection schemes. This means that there will be reliance on operating backup protection since any delay waiting for normal fault clearing to act may bring on system instability. The operation of backup protection means more facilities will be removed from service during a fault.

Results were analyzed for the response of several generators to three phase line faults. The most severe faults are represented on the Apache to RedTail 230 kV line for the existing system and on the Apache to Winchester 230 kV line for the system with the Winchester Interconnect Project. Results were examined for terminal voltage and rotor angle (angle) for Apache Steam Unit 2 (Apache ST2), Irvington Steam Unit 4, Springerville Unit 1, Saguaro Steam Unit 1, Palo Verde Unit 1, and Bridger Unit 2. The angle plot for Apache ST2 produced the most identifiable signal when instability occurred by showing the rotor angle continuing to increase steadily until synchronism was lost. This is known as first-swing instability and is caused by insufficient synchronizing torque. The fault clearing time was decreased by one-cycle increments until the rotor angle decreased in amplitude showing steady state being reached.

SYSTEM RELIABILITY

Formal introduction of the Winchester Interconnect Project was done in a meeting with the Arizona Corporation Commission (ACC) Staff on August 23, 2001. It was then introduced at a Steering Committee Meeting of the Central Arizona Transmission System (CATS) Study Group on October 5, 2001. SWTC is committed to the CATS study effort, to ensure continued reliable operation of the transmission grid within the state of Arizona. ACC Staff and CATS members are in support of the Winchester Interconnect Project and believe it will be a valuable addition to supporting increased system reliability in Southeast Arizona.

The Winchester Interconnection Project allows the SWTC transmission system to withstand any N-1 situation and decreases the need for RAS's for double and multiple contingency events. With the Winchester Interconnect in place the time a system fault has to clear is increased which provides additional transmission system stability. The Winchester Interconnect Project also increases the SWTC transmission system import and export capability by over 400 MW, which represents an approximate 70% improvement over the current system. This will allow SWTC to provide uninterrupted service to customers when experiencing critical outage events.

The addition of the Winchester Interconnect provides a superior system voltage profile and increased dynamic stability for the SWTC transmission system, due to strengthening of the tie between the SWTC and TEP systems. With the Winchester Interconnect in place, SWTC is assured of increased system reliability to meet its projected needs.

ENVIRONMENTAL CONSIDERATIONS

SWCA, Inc. was contracted to conduct an archaeological survey of the Apache to Winchester transmission corridor in 1995. According to the survey results, there are no

significant archaeological resources within the transmission corridor that will be impacted by upgrading the transmission line. In early 1997, SWCA was contracted to conduct a biological resources survey of the same area. According to the survey results, there are no sensitive biological resources located within the transmission corridor right-of-way. Recent evaluation of the transmission right-of-way does not change the findings of the two previous reports. There have been no changes in Endangered Species listings, critical habitat designations or special land management designations that have occurred in the project area since the initial surveys were conducted.

The environmental due diligence is expected to consist of an Environmental Report that will be submitted to the Rural Utilities Service to fulfill National Environmental Policy Act (NEPA) requirements for this project. At this time, impacts from the project are expected to be minimal. Since the transmission line portion of the project is located within an existing corridor, impacts to the surrounding area are expected to be considerably less than if the line was constructed on a new right-of-way. Construction of single pole structures will also minimize the impacts to the surrounding area. Most of the project area is located in a rural area, away from existing communities that further diminishes environmental and public concerns.

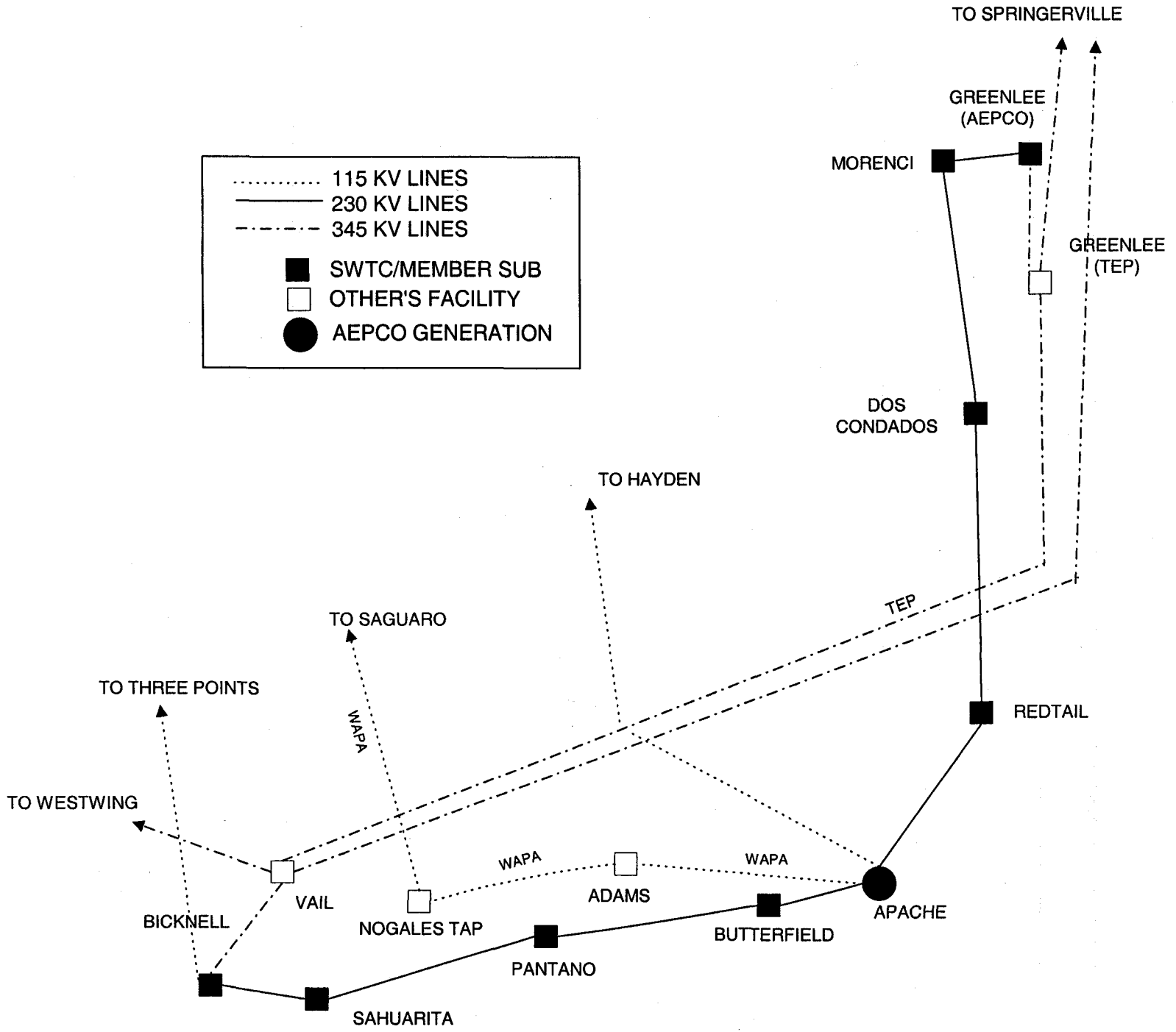
CONCLUSIONS AND RECOMMENDATION

The Winchester Interconnect Project is recommended as it provides superior system stability, performance and reliability over the closest alternative. With this project, the SWTC transmission system will be able to provide reliable service to its Class A member-owners, as well as other transmission customers well into the future.

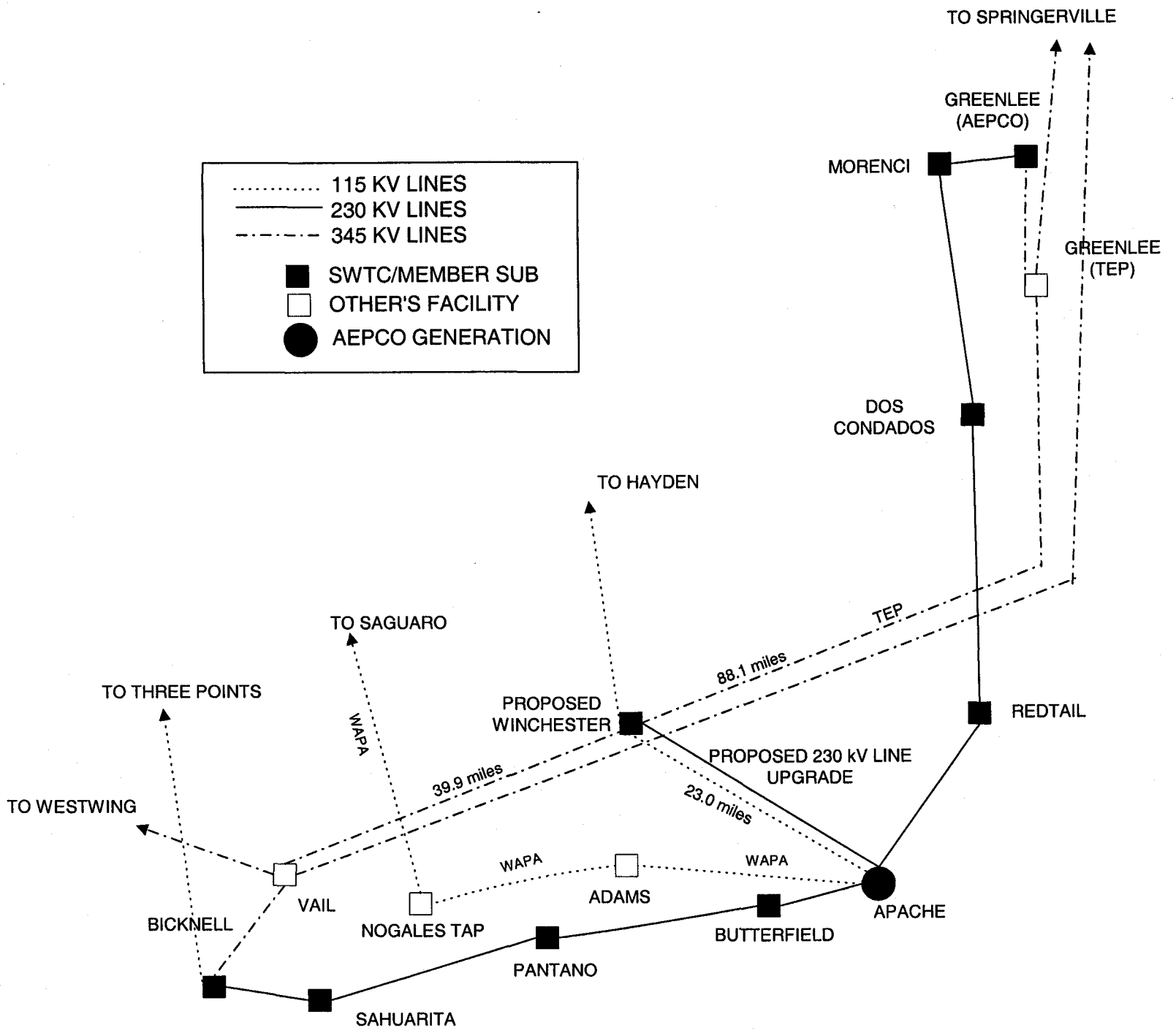
Appendix A

Existing and Proposed Transmission System Diagrams

EXISTING TRANSMISSION SYSTEM

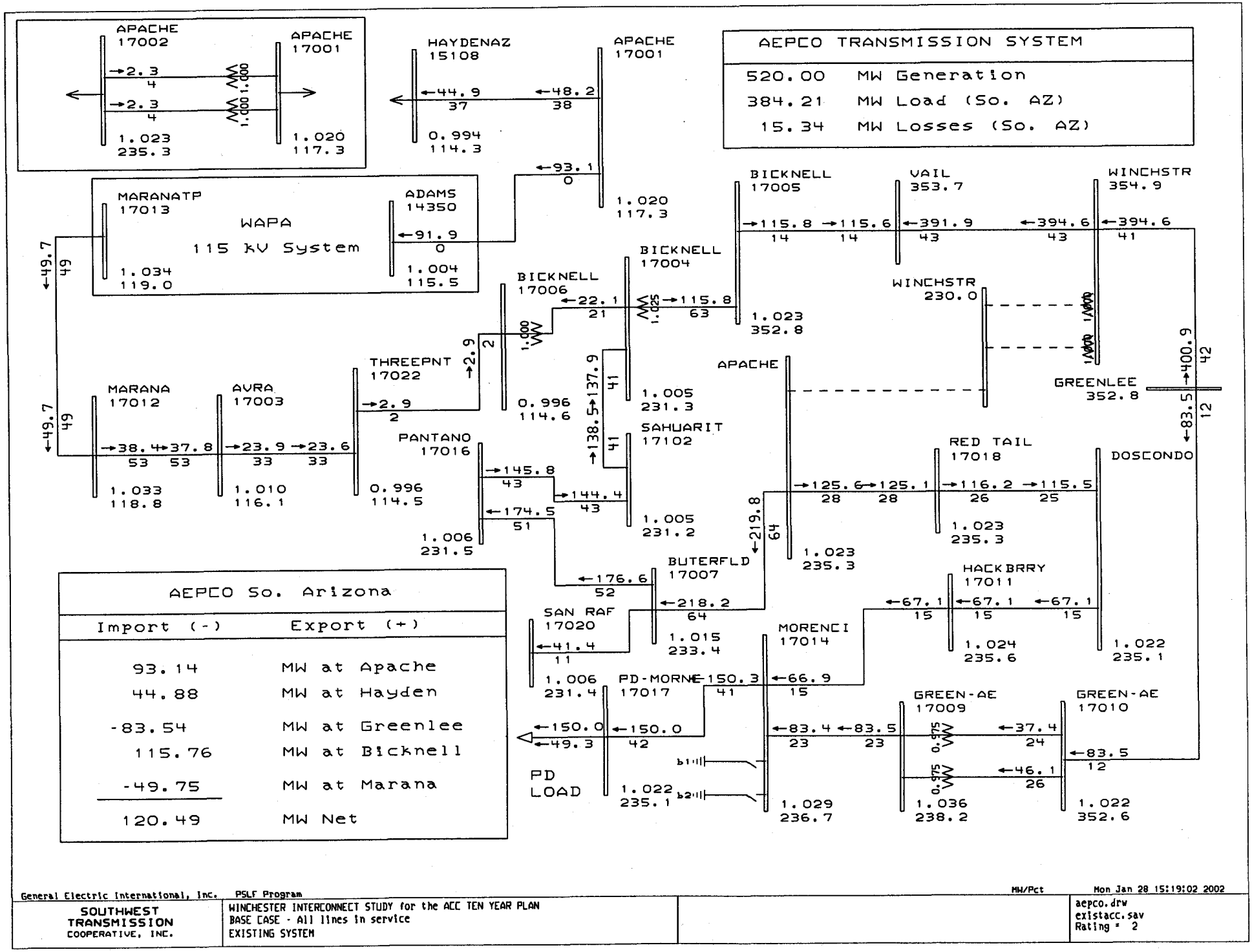


TRANSMISSION SYSTEM WITH PROPOSED UPGRADES



Appendix B

Power Flow One Line Diagrams



General Electric International, Inc. PSLF Program MW/Pct Mon Jan 28 15:19:02 2002

SOUTHWEST TRANSMISSION COOPERATIVE, INC.

WINCHESTER INTERCONNECT STUDY for the ACC TEN YEAR PLAN
BASE CASE - All lines in service
EXISTING SYSTEM

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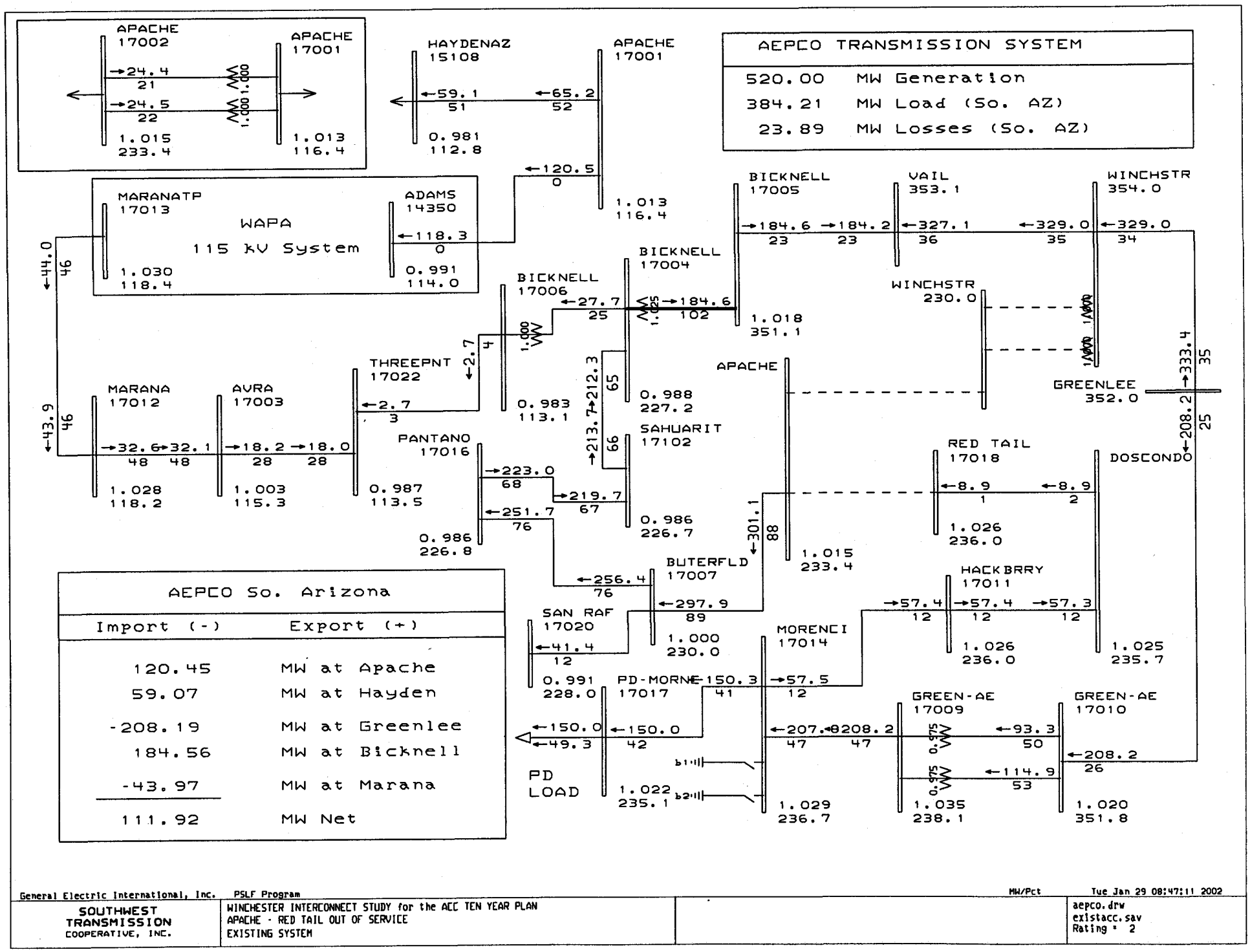

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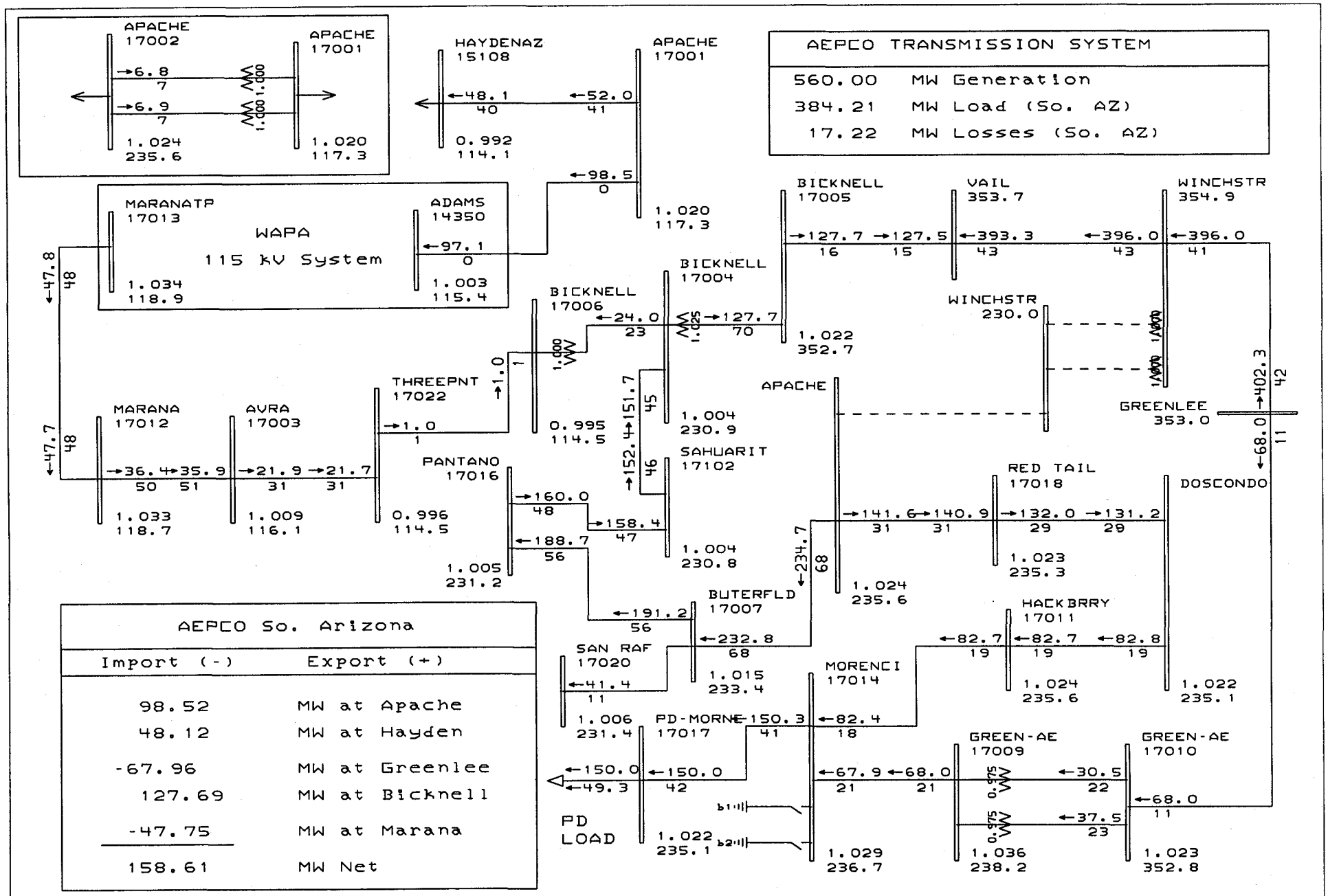
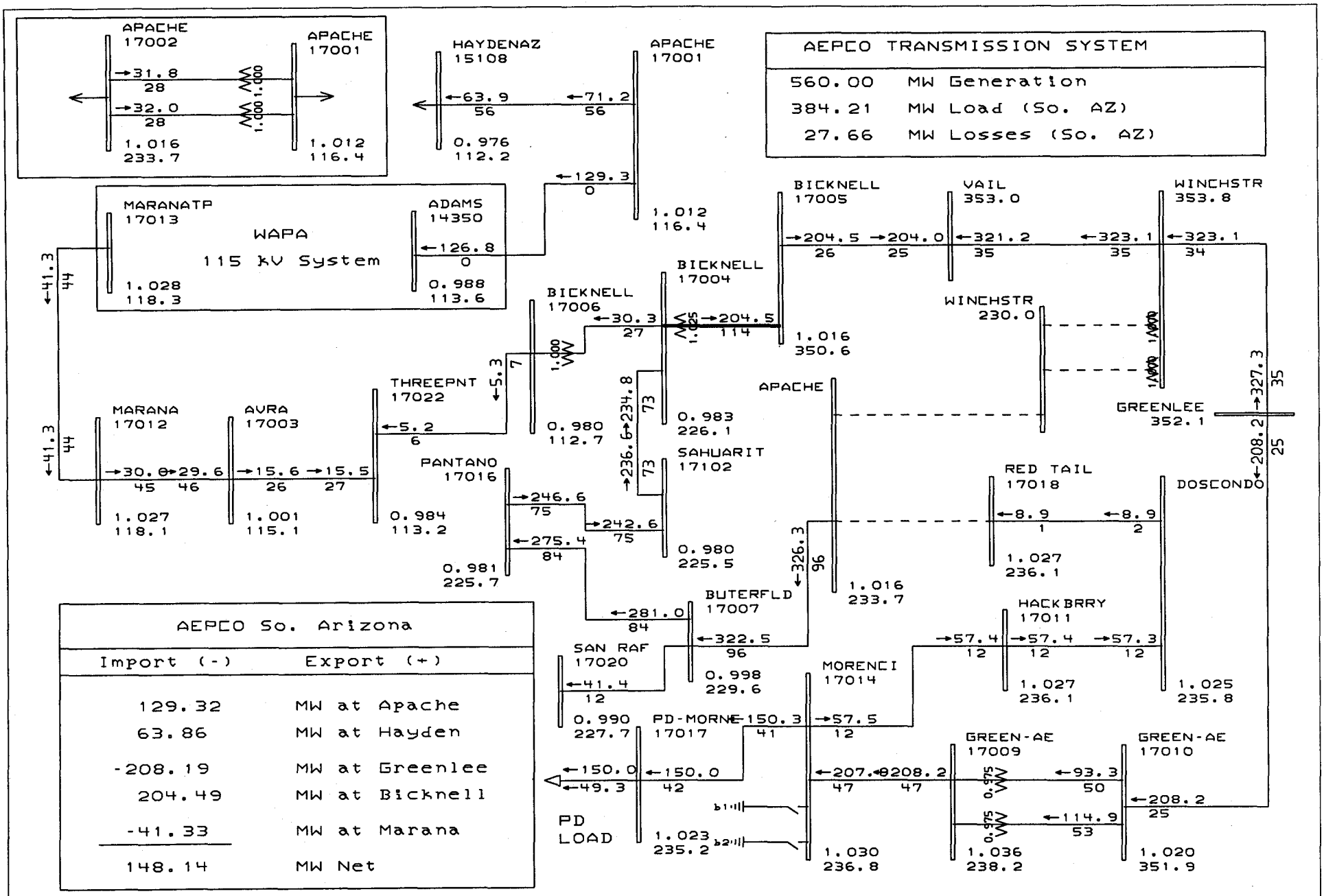


AEPCO So. Arizona	
Import (-)	Export (+)
98.52	MW at Apache
48.12	MW at Hayden
-67.96	MW at Greenlee
127.69	MW at Bicknell
-47.75	MW at Marana
158.61	MW Net

General Electric International, Inc. PSLF Program MW/Pct Mon Jan 28 15:34:05 2002

SOUTHWEST TRANSMISSION COOPERATIVE, INC.	WINCHESTER INTERCONNECT STUDY for the ACC TEN YEAR PLAN BASE CASE - All lines in service EXISTING SYSTEM - 40 MW ADDITIONAL GENERATION AT APACHE		aepco.drw existacc.sav Rating = 2



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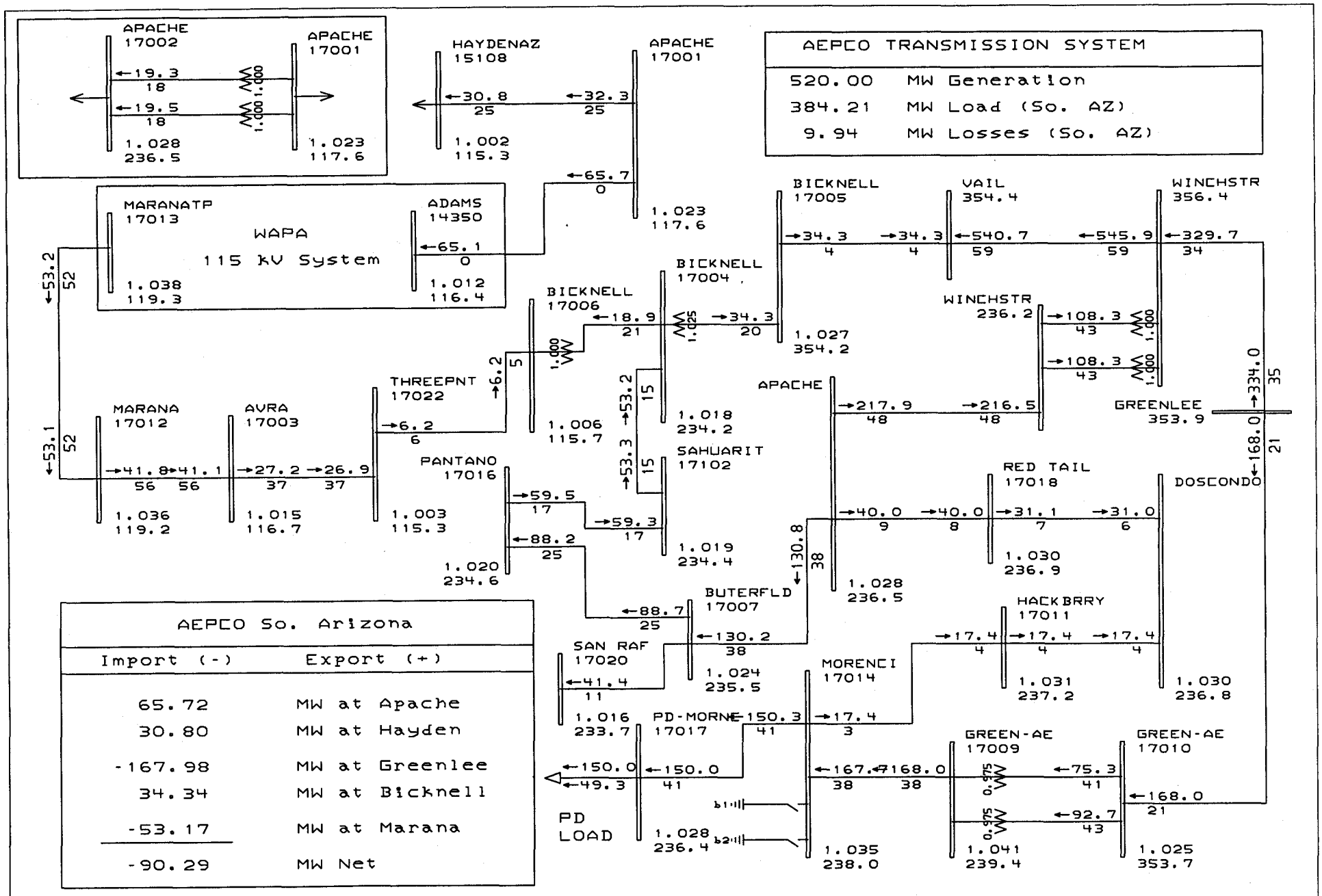

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SOUTHWEST TRANSMISSION COOPERATIVE, INC.

WINCHESTER INTERCONNECT STUDY for the ACE TEN YEAR PLAN
BASE CASE - ALL LINES IN SERVICE
SYSTEM WITH THE WINCHESTER INTERCONNECT

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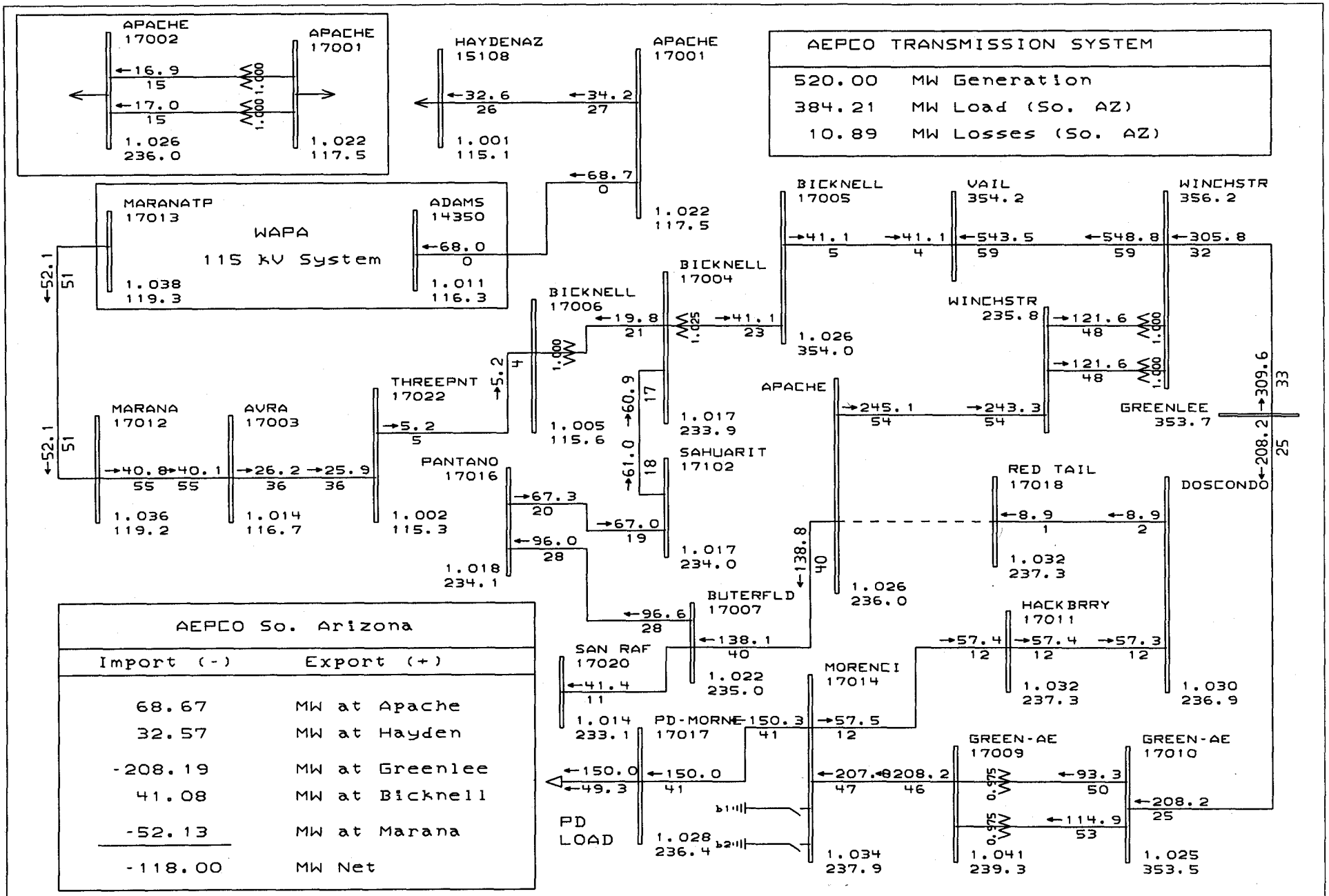

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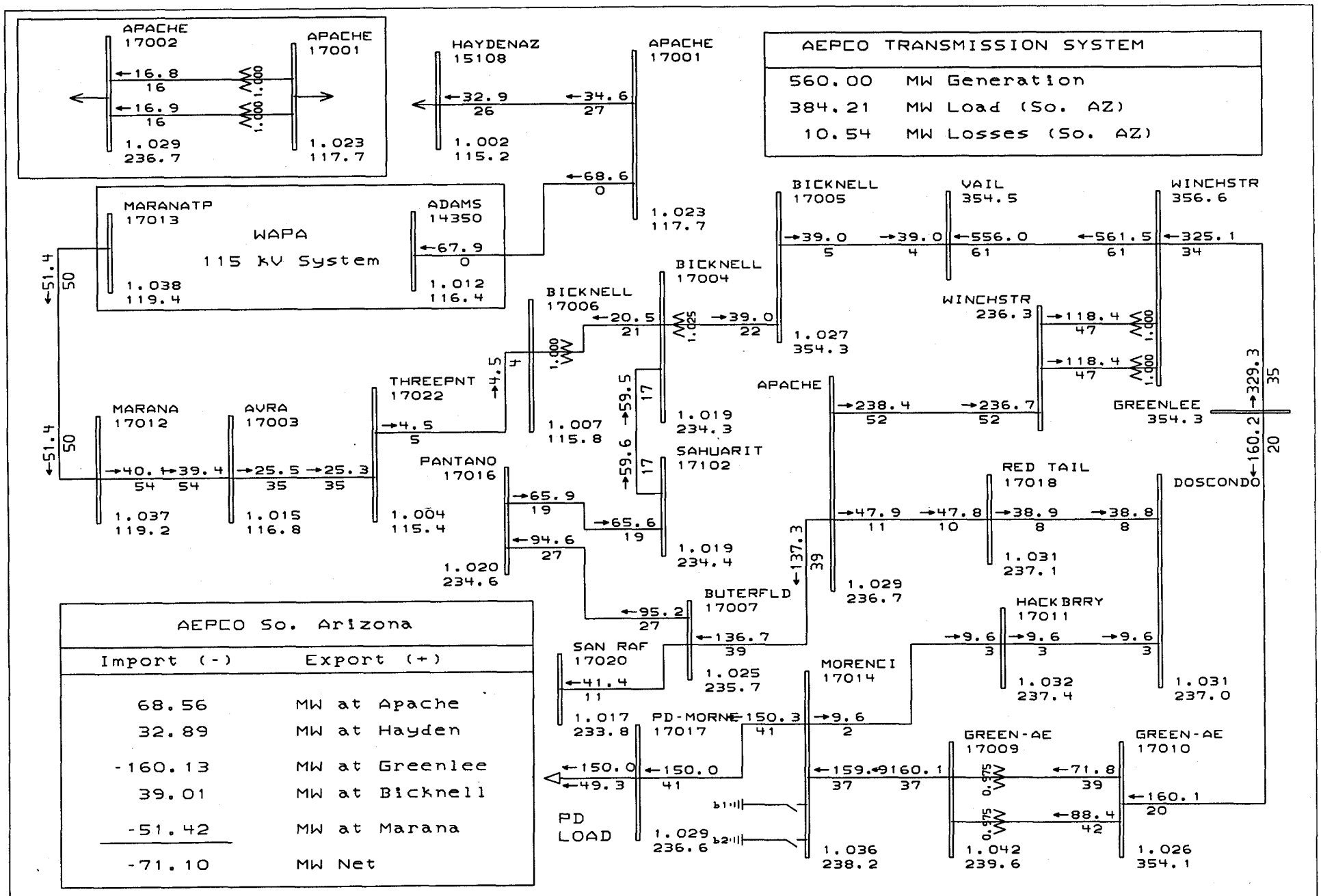

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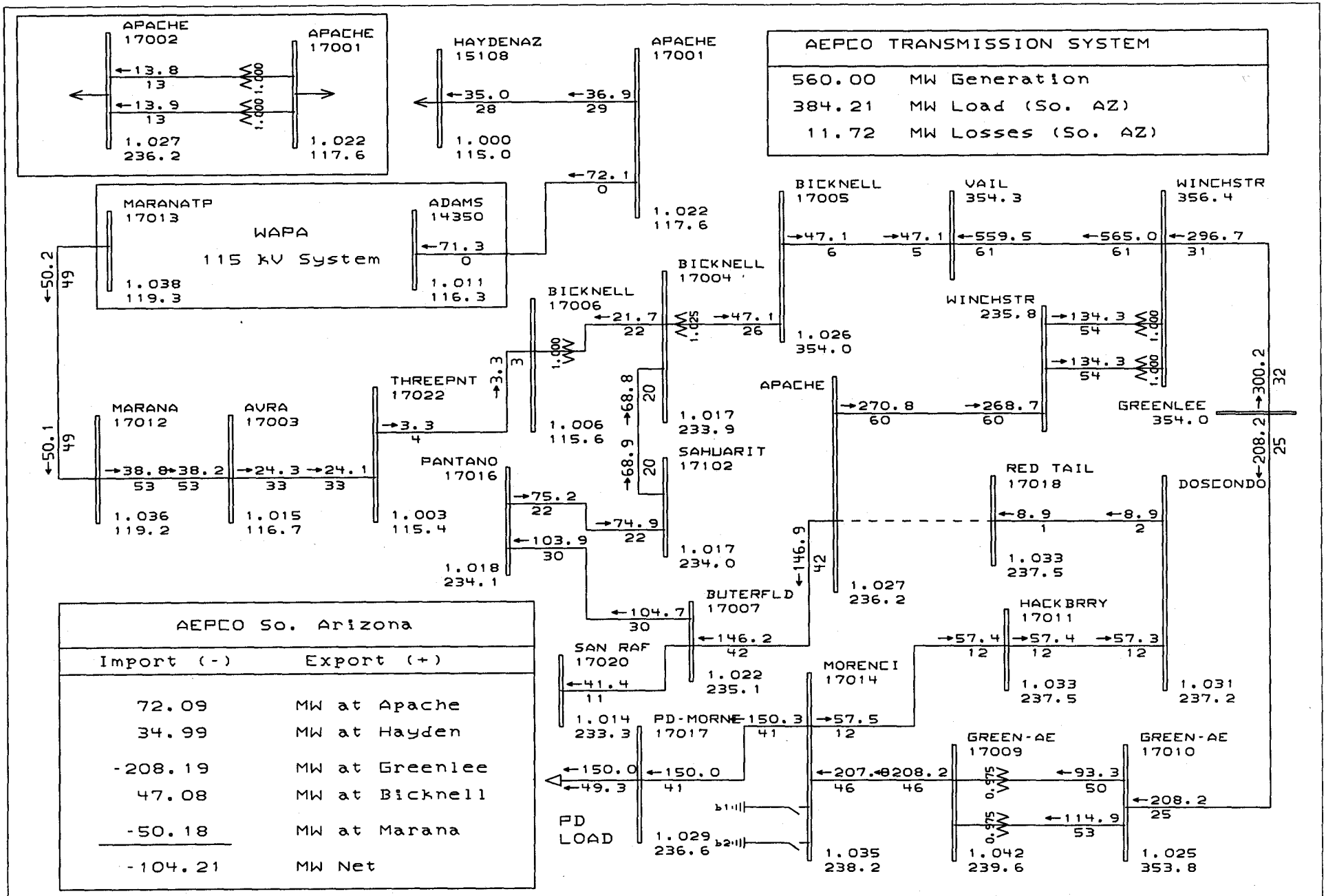

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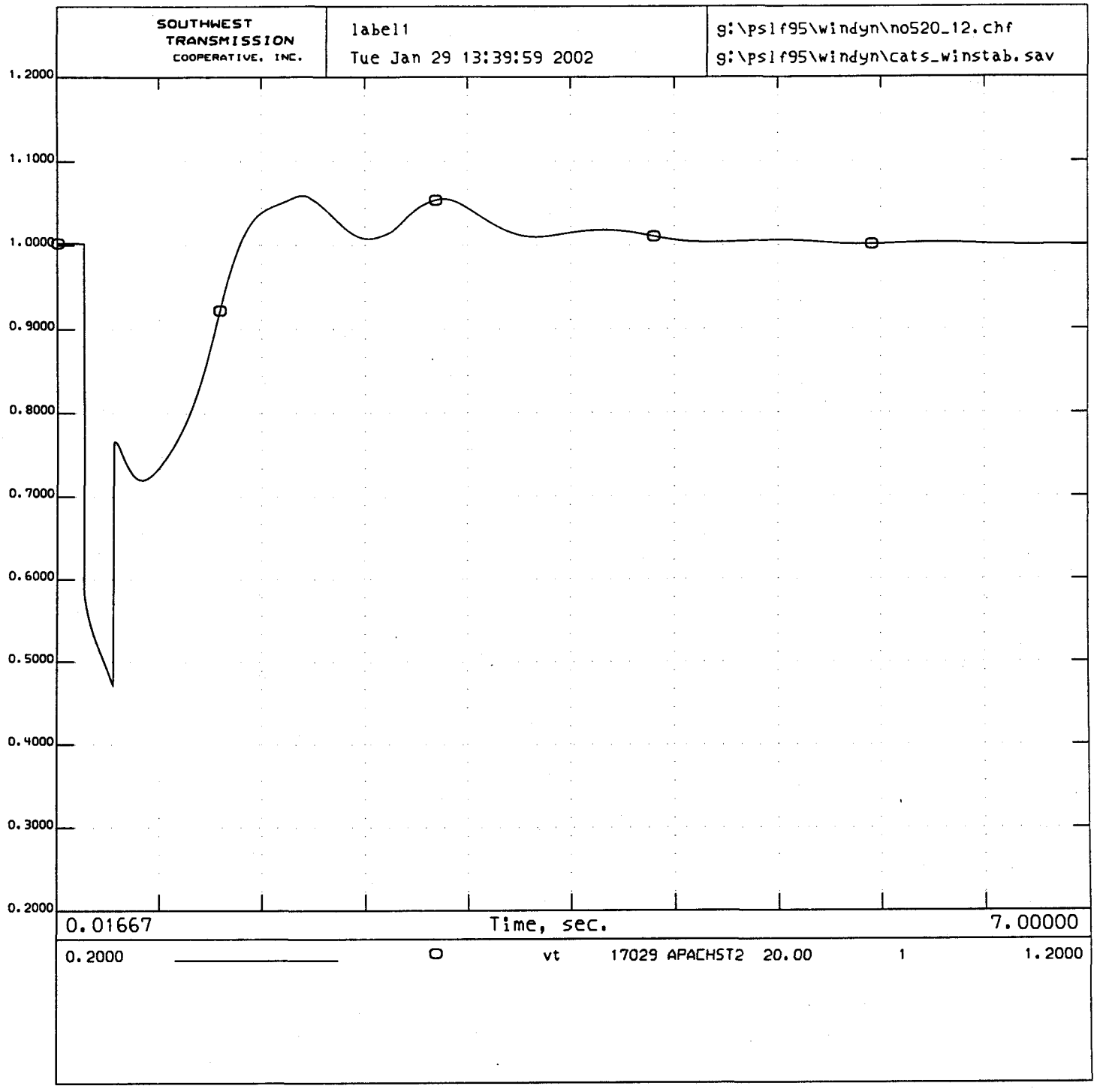
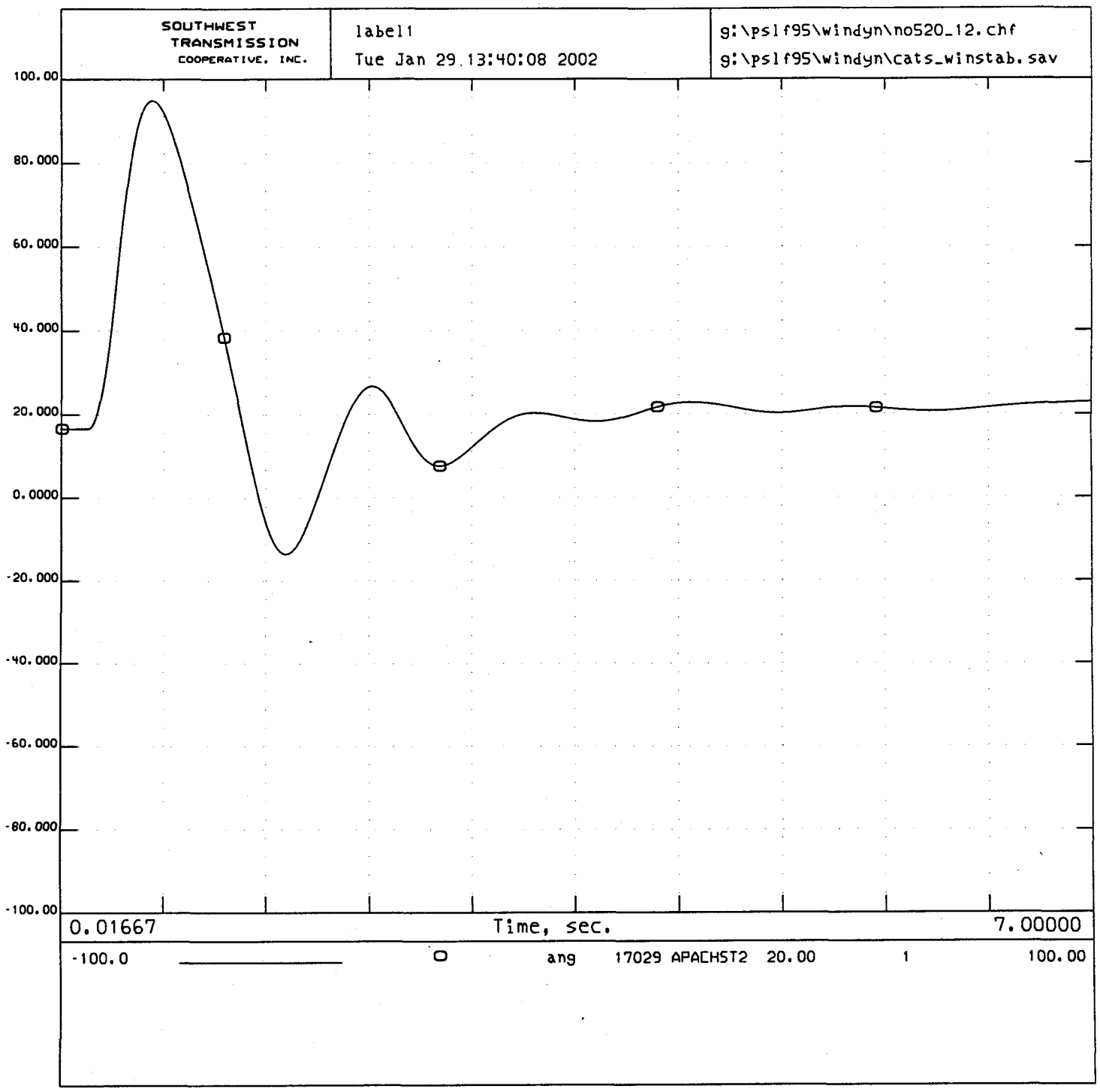
Appendix C

Dynamic Stability Analysis Plots



Critical Fault Clearing Analysis
Existing System
Apache-RedTail Line Fault
Both Ends of the Line Opened 12 Cycles After Applying Fault



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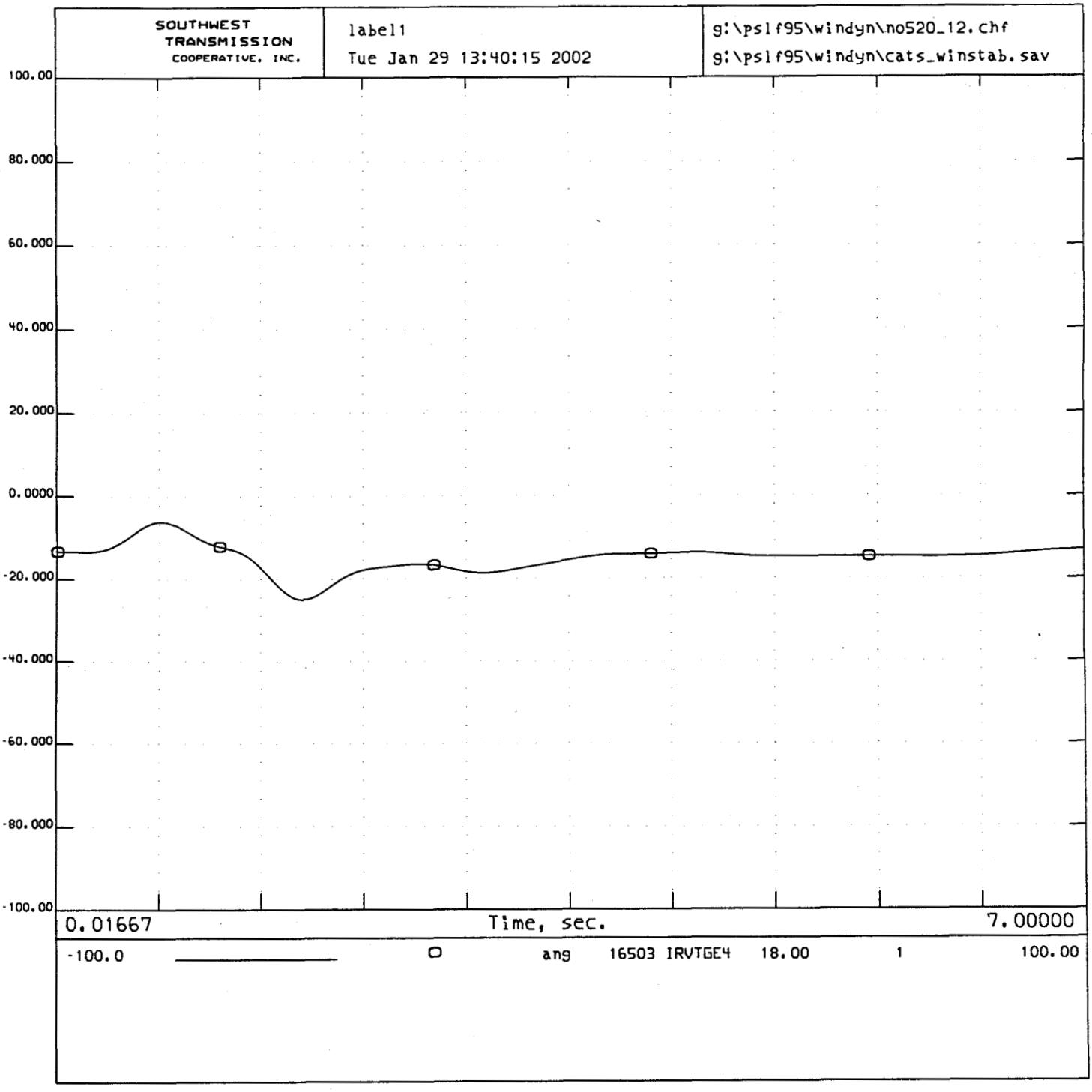
Existing System
Apache-RedTail Line Fault
Both Ends of the Line Opened 12 Cycles After Applying Fault



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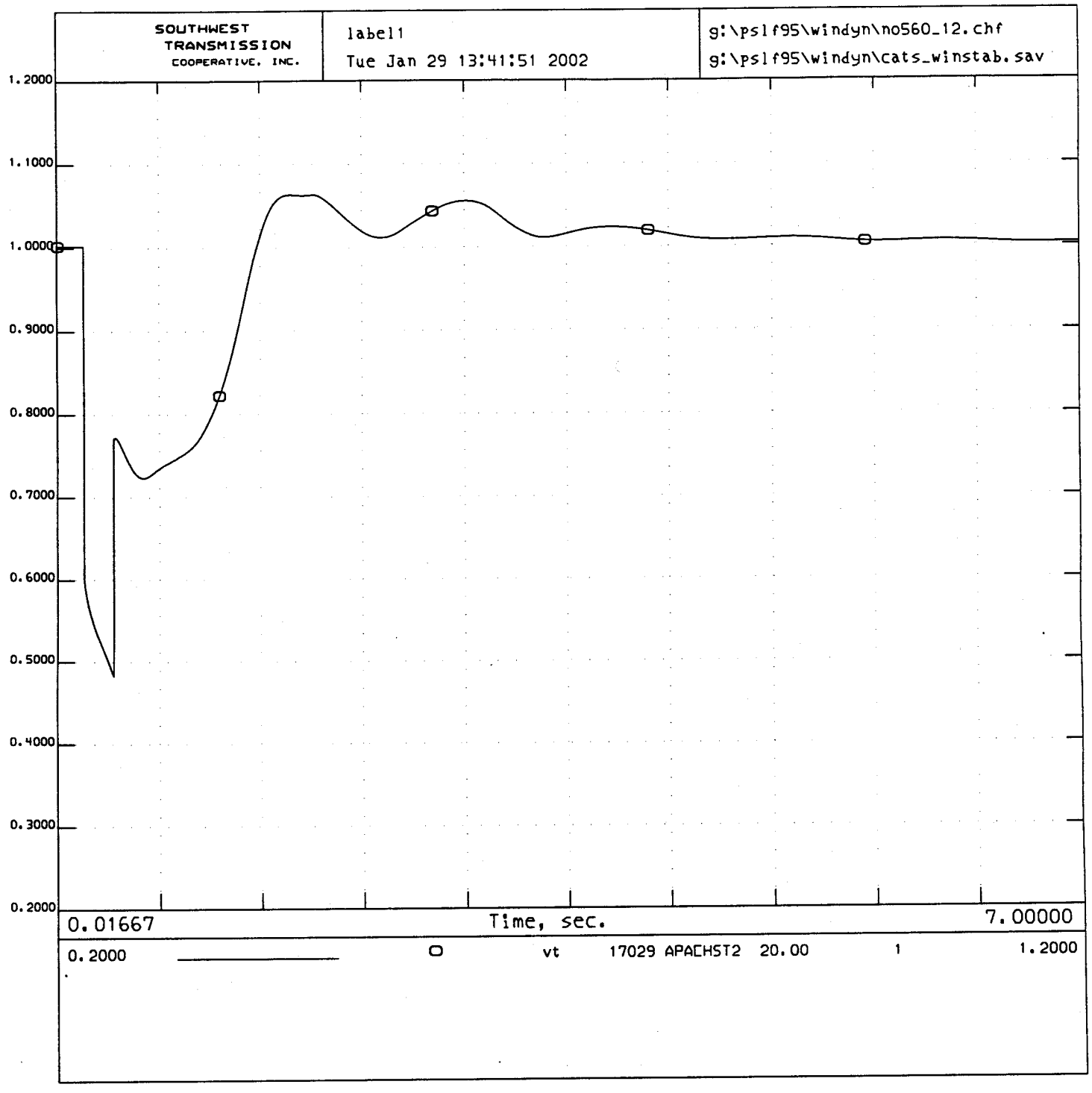
Existing System
Apache-RedTail Line Fault
Both Ends of the Line Opened 12 Cycles After Applying Fault



Critical Fault Clearing Analysis
Existing System - 40 MW Additional Generation at Apache
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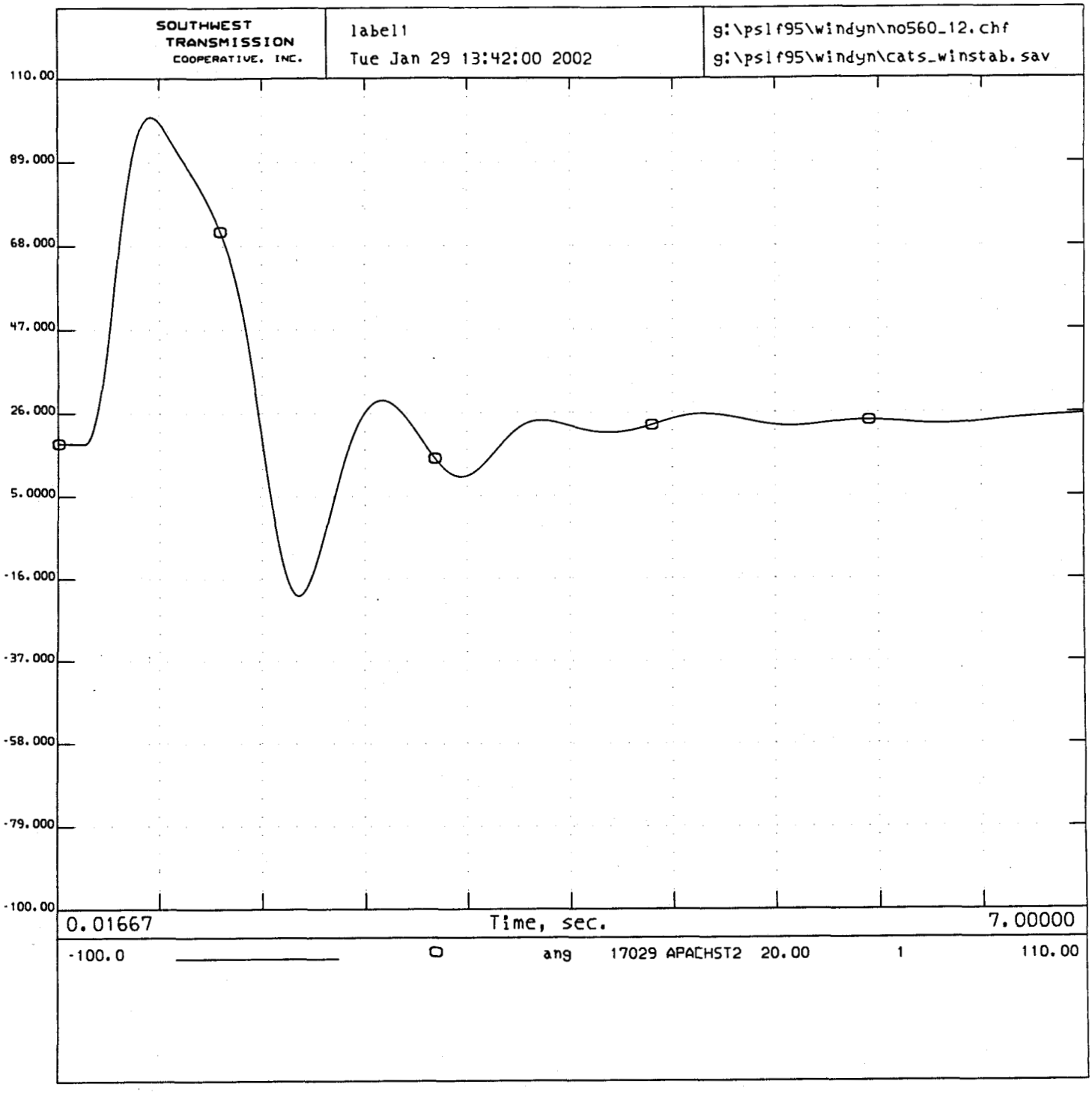
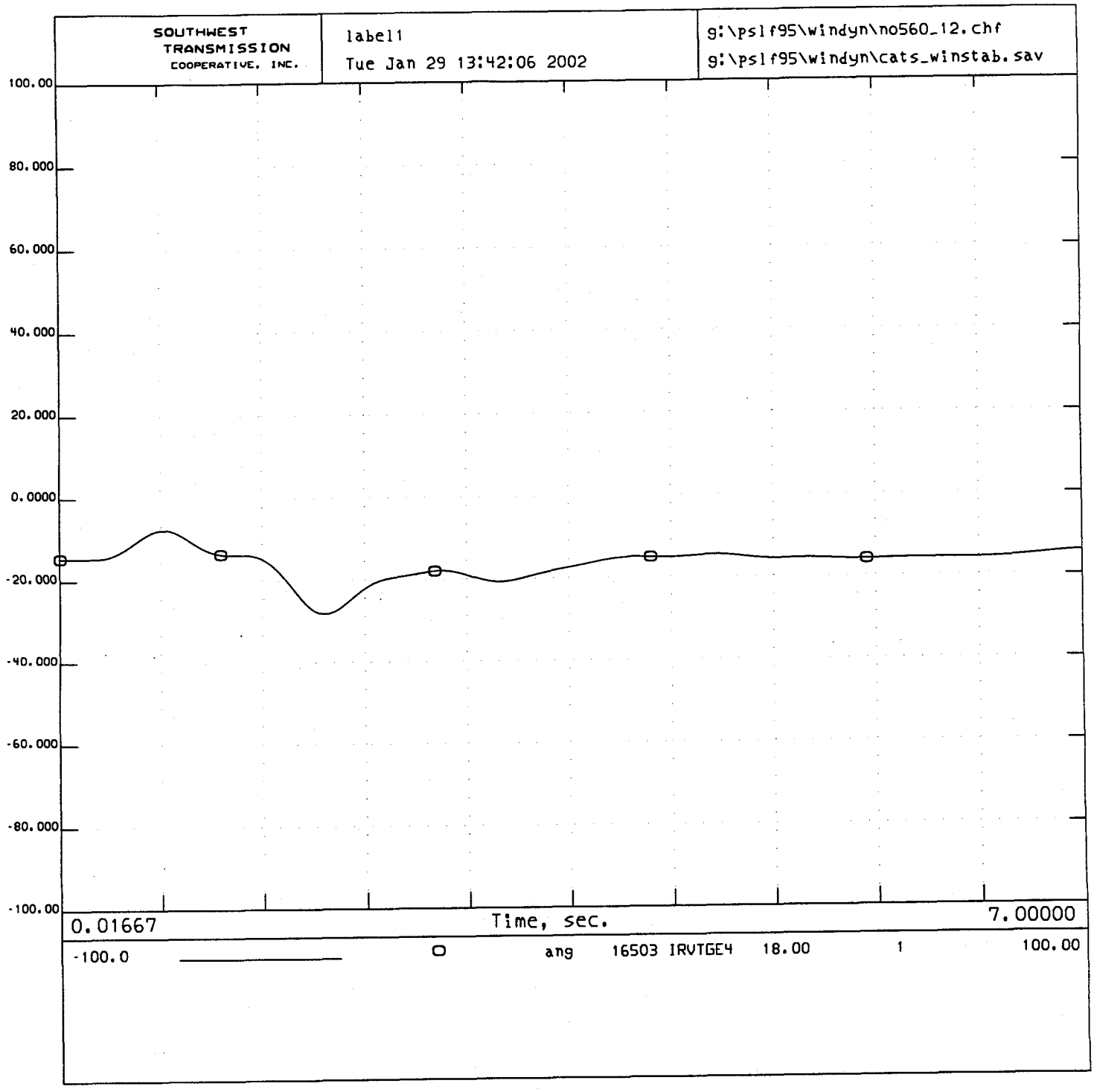
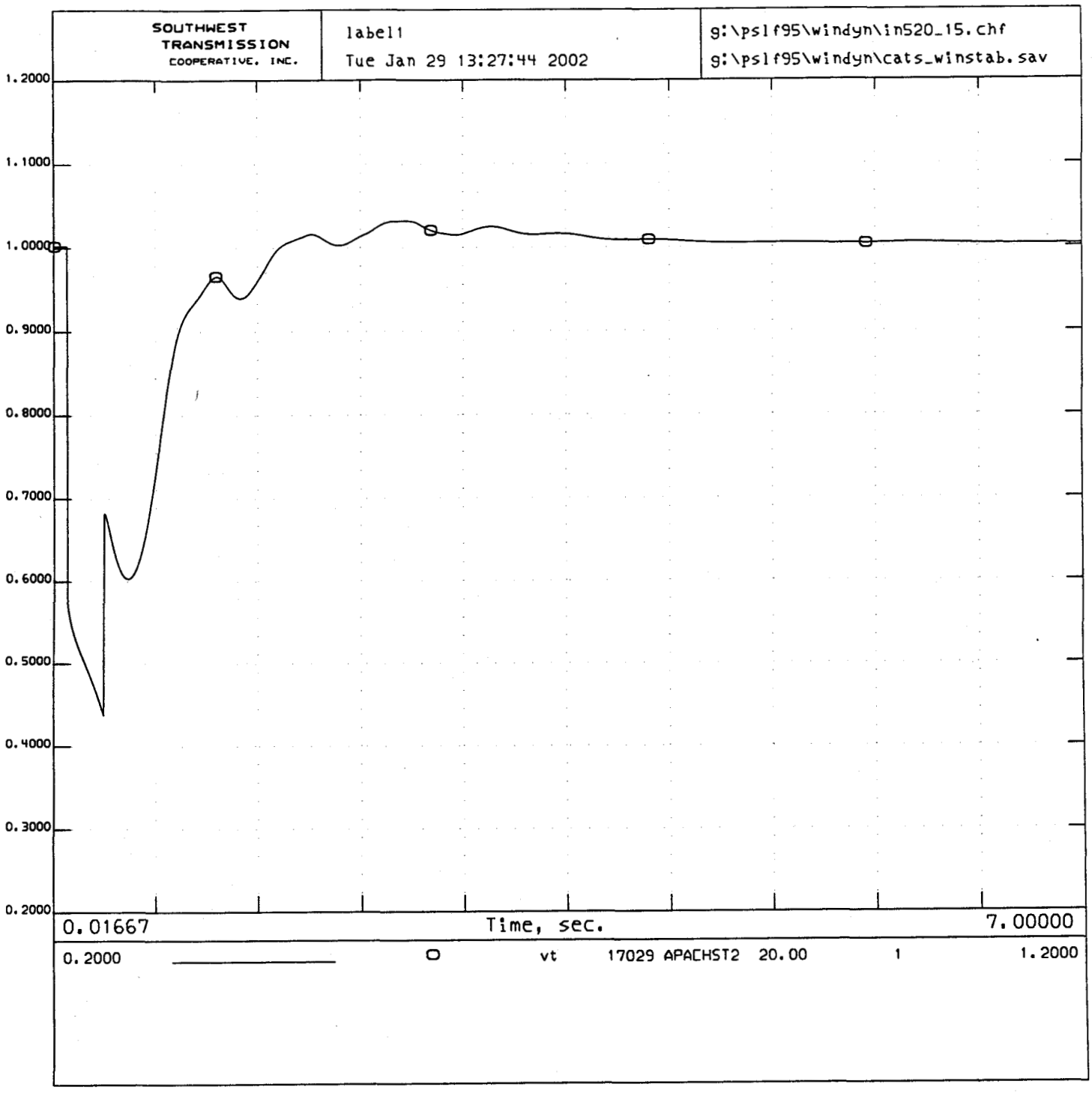


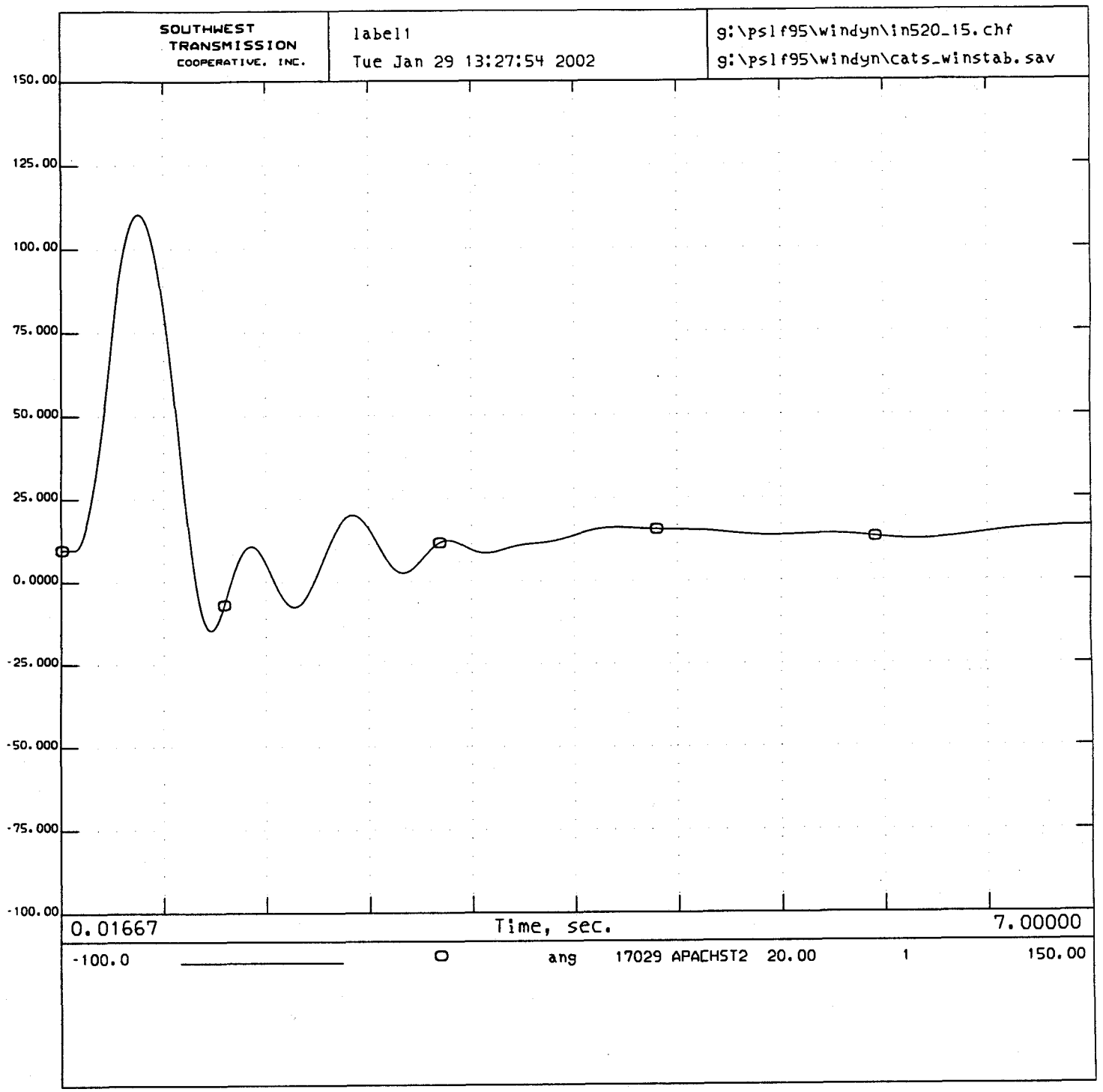
Critical Fault Clearing Analysis
Existing System - 40 MW Additional Generation at Apache
Apache-RedTail Line Fault
Both Ends of the Line Opened 12 Cycles After Applying the Fault



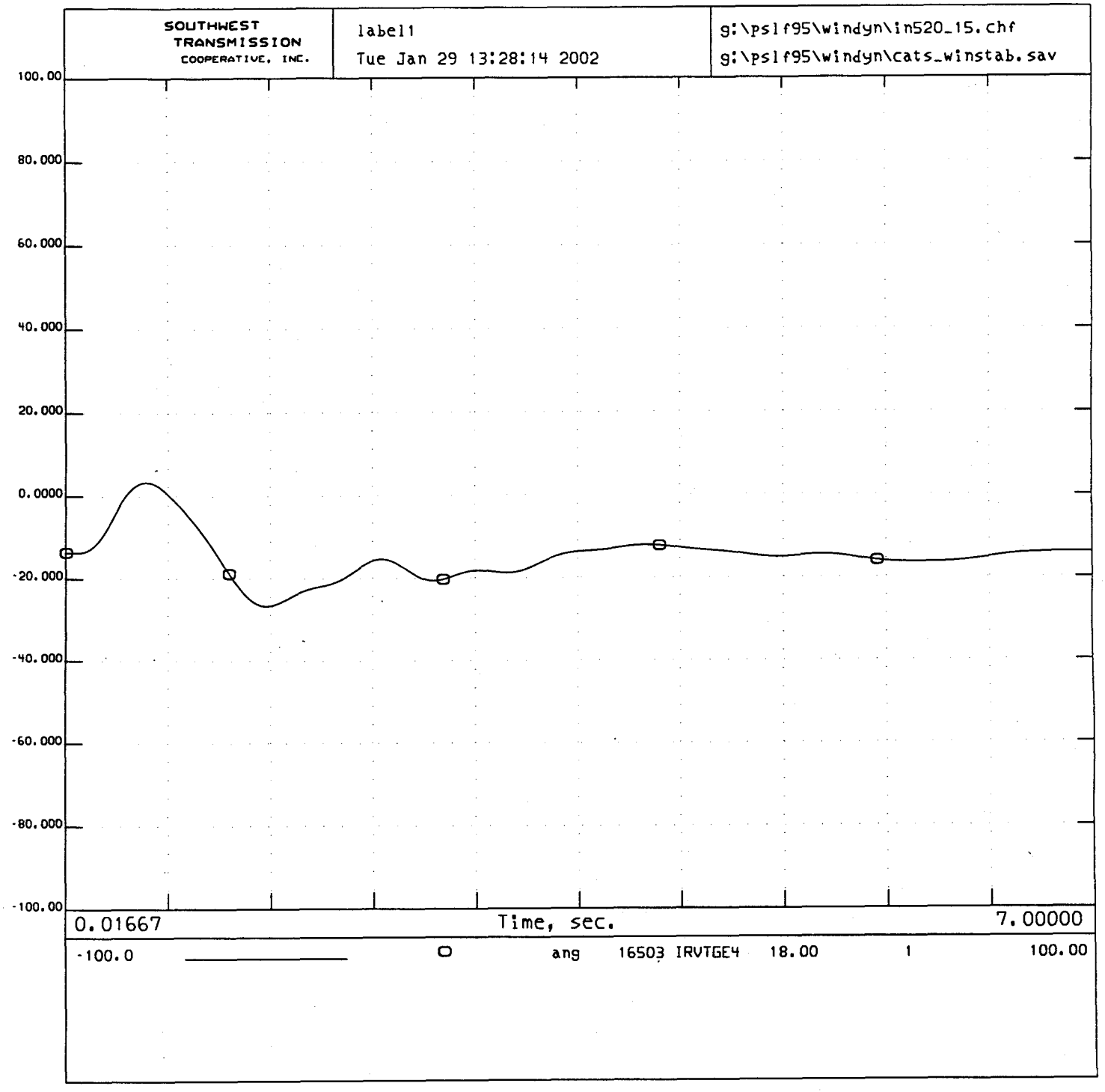
Critical Fault Clearing Analysis
Existing System - 40 MW Additional Generation at Apache
Apache-RedTail Line Fault
Both Ends of the Line Opened 12 Cycles After Applying the Fault



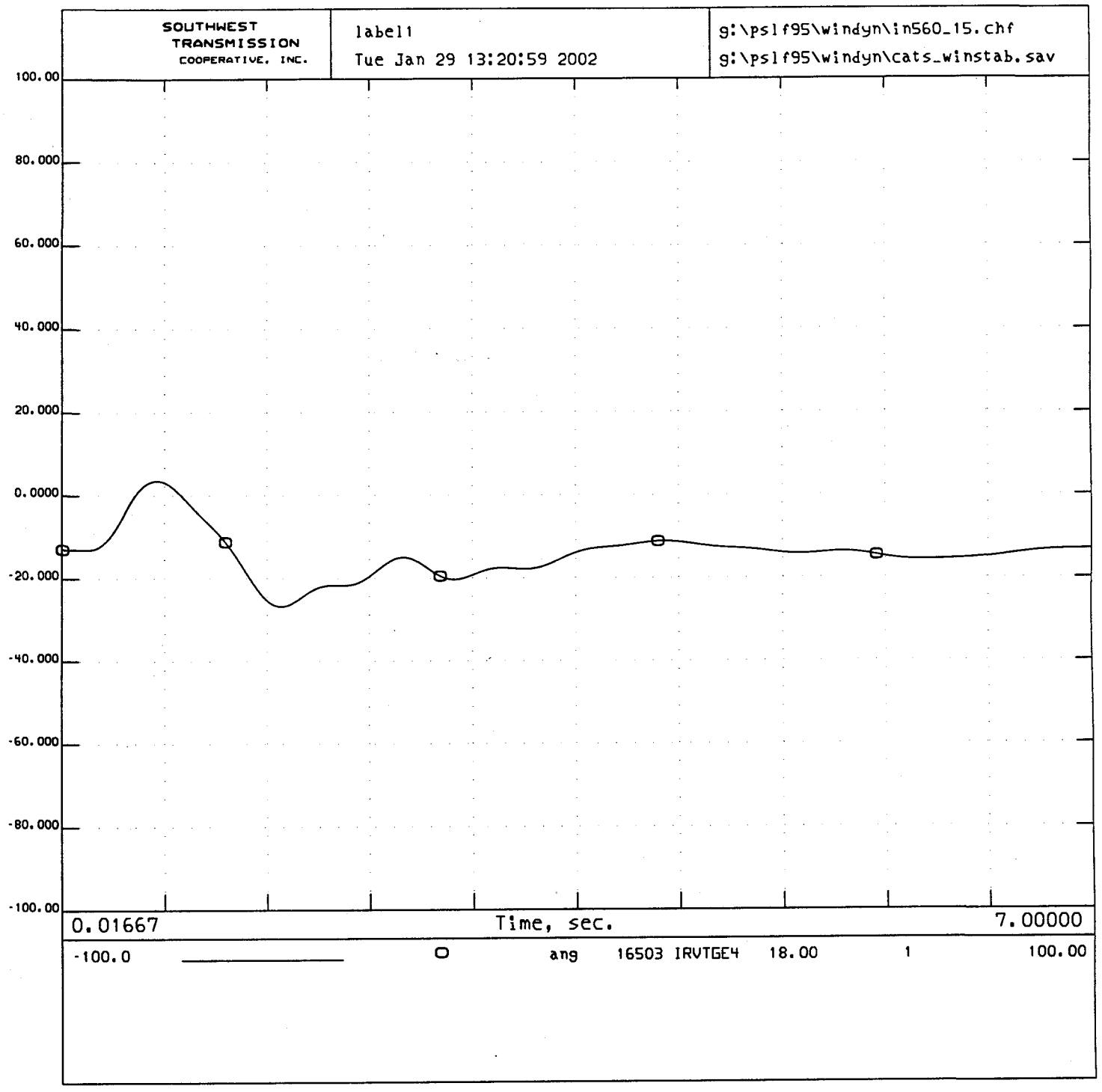
Critical Fault Clearing Analysis
System with the Winchester Interconnect
Apache-Winchester Line Fault
Both Ends of the Line Opened 15 Cycles After Applying the Fault



Critical Fault Clearing Analysis
System with the Winchester Interconnect
Apache-Winchester Line Fault
Both Ends of the Line Opened 15 Cycles After Applying the Fault



Critical Fault Clearing Analysis
System with the Winchester Interconnect
Apache-Winchester Line Fault
Both Ends of the Line Opened 15 Cycles After Applying the Fault



Critical Fault Clearing Analysis
System with the Winchester Interconnect - 40 MW Additional Generation at Apache
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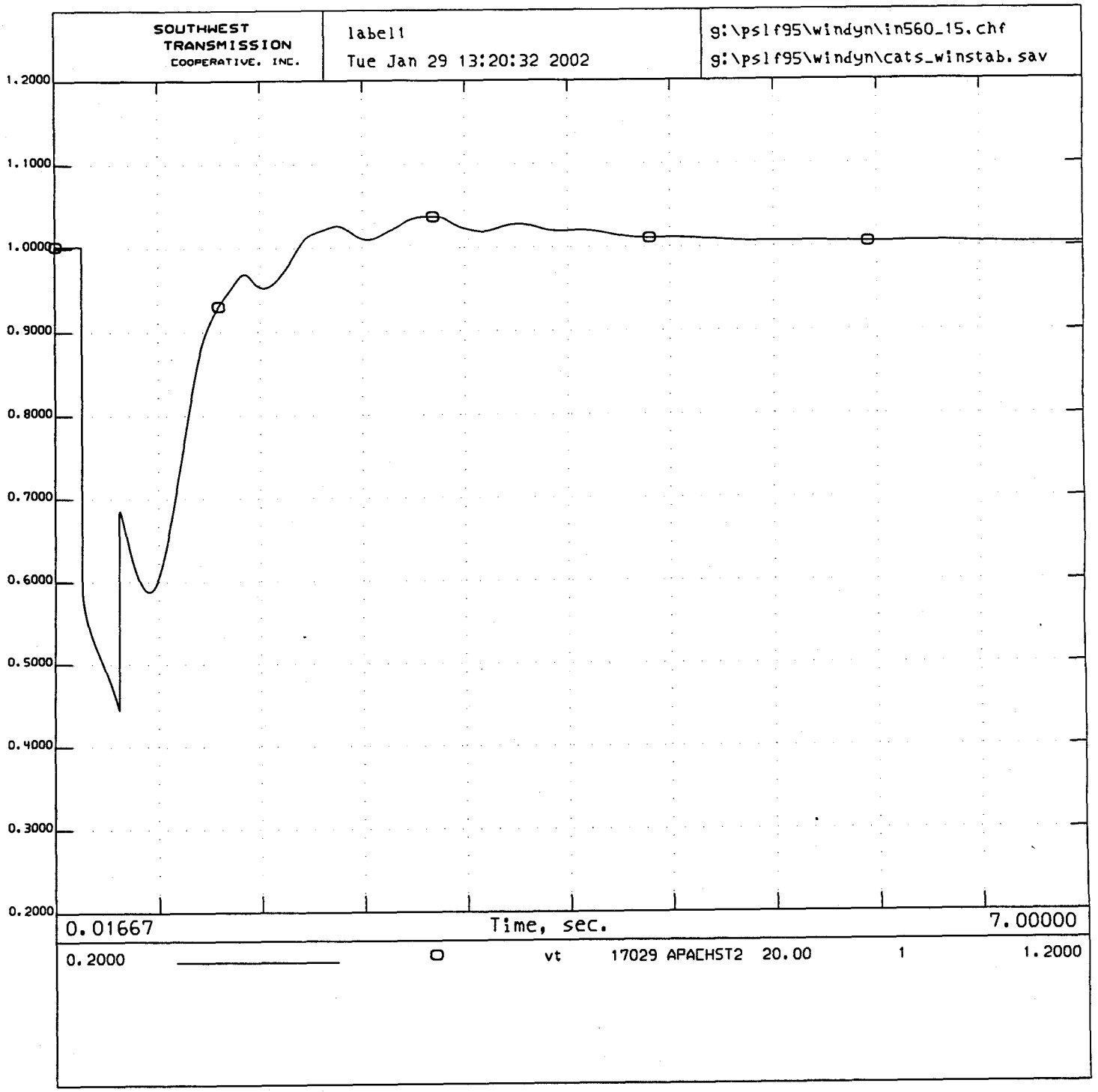

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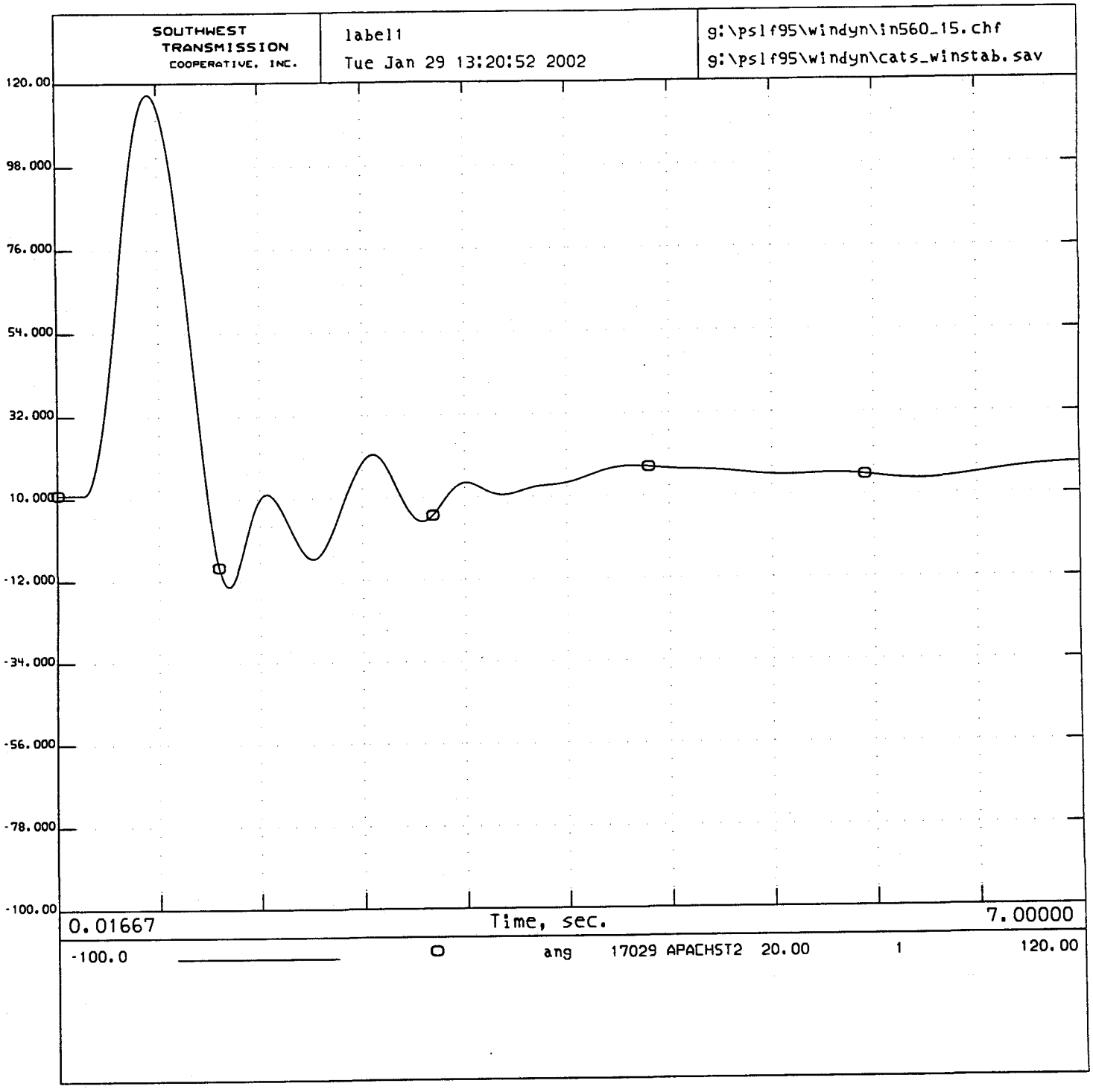

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