ATTACHMENT 2

OCONEE NUCLEAR STATION
UNITS 1,2 and 3
CYME-KEOWEE PROGRAM VERIFICATION

1.0 SCOPE AND PURPOSE

The purpose of this calculation is to verify the validity of the Cyme induction motor model and the Keowee unit model. Because the Cymebase data base is used for other calculations, the data base may include components that are not relevant to this study. Since their presence in the data base does not affect the results of this study, they were not removed from the data base. If any of these extra components are used in future studies, the accuracy of their data must be verified.

2.0 REFERENCES

1. KM-301-3, Keowee Main Step Up Transformer Name Plate
2. OSC-4441 Rev. 01, Oconee Unit 1 ASDOP Input
3. OSC-4442 Rev. 01, Oconee Unit 2 ASDOP Input
4. OSC-4443 Rev. 01, Oconee Unit 3 ASDOP Input

3.0 ASSUMPTIONS

1. For the load rejection test, the Keowee generator voltage was not recorded and is assumed to be at nominal, 13.8 KV.
2. The voltage at the switchyard was at nominal, 230 KV.

4.0 CONCLUSION

The Keowee Cyme model and the adjusted parameters as shown in this calculation provide good correlations between the computer results and the test results. Therefore the model and the Cyme program are concluded to be valid for use in simulating the Keowee hydro unit supplying power to Oconee via the overhead path or the underground circuit, from a steady state or a load rejection condition.

5.0 METHOD OF ANALYSIS

The validity of the Keowee Cyme-model is verified by using the model to simulate various tests and then compare the computer results with recorded test data. Various parameters of the models are adjusted until a good correlation between the Cyme results and test data is obtained.

For the purpose of verifying the program, three tests were performed and relevant data recorded. The first test was a motor signature test of a reactor coolant pump motor; the second test was the Keowee-reactor coolant pump motor combination test, and the third test was a load rejection test. To prevent any RCP flow during the 0% power, the pump was disconnected from the RCP motor during any tests that involved the starting of the RCP motor.

The purpose of the motor signature test was to obtain the start and run characteristics of the motor independently from the transient state of the Keowee generator. With the aid of these characteristics, a simulation of this test was performed using the Cyme program to validate the RCP motor model. To accomplish this objective, the RCP motor was aligned to receive power from the 230 KV system. This portion of the calculation is covered in Section 6.0.

For the second test, the Keowee unit was isolated and aligned to supply power to the RCP motor via the overhead path. The responses of the Keowee unit to the starting and running condition of the RCP motor were recorded. With the aid of the recorded data, a simulation of this test was performed using the Cyme program to validate the Keowee unit model. A more accurate model of the Keowee unit was obtained by adjusting some of the manufacturer calculated parameters and constants until a good correlation between the simulation and the test results was obtained. Since the motor model was already verified in the motor signature test and simulation, only the Keowee model was adjusted. This portion of the calculation is covered in Section 7.0.

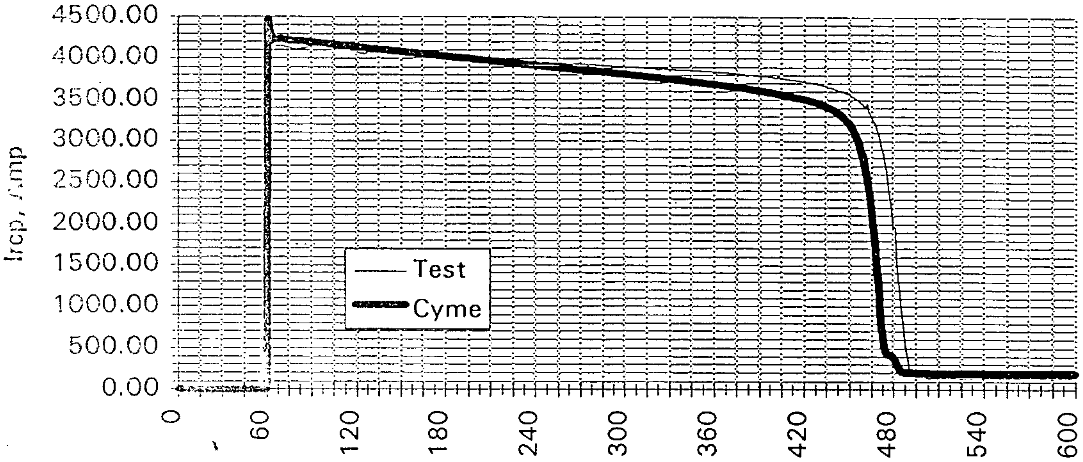
A third test was a load rejection test. For this test, one Keowee unit was supplying 93 MW of power to the grid and then the unit was isolated to simulate a 93 MW load rejection. The generator frequency response was recorded during this test. With the aid of the recorded data, a Cyme simulation of the test was performed to validate the Keowee model for use in a load rejection simulation. Adjustments were made to the Keowee model such that a good correlation between the Cyme simulation and the test data exists for both the load application case (second test), and the load rejection case (third test). This portion of the calculation is covered in Section 8.0.

Once a single Cyme model of the Keowee unit is adequately validated, it can be used to perform analyses for Keowee supplying Oconee via the overhead or underground path.

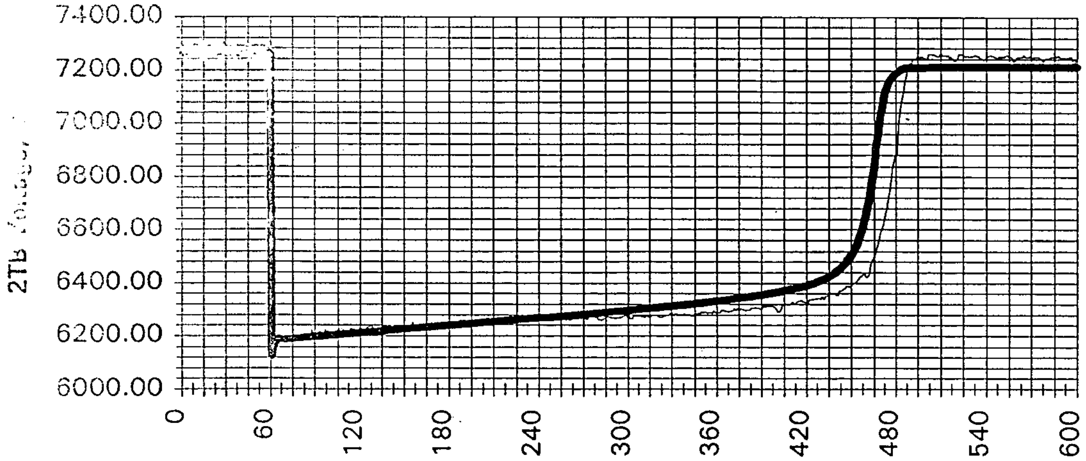
The following Cyme program modules were used:

1. CYMBASE V 2.36
2. MOTORP V 2.06
3. CYMFLOW 4.70
4. CYMEDIT V 5.40
5. CYMSTAB / UDM V 5.70

RCP Mtr Sign- Ircp,Amp



RCP Mtr Sign, 2TB Volts



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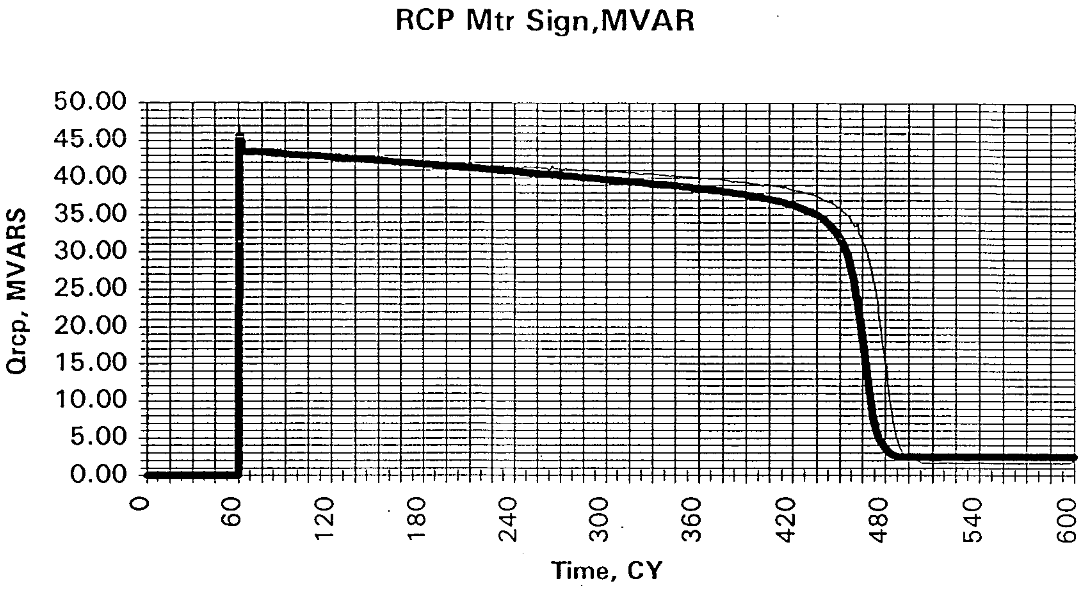

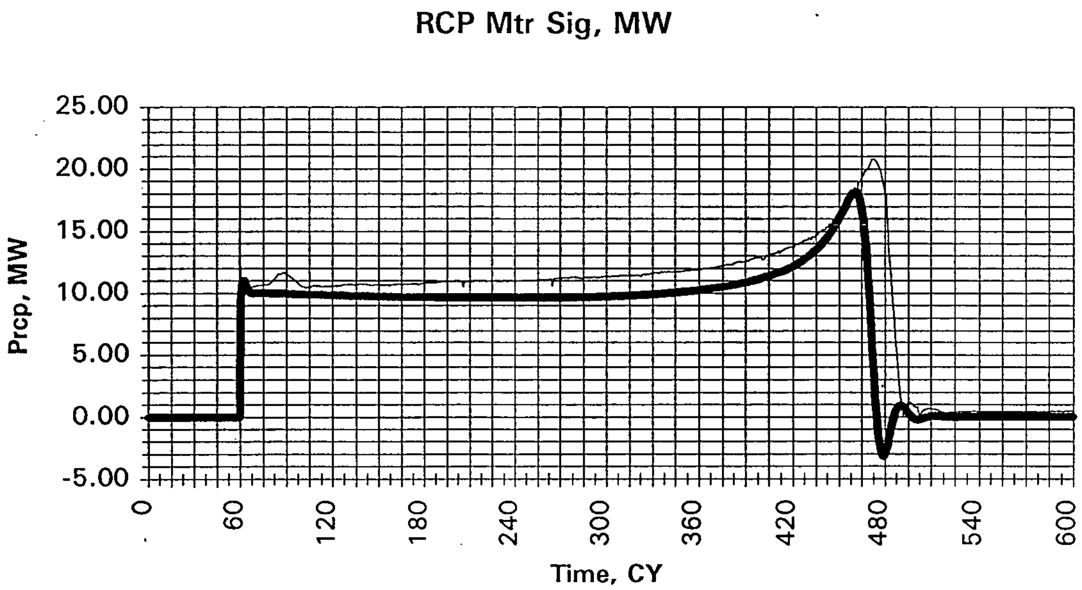

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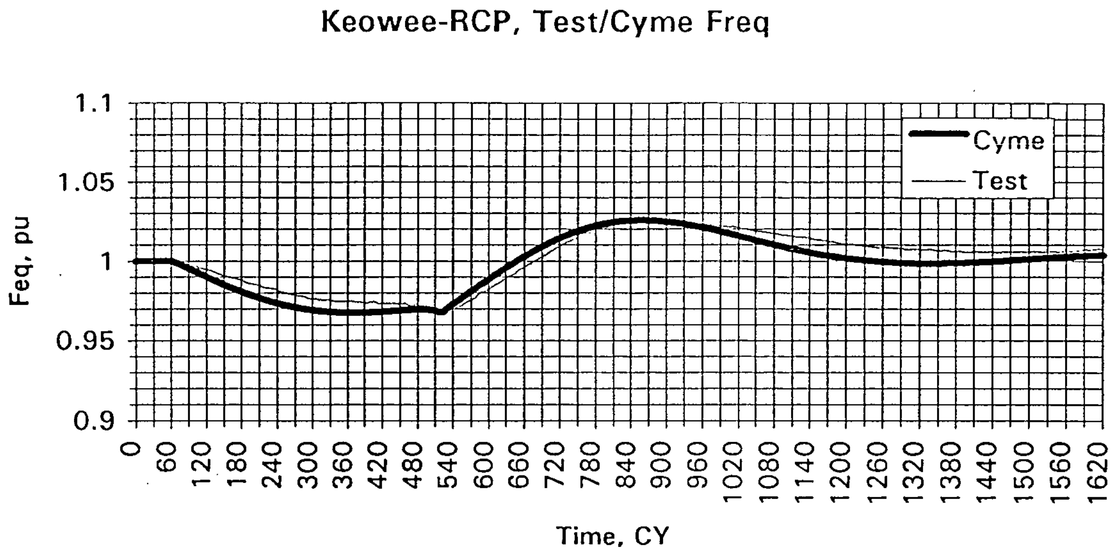
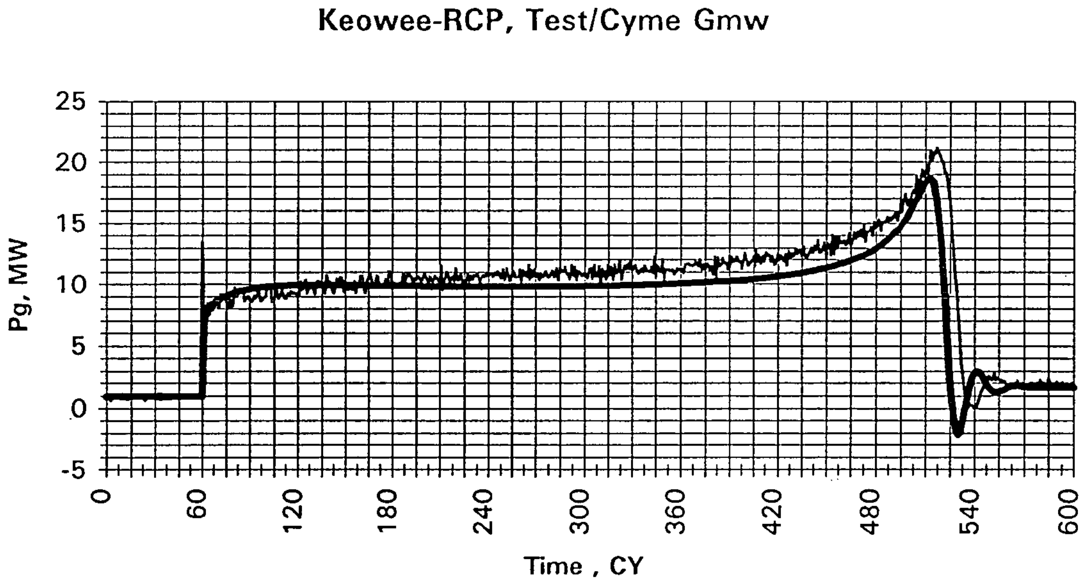
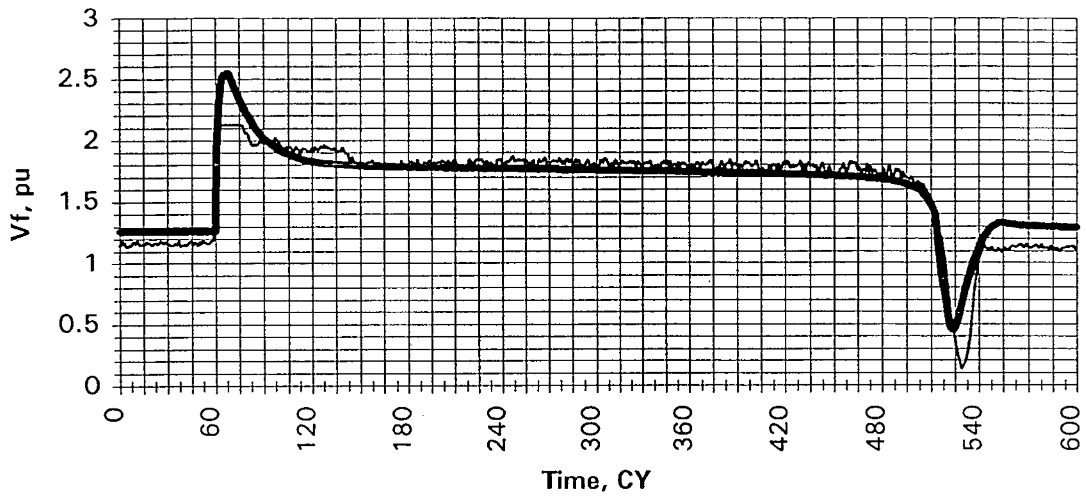
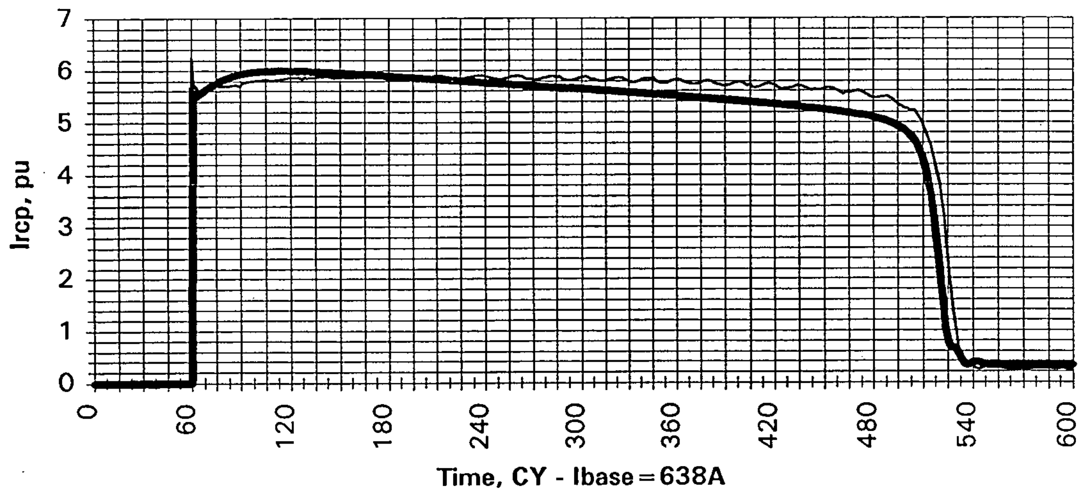




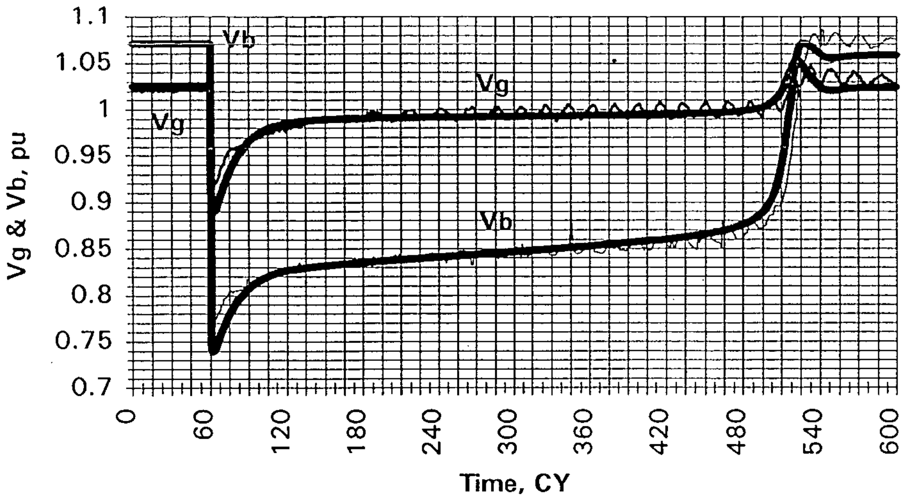
Keowee-RCP, Test/Cyme Vf



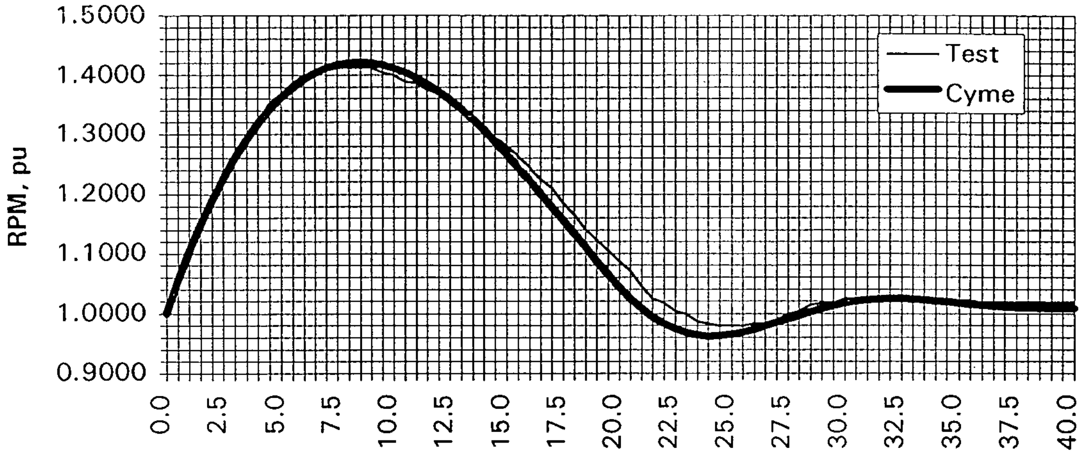
Keowee-RCP, Test/Cyme Ircp



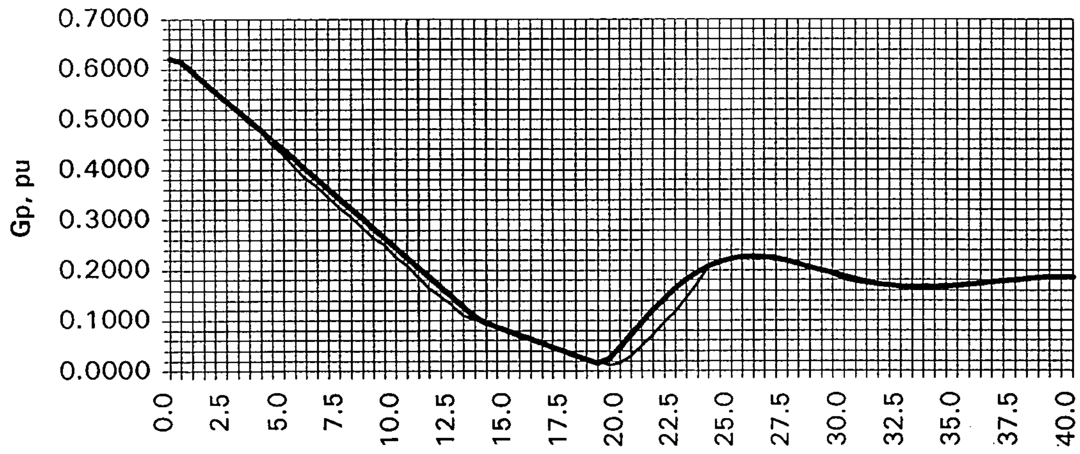
Kw-RCP, Test/Cyme Vg&Vb



KW, 93MW LR, RPM



KW, 93MW LR, GP



ATTACHMENT 3

APPENDIX A CYME Simulation of Field Tests

A-1. GENERAL

In order to certify/validate the CYME program, a series of four tests were performed with the grid or combustion turbine supplying the load. These tests are as follows:

Test2: Start of Supercharger Fan 5C from Combustion Turbine 6C

For this test, Combustion Turbine 6C was running isolated from the grid but was connected to the other combustion turbine units as illustrated in Figure A-1. The supercharger fan on Unit 6C was initially running supplied from Unit 6C and the auxiliaries of Units 4C and 5C were also supplied from Unit 6C. Supercharger fan 5C was then started. Once supercharger fan 5C was up to speed, supercharger fan 4C was started. After both fans were running at steady state, supercharger fans 4C and 5C were tripped simultaneously. In modeling this test, only the start of supercharger fan 5C was modeled because once supercharger fan 5C was started, the running load was not stable resulting in a situation which could not be modeled accurately.

Test3: Start of Supercharger Fan 5C from the grid

For this test, all combustion turbines were shutdown with their auxiliaries supplied from the grid. Supercharger 5C on Unit 5C was then started.

Test4: Start of ASW Pump at Oconee from Combustion Turbine 6C

For this test, Combustion Turbine 6C was running isolated from the grid but connected to the Oconee Standby Bus. Unit 6C was supplying its own auxiliaries and Supercharger 6C as well as the charging load for the circuit to Oconee. No loads were initially connected to the standby bus at Oconee. The ASW pump was then started from the standby bus. All electrical parameters(voltage, amperes, power, etc.) for the ASW pump was monitored at the Standby Bus.

Test5: Tripping of Supercharger Fan 6C when supplied from Combustion Turbine 6C isolated from grid

For this test, the initial conditions were identical to that in Test4 above. The ASW was not running. Supercharger 6C was then tripped and the response of Combustion Turbine 6C was monitored. Note that tripping the supercharger on a unit would be expected to change the units response and is hence not a very good indication on how the unit would respond on load rejection when connected to Oconee. When a Lee unit is supplying Oconee, the supercharger on the unit would be running.

The purpose of the above tests was to verify the CYME modeling of the motors, the combustion turbines and the circuit connecting LEE to Oconee.

A-2. CYMBASE

Network models representing the systems illustrated in figures A-1, A-2, A-3, and A-4 were created using CYMBASE. As illustrated in figure A-2, the system for Test3 was represented as a generator connected to the 100KV Switchyard bus. CYMBASE was then used to create files for input to CYMFLOW. The following are the input and output file names for each test:

Table A-1 CYMBASE Files Created for Each Field Test		
Field Test	**CYMBASE *.NET Files**	**CYMBASE Ouput Files for Load Flow**
Test2	TEST2.NET	TEST2.NND
Test3	TEST3.NET	TEST3.NND
Test4	TEST4.NET	TEST4.NND
Test5	TEST5.NET	TEST5.NND

FOR Test2,Test4, and Test5, generator data is from Attachment 2. For Test3, generator data is based on Attachment 3. Initial loads and generator data was obtained from Tables E-1,E-2,E-3 and E-4(See Appendix E). All initial loading was modeled as static loads in CYMBASE.

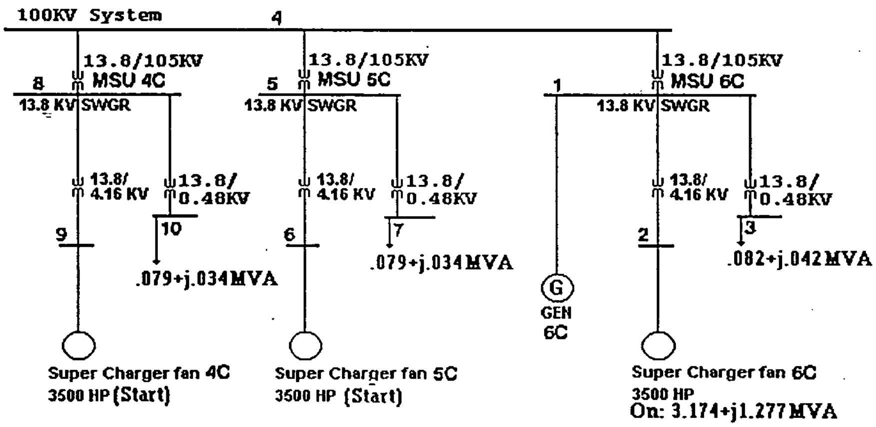


Fig. A-1: TEST2 - Start of Supercharger 5C from Combustion Turbine 6C

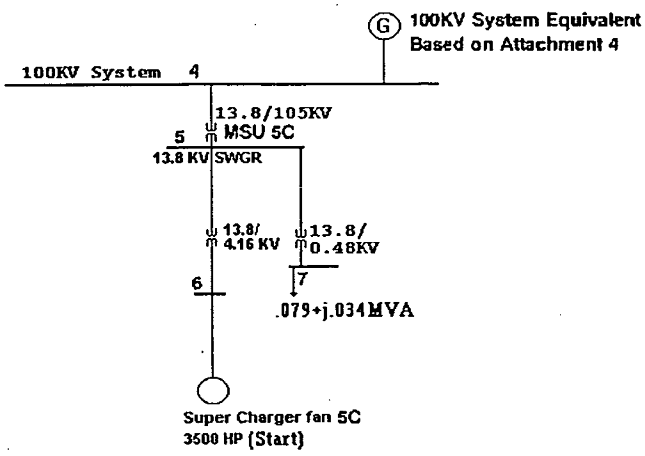


Fig. A-2: TEST3 - Start of Supercharger 5C from the 100KV Grid

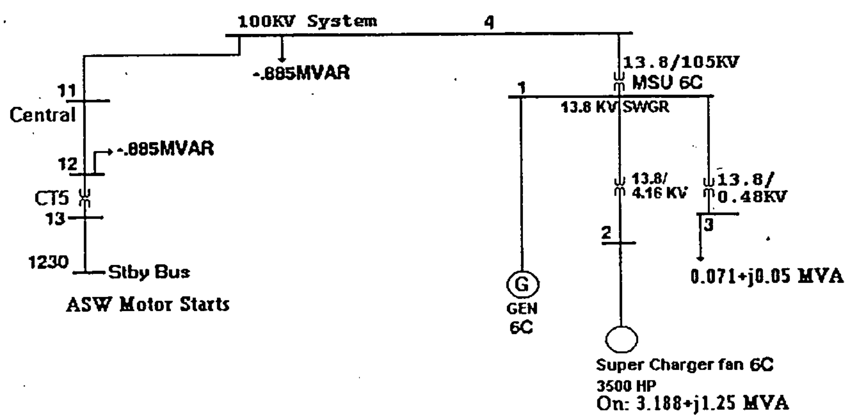


Fig. A-3: TEST4 - Start of ASW Pump Mtr from Combustion Turbine 6C

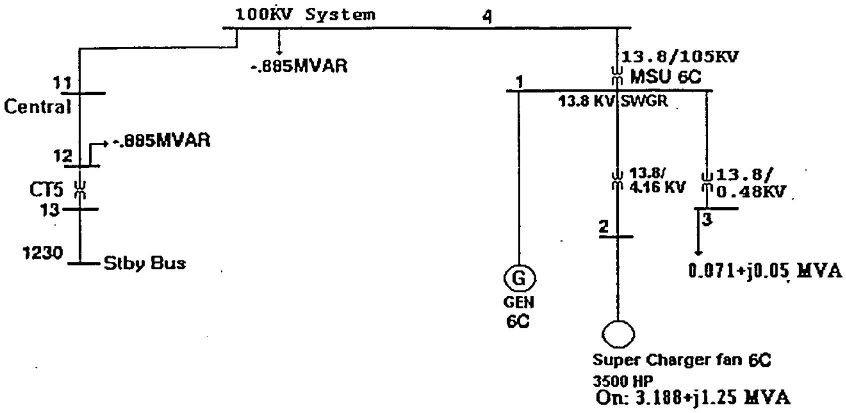


Fig. A-4: TEST5 - Tripping of Supercharger 6C

Figure A-5: TEST2, SC 5 Start, Gen. 6C Volts

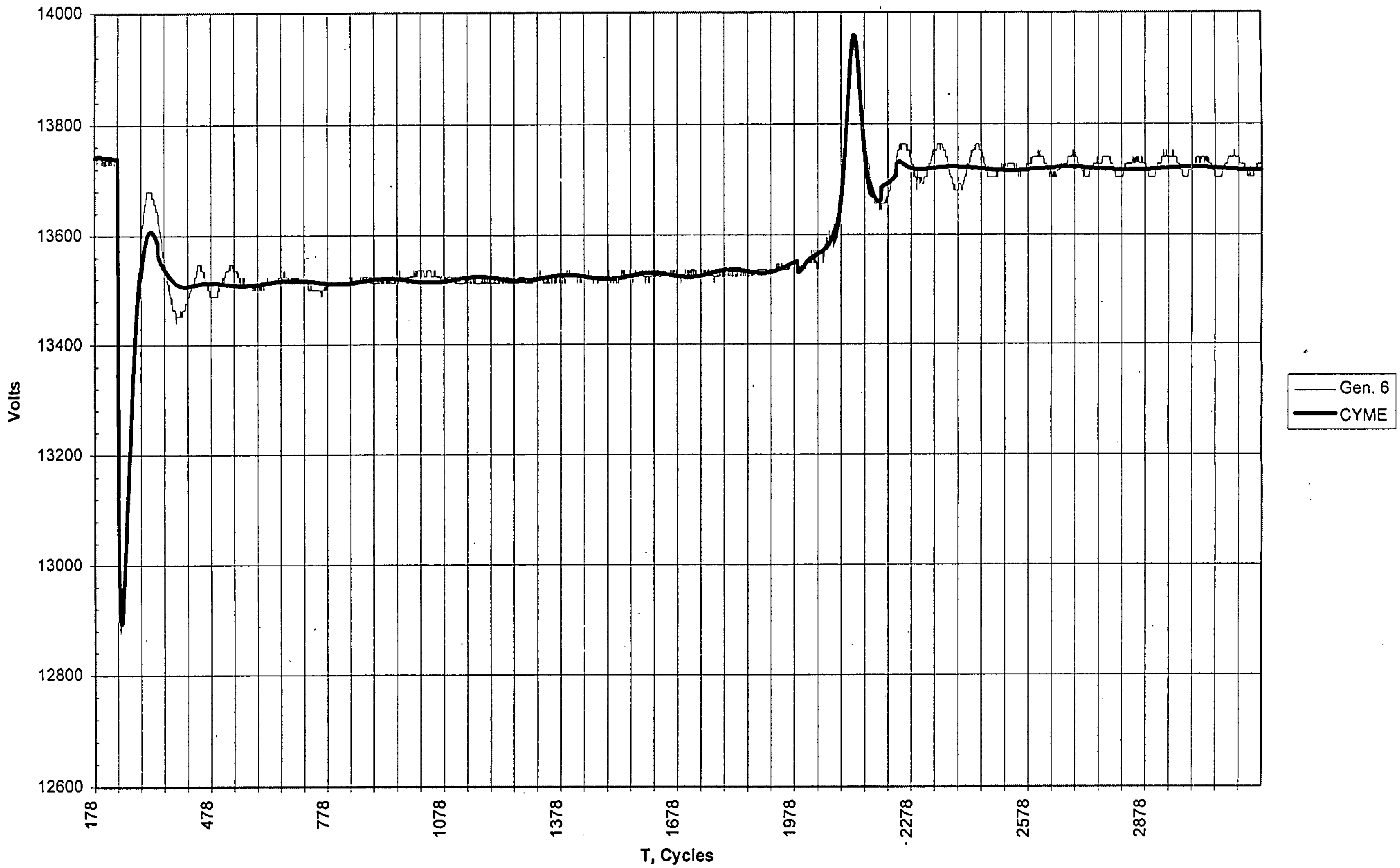


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Figure A-6: Test 2, SC 5 Start, Frequency

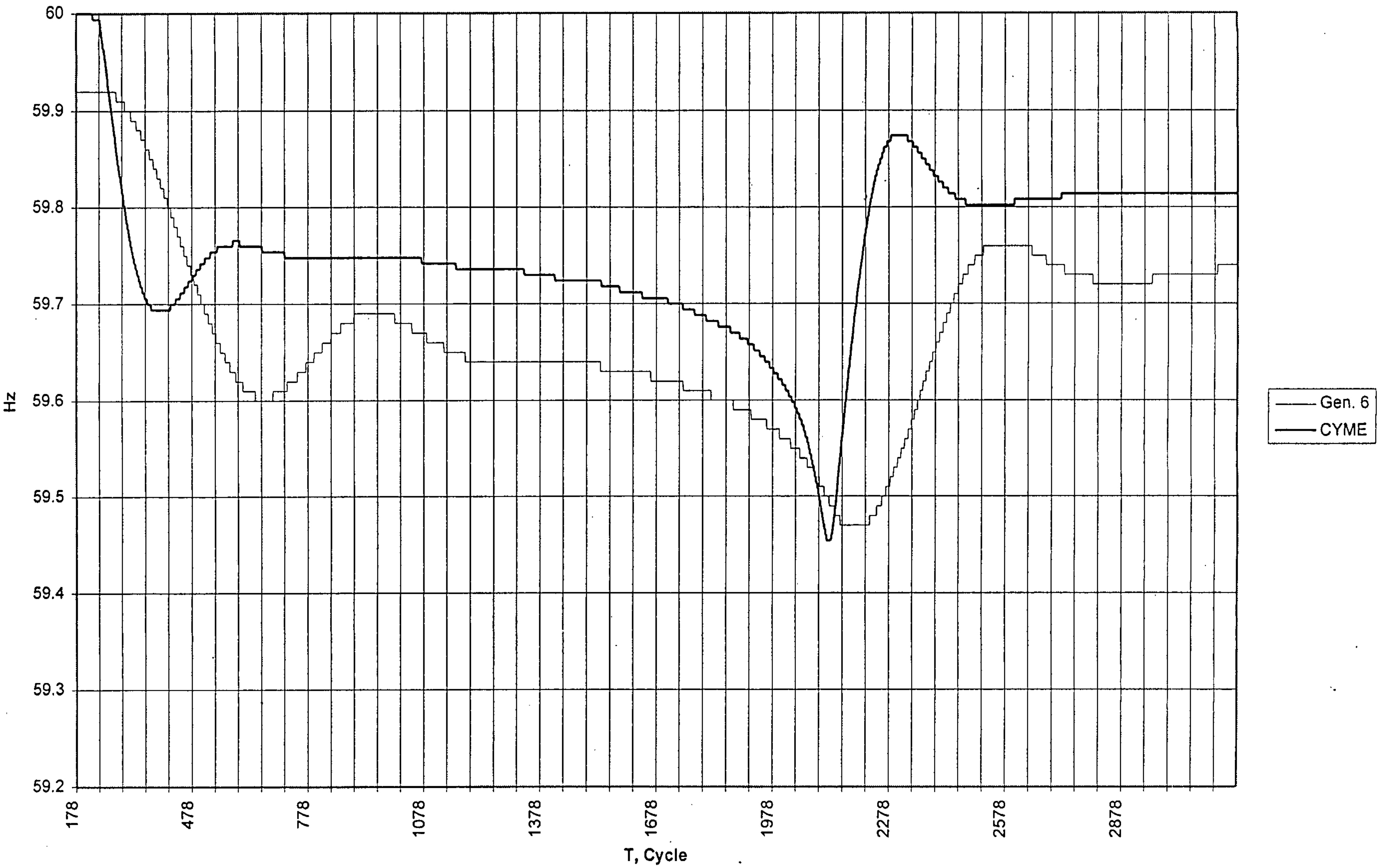

Figure A-7
: Test 2, SC 5 Start, Voltage

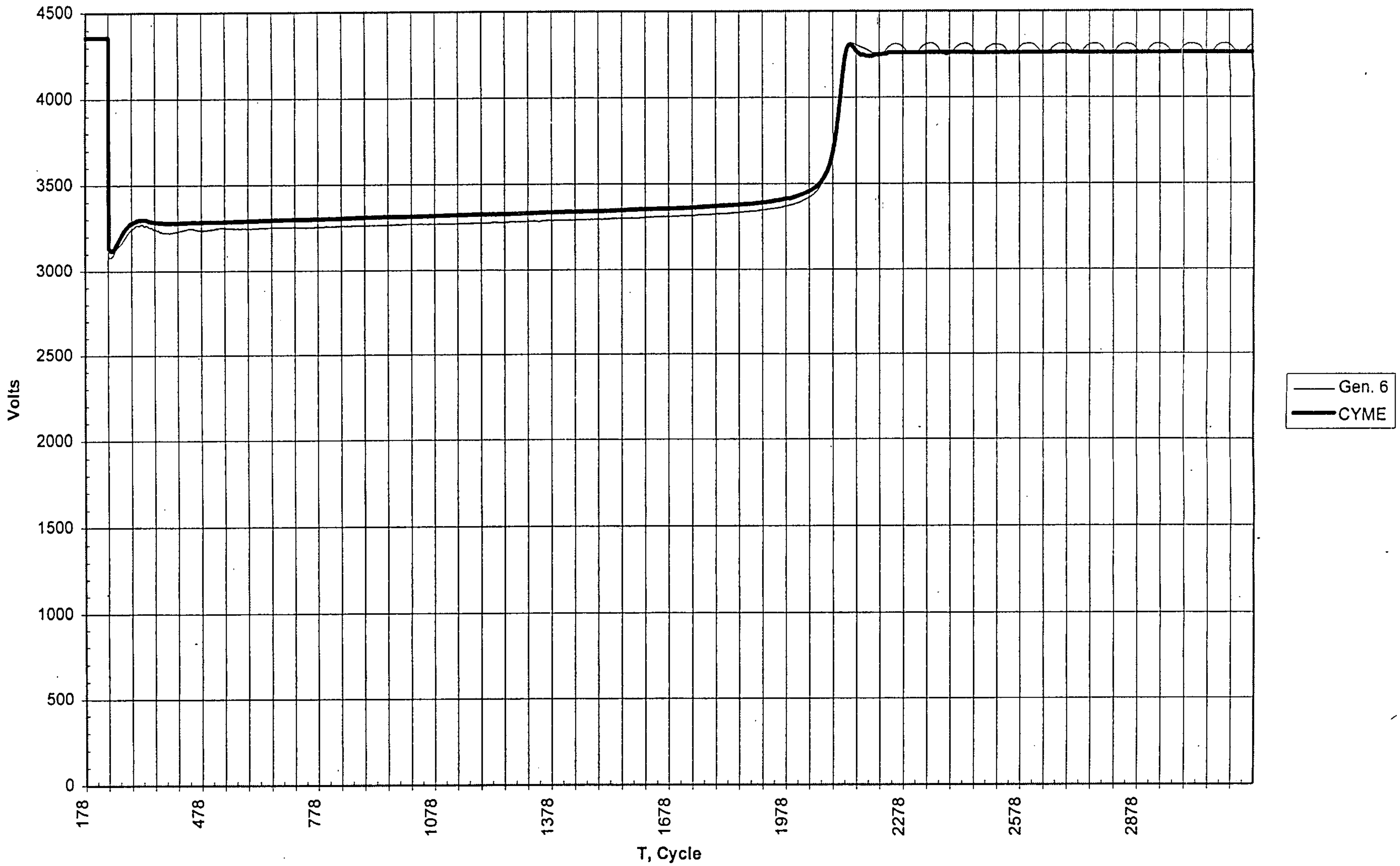

Figure A-8: Test2, SC 5 Start, Gen 5
Power

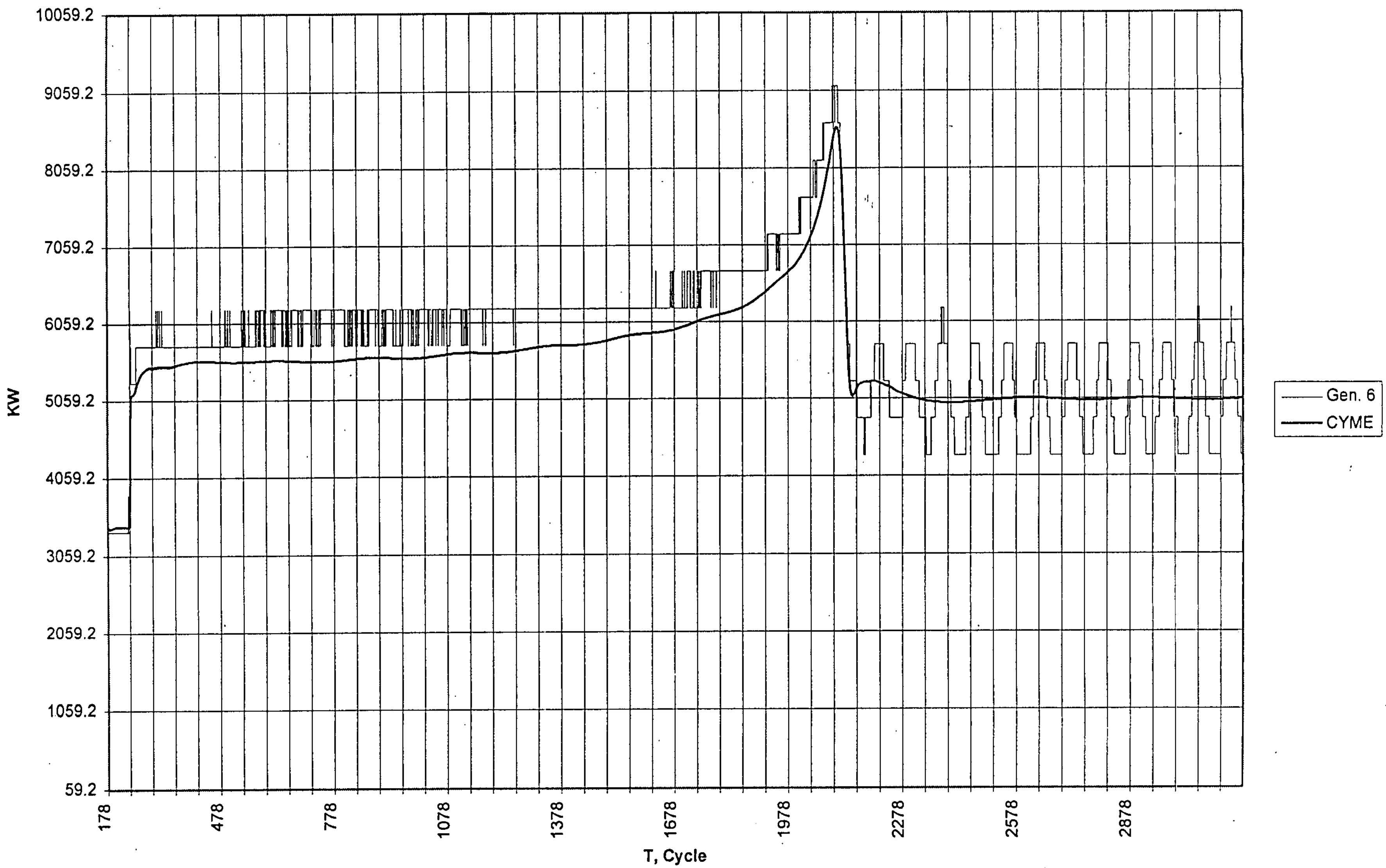

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Figure A-9: TEST3, Super Charger 5C Start from Grid

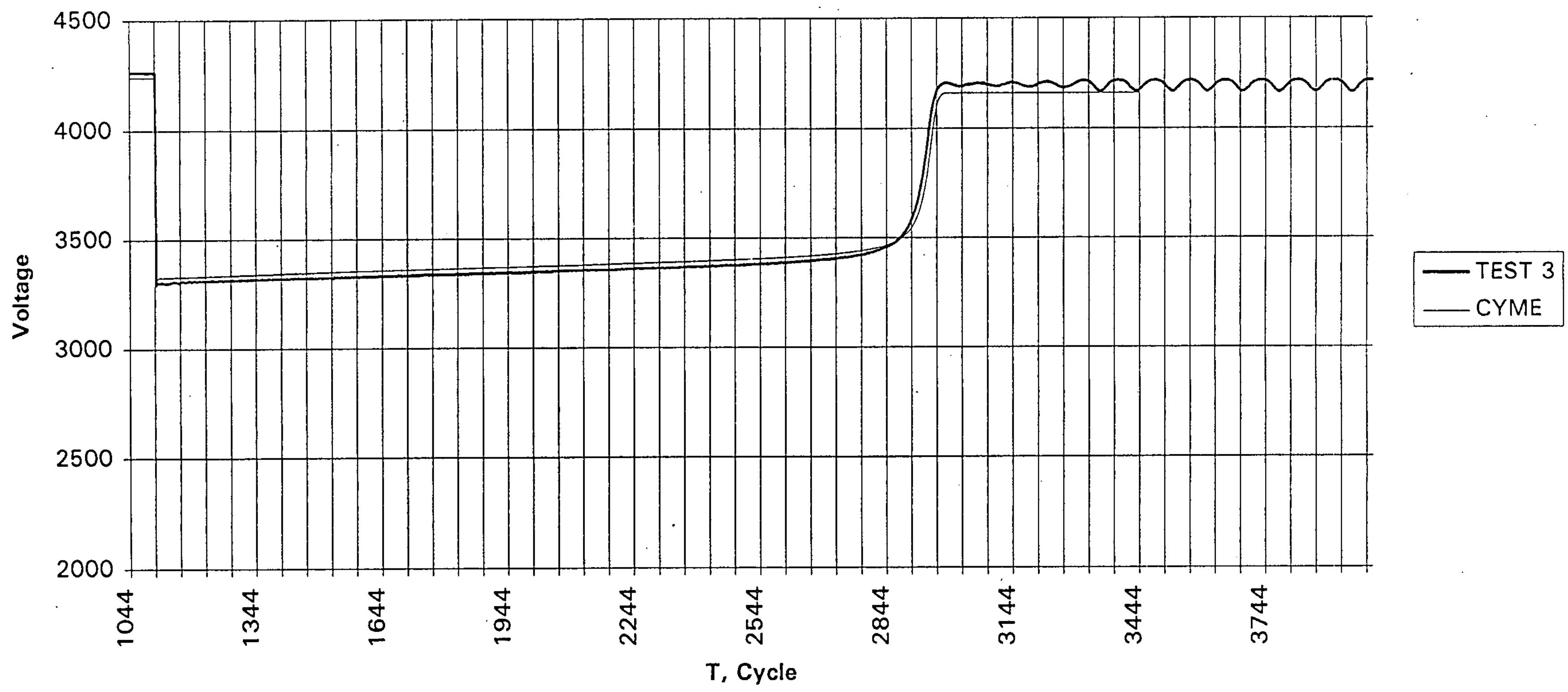

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Figure A-10: TEST3, Super Charger 5C Start from Grid, KW

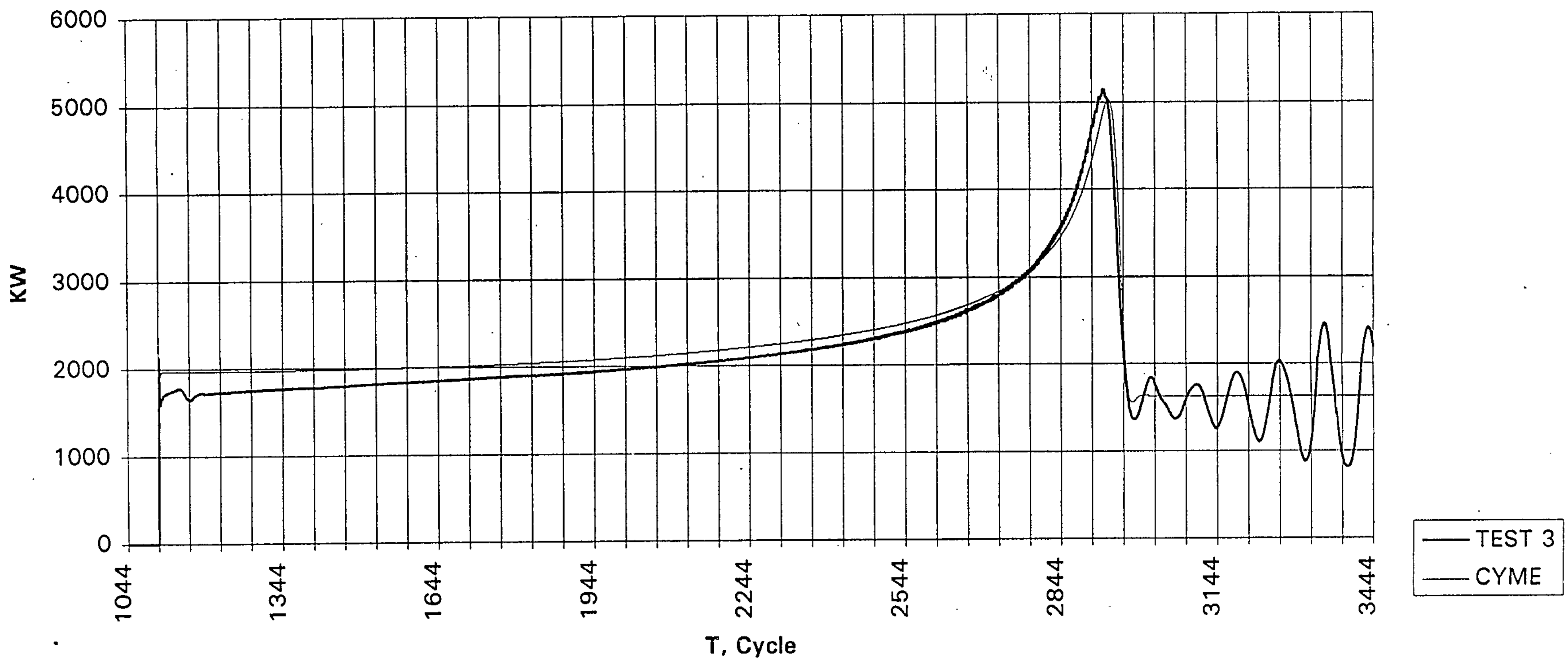

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Figure A-11: TEST3, SC 5 AMPERES

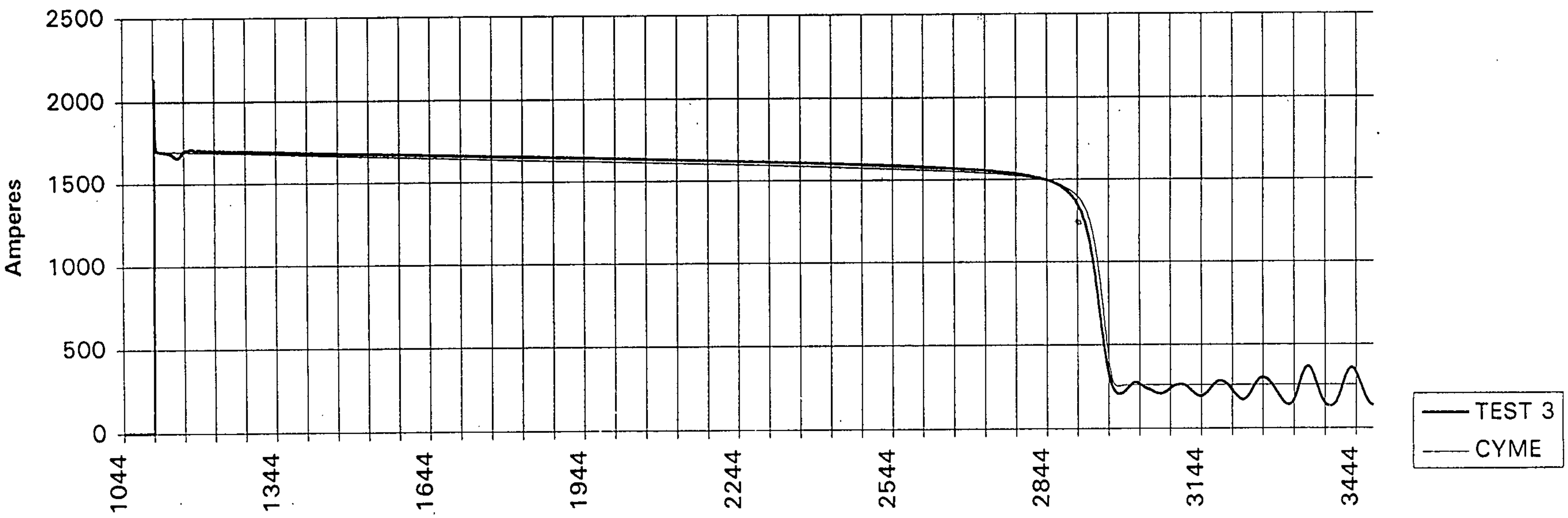

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Figure A-12: TEST3, SC 5 KVAR

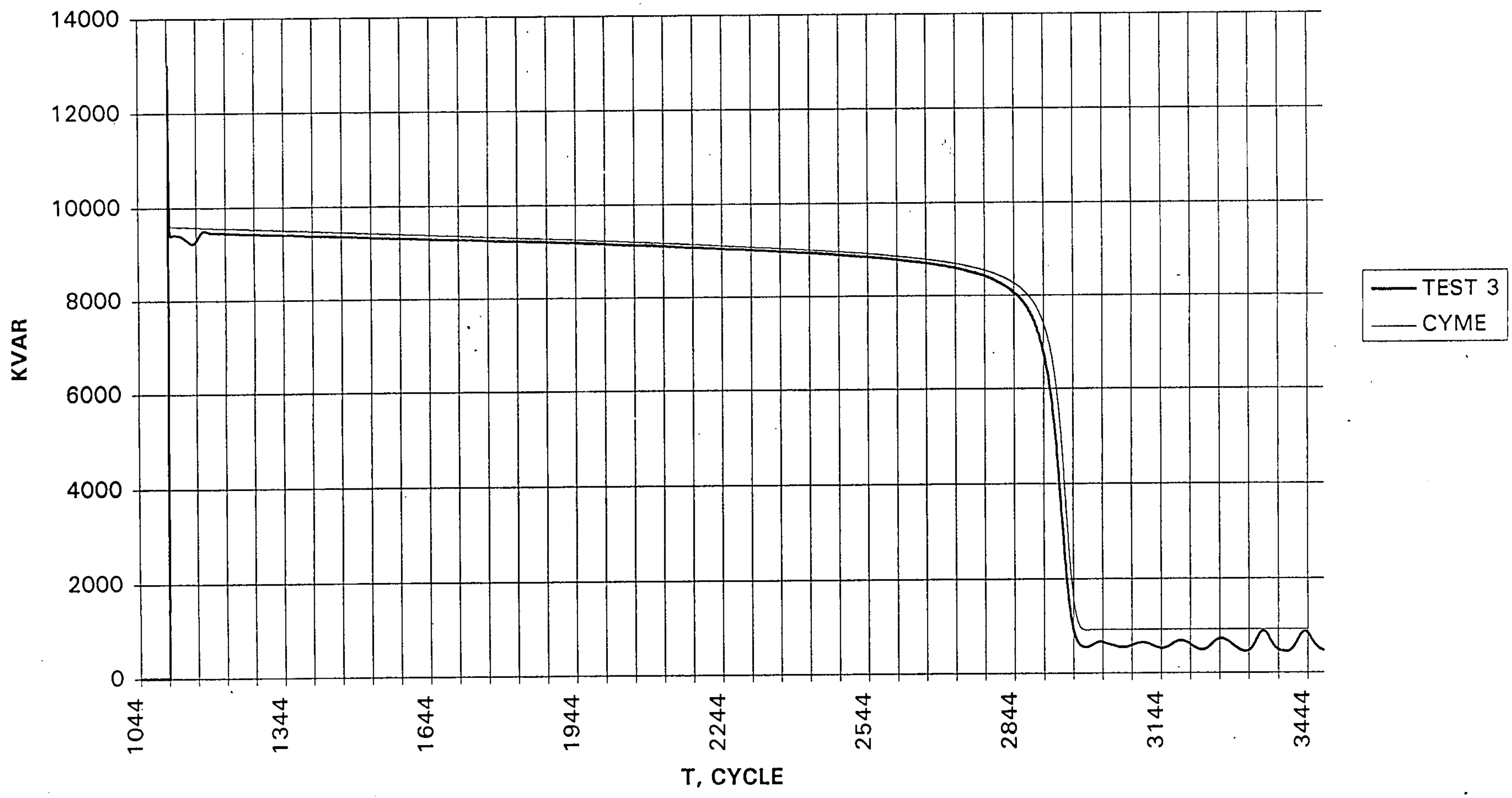

**Figure A-13:
TEST4, ASW START, STANDBY BUS VOLTS**

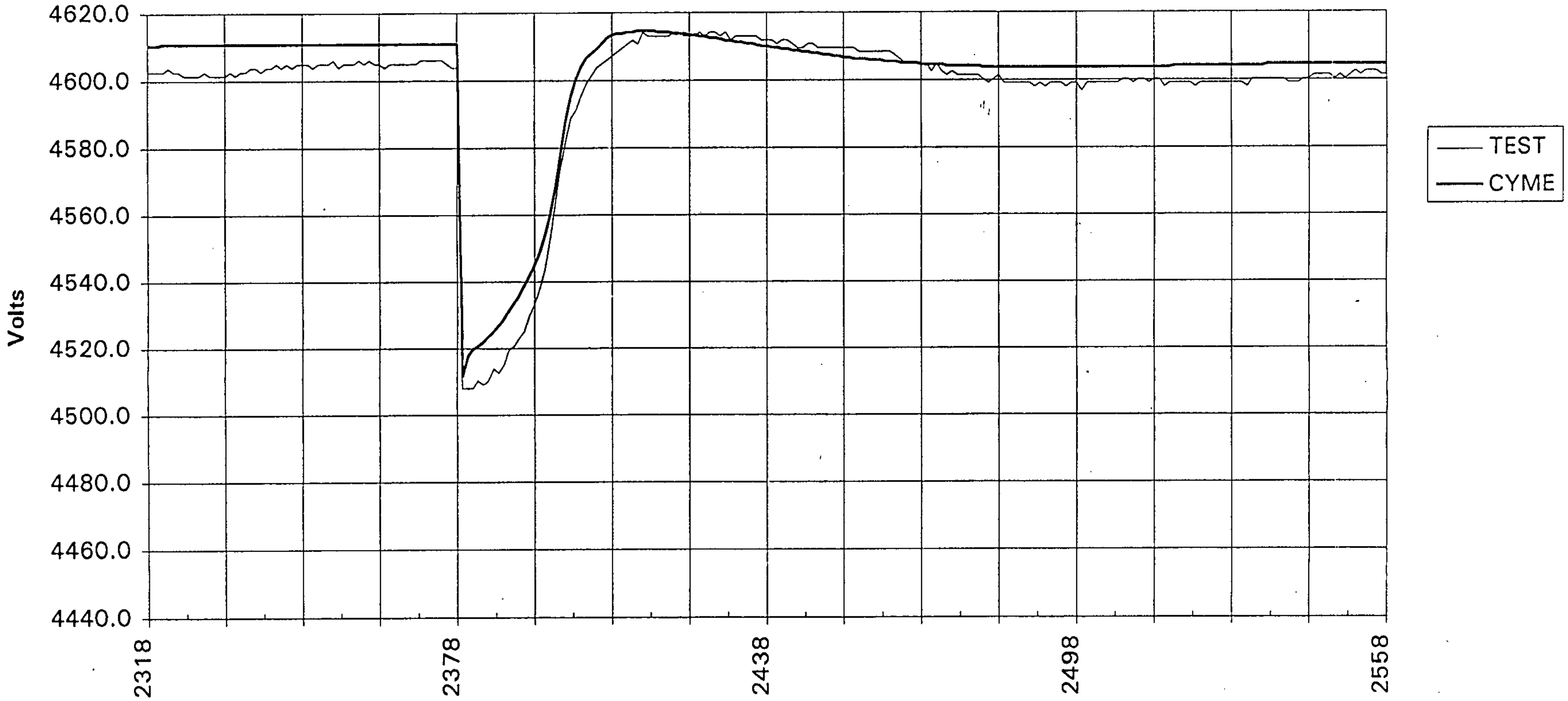

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Figure A-14: TEST4, ASW START, MOTOR AMPERES

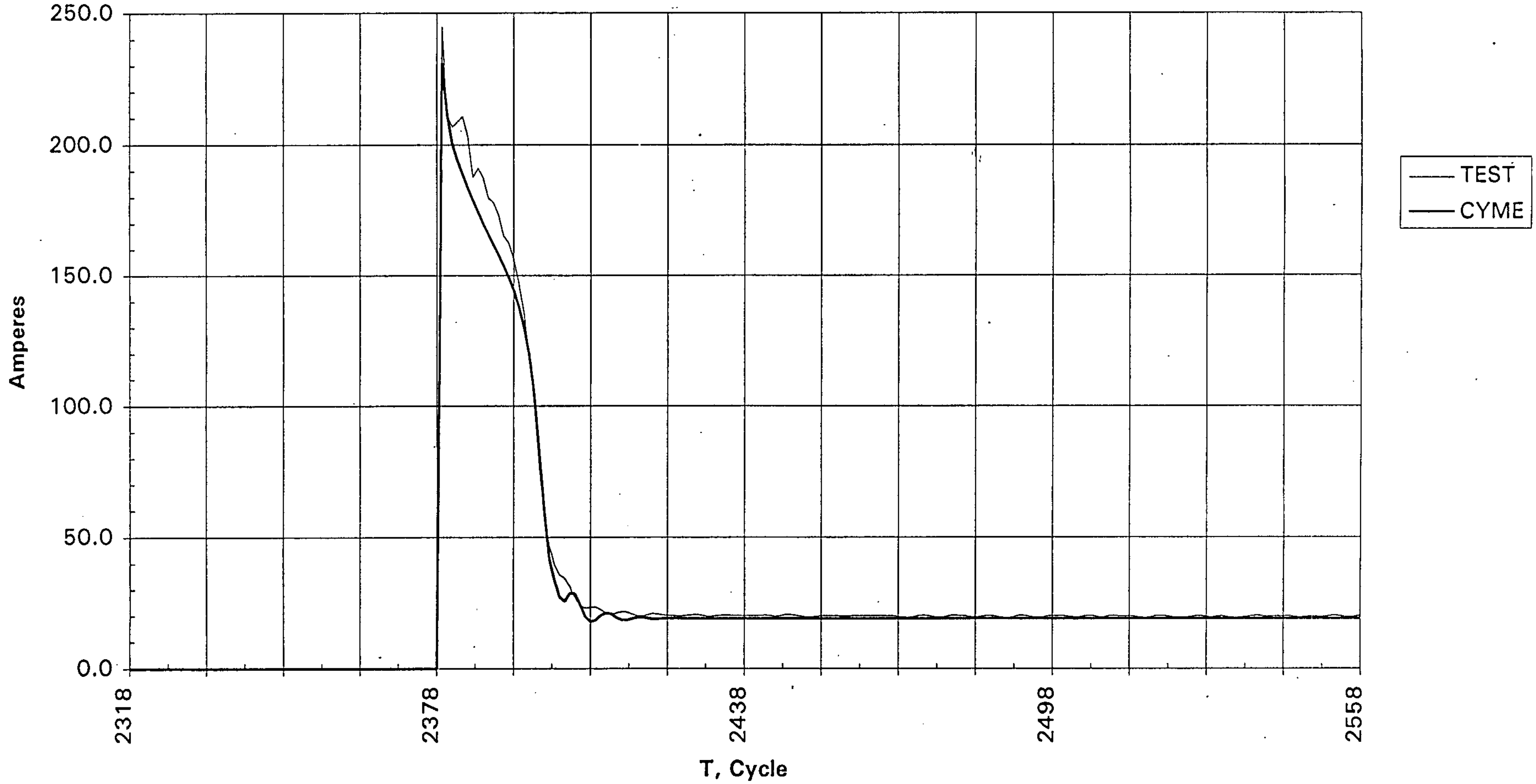

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Figure A-15: TEST4, ASW START, MOTOR KW

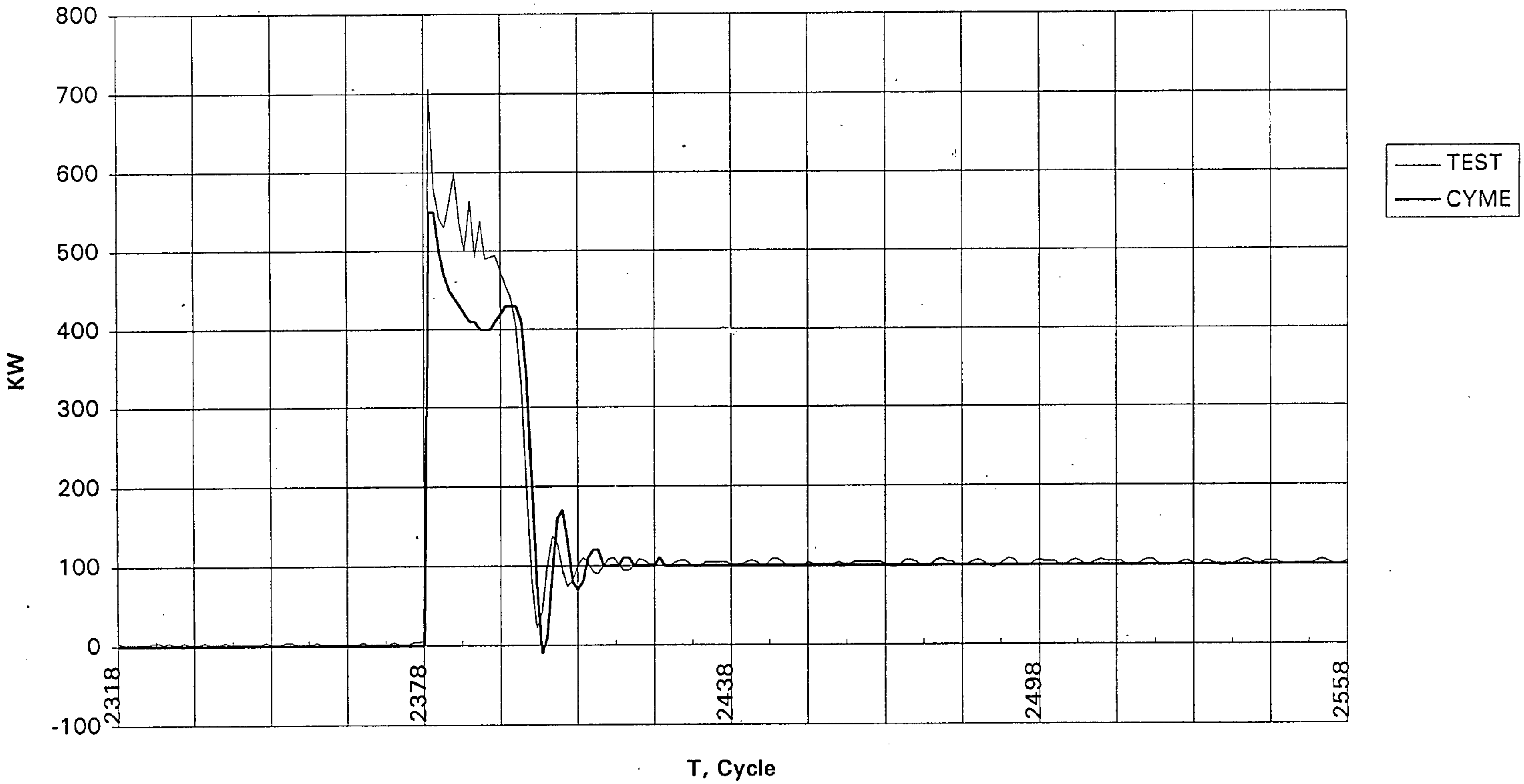

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Figure A-16: TEST4, ASW START, MOTOR KVAR

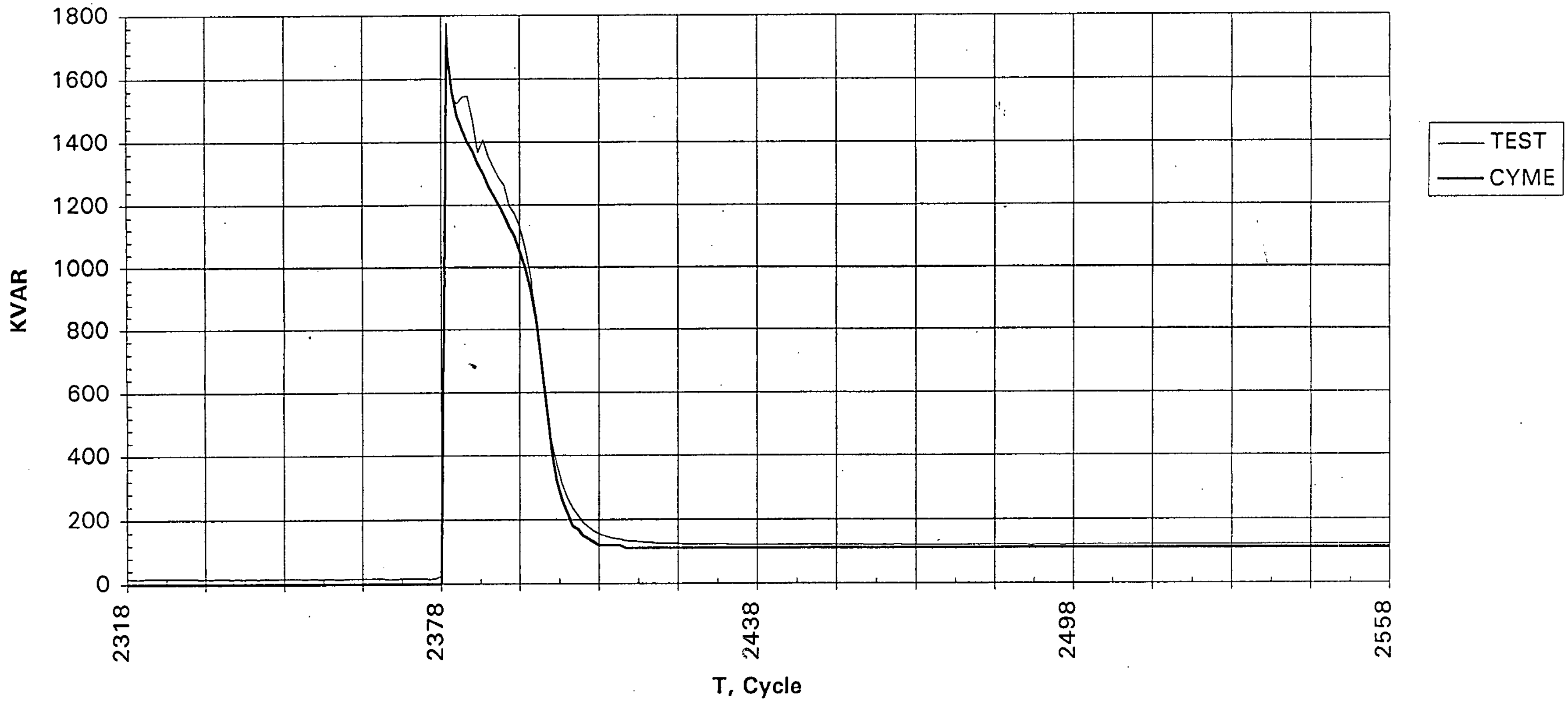
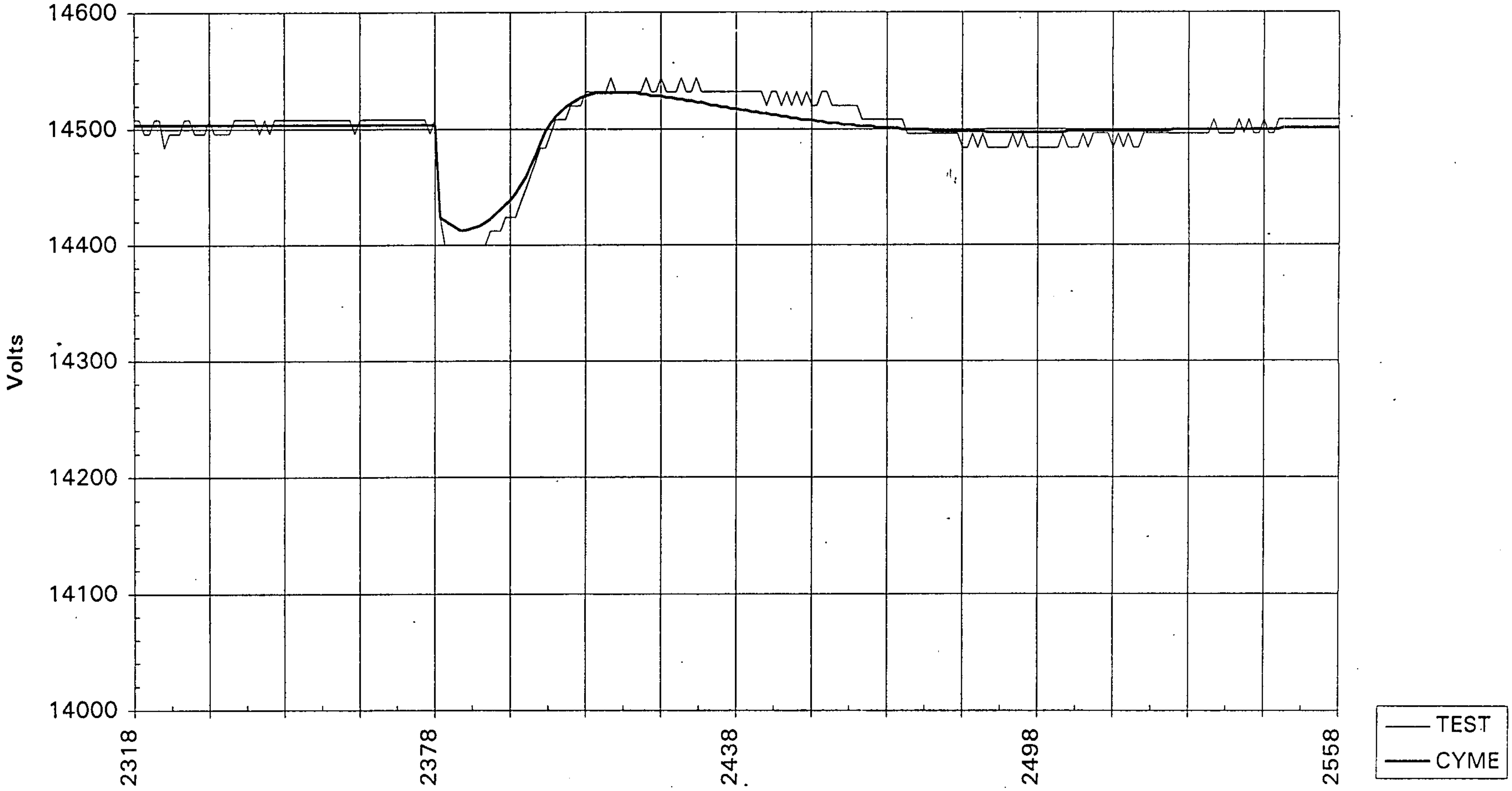


Figure A-17: TEST4, Generator Volts



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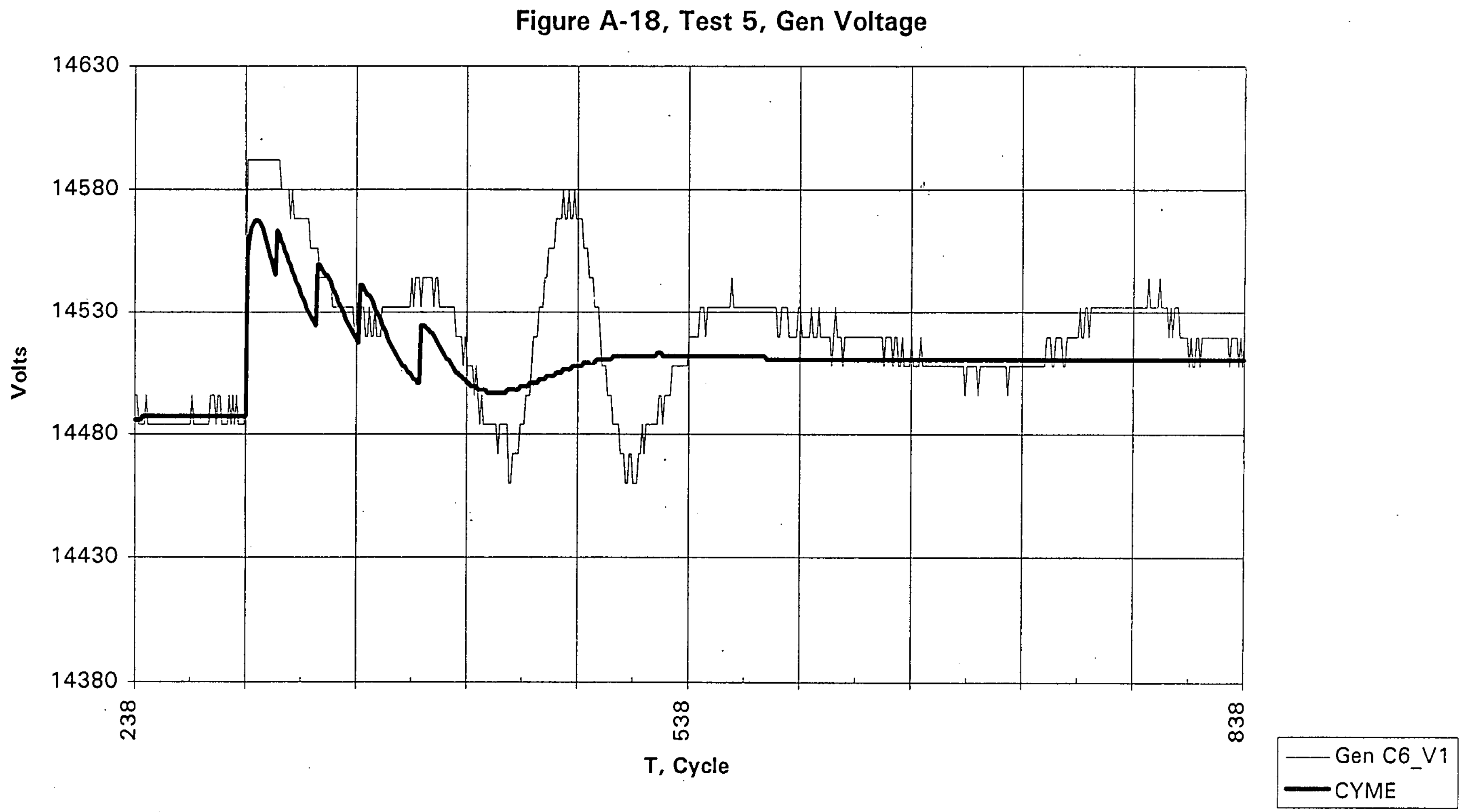

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Figure A-19: Test 5, Generator KW

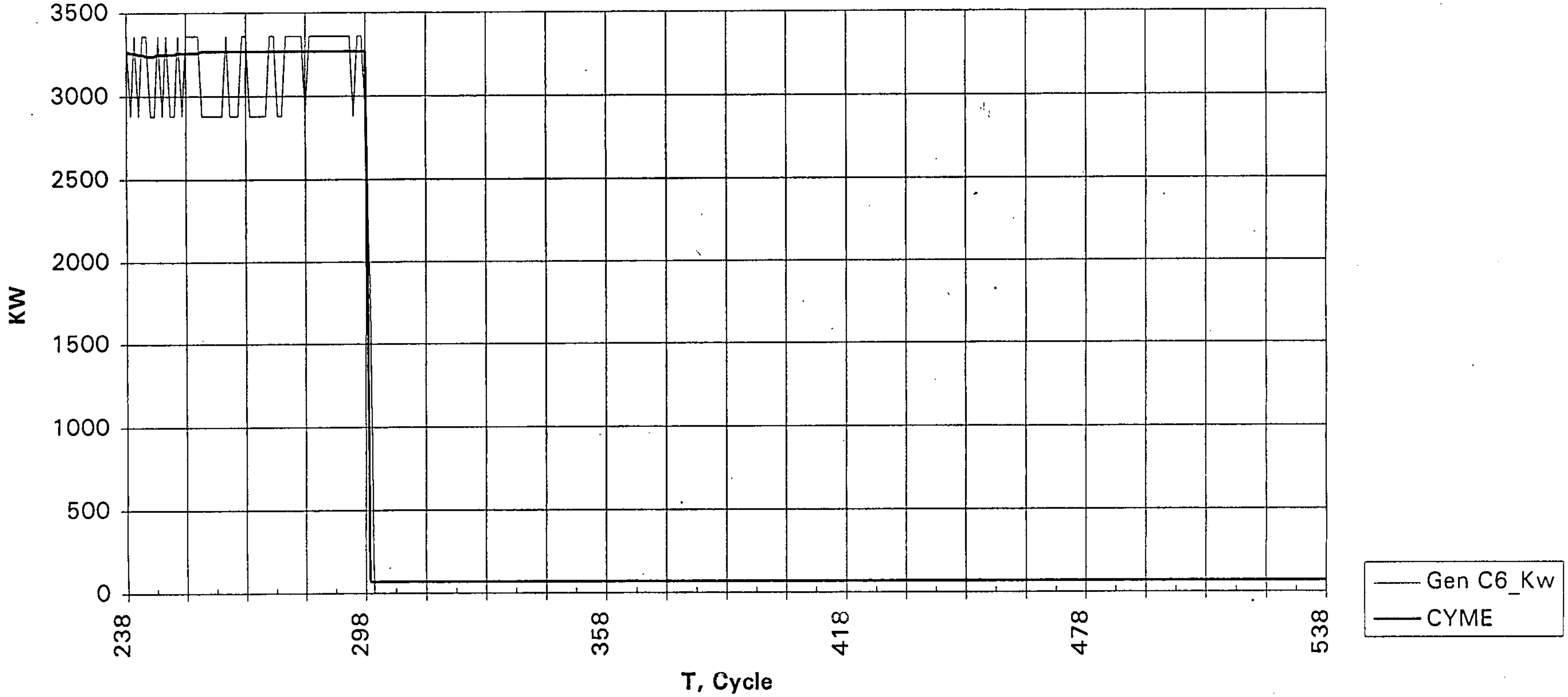

Figure A-20: Test 5, Genenerator KVAR

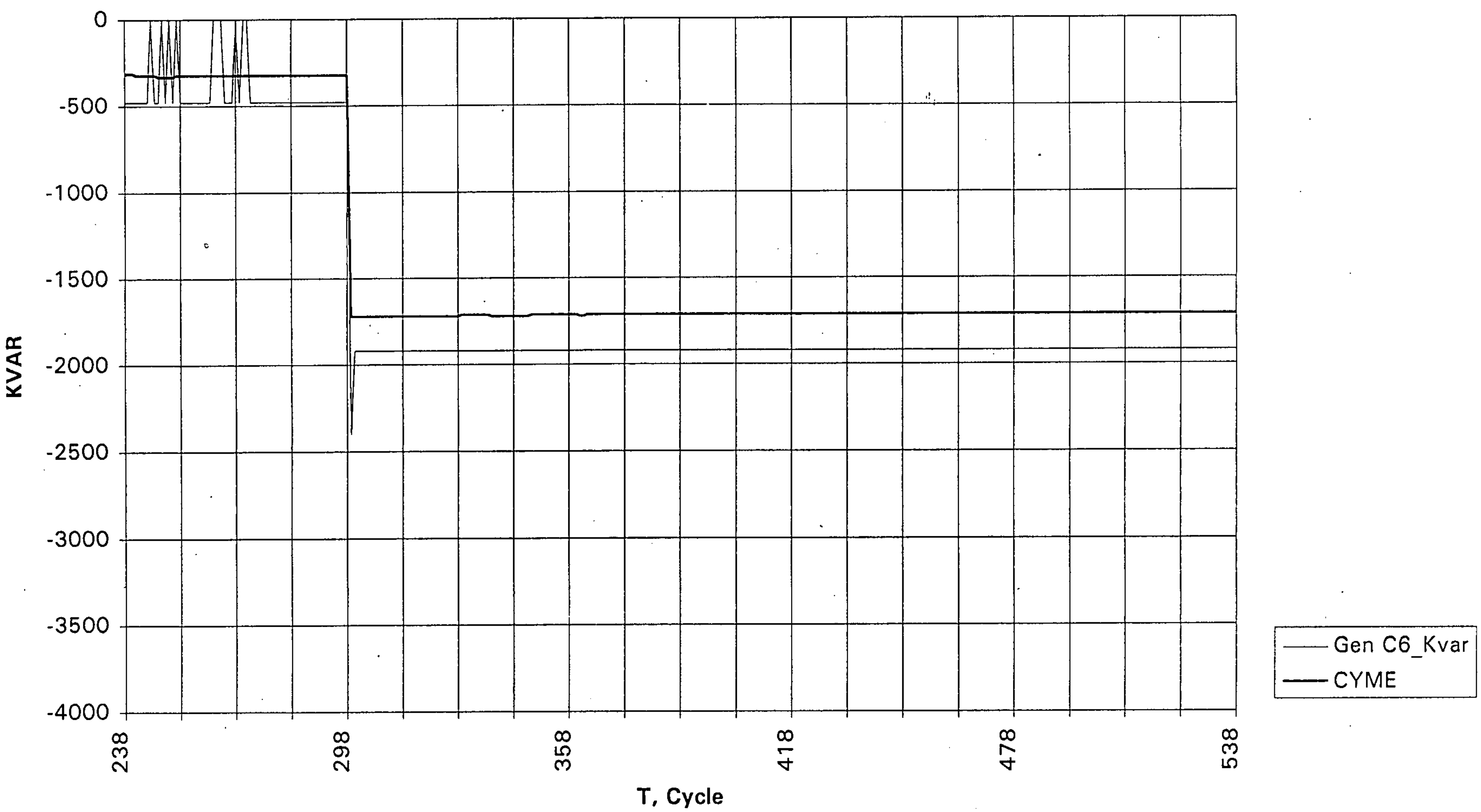

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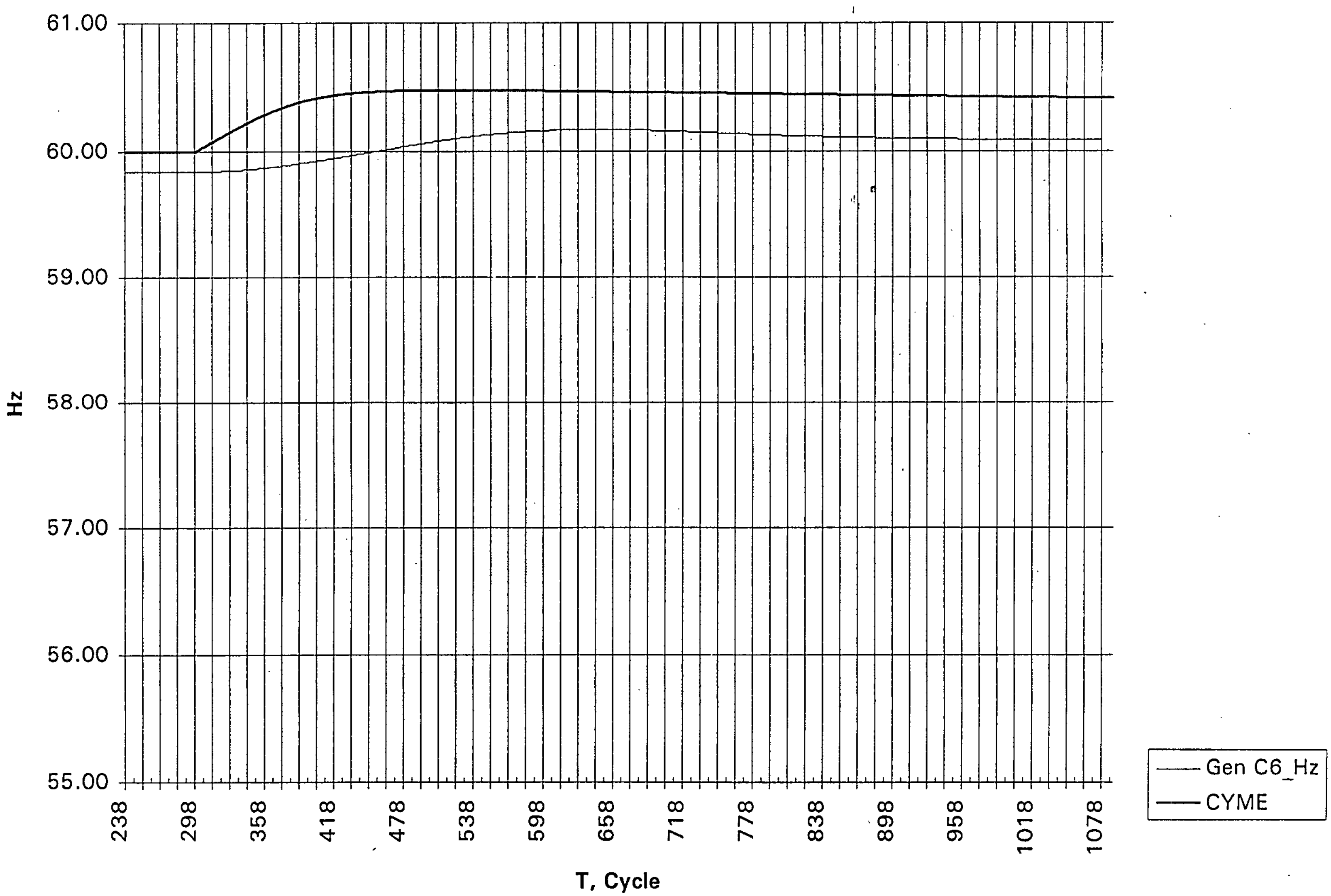
Figure A-21: Test 5, Frequency



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ATTACHMENT 4

Keowee Hydro Testing

Testing of Keowee has been reviewed and determined to be acceptable to ensure the units as designed and maintained will function as intended when required.

Keowee Design:

To meet design basis Keowee has to be capable to:

1. Start on ES (if not presently running)
2. Accelerate to voltage and frequency capable of satisfactorily starting loads within committed times
3. Start the loads and continuously supply them

OR

4. Separate from the grid and continue to run until needed
5. Satisfactorily start loads within committed times and continuously supply them

OCONEE TESTS

Tests Presently Performing:

1. Keowee Emergency Start Test

Annual Periodic Surveillance
TS related (4.6.2.a, 4.6.2.b)
Verifies Keowee's ability to:
(1) emergency start,
(2) accelerate to rated speed and voltage within committed time and,
(3) supply the sum of the loads needed to be powered during a worse case accident.

2. Emergency Power Switching Logic Test

Oconee Unit Refueling Cycle Periodic Surveillance
TS related (4.6.4)
Verifies the proper operation of breakers and transfer logic needed to align the Oconee loads to the appropriate power path.
Demonstrates Keowee's ability to:
(1) emergency start,
(2) accept block loads (≈ 2 MVA) from a steady state (speed NO-LOAD) condition
Typically during this test Keowee carries this load ≈ 1 hour. During a past recent test, problems with Lee source required Keowee to carry the loads ≈ 4 hours.

NOTE: **Pre- 1987 Emergency Power Switching Logic Test**

Performed slightly different than present test.
Along with testing the EPSL logic, the Keowee U/G unit was verified to emergency start and accept block load at ≈11 seconds while accelerating.

3. Degraded Grid Test

One Oconee Unit Refueling Cycle Periodic Surveillance
"NEW" TS related (3.7.7.1)
Demonstrates the following:
(1) Keowee Unit separate from the system grid (ie. load reject) on ES actuation,
(2) proper switchyard isolate actuation, and
(3) Keowee O/H path re-energization (start-up transformers and Keowee house loads)

Keowee Hydro Testing

Test Performed in the Past (ie. one time test):

4. Keowee O/H Path & RCP Motor Load Test

Test performed to obtain data for computer model verification
Test was performed with the Degraded Grid periodic surveillance.
Keowee was verified to:

(1) emergency start,
(2) energize the O/H path, and
(3) block start a RCP motor (≈47 MVA inrush)

5. October 19, 1992 Event "TEST"

Keowee emergency started
Accepted a block loaded of ≈4 MVA
Followed by additional block load of ≈ 2 MVA and 1 MVA.
No problems or indication of voltage and frequency excursions noted. Keowee performed as designed.

TYPICAL PLANT DIESEL TEST

1. Engineered Safeguards Test (generator/sequensor)

The intent of the diesel generator start and sequencer timer test is to ensure:

(1) the diesel starts and accelerates to rated speed and voltage within preset times
(2) proper breakers open and close to align the diesel to its emergency loads allowing the loads to start (after last sequence the steady state load is ≈ 2.5MVA *), and
(3) the sequencer timers operate properly so that the loads being added to the diesel are added at their designed time and no overlapping sequences exist.

* It is not practical to simulate Design Basis Event (DBE) loading therefore, loads are aligned in "mini flow" or "recirculating flow" paths. This does not represent actual accident loading profile.

[At Oconee, tests # 1 and # 2 (present and past tests) above are similar to this test.]

2. Diesel Run Capability Test

The intent of this test is to ensure the on-site power source is capable of supplying continuously the sum of the loads needed to be powered.
This intent is met by connecting the on-site power source to the system grid and generating 110%rated kW for 2 hours and 100% rated kW for 22 hours.
This load is not "sequenced" on nor generated isynchronously. Most diesels are rated just slightly above their maximum load requirements (ie. 4 - 5 MVA).

[At Oconee test # 1 above is similar to this test.]

ATTACHMENT 5