NASA
National Aeronautics and
Space Administration

JSC 16303

Lyndon B. Johnson Space Center
Houston, Texas 77058

November 1979

(NASA-TM-80946) EVALUATION OF USE OF MPAD TRAJECTORY TAPE AND NUMBER OF ORBIT POINTS FOR ORBITER MISSION THERMAL PREDICTIONS (NASA) 126 p HC A06/MF A01 CSCL 22A

N80-16081

Unclas
G3/13 12280

EVALUATION OF USE OF MPAD TRAJECTORY TAPE AND NUMBER OF ORBIT POINTS FOR ORBITER MISSION THERMAL PREDICTIONS

STRUCTURES AND MECHANICS DIVISION

THERMAL TECHNOLOGY BRANCH

ES3-79-6

Evaluation Of Use Of MPAD Trajectory Tape

And Number Of Orbit Points For

Orbiter Mission Thermal Predictions

Prepared by: Robert A. Vogt ES 3

Approved by: ET Chimenti

E. T. Chimenti, Head
Thermal Analysis Section

J. A. Smith

J. A. Smith, Chief
Thermal Technology Branch

Table of Contents

1.0 SUMMARY

The TRASYS[1] computer program has the capability to compute orbital heating rates utilizing the JSC Mission Planning and Analysis Division (MPAD) common format trajectory data tape[2]. This tape defines the on-orbit flight profile for a given flight. In the past, this option has not been utilized for Shuttle thermal analysis because initially the analysis performed was for design and mission planning purposes. In these situations, the current method of specifying nominal orbital and attitude parameter data and letting TRASYS determine the position and orientation is more suitable and convenient.

The subject of this report is to document an evaluation of the application of this simplified approach to predicting temperatures for preflight and post flight mission analysis. All of the analysis presented utilized the latest STS-1 MPAD trajectory tape[3], and the simplified "136 node" midsection/payload bay thermal math model[4]. For the first 6.7 hours of the STS-1 flight profile, transient temperatures are presented for selected nodal locations with the current standard method, and the trajectory tape method. Whether the differences are considered significant or not depends upon the view point. For a specified time, temperature differences of well over 100°F on externally exposed surfaces, and up to 15°F on the Thermal Protection System (TPS) bondline locations, can be noted by comparing the results. On the other hand, if the cyclic extremes per orbit at the bondline are the real interest, the maximum difference is less than 10°F. The cyclic extremes on the surface nodes approach a maximum difference of 100°F.

Other transient temperature predictions are also presented. These results were obtained to investigate an initial concern that perhaps the predicted temperature differences between the two methods would not only be caused by the inaccuracies of the current method's assumed nominal attitude profile but also be affected by a lack of a sufficient number of orbit points in the current method. The current practice for an attitude hold profile is to

utilize 12 orbit points plus the entry and exit points for the earth's shadow. Data is presented where 24 and 6 orbit points were used in place of 12 orbit points. The comparison between the 6, 12 and 24 orbit point parameter shows a surprising insensitivity to the number of orbit points. For the example used, the temperature differences between the current method and the trajectory tape method are primarily related to the differences in the attitude time line.

2.0 TRAJECTORY VERSUS CURRENT METHOD

This section defines the baseline conditions and methods utilized to permit an objective comparison of the trajectory tape method, and the current method used to generate the on-orbit external environmental heat loads for JSC Shuttle Orbiter/payload thermal analysis.

An essential part of the comparison are the SINDA[5] temperature-time plots and environmental heat rates. This data is also presented for both approaches.

2.1 INTRODUCTION

The trajectory tape utilized by TRASYS to compute the environmental heat loads was the latest available MPAD tape for the STS-1 Shuttle flight. It supposedly has a predominant nominal +Z LV attitude (top to earth) hold. A JSC program which prints the pertinent data of interest to a TRASYS user revealed, however, that a strict +Z LV attitude is seldom adhered to. How these attitude deviations from the nominal, feed back into the temperatures is basically the subject of this report. Table 1 summarizes the trajectory tape timeline analyzed from the printout of the data on the trajectory tape and reference 6. It should be noted that only 139 minutes of actual +Z LV attitude was included.

Full advantage of several new features which have recently been implemented in TRASYS to make it more convenient and efficient to utilize the trajectory tape input were used. Only the first 6.7 hours of elapsed on-orbit time was evaluated because of the desire to make this study available in a timely manner, so its significance may be evaluated with respect to on-going Orbiter/payload thermal analysis. To prepare the trajectory tape input for maximum program efficiency, the procedure is still very time consuming and error prone.

TABLE 1 - STS-1 ATTITUDE TIME LINE

TIME H:M:S	EVENT	LOOK ANGLES TO:* SUN CLOCK	SUN CONE	EARTH CLOCK	EARTH CONE	ATTITUDE MAINTENANCE MODE	MIN	REMARKS
0:45:30	OMS-2 CutOff	328.2	93.4	90.0	0.0	Inertial	17	
1:02:00		328.2	93.4	0.0	66.0			
1:08:00	+ZLV Hold	276.6	31.9	N/A	0.0	LV	79	Open Payload Bay Doors
2:27:00	Maneuver	320.7	55.4	N/A	0.0			Maneuver to COAS Calibration
2:33:00	COAS Calibration	97.6	120.4	140.6	145.1	Inertial	6	
2:39:00	Maneuver	97.5	120.4	95.5	151.9			Maneuver to IMU Alignment Attitude
2:45:00	IMU Alignment Attitude	97.5	120.3	53.9	142.3	Inertial	15	
3:19:00	Maneuver	145.5	95.2	2.5	87.5			
3:25:00	+ZLV Hold	275.4	148.4	N/A	0.0	LV	60	
4:25:00	Maneuvers	214.2	67.2	N/A	0.0			
6:27:00	Maneuver	108.1	8.1	326.9	141.3			Maneuver to IMU Alignment Attitude
6:33:00	IMU Alignment Attitude	213.2	123.8	32.3	101.3	Inertial	29	
6:53:00	COAS Verification	213.2	123.8	119.3	135.1			
6:57:00	COAS IMU Alignment	213.2	123.8	140.7	131.4			
7:02:00	Maneuver	213.2	123.8	162.9	122.0			Maneuver to COAS IMU Alignment #2
7:05:00	COAS IMU Alignment #2	118.9	133.7	143.6	105.4	Inertial	22	
7:13:00	COAS Verification #2	118.9	133.7	165.4	147.4			
7:27:00	COAS Verification #3	118.9	133.7	253.6	145.9			

* LOOK ANGLE DEFINITIONS AS DEFINED IN REFERENCE 1

The TRASYS computational charges to compute all the required direct incident fluxes for the 78 node geometric math model (GMM) was approximately 1 hour and 5 minutes for the trajectory tape method and 18 minutes for the run depicting the current method. The time interval between points does not exceed 10 minutes on the trajectory tape generated by MPAD. If events of interest occur between these 10 minute intervals, these points are also included on the tape. If justified, it is believed MPAD would honor a user's request to output at smaller nominal time intervals. Some attitude changes on the tape can be noted by double time point entries, in which case two records are given for the same time, but have a different orientation specified. These orientation changes are assumed instantaneous step changes within TRASYS. For the 6.6916 hours elapsed time, starting at 0.7584 hours and ending at 7.45 hours, the trajectory tape has a total of 80 records. These 80 records were reduced to 51 points utilizing a criteria to make it as comparable as possible to a 12 point parameter TRASYS ORBGEN option run. The criteria limited the maximum time interval to 7.5 minutes unless all heat loads were constant. To the 51 points, 20 entry and exit points of the earth's shadow are added because shadow points are not given on the trajectory tape. This gave a total of 71 discrete heat rate computation points. Conversely, the current method with a 12 point parameter TRASYS ORBGEN run has only 16 heat rate computation points computed. On a point bases the computational charges of both methods are comparable, indicating that the trajectory point method achieved the computational efficiencies of the ORBGEN option. The greater computational charges can thus be accounted to the greater number of points and the resulting fidelity of the trajectory method.

In setting up the 12 point parameter ORBGEN run, the objective was to make it as comparable as possible with the trajectory tape orbit parameters, and also with the currently accepted method of executing TRASYS. All of the required orbit parameters were specified based upon the trajectory tape data. Since the nominal orientation for the STS-1 trajectory tape is defined as +Z LV, this orientation was used in the ORBGEN run. The compatibility of both TRASYS runs was verified where similarity should exist. For example, the initial fluxes are identical and the shadow entry and exit points times are within a fraction of a minute for the first orbit.

The differences in the TRASYS runs have been noted. All inputs were specified to minimize to the maximum extent possible any differences not related to an objective comparison. Both methods used the identical radiation exchange matrices, and all the SINDA runs used identical models including the radiation conductors. The only thing that was changed was the tape containing the heating rates computed by TRASYS and converted by the JSC TOTALQ2 TRASYS/SINDA interface program for the SINDA FLXRD subroutine which inputs the heat loads to the SINDA thermal analyzer which predicts the temperatures.

2.2 RESULTS

The transient temperatures (°F) predictions for the trajectory tape method are shown in Figures 1-17. The nodal locations are defined by reference 4. For the external exposed nodes, Figures 18-28 show the total environmental heat loads (Btu/hr) as supportive data. Immediately following these figures the same data set is shown in Figures 29-45 for the temperatures, and Figures 46-56 for the heat loads of the currently utilize method with an ORBGEN orbit point parameter of 12. Some discontinuties may be noted in the temperature results for the current method (for example Figure 35). This was verified to be because of the computation and/or output interval in SINDA was too large to pick up all the peaks accurately. Although all the SINDA run data presented, utilized a 0.1 hours compute and output interval, a test using a compute and output interval of 0.05 hours showed improved symmetry in the cyclic data. The differences occur only when the input heat rates change very rapidly with respect to time. The reader should be aware of the problem when evaluating the results although its true significance is not considered a serious problem since this occurs only over a short time pulse. Because symmetry is not generally expected in the STS-1 trajectory data, the detection of this type of error is not obvious, although it no doubt occurs.

3.0 EFFECT OF NUMBER OF ORBIT POINTS

The effect the number of orbit points used in the ORBGEN option of TRASYS has on temperature predictions was evaluated utilizing the nominal attitude hold of the STS-1 mission (+Z LV) and the simplified midsection/payload bay thermal model defined in reference 4. This analysis is described and the SINDA temperature time plots and environmental heat rates for a true anomaly increment of 15°, 30°, and 60° are presented for comparisons.

3.1 INTRODUCTION

The ORBGEN option has a variable called NPT, which is the number of equal true anomaly increments desired. Currently in the application of TRASYS for Shuttle thermal analysis the standard practice is to set NPT equal to 12 for fixed nominal attitude hold flight profiles. An additional four points are automatically added if TRASYS determines the vehicle enters and exits the earth's shadow. These four points are just each side of the terminators. With NPT equal to 12, the true anomaly increment is 30° exclusive of the shadow points. To bracket the standard 30° true anominaly increment, the temperatures were also computed for a 60° (NPT=6) and 15° (NPT=24) time anomaly increment.

3.2 RESULTS

The NPT=12 results have already been presented in Figures 29 through 56. A one-to-one comparison with NPT=6 can be made by examining Figures 57 through 84. Similarly, these may be compared with the NPT=24 results shown in Figures 85-112. The temperature results show very little difference between the three cases. Except for a momentary temperature spike, surface temperature all agree within 3 to 4°F, and for all practical purposes the bondline temperatures are identical in each case. Even if one is concerned by the temperature spikes there is only a maximum difference in surface temperature of approximately 20°F for a very short period of time. These spikes occur because the rapid transition in the heating rates of some surfaces as they get a glimpse of the sun before the fixed earth orientation causes it to block itself, or be blocked by another intervening surface, from the sun. The heating rates differ in these instances for the three cases because the variation in the true anomaly interval used. These differences can be seen by comparing the "Impressed Heat" curves for each data set.

4.0 CONCLUSIONS

The comparison of transient on-orbit temperature predictions based on the TRASYS computed heat load with the latest STS-1 trajectory tape and assumed nominal +Z LV ORBGEN run shows large differences do occur. This study has determined that these differences occur primarily because the STS-1 mission attitude profile can not be simulated by a nominal fixed attitude hold for the elapsed time period investigated. The largest differences occured on the externally exposed surfaces. On the TPS bondline nodes, the differences are much smaller. A longer period of time should be analyzed, however, to determine if the bondline differences will exceed the 15°F maximum variance noted thus far. A longer time is required because the structural nodes have not reached cyclic equilibrium for the fixed nominal attitude data case. Whether the necessity for utilizing a trajectory tape is established by this study, lies in the response to the questions; for what purpose the predictions will be used, and what vehicle locations are of interest? For example, if only the bondline temperatures are of interest, the 15°F maximum difference would probably not justify the added difficulty and expense of the more vigorous treatment of the trajectory tape method. Thinking in terms of the more widely utilized larger 400 to 520 node math models and the 52 hours mission duration, this has to be an important consideration. In considering the accuracy-run time relation of this study, one thing to keep in mind is that we are comparing the extreems of the spectrum. The real solution may be in the fact that the strength of both methods can be compromised to a degree to improve their respective weaknesses. For the trajectory this would mean sacrificing some accuracy to reduce run time by skipping more points on the trajectory tape. In addition, more attitude holds could be assumed whenever the attitude changes are judged to be insignificant. The nominal fixed attitude method could have improved accuracy by subdividing orbits and specifying more applicable attitudes for each segment.

The ORBGEN temperature predictions are shown in this study to be rather insensitive to the number of orbit points. Not documented herein, the results from a -Z LV (bottom to earth, +Y direction of velocity vector) further substantiates the belief that for any fixed attitude holds; 12 points and possible 6 points are adequate for heat flux calculations with the subject model. The -Z LV attitude hold case is judged to be the severest test to evaluate the sensitivity to the number of orbit points. Sun orientation in general will be less sensitive than earth orientations. Selection of the severest STS-1 trajectory and ORBGEN sensitivity tests must be qualified with respect to the model being utilized. Whether other models will give significantly different results is uncertain since only one model was evaluated. In general, it is expected a more detail external midsection model would show greater differences relative to the simplified midsection model used, because the course nodal breakdown of the simplified model will smear out discontinuities in heating rates caused by shadowing, and also the sharp gradients caused by localized radiation entrapment. It is further anticipated that a detail model of the external surfaces of the Orbiter's nose section will not show differences as great as the simplified midsection model, because it is not affected by these factors to any great extent.

REFFERENCES

1. Jensen, Carl L. and Goble, Richard G.; "Thermal Radiation Analysis System - User's Manual," MCR 73-105 (Revision 2), June 1979.

2. Conway, H. L.; "MPAD Common Format Data Tape," (Revision 5), FM17 (79-120), August 27, 1979.

3. JSC/MPAD Non-format 7 Track Tape; Bin Number X18573.

4. Proctor, B. W., Ting, P. C. and Russel, D. J.; "Simplified '136 Node' On-orbit Orbiter Midsection/Payload Bay Thermal Math Model Description," ES3-76-7 (Revision C), April 1979.

5. Smith, James P.; Systems Improved Numerical Differencing Analyzer SINDA User's Manual, April 1971.

6. "STS-1 Operational Flight Profile, Appendix A On-orbit Trajectory and Attitude Data Cycle 2," JSC-14483, January 1979.

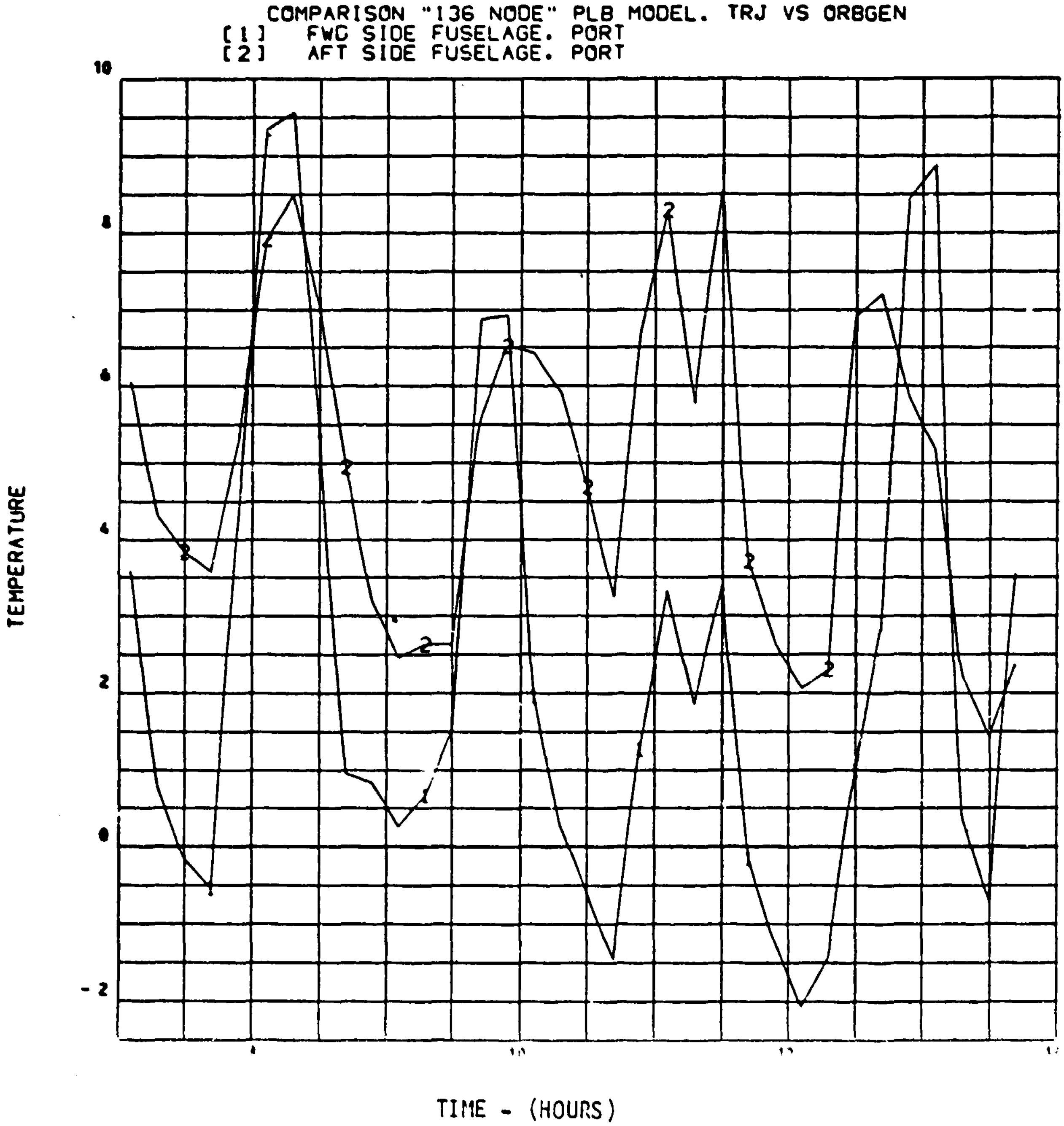
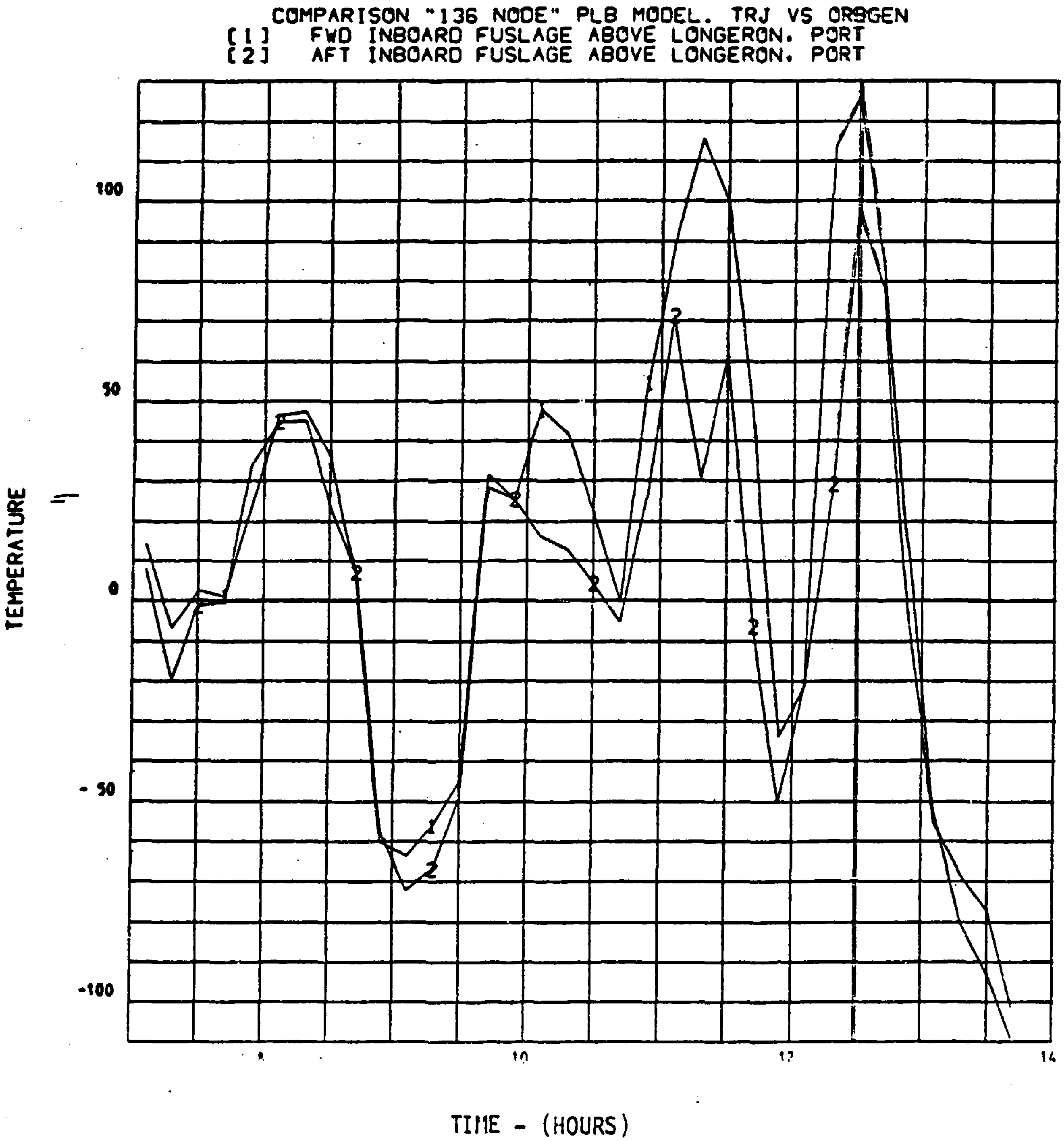
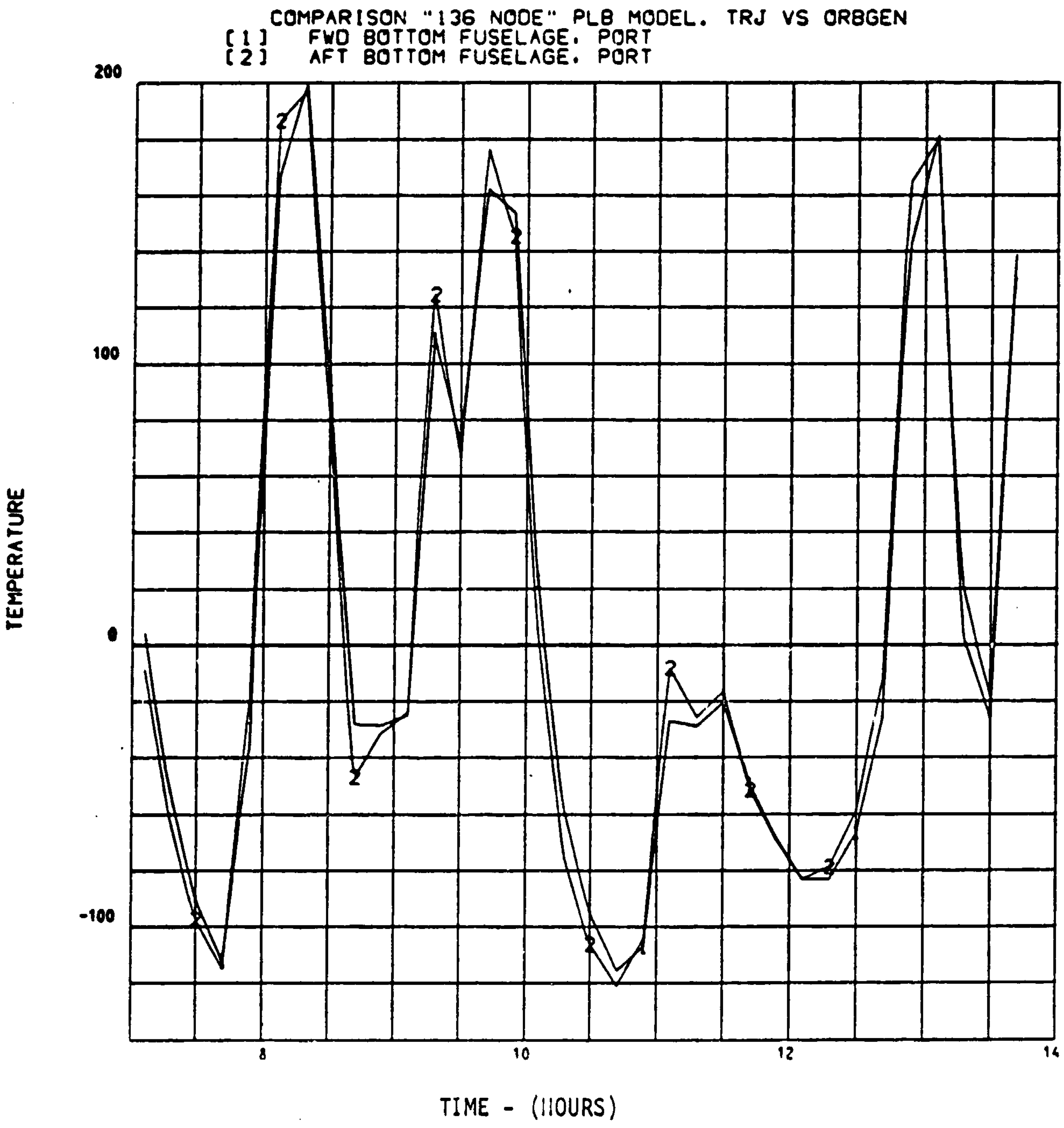

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD SIDE FUSELAGE. PORT
[2] AFT SIDE FUSELAGE. PORT
10
8
6
4
2
0
-2
TEMPERATURE
TIME - (HOURS)

Figure 1



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD INBOARD FUSLAGE ABOVE LONGERON. PORT
[2] AFT INBOARD FUSLAGE ABOVE LONGERON. PORT
TEMPERATURE
100
50
0
-50
-100
10
12
14
TIME - (HOURS)

Figure 2



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD BOTTOM FUSELAGE. PORT
[2] AFT BOTTOM FUSELAGE. PORT
200
100
0
-100
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 3

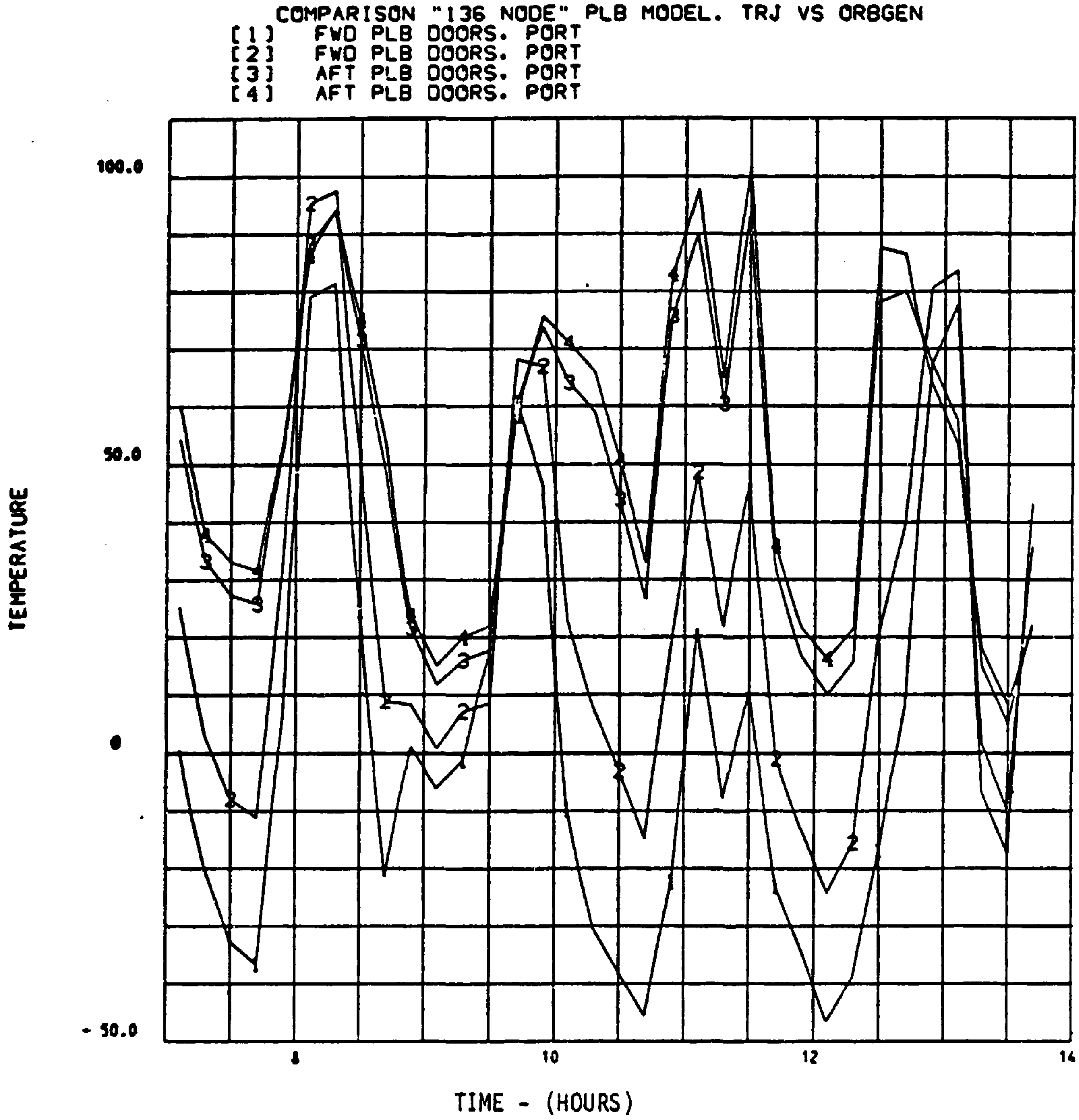
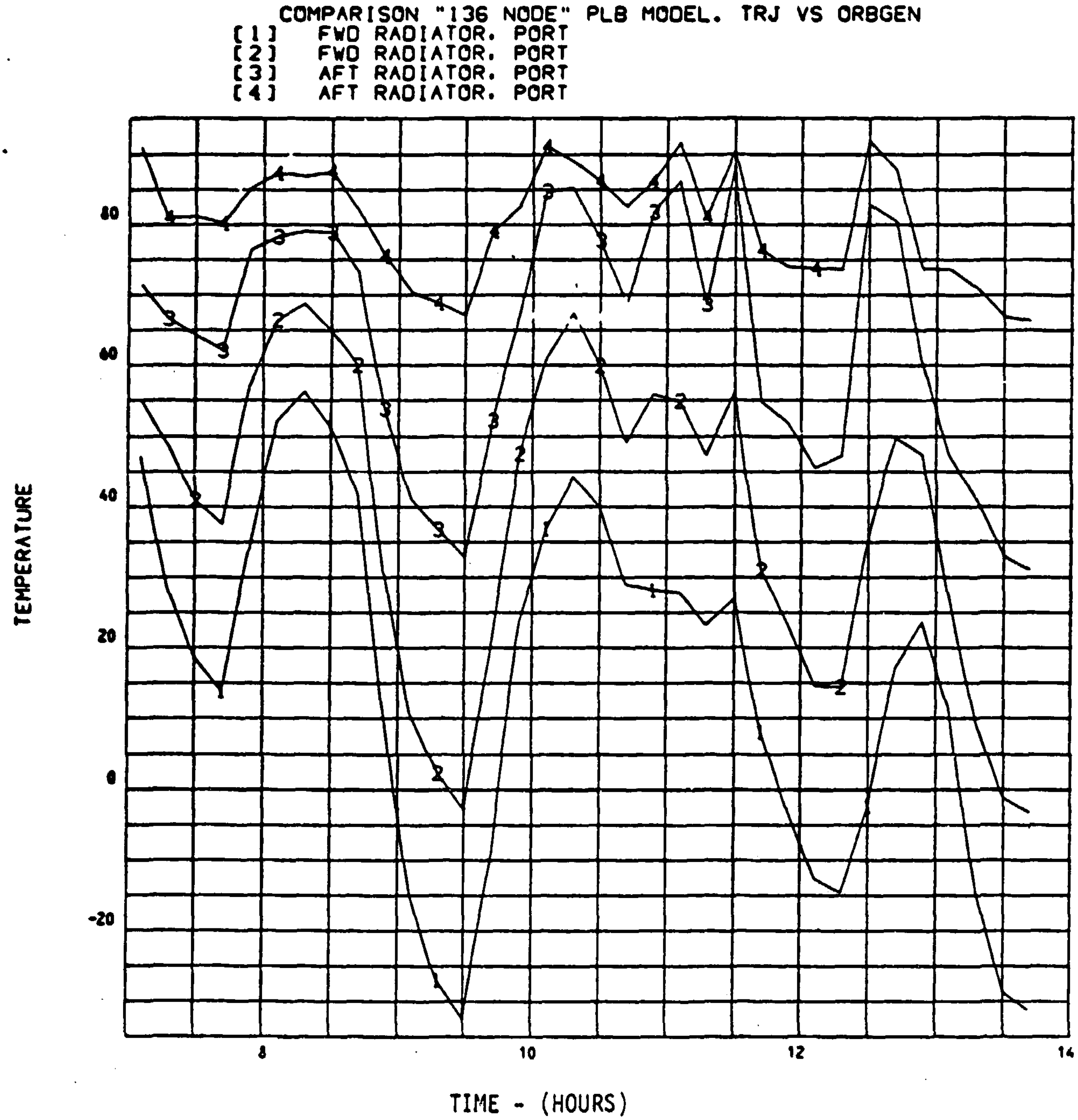

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD PLB DOORS. PORT
[2] FWD PLB DOORS. PORT
[3] AFT PLB DOORS. PORT
[4] AFT PLB DOORS. PORT
TEMPERATURE
100.0
50.0
0
- 50.0
8
10
12
14
TIME - (HOURS)

Figure 4



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD RADIATOR. PORT
[2] FWD RADIATOR. PORT
[3] AFT RADIATOR. PORT
[4] AFT RADIATOR. PORT
TEMPERATURE
80
60
40
20
0
-20
8
10
12
14
TIME - (HOURS)

Figure 5

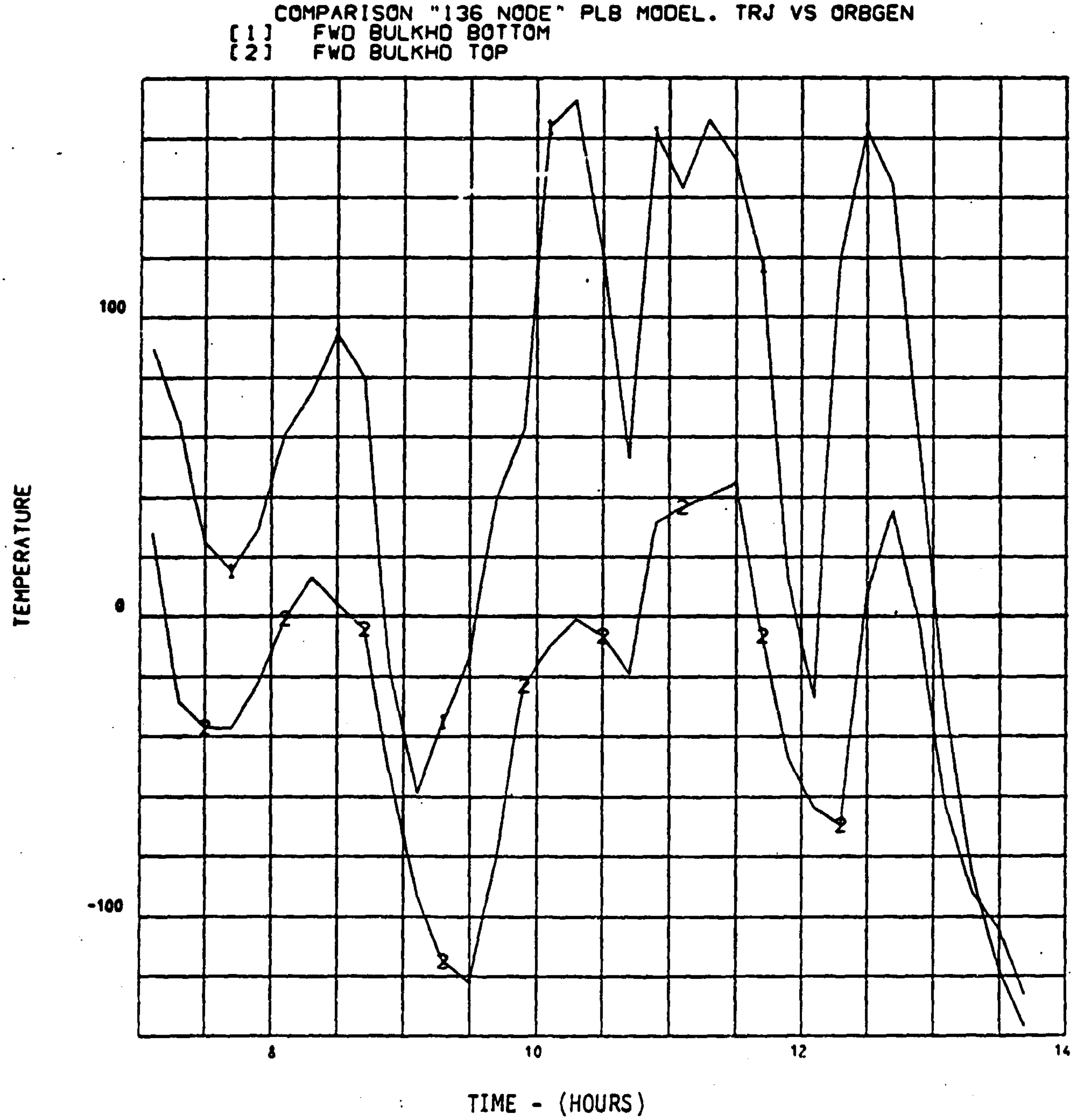

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD BULKHD BOTTOM
[2] FWD BULKHD TOP
TEMPERATURE
100
0
-100
8
10
12
14
TIME - (HOURS)

Figure 6

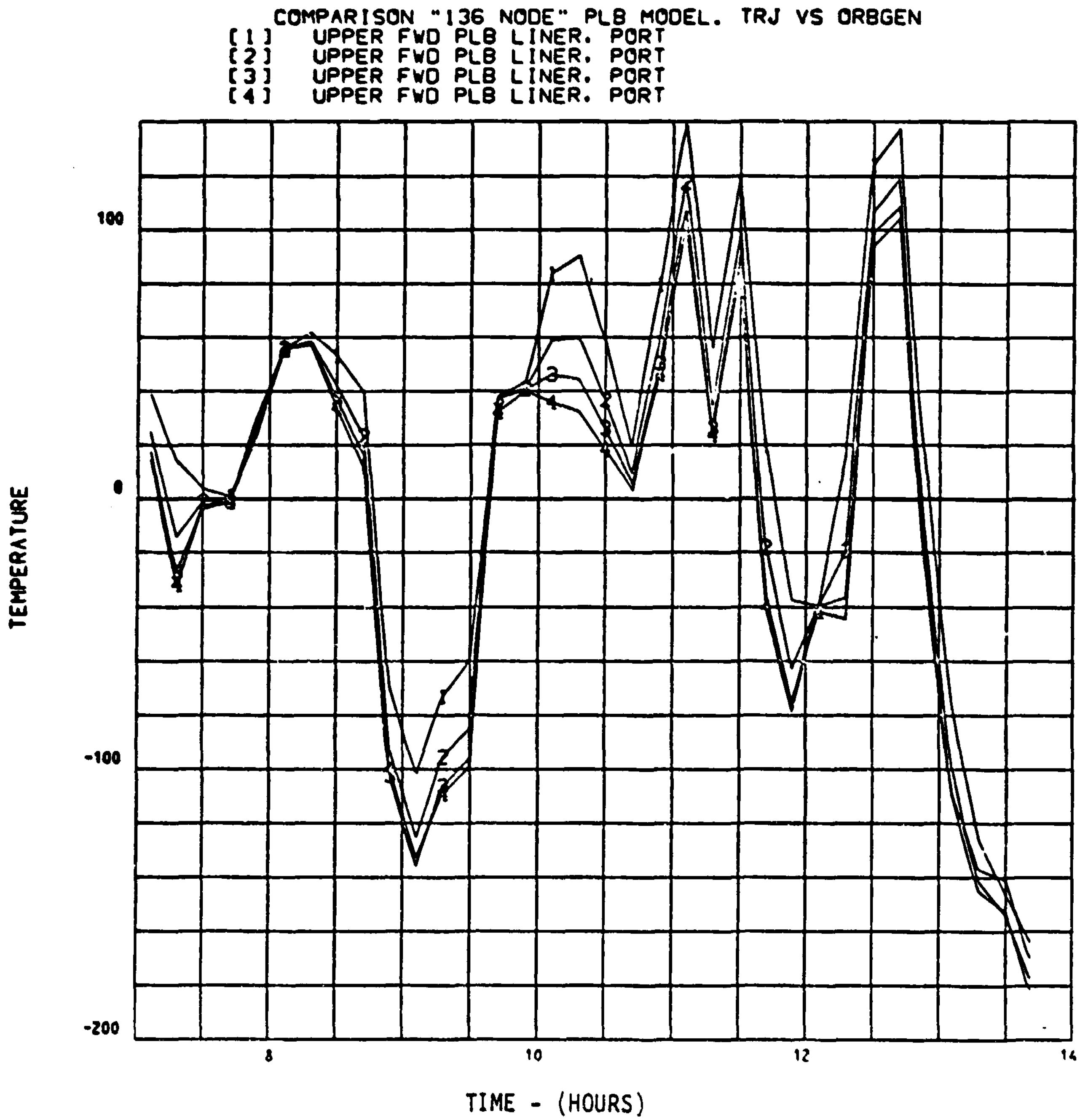

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] UPPER FWD PLB LINER. PORT
[2] UPPER FWD PLB LINER. PORT
[3] UPPER FWD PLB LINER. PORT
[4] UPPER FWD PLB LINER. PORT
TEMPERATURE
100
0
-100
-200
8
10
12
14
TIME - (HOURS)

Figure 7

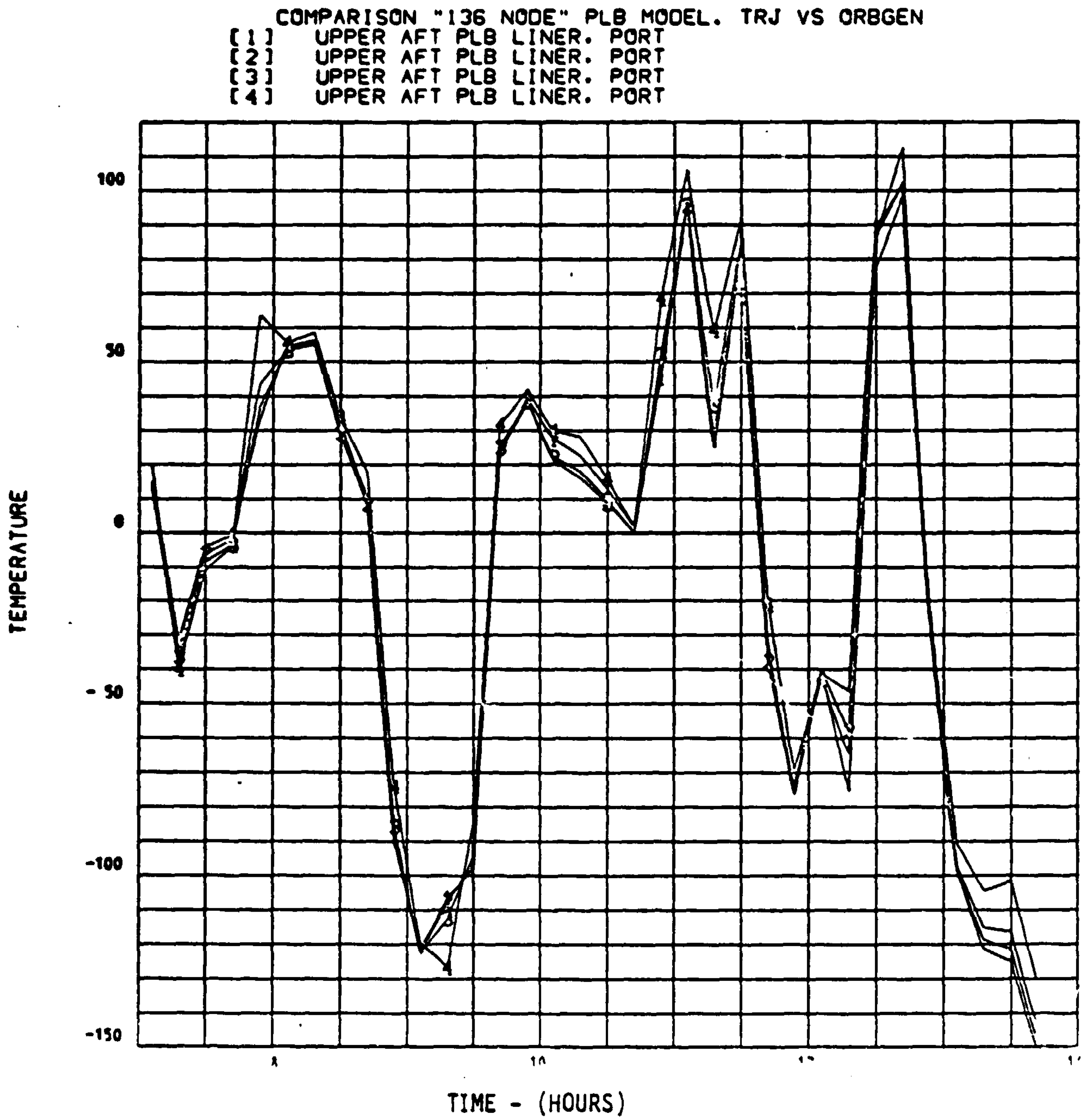

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] UPPER AFT PLB LINER. PORT
[2] UPPER AFT PLB LINER. PORT
[3] UPPER AFT PLB LINER. PORT
[4] UPPER AFT PLB LINER. PORT
100
50
0
-50
-100
-150
TEMPERATURE
TIME - (HOURS)

Figure 8

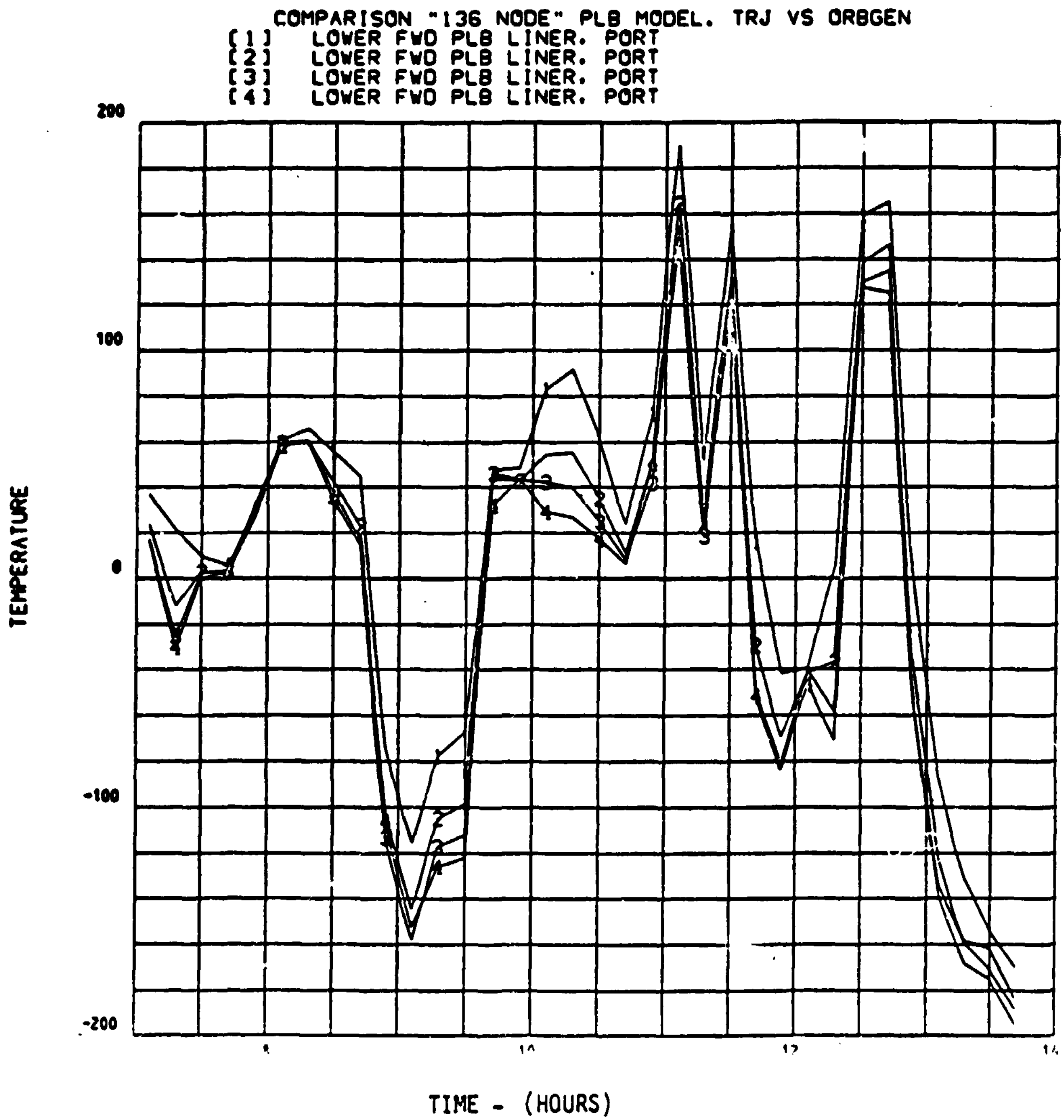
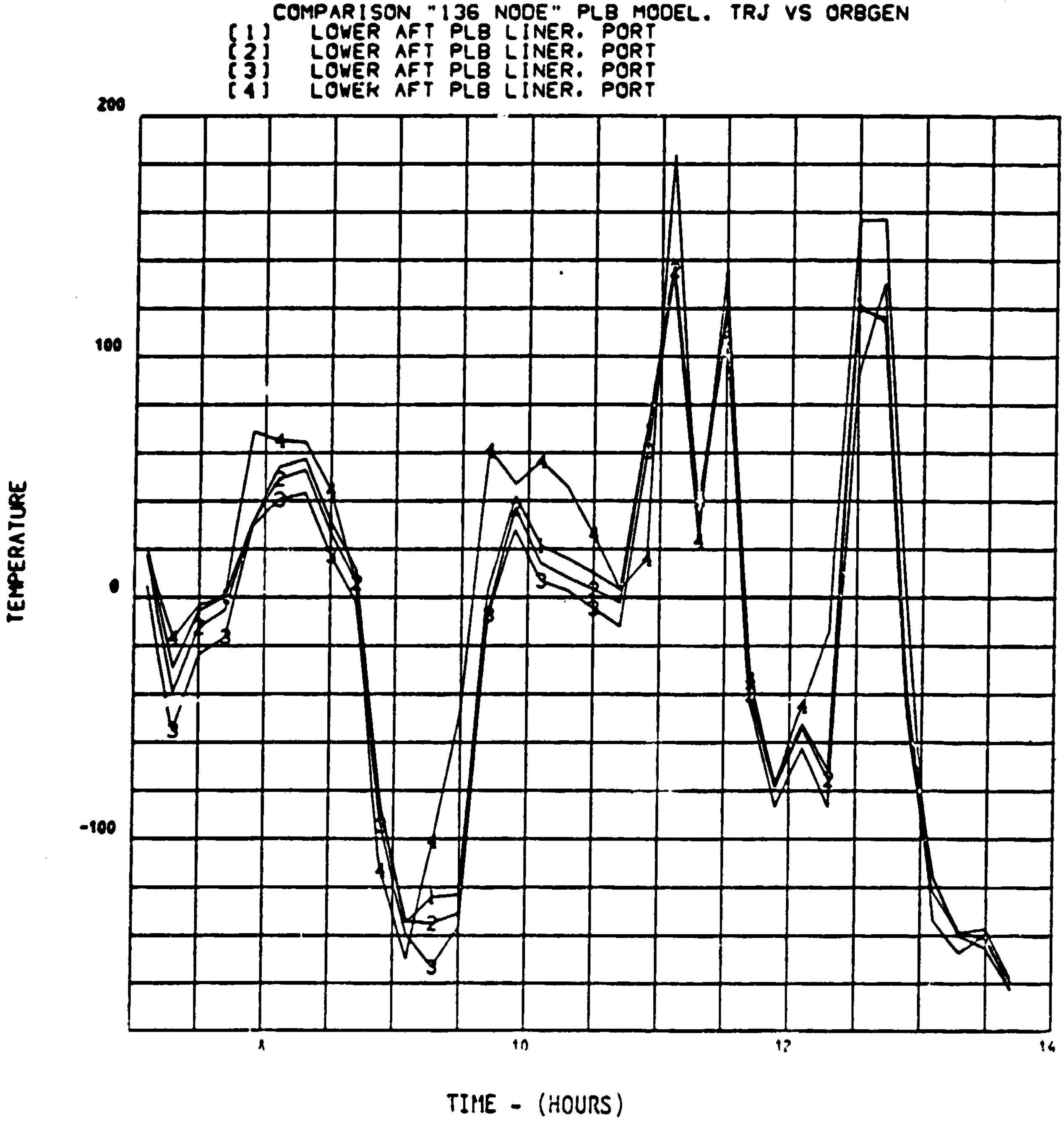

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] LOWER FWD PLB LINER. PORT
[2] LOWER FWD PLB LINER. PORT
[3] LOWER FWD PLB LINER. PORT
[4] LOWER FWD PLB LINER. PORT
200
100
0
-100
-200
TEMPERATURE
TIME - (HOURS)

Figure 9



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] LOWER AFT PLB LINER. PORT
[2] LOWER AFT PLB LINER. PORT
[3] LOWER AFT PLB LINER. PORT
[4] LOWEK AFT PLB LINER. PORT
200
100
0
-100
TEMPERATURE
10
12
14
TIME - (HOURS)

Figure 10

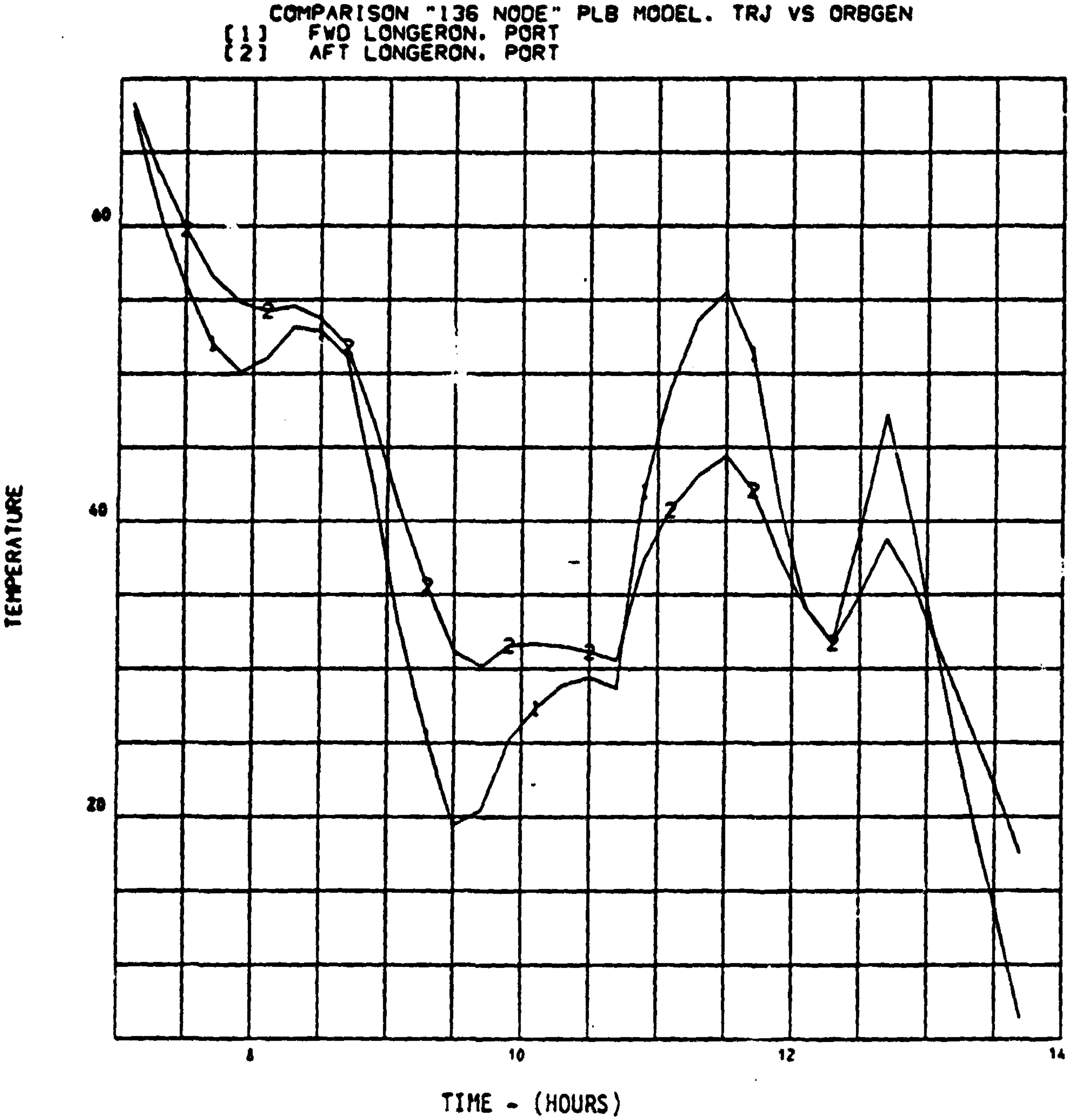
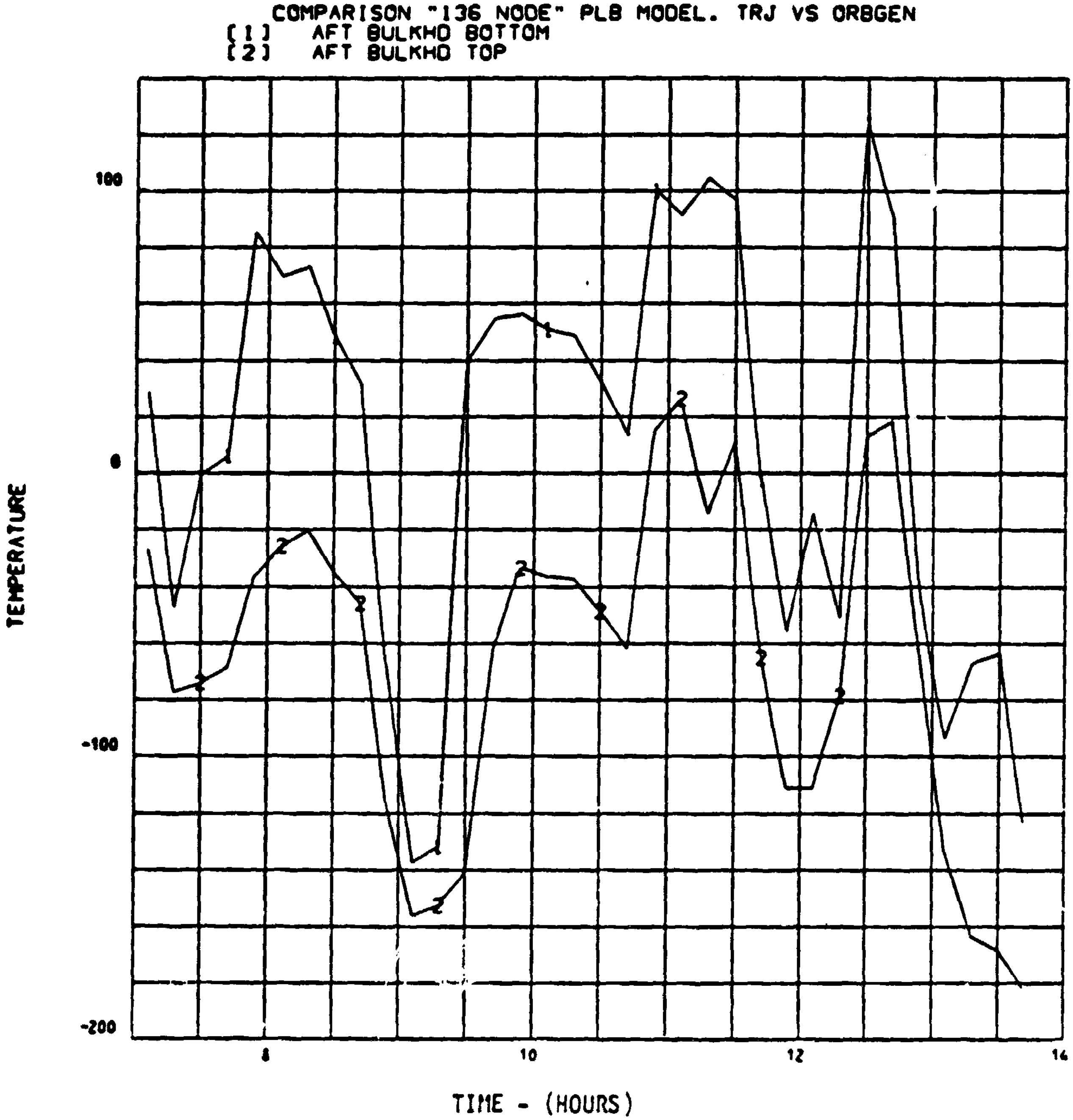
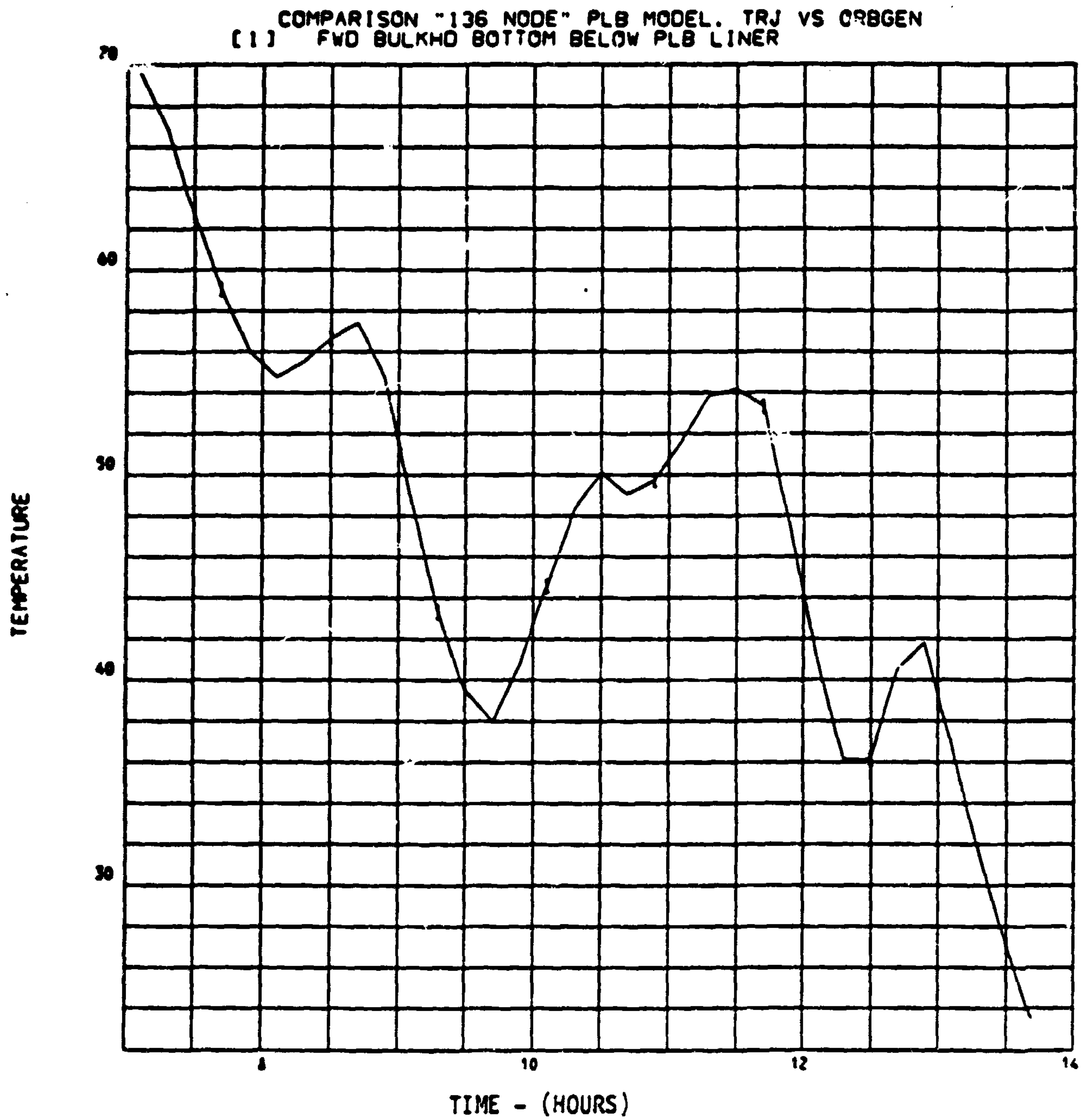

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD LONGERON. PORT
[2] AFT LONGERON. PORT
TEMPERATURE
60
40
20
8
10
12
14
TIME - (HOURS)

Figure 11



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] AFT BULKHD BOTTOM
[2] AFT BULKHD TOP
100
0
-100
-200
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 12



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD BULKHD BOTTOM BELOW PLB LINER
70
60
50
40
30
8
10
12
14
TEMPERATURE
TIME - (HOURS)

Figure 13

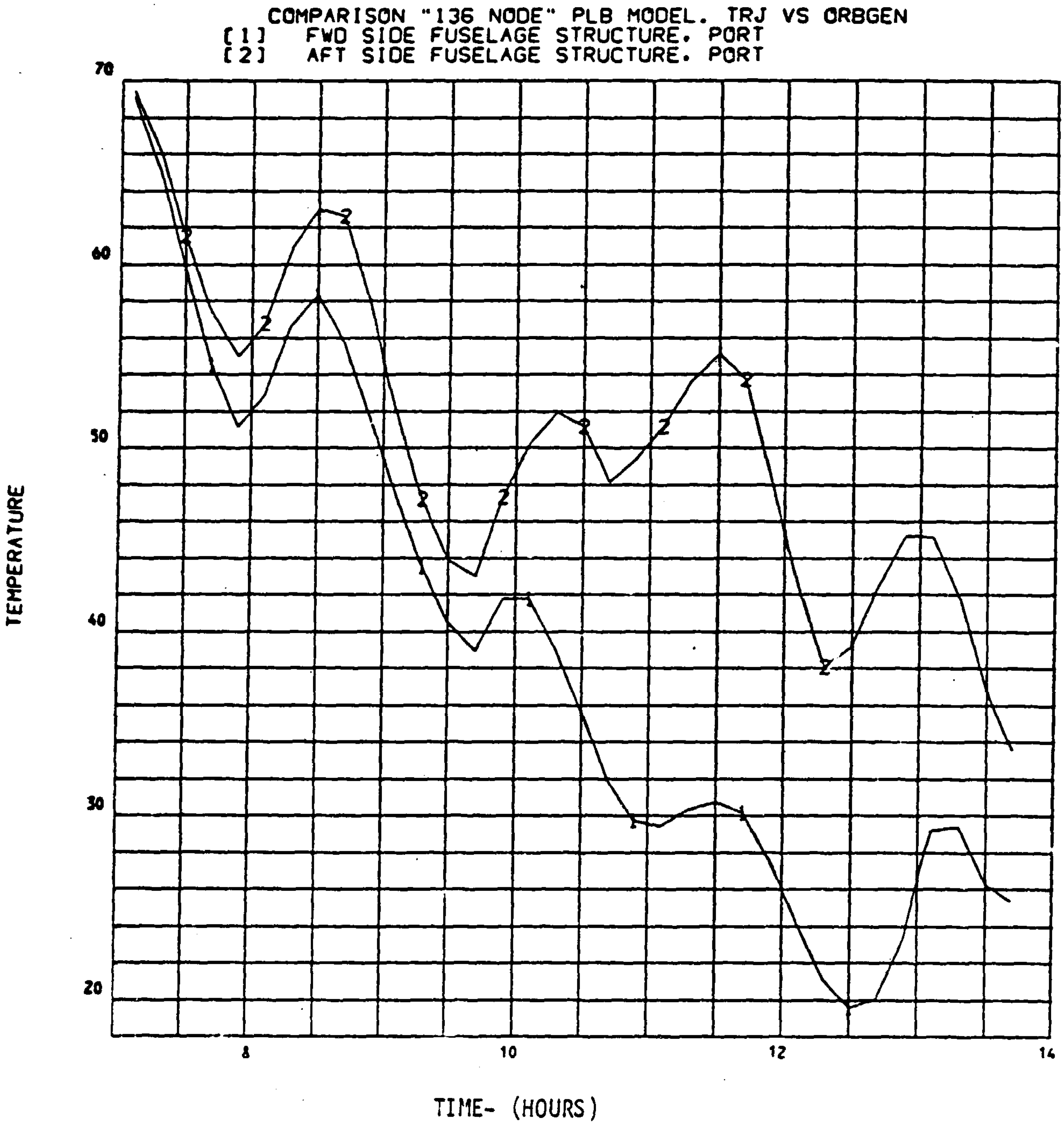

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD SIDE FUSELAGE STRUCTURE. PORT
[2] AFT SIDE FUSELAGE STRUCTURE. PORT
70
60
50
40
30
20
TEMPERATURE
8
10
12
14
TIME- (HOURS)

Figure 14

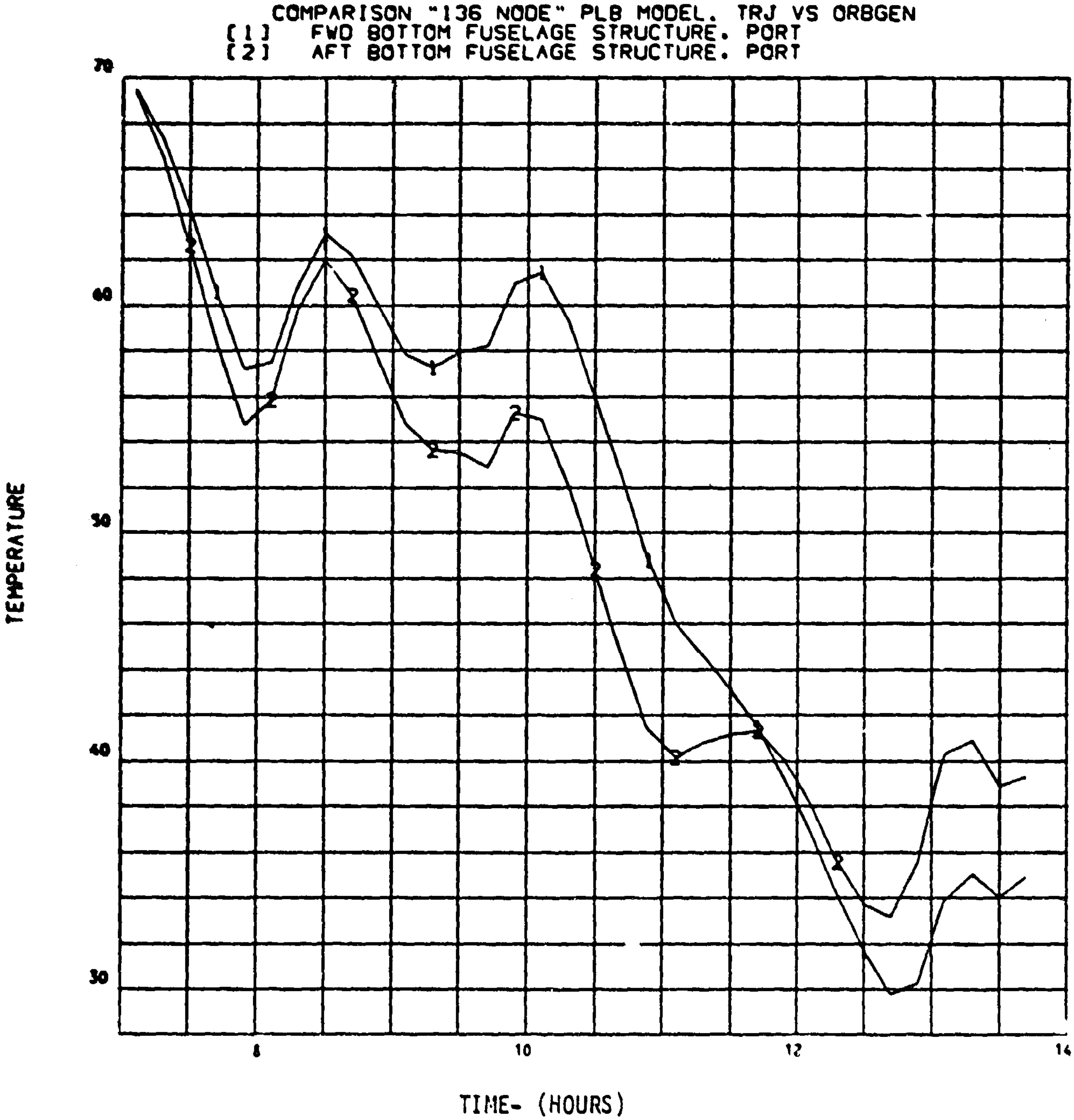
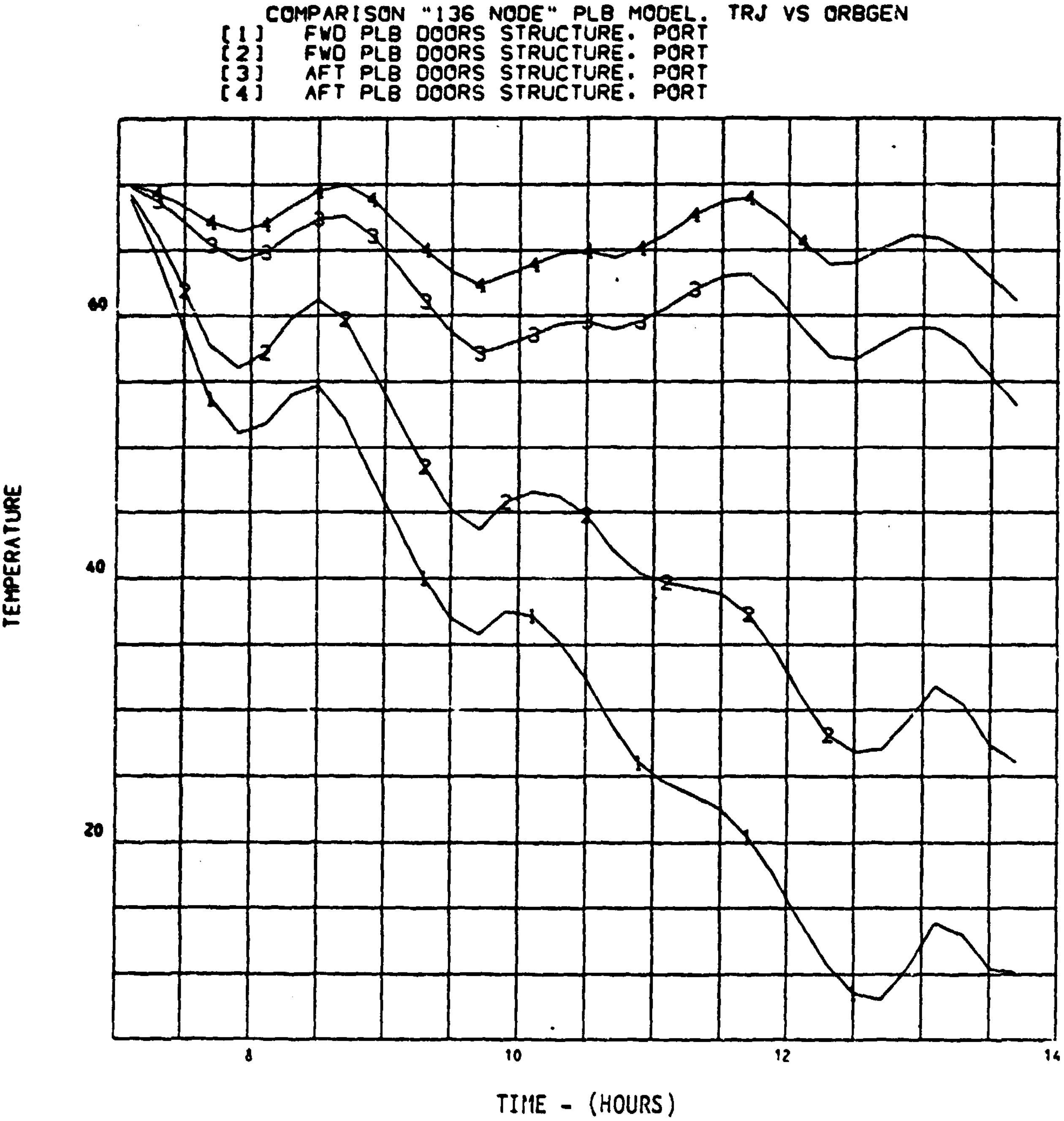
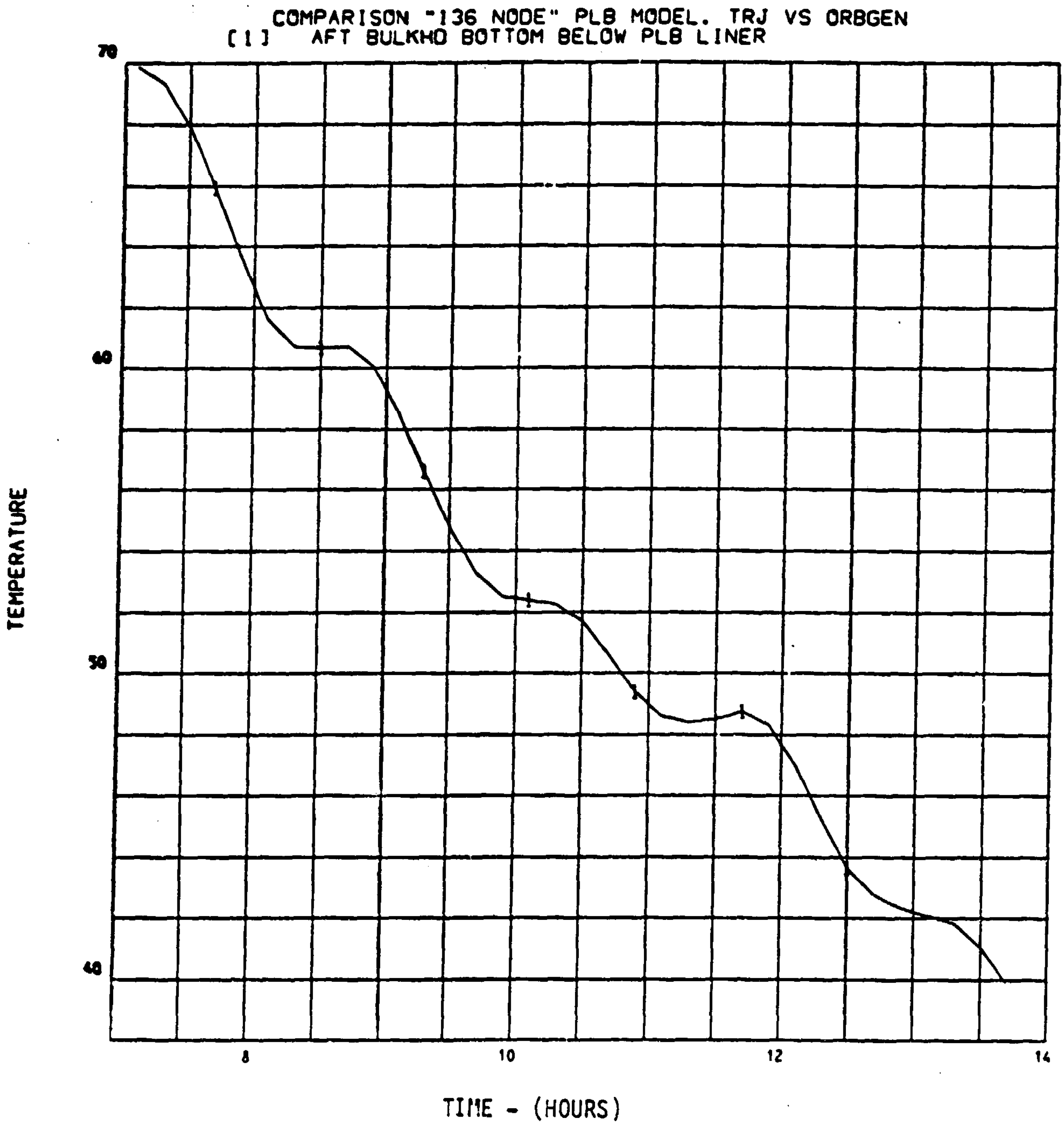

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD BOTTOM FUSELAGE STRUCTURE. PORT
[2] AFT BOTTOM FUSELAGE STRUCTURE. PORT
70
60
50
40
30
TEMPERATURE
8
10
12
14
TIME- (HOURS)

Figure 15



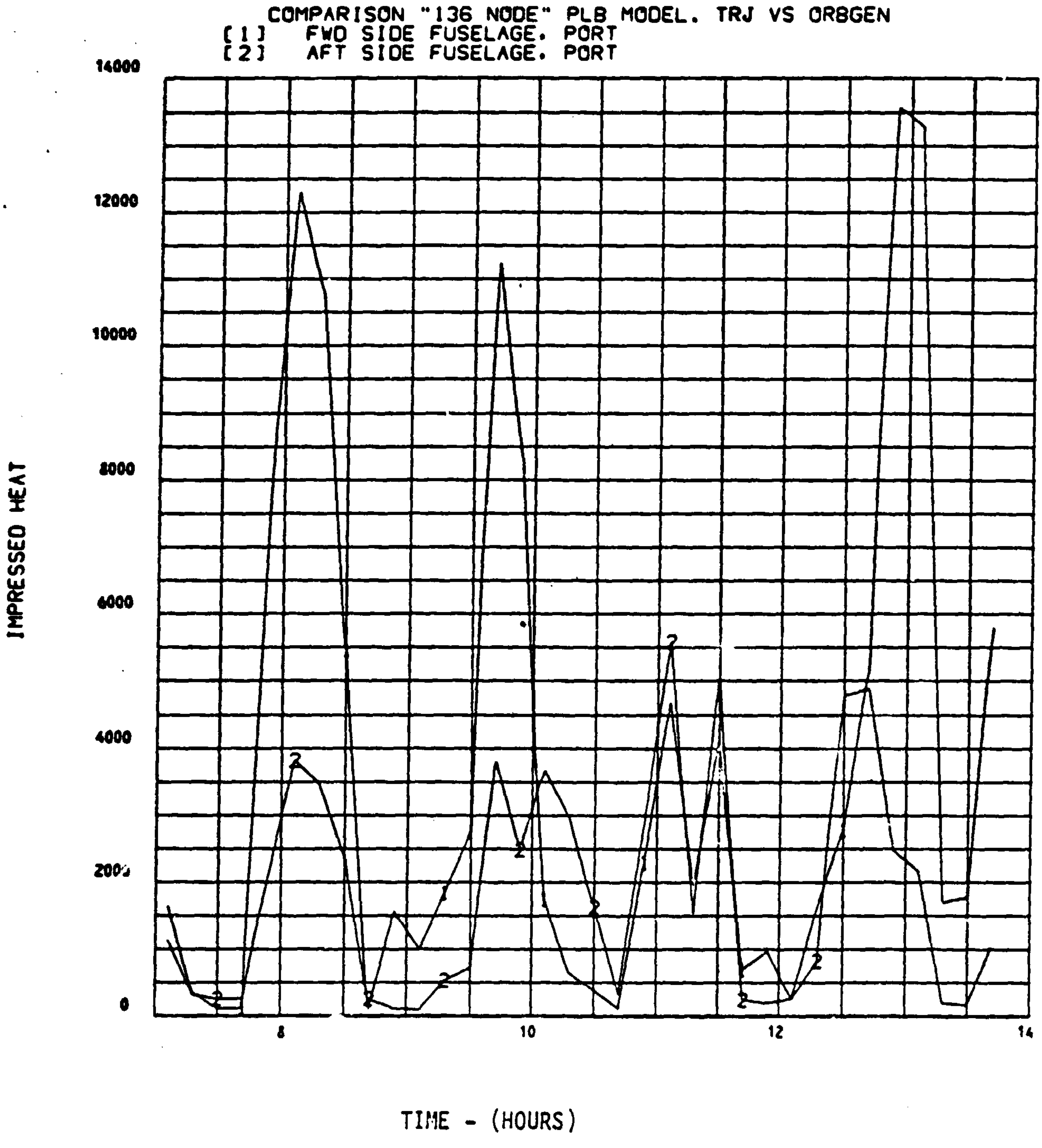
COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD PLB DOORS STRUCTURE. PORT
[2] FWD PLB DOORS STRUCTURE. PORT
[3] AFT PLB DOORS STRUCTURE. PORT
[4] AFT PLB DOORS STRUCTURE. PORT
TEMPERATURE
60
40
20
8
10
12
14
TIME - (HOURS)

Figure 16



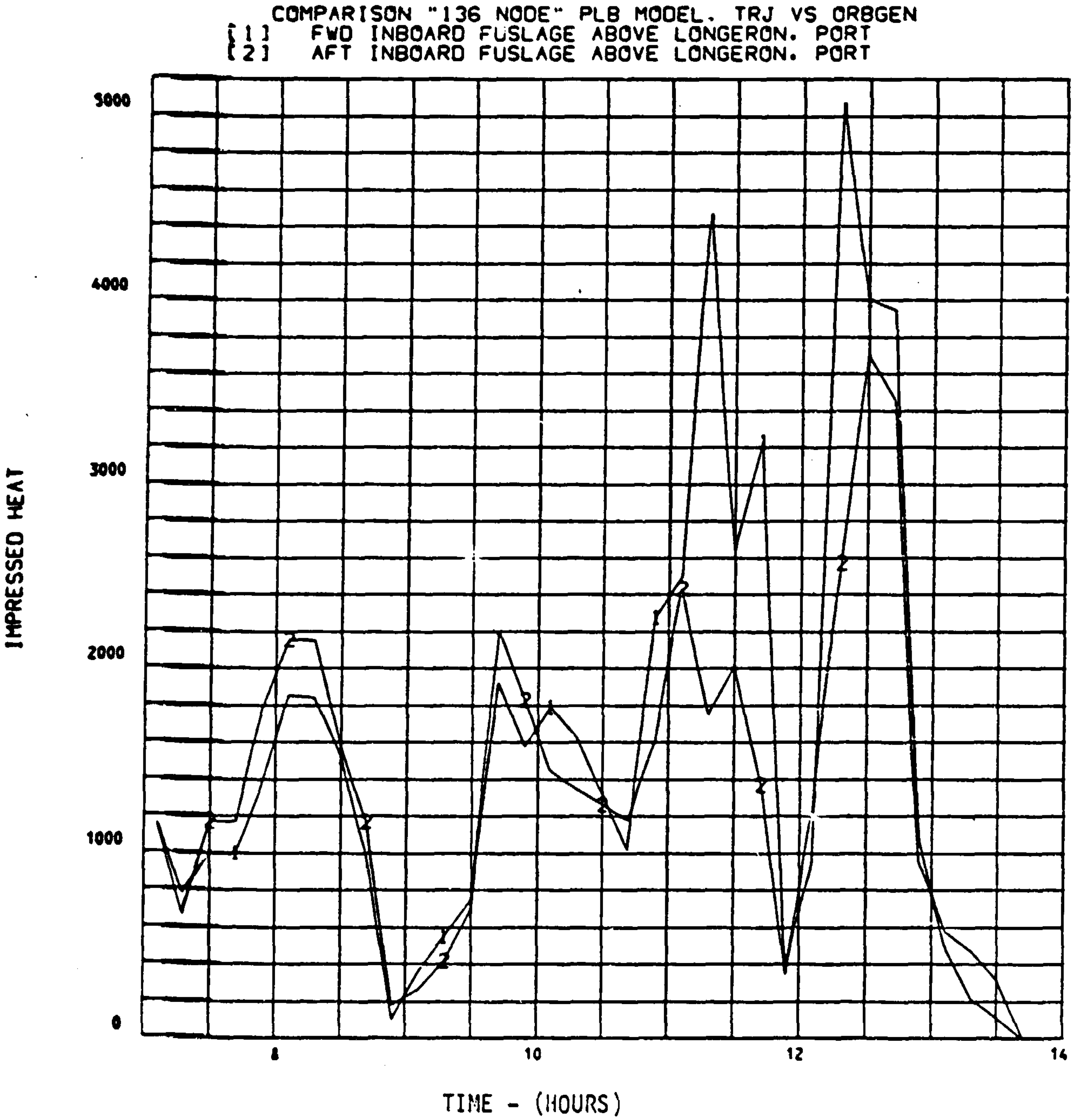
COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] AFT BULKHD BOTTOM BELOW PLB LINER
70
60
50
40
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 17



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD SIDE FUSELAGE. PORT
[2] AFT SIDE FUSELAGE. PORT
14000
12000
10000
8000
6000
4000
0
8
10
12
14
IMPRESSED HEAT
TIME - (HOURS)

Figure 18



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD INBOARD FUSLAGE ABOVE LONGERON. PORT
[2] AFT INBOARD FUSLAGE ABOVE LONGERON. PORT
IMPRESSED HEAT
5000
4000
3000
2000
1000
0
8
10
12
14
TIME - (HOURS)

Figure 19

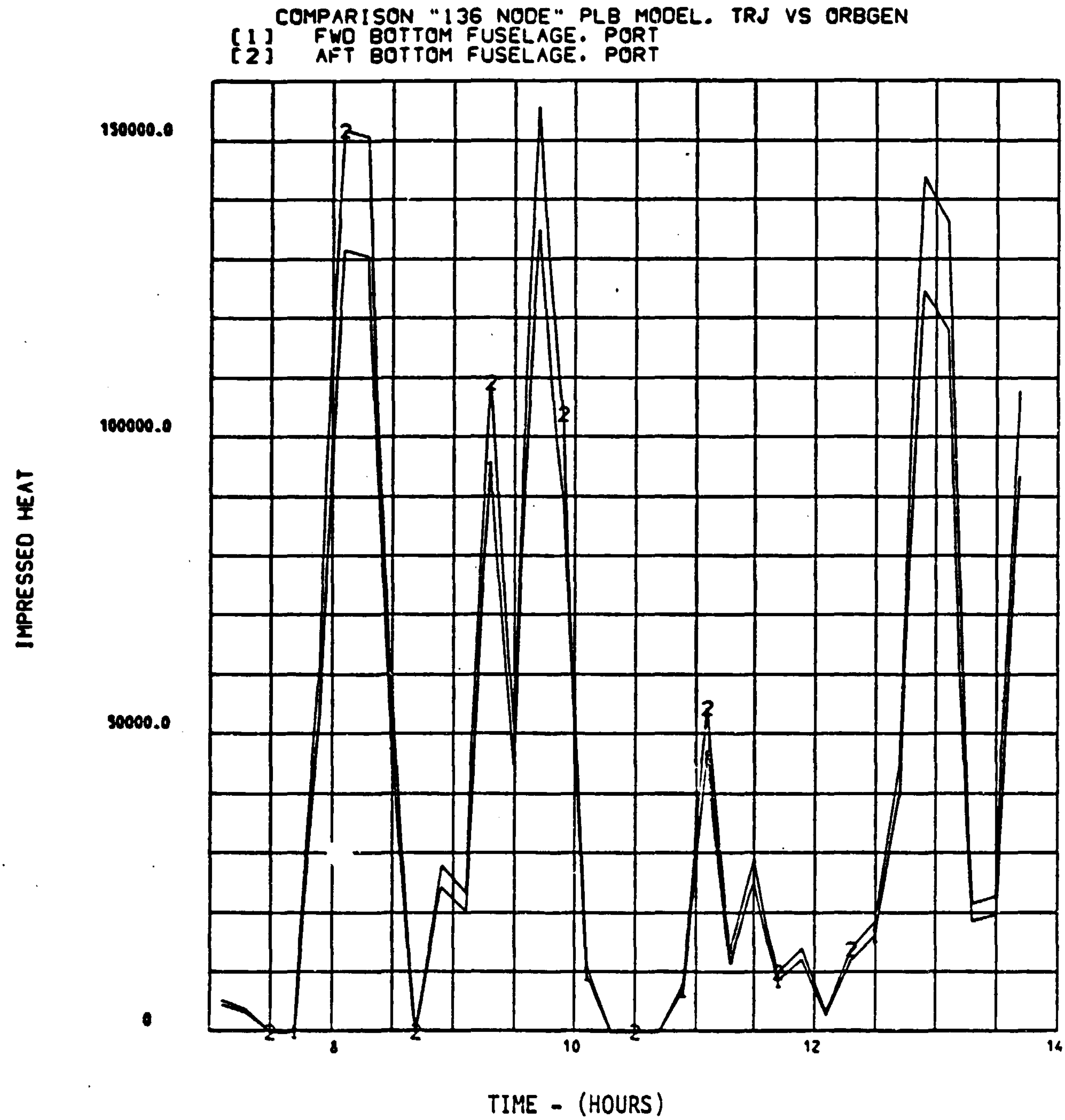

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD BOTTOM FUSELAGE. PORT
[2] AFT BOTTOM FUSELAGE. PORT
150000.0
100000.0
50000.0
0
8
10
12
14
IMPRESSED HEAT
TIME - (HOURS)

Figure 20

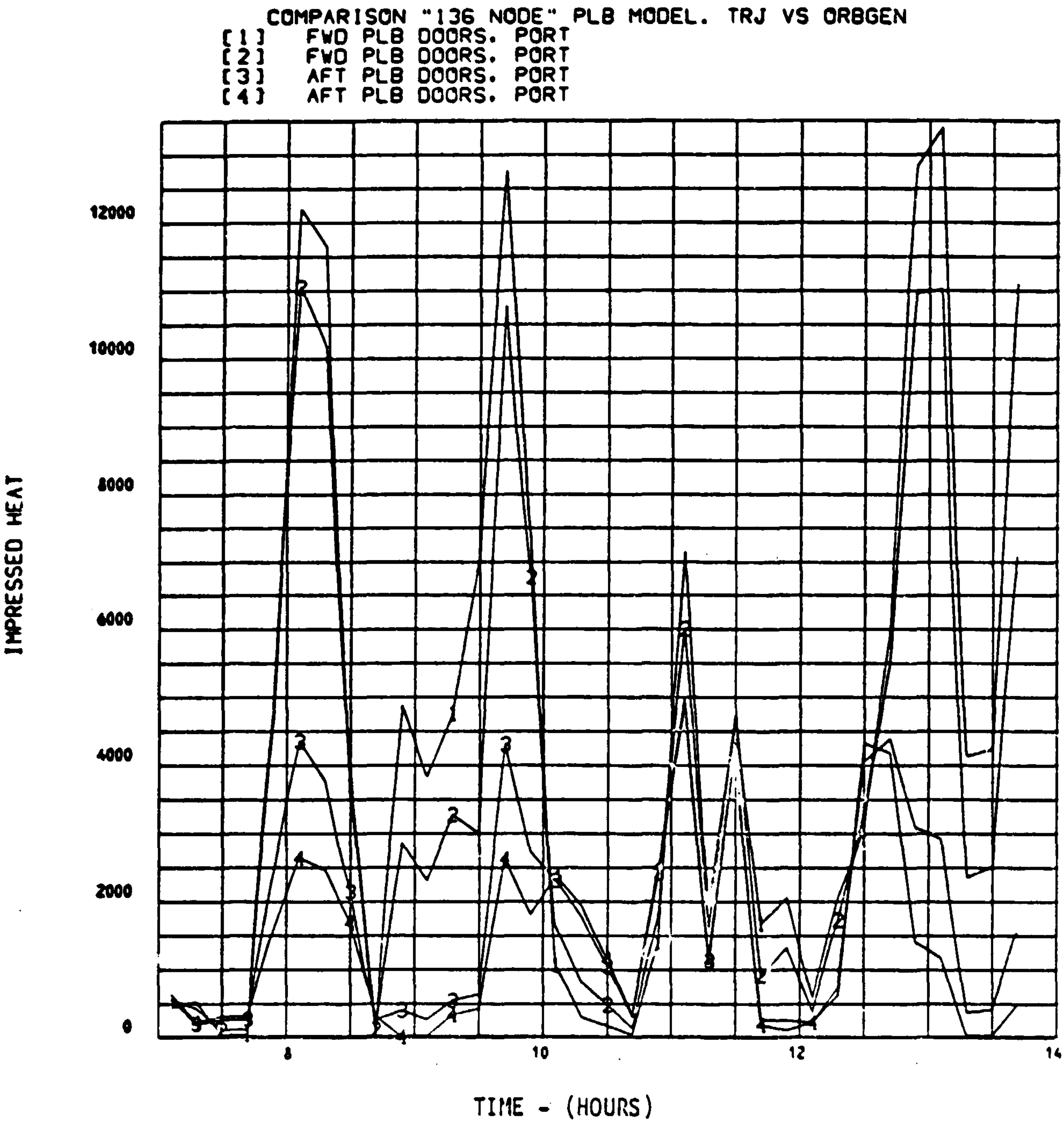

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD PLB DOORS. PORT
[2] FWD PLB DOORS. PORT
[3] AFT PLB DOORS. PORT
[4] AFT PLB DOORS. PORT
IMPRESSED HEAT
12000
10000
8000
6000
4000
2000
0
8
10
12
14
TIME - (HOURS)

Figure 21

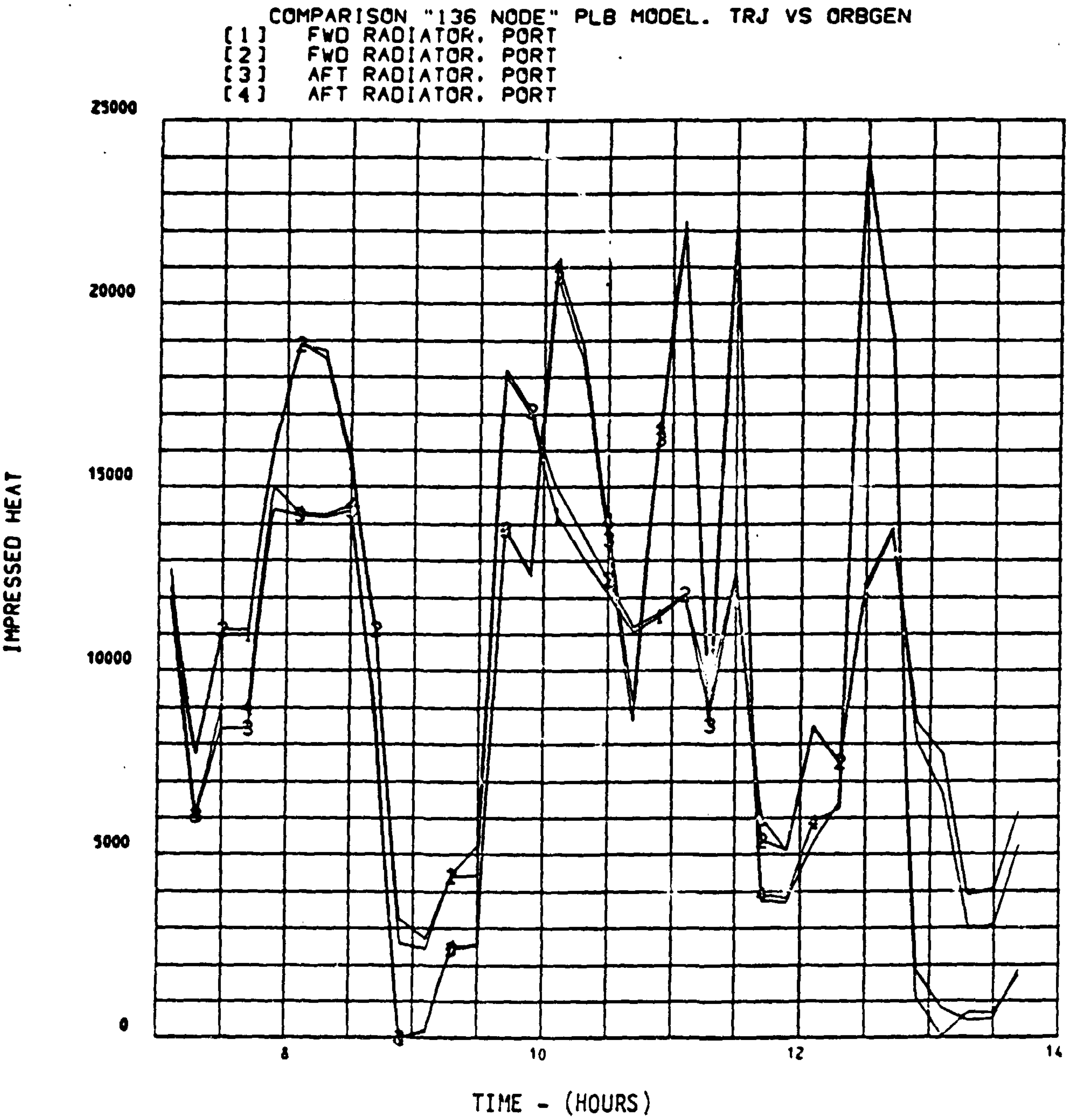
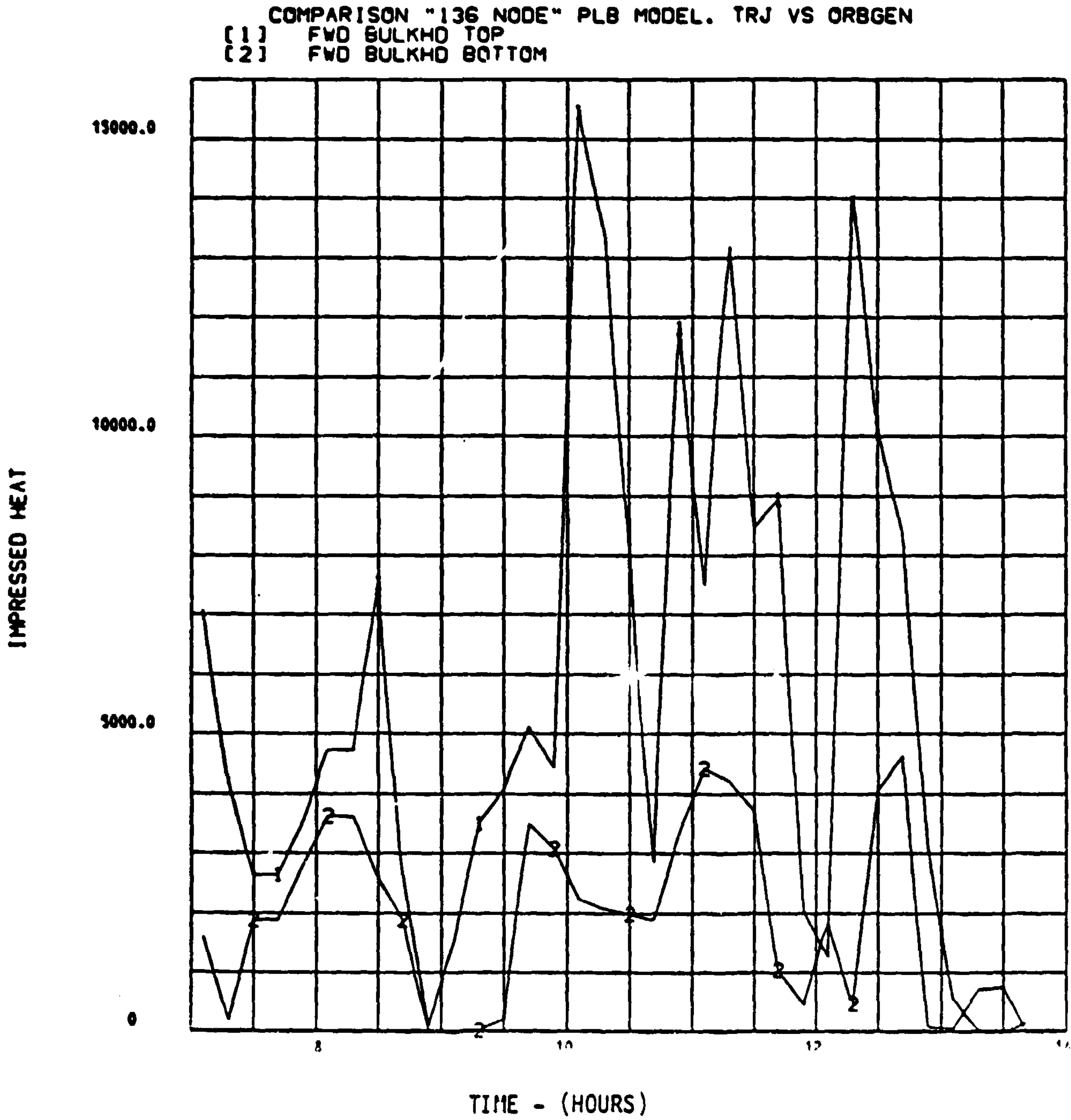

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD RADIATOR, PORT
[2] FWD RADIATOR, PORT
[3] AFT RADIATOR, PORT
[4] AFT RADIATOR, PORT
25000
20000
15000
10000
5000
0
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 22



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD BULKHD TOP
[2] FWD BULKHD BOTTOM
15000.0
10000.0
5000.0
0
IMPRESSED HEAT
8
10
12
TIME - (HOURS)

Figure 23

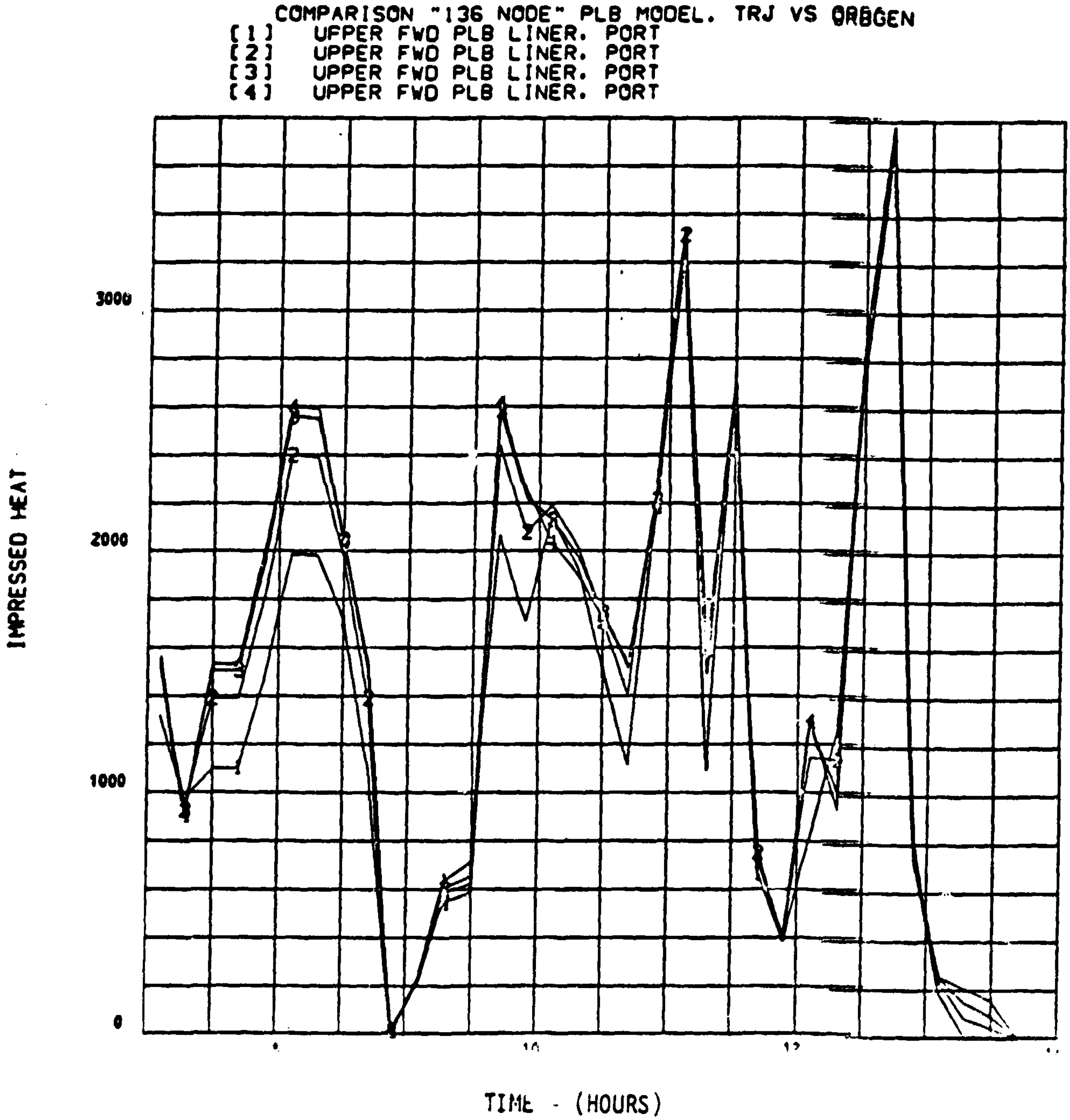

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] UPPER FWD PLB LINER. PORT
[2] UPPER FWD PLB LINER. PORT
[3] UPPER FWD PLB LINER. PORT
[4] UPPER FWD PLB LINER. PORT
IMPRESSED HEAT
3000
2000
1000
0
TIME - (HOURS)

Figure 24

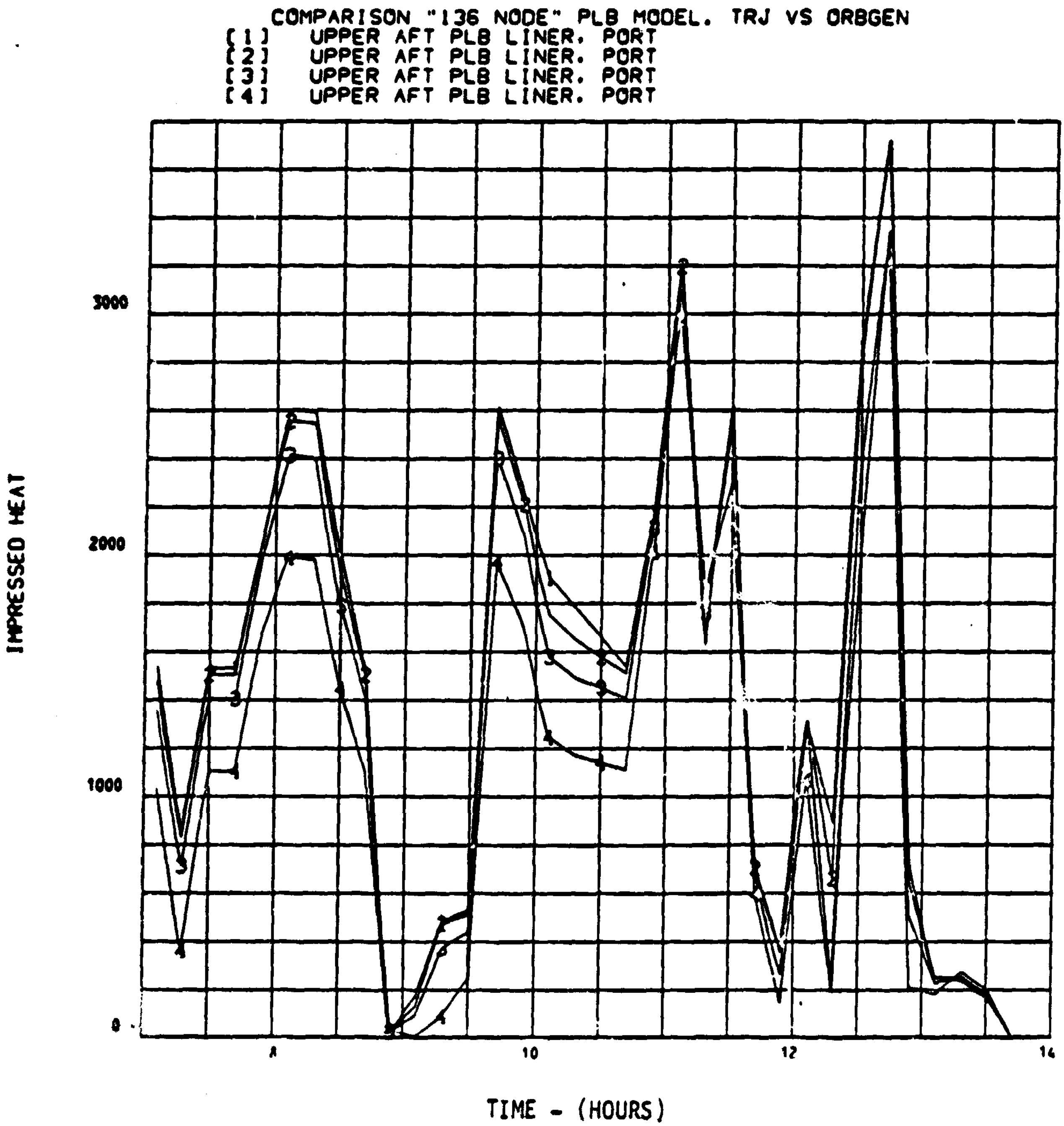
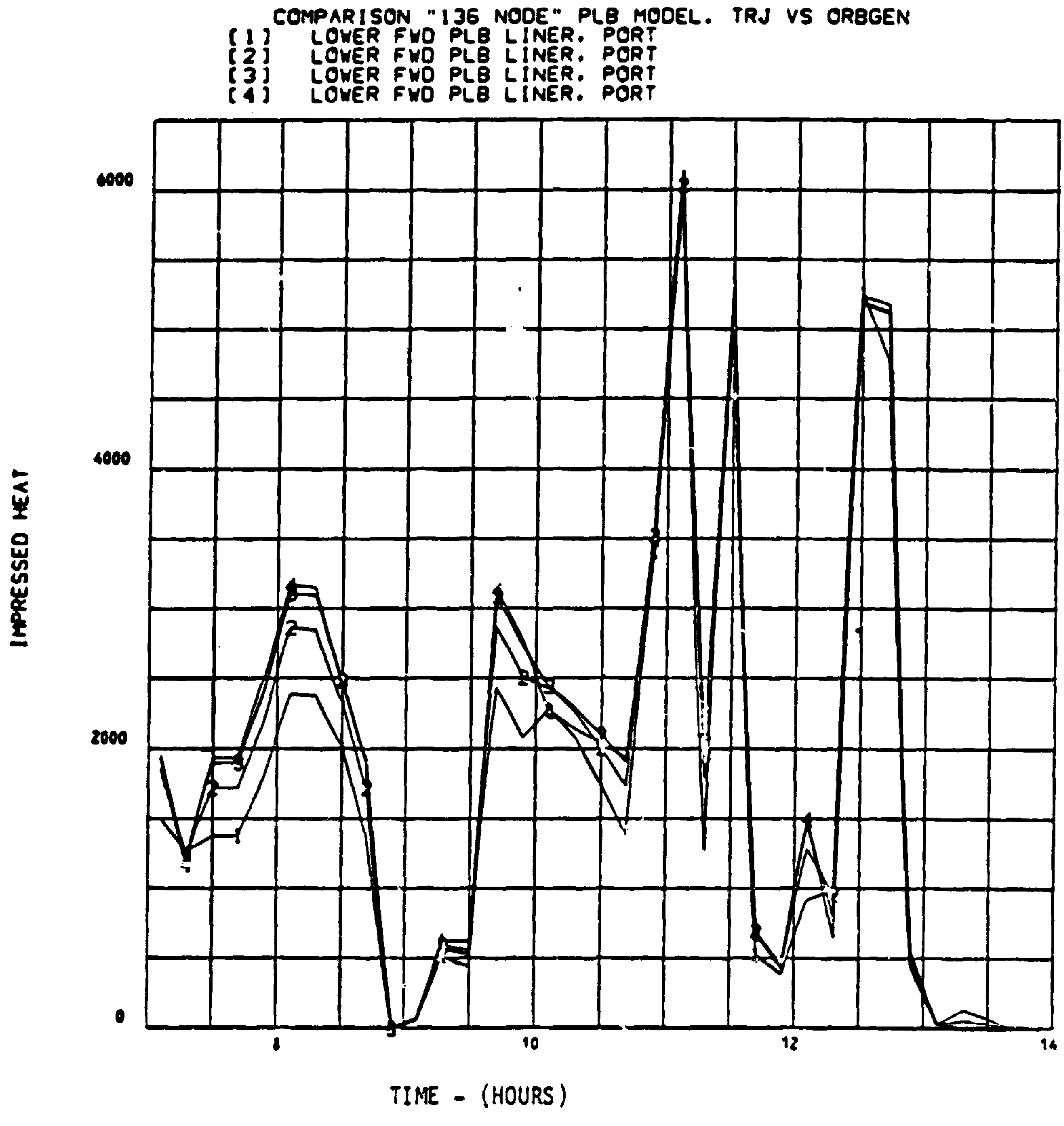

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] UPPER AFT PLB LINER. PORT
[2] UPPER AFT PLB LINER. PORT
[3] UPPER AFT PLB LINER. PORT
[4] UPPER AFT PLB LINER. PORT
IMPRESSED HEAT
3000
2000
1000
0
8
10
12
14
TIME - (HOURS)

Figure 25



COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] LOWER FWD PLB LINER. PORT
[2] LOWER FWD PLB LINER. PORT
[3] LOWER FWD PLB LINER. PORT
[4] LOWER FWD PLB LINER. PORT
IMPRESSED HEAT
6000
4000
2000
0
8
10
12
14
TIME - (HOURS)

Figure 26

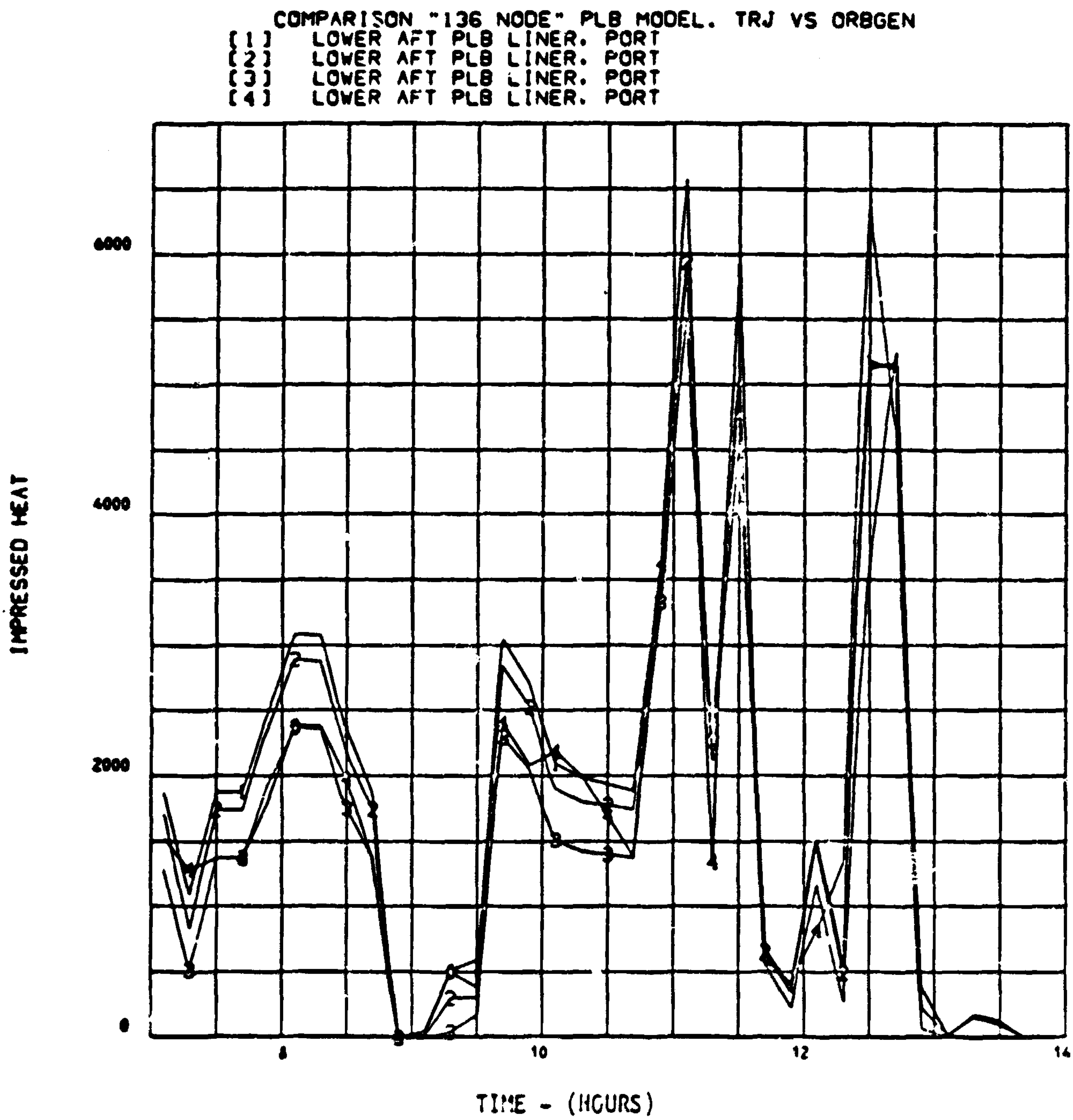

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] LOWER AFT PLB LINER. PORT
[2] LOWER AFT PLB LINER. PORT
[3] LOWER AFT PLB LINER. PORT
[4] LOWER AFT PLB LINER. PORT
IMPRESSED HEAT
6000
4000
2000
0
8
10
12
14
TIME - (HOURS)

Figure 27

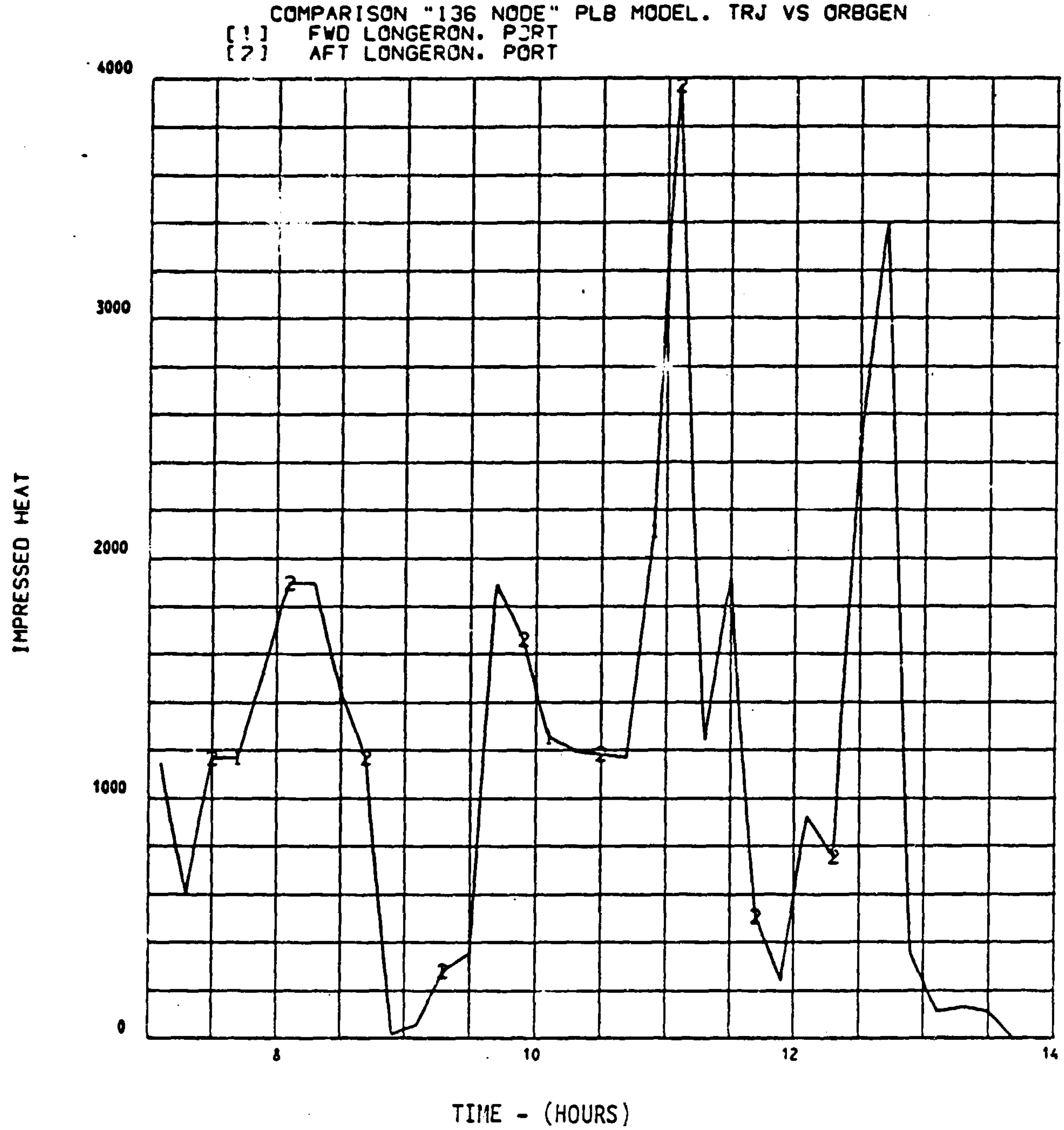

COMPARISON "136 NODE" PLB MODEL. TRJ VS ORBGEN
[1] FWD LONGERON. PORT
[2] AFT LONGERON. PORT
IMPRESSED HEAT
4000
3000
2000
1000
0
8
10
12
14
TIME - (HOURS)

Figure 28

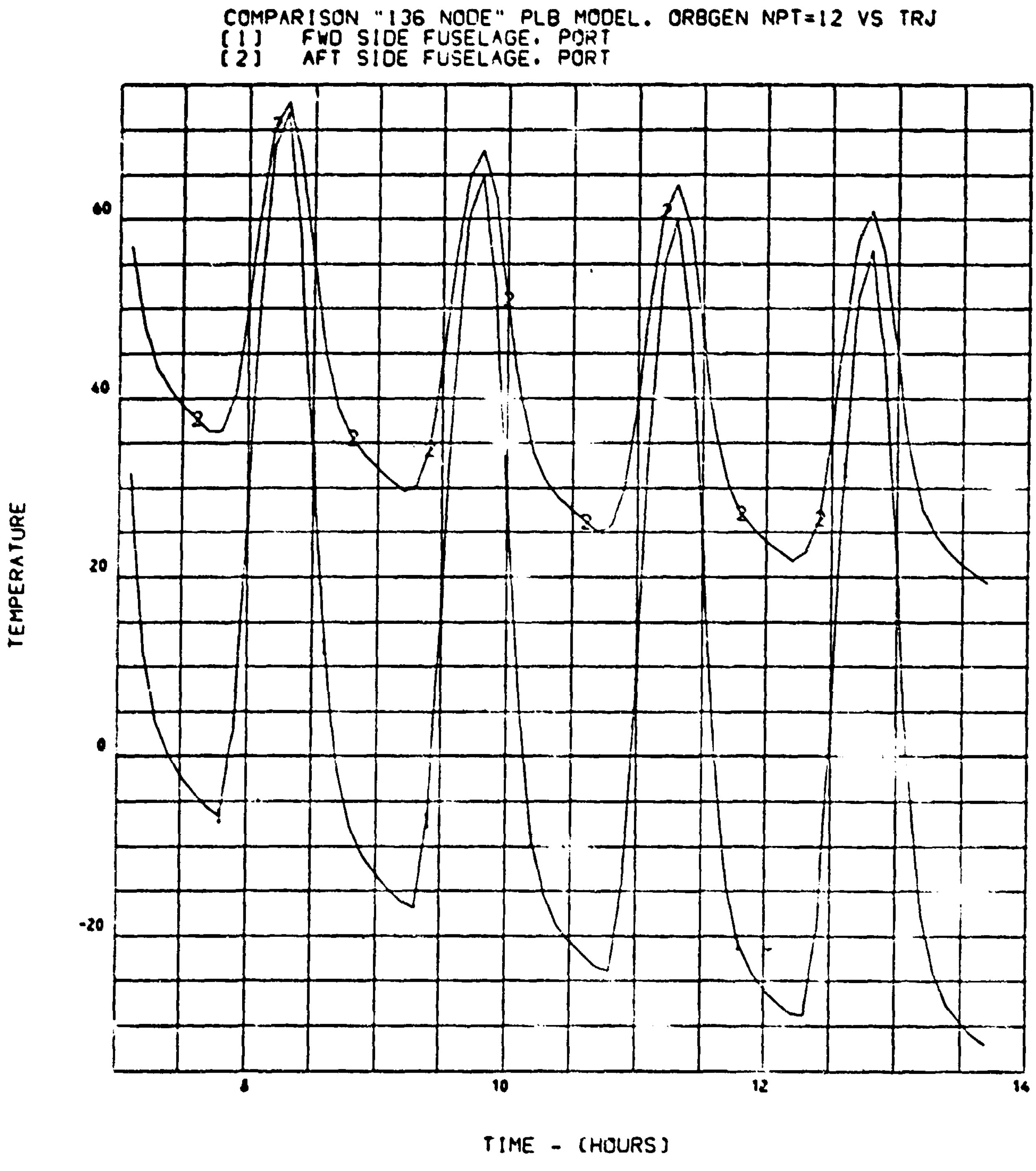
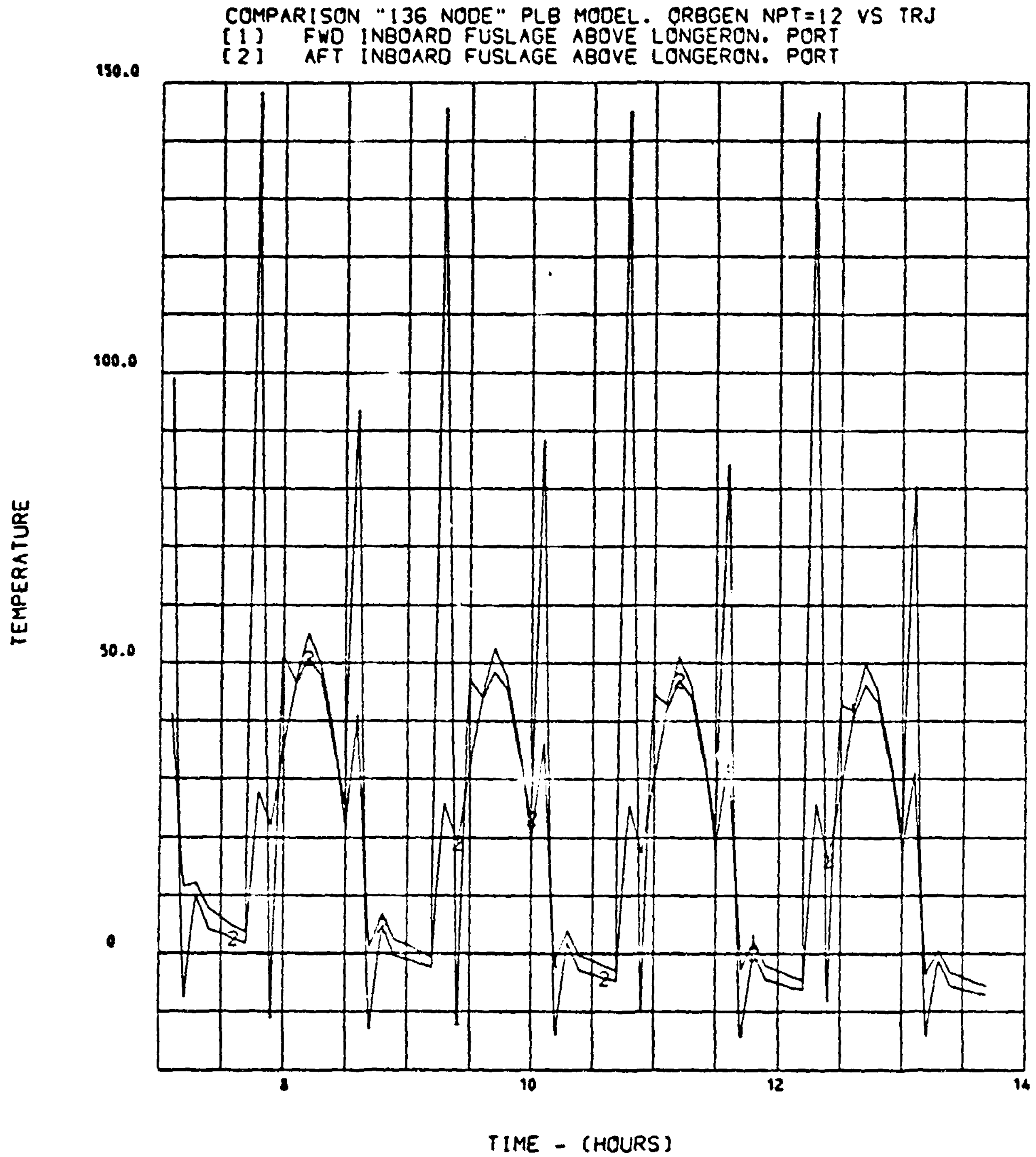

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD SIDE FUSELAGE. PORT
[2] AFT SIDE FUSELAGE. PORT
TEMPERATURE
60
40
20
0
-20
8
10
12
14
TIME - (HOURS)

Figure 29



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD INBOARD FUSLAGE ABOVE LONGERON. PORT
[2] AFT INBOARD FUSLAGE ABOVE LONGERON. PORT
150.0
100.0
50.0
0
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 30

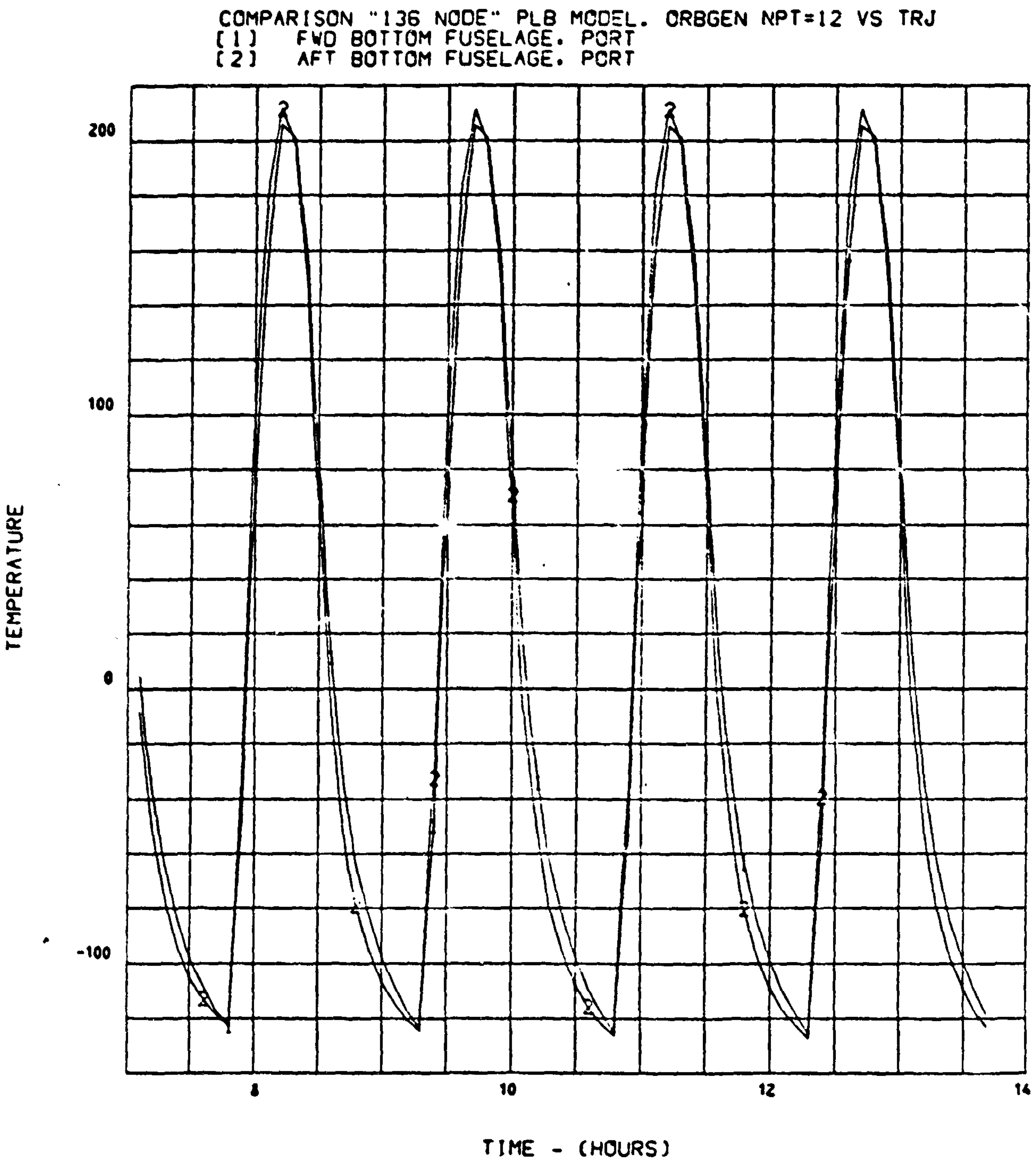

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD BOTTOM FUSELAGE. PORT
[2] AFT BOTTOM FUSELAGE. PORT
200
100
0
-100
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 31

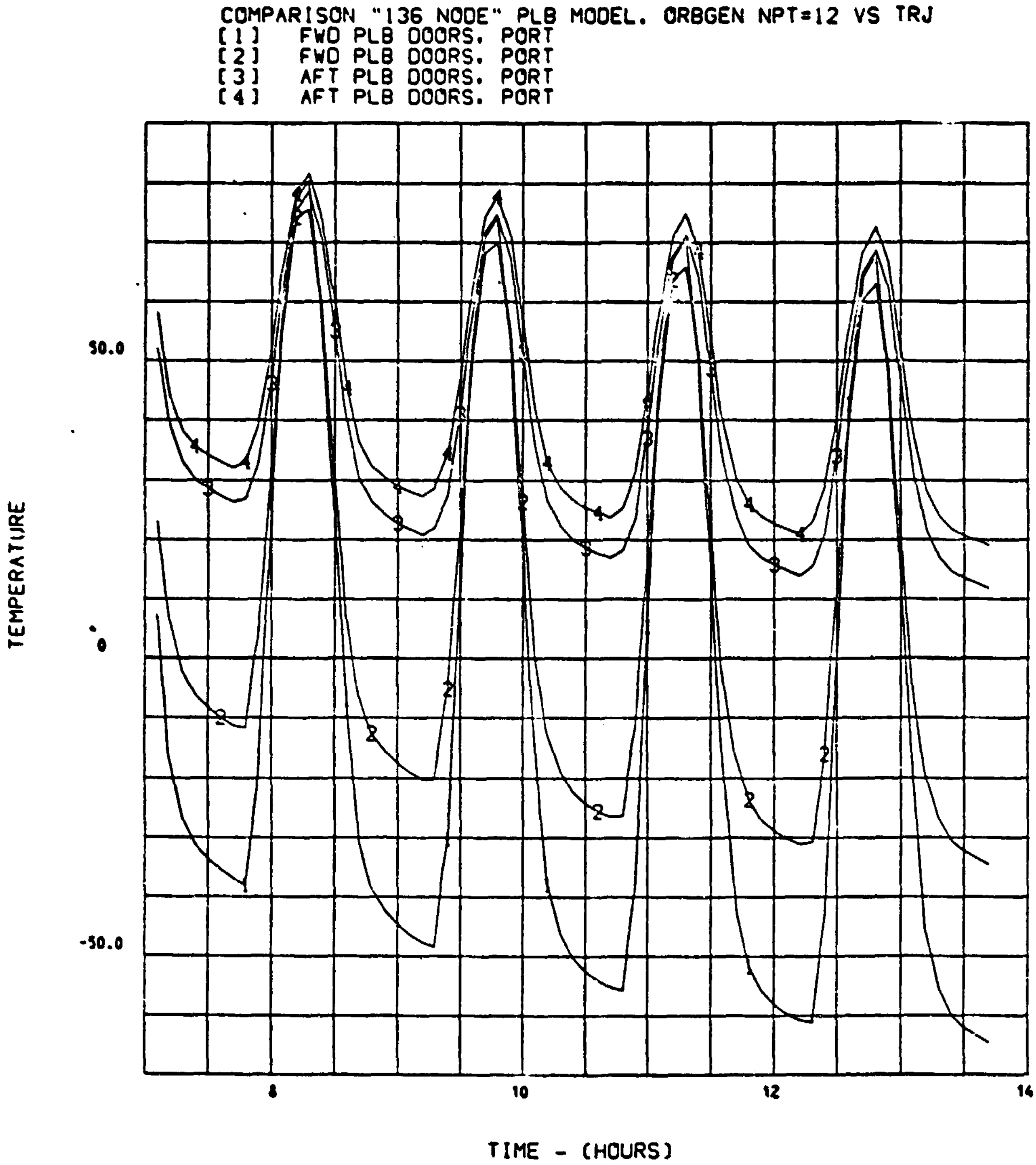

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD PLB DOORS. PORT
[2] FWD PLB DOORS. PORT
[3] AFT PLB DOORS. PORT
[4] AFT PLB DOORS. PORT
50.0
0
-50.0
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 32

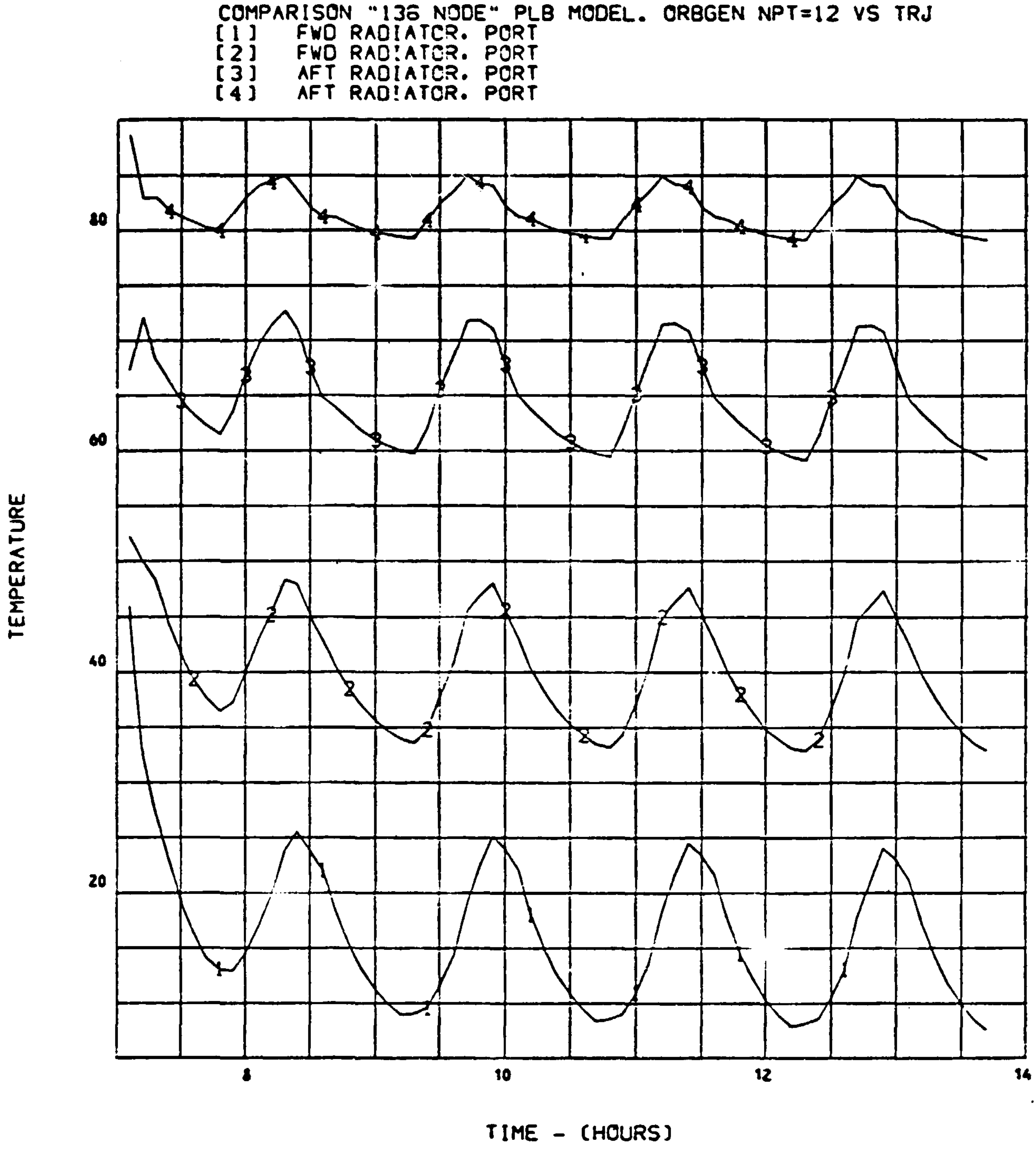
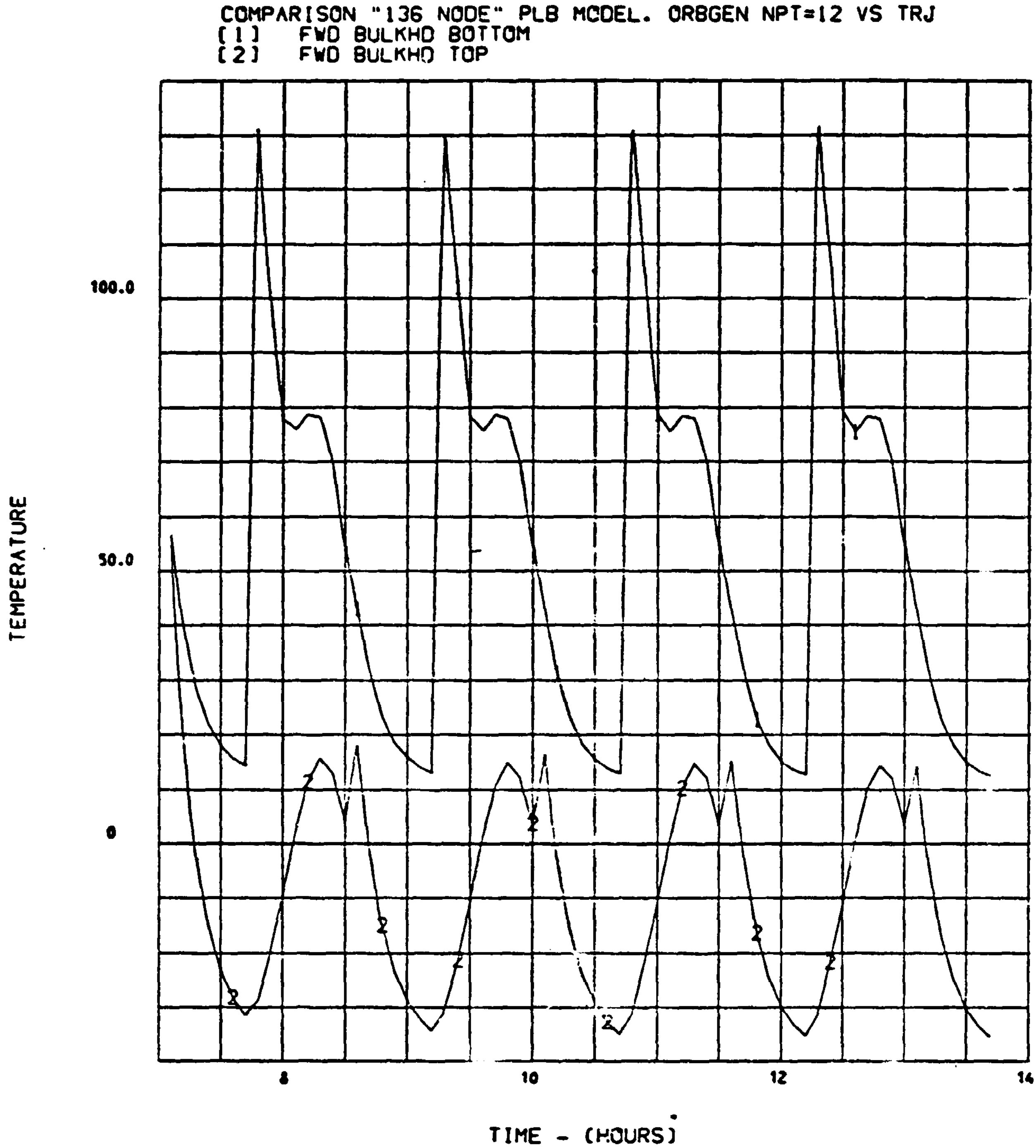

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD RADIATOR. PORT
[2] FWD RADIATOR. PORT
[3] AFT RADIATOR. PORT
[4] AFT RADIATOR. PORT
80
60
40
20
8
10
12
14
TEMPERATURE
TIME - (HOURS)

Figure 33



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD BULKHD BOTTOM
[2] FWD BULKHD TOP
100.0
50.0
0
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 34

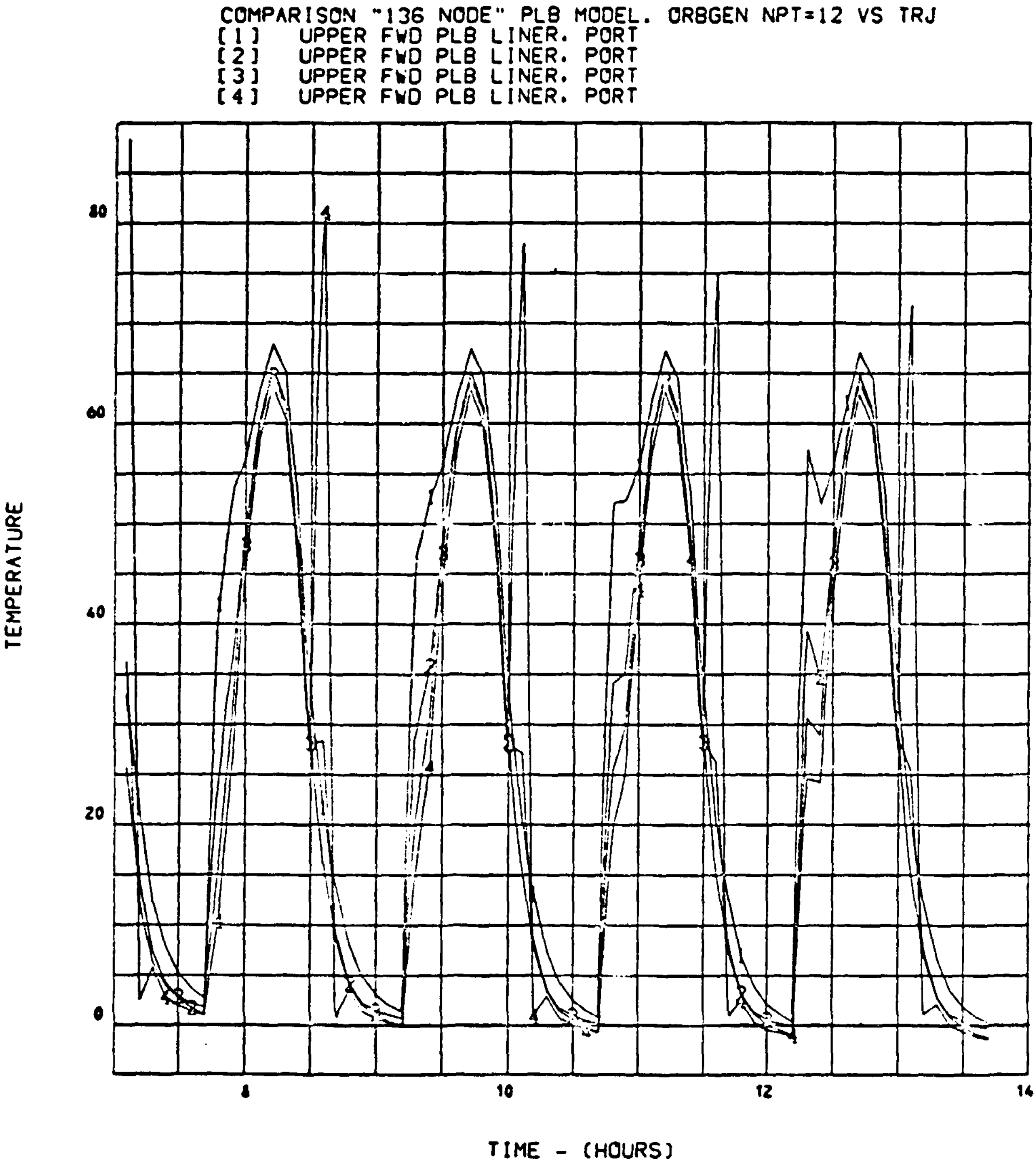

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] UPPER FWD PLB LINER. PORT
[2] UPPER FWD PLB LINER. PORT
[3] UPPER FWD PLB LINER. PORT
[4] UPPER FWD PLB LINER. PORT
TEMPERATURE
80
60
40
20
0
8
10
12
14
TIME - (HOURS)

Figure 35

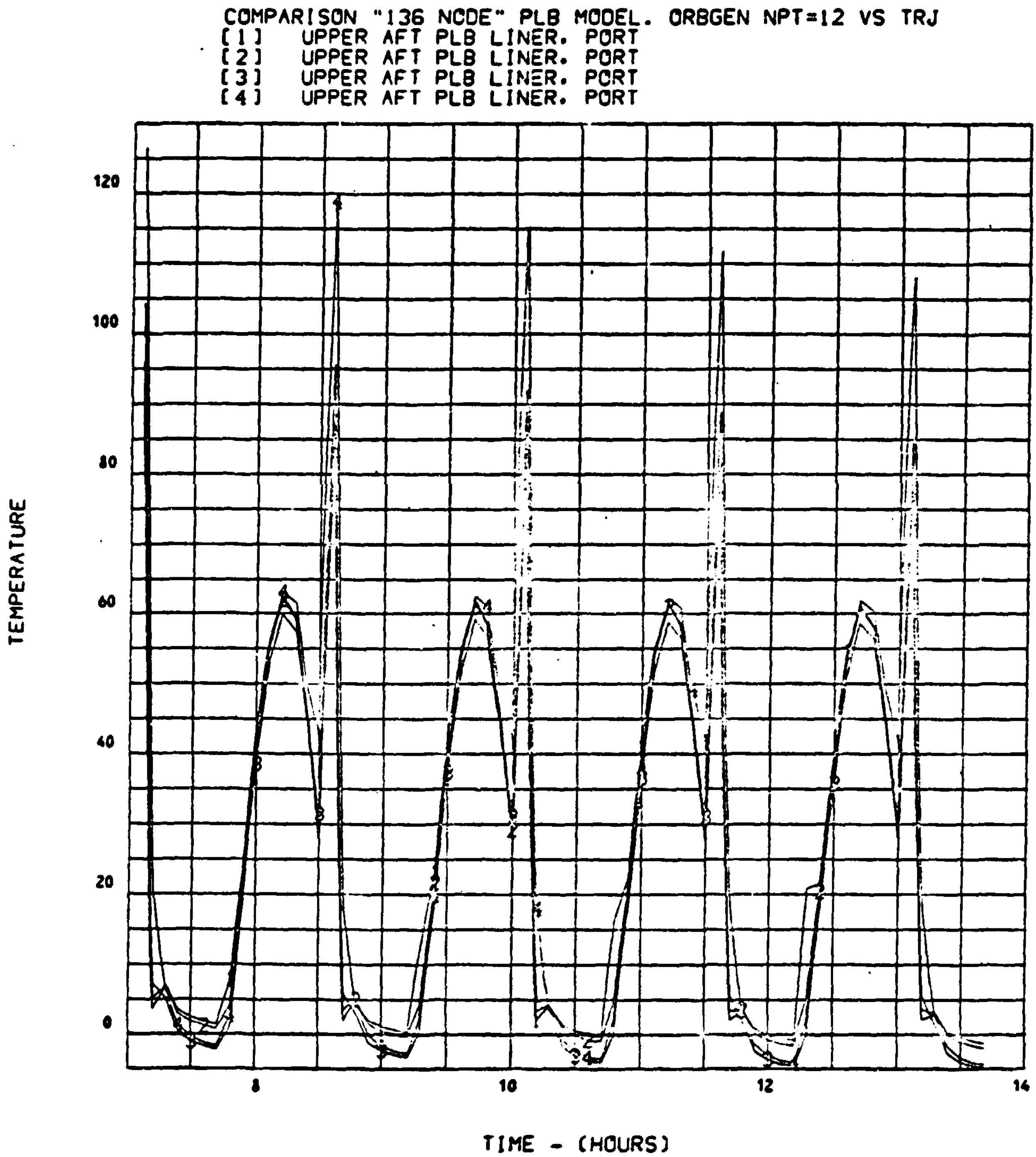

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] UPPER AFT PLB LINER. PORT
[2] UPPER AFT PLB LINER. PORT
[3] UPPER AFT PLB LINER. PORT
[4] UPPER AFT PLB LINER. PORT
120
100
80
60
40
20
0
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 36

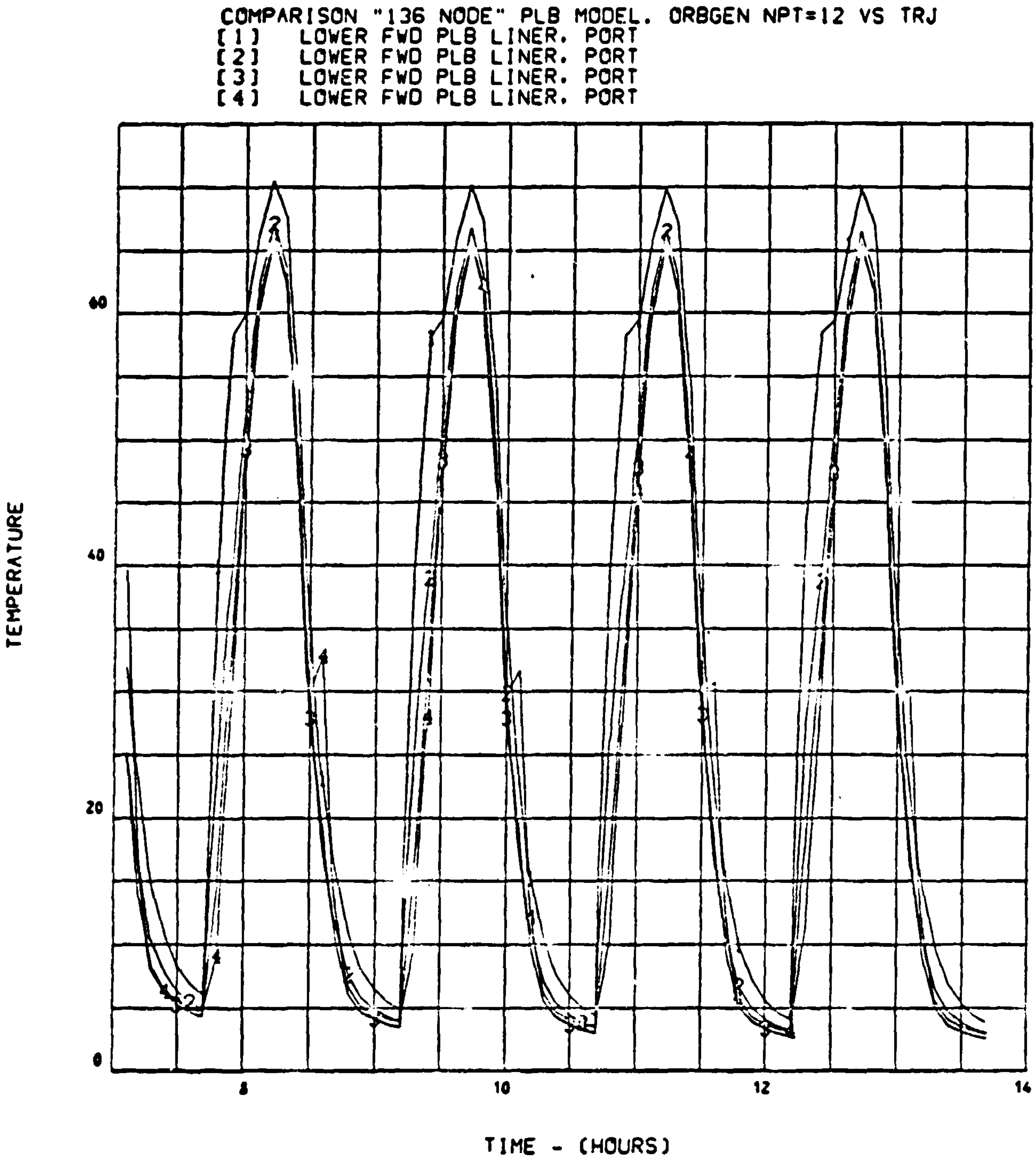

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] LOWER FWD PLB LINER. PORT
[2] LOWER FWD PLB LINER. PORT
[3] LOWER FWD PLB LINER. PORT
[4] LOWER FWD PLB LINER. PORT
TEMPERATURE
60
40
20
0
8
10
12
14
TIME - (HOURS)

Figure 37

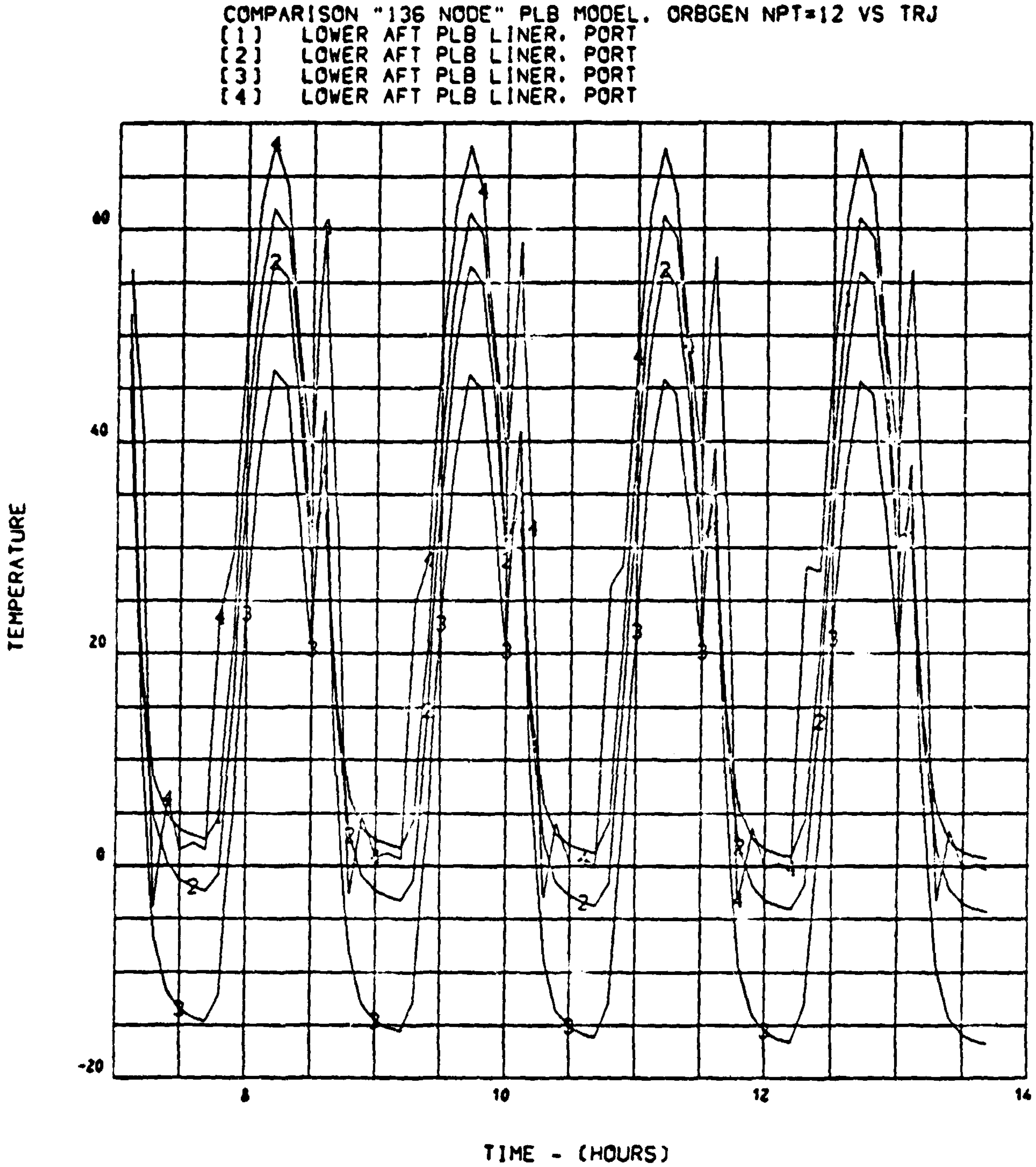

COMPARISON "136 NODE" PLB MODEL, ORBGEN NPT=12 VS TRJ
[1] LOWER AFT PLB LINER, PORT
[2] LOWER AFT PLB LINER, PORT
[3] LOWER AFT PLB LINER, PORT
[4] LOWER AFT PLB LINER, PORT
TEMPERATURE
60
40
20
0
-20
8
10
12
14
TIME - (HOURS)

Figure 38

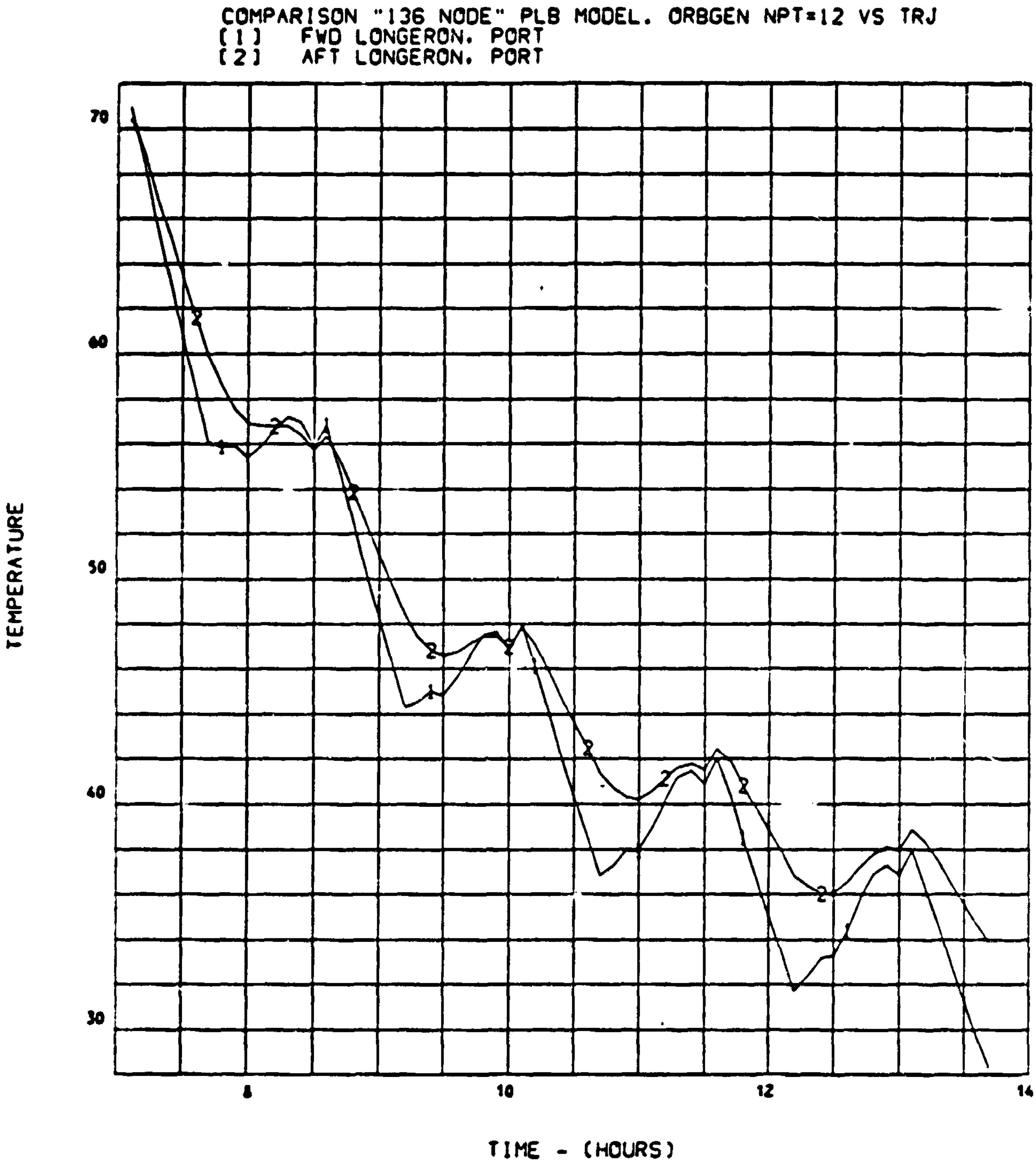

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD LONGERON. PORT
[2] AFT LONGERON. PORT
70
60
50
40
30
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 39

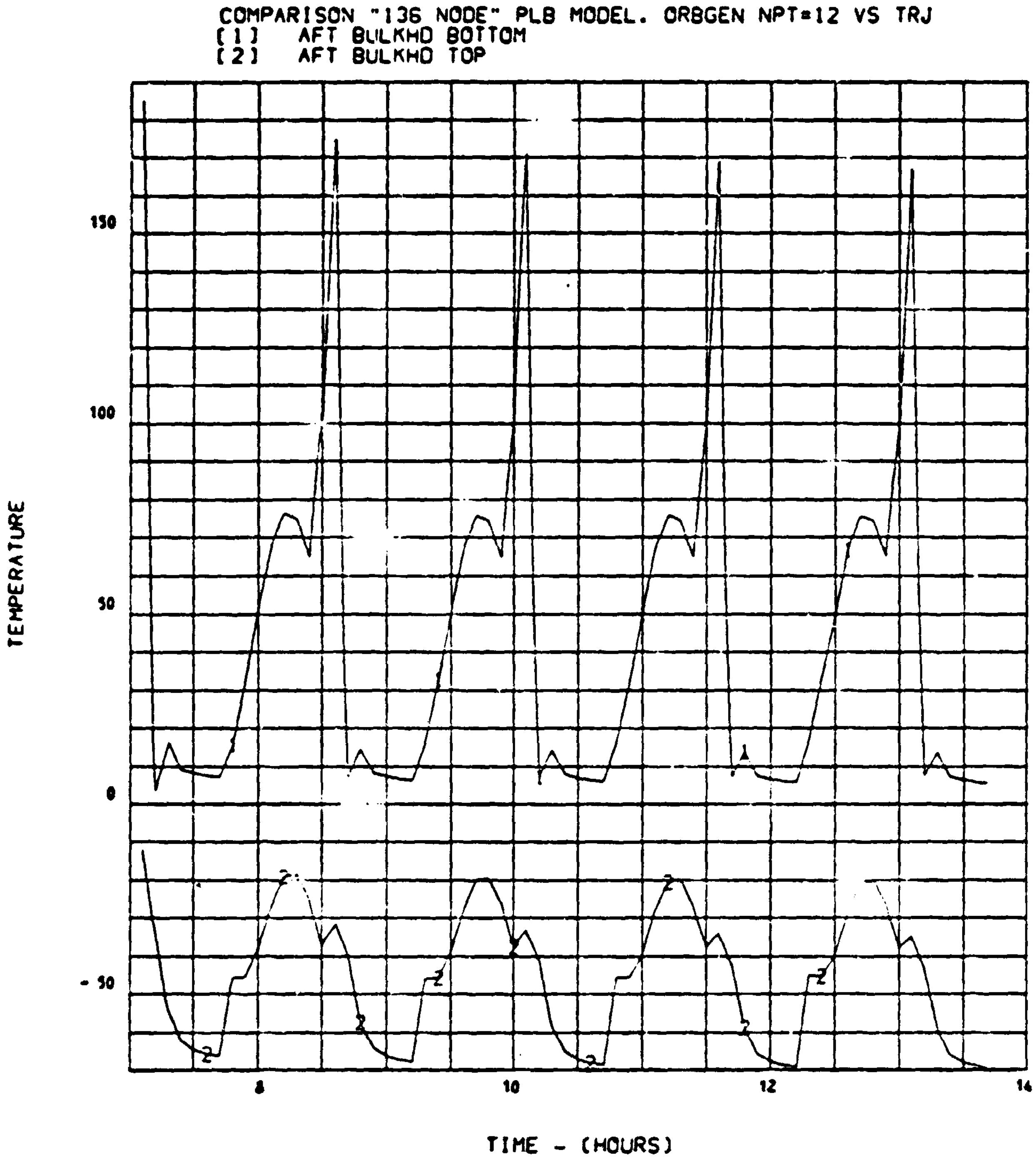
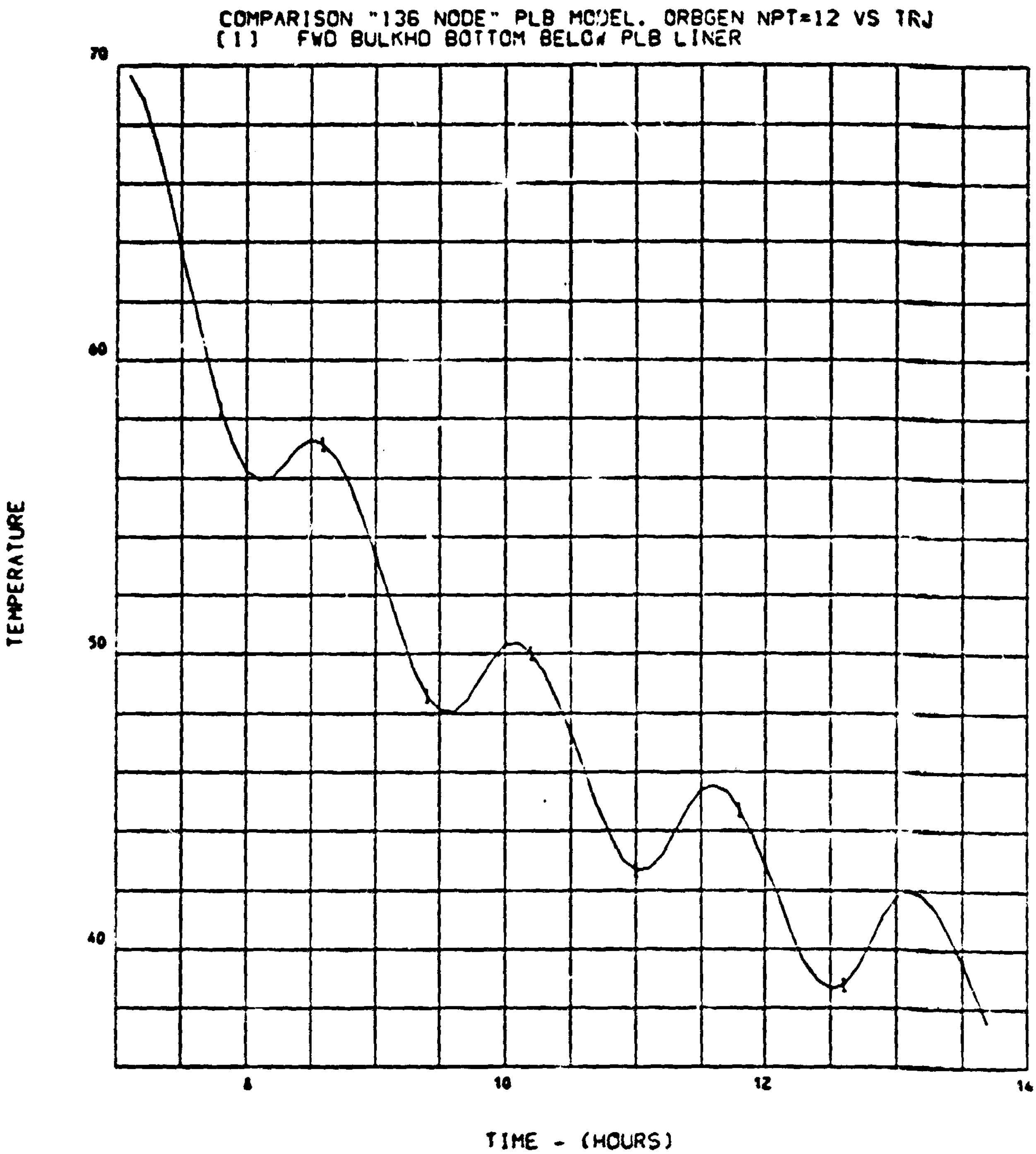

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] AFT BULKHD BOTTOM
[2] AFT BULKHD TOP
TEMPERATURE
150
100
50
0
-50
8
10
12
14
TIME - (HOURS)

Figure 40



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD BULKHD BOTTOM BELOW PLB LINER
70
60
50
40
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 41

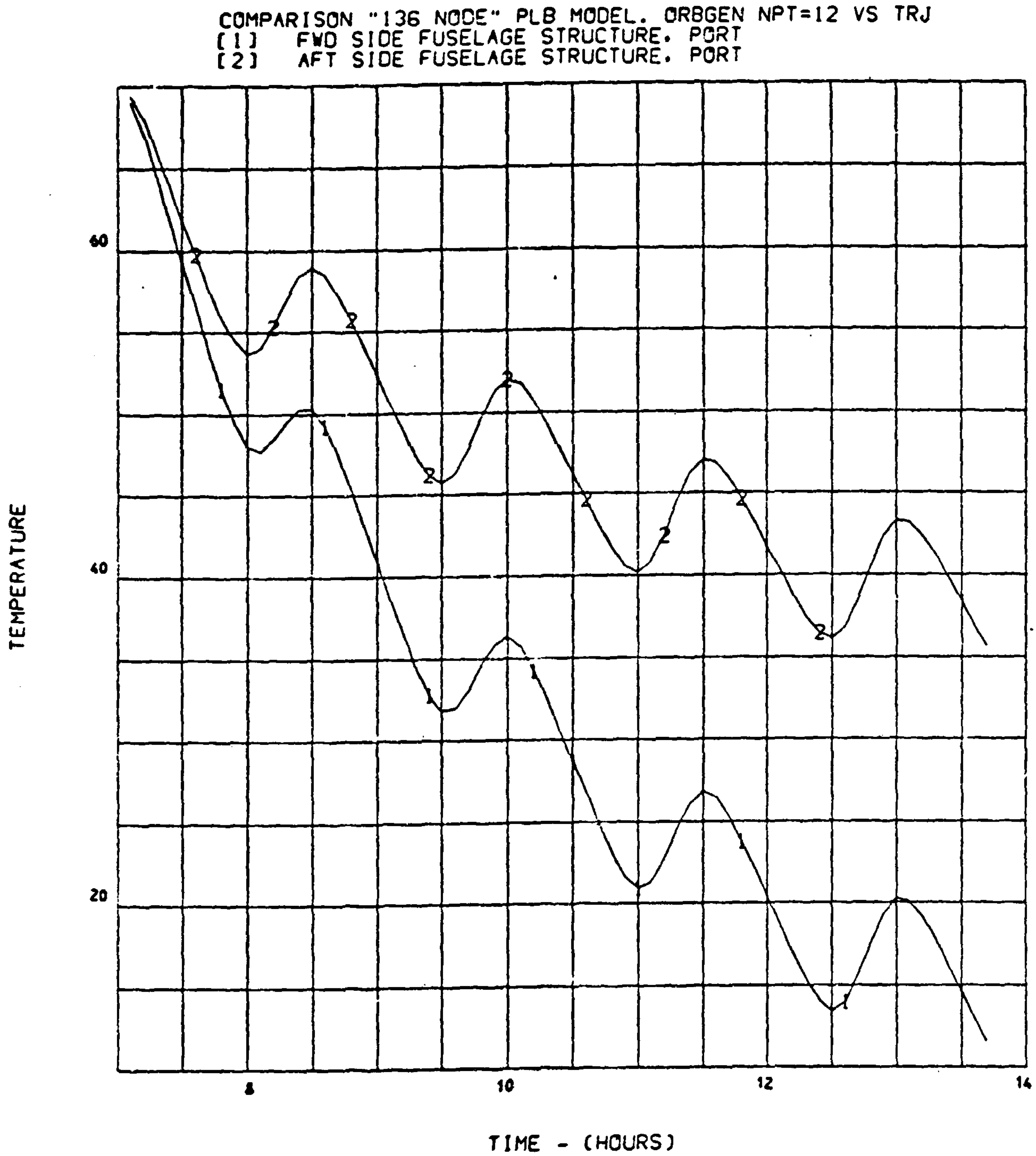

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD SIDE FUSELAGE STRUCTURE. PORT
[2] AFT SIDE FUSELAGE STRUCTURE. PORT
TEMPERATURE
60
40
20
8
10
12
14
TIME - (HOURS)

Figure 42

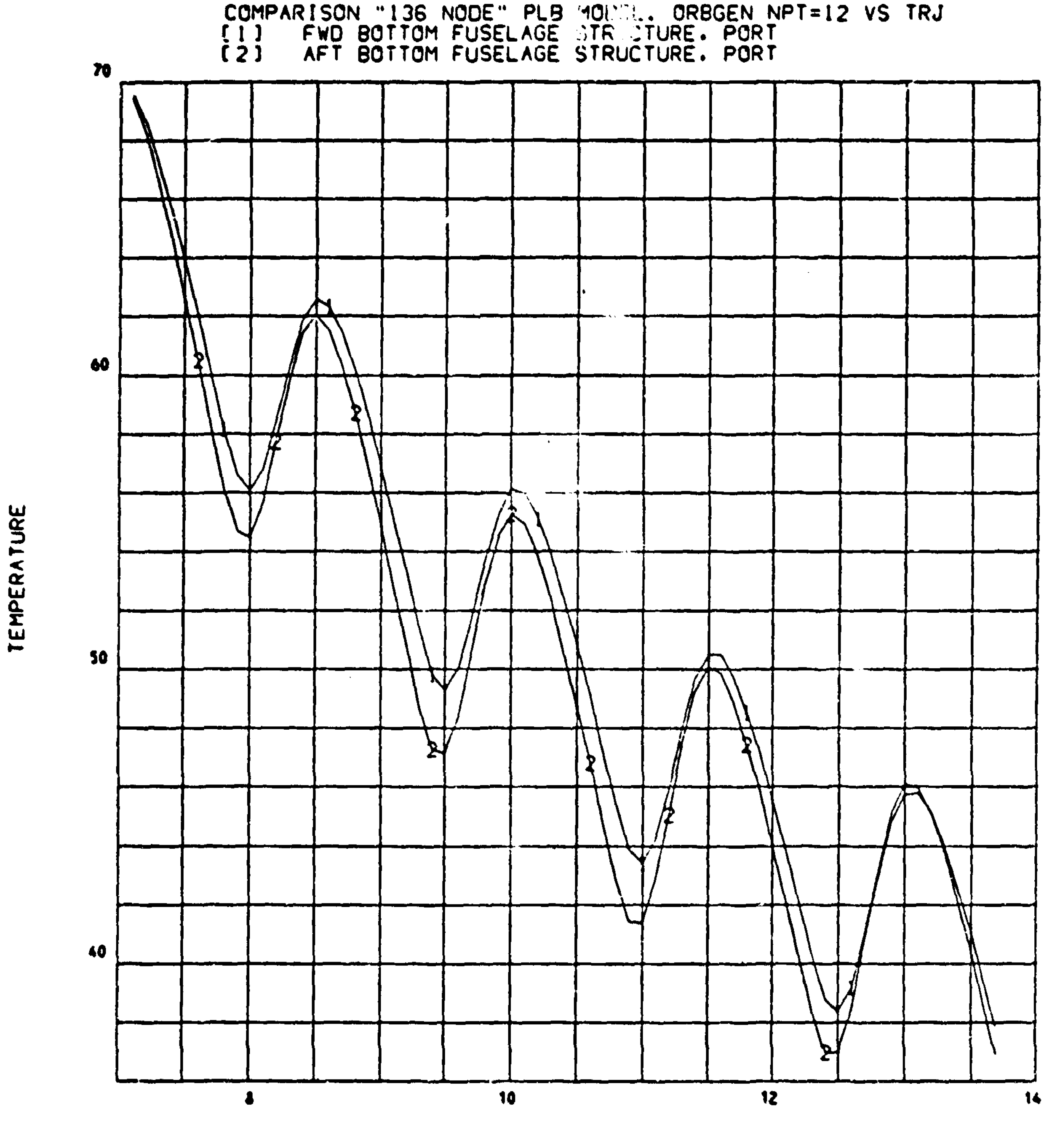
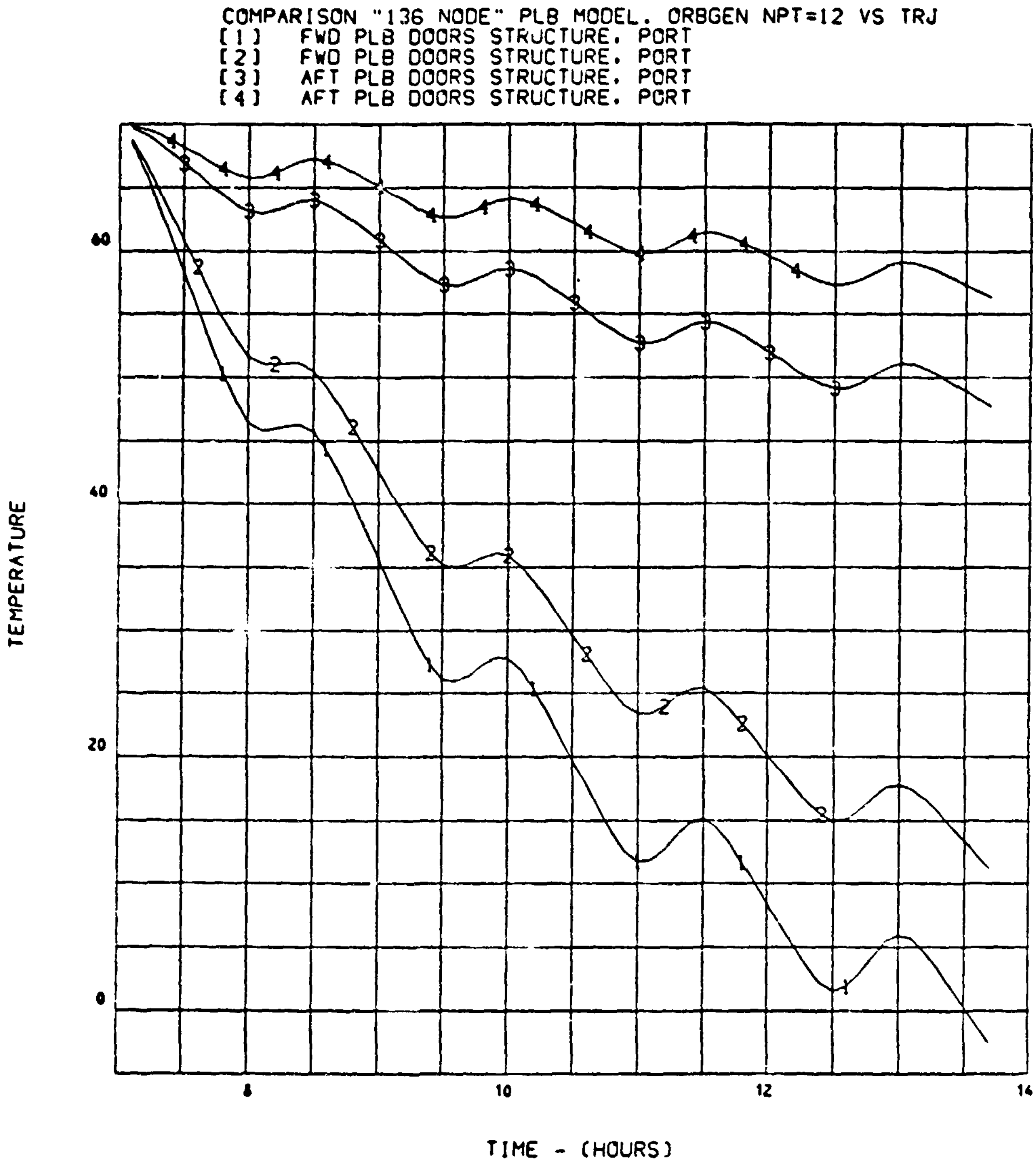

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD BOTTOM FUSELAGE STRUCTURE. PORT
[2] AFT BOTTOM FUSELAGE STRUCTURE. PORT
70
60
50
40
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 43



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD PLB DOORS STRUCTURE. PORT
[2] FWD PLB DOORS STRUCTURE. PORT
[3] AFT PLB DOORS STRUCTURE. PORT
[4] AFT PLB DOORS STRUCTURE. PORT
TEMPERATURE
60
40
20
0
8
10
12
14
TIME - (HOURS)

Figure 44

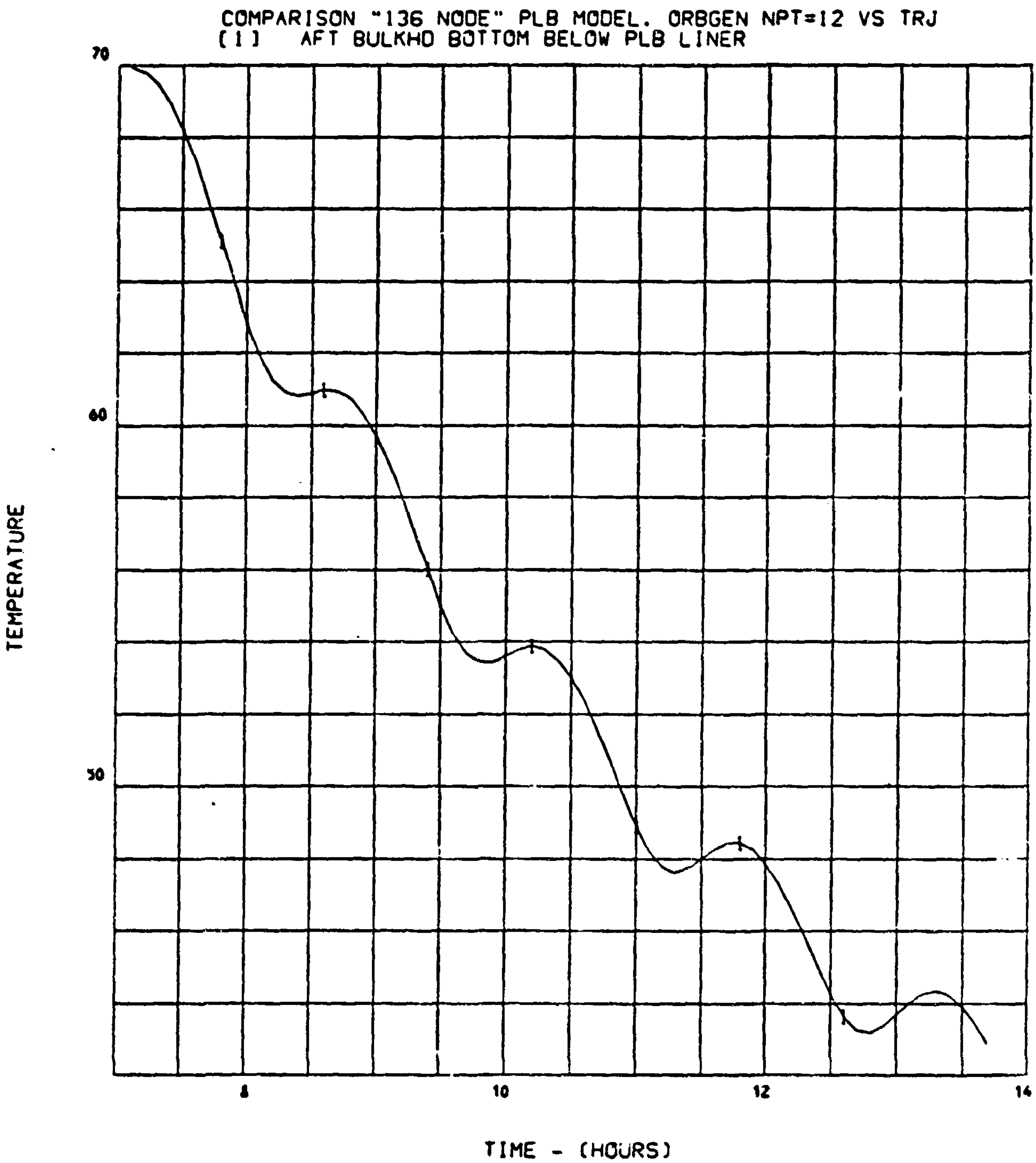

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] AFT BULKHD BOTTOM BELOW PLB LINER
70
60
50
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 45

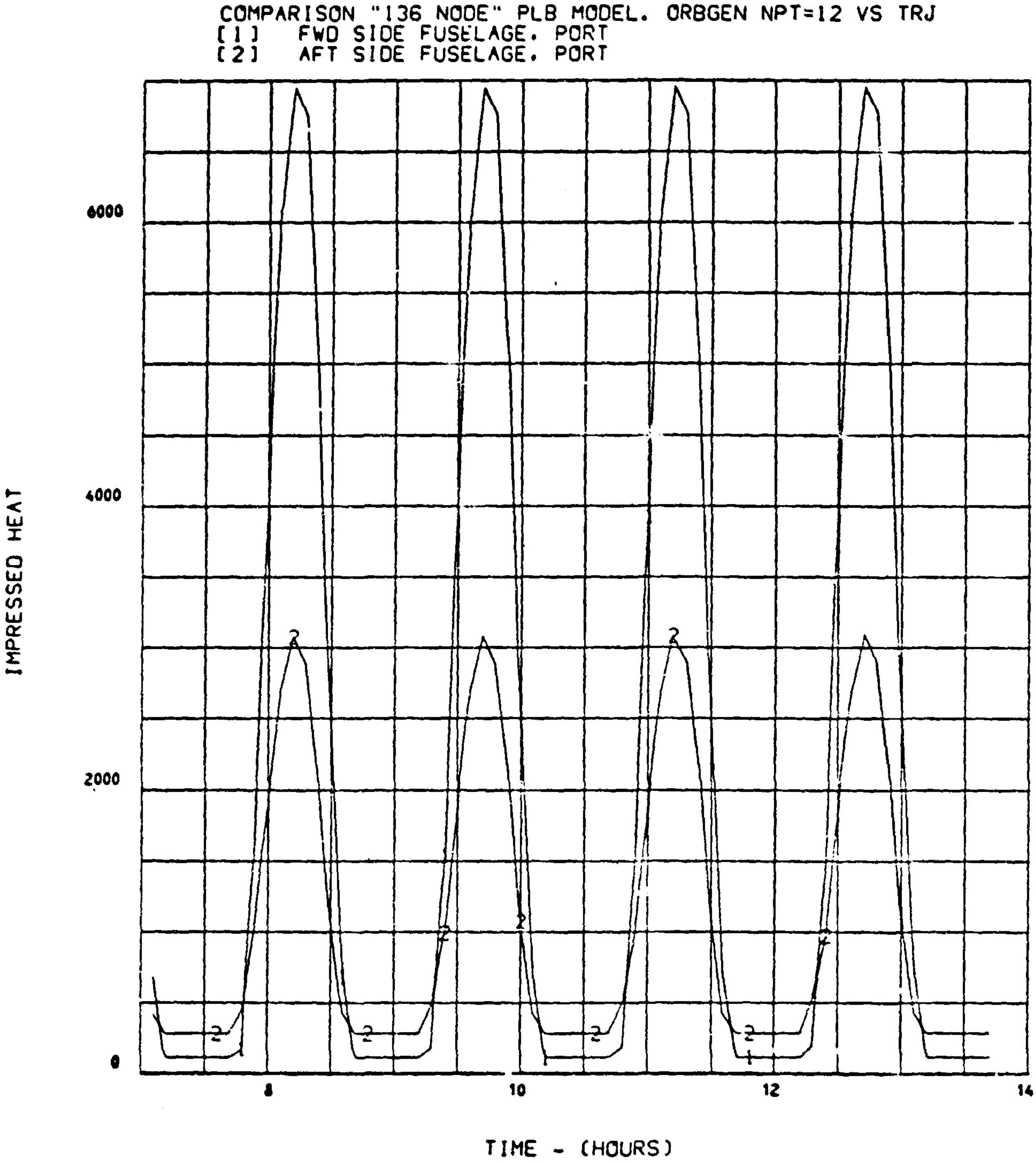

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD SIDE FUSELAGE. PORT
[2] AFT SIDE FUSELAGE. PORT
IMPRESSED HEAT
6000
4000
2000
0
8
10
12
14
TIME - (HOURS)

Figure 46

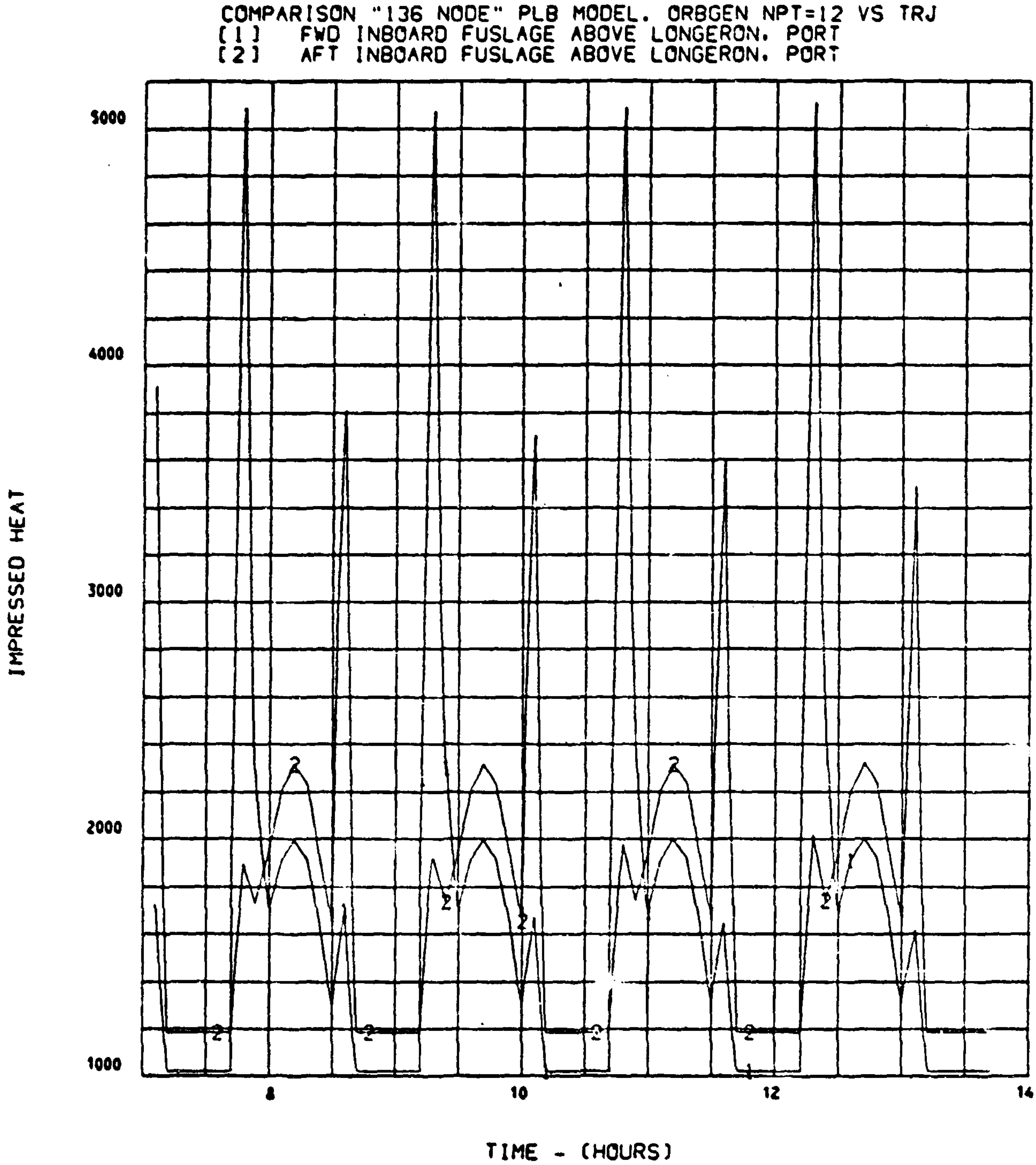
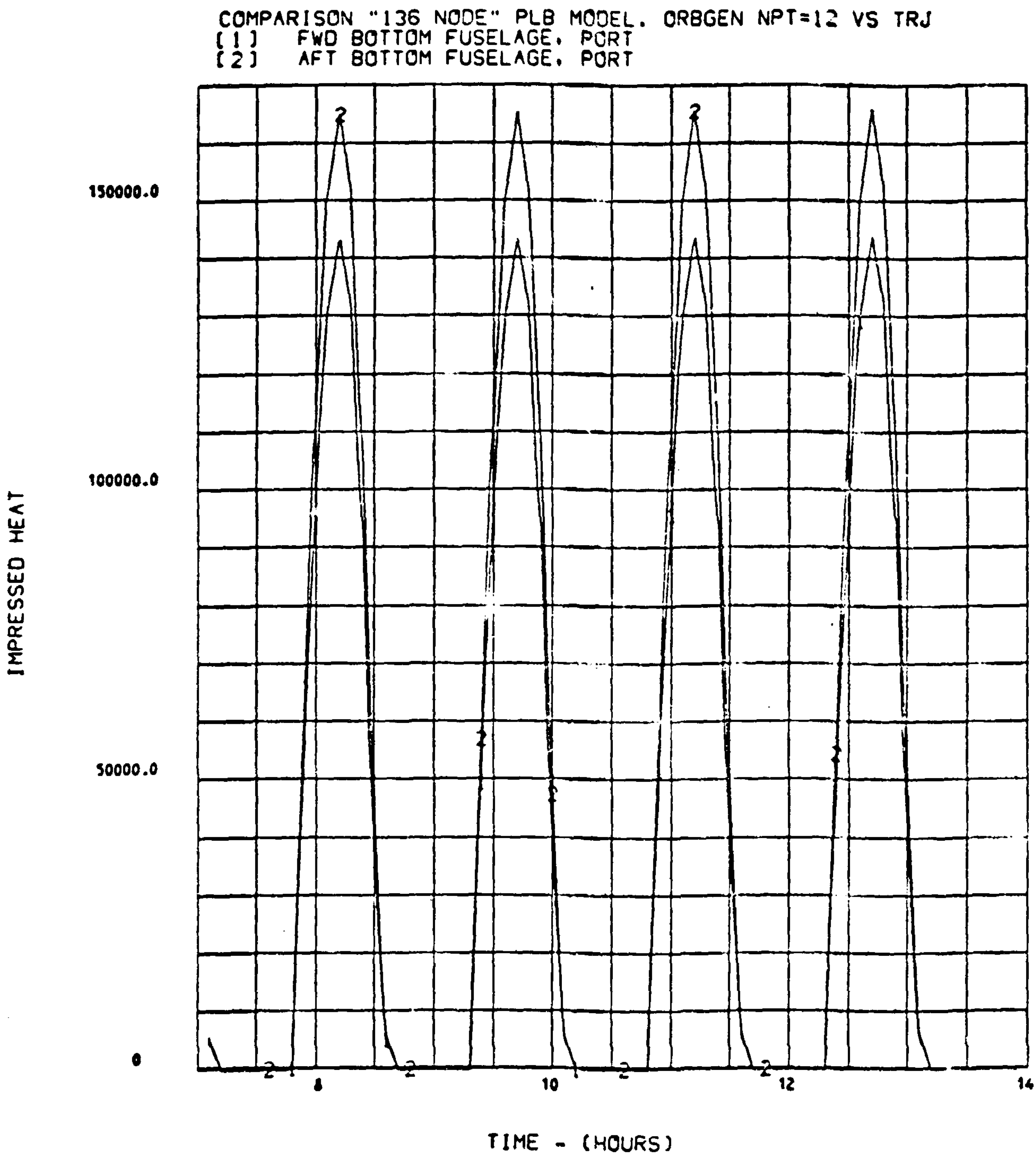

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD INBOARD FUSLAGE ABOVE LONGERON. PORT
[2] AFT INBOARD FUSLAGE ABOVE LONGERON. PORT
IMPRESSED HEAT
5000
4000
3000
2000
1000
8
10
12
14
TIME - (HOURS)

Figure 47



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD BOTTOM FUSELAGE, PORT
[2] AFT BOTTOM FUSELAGE, PORT
150000.0
100000.0
50000.0
0
8
10
12
14
IMPRESSED HEAT
TIME - (HOURS)

Figure 48

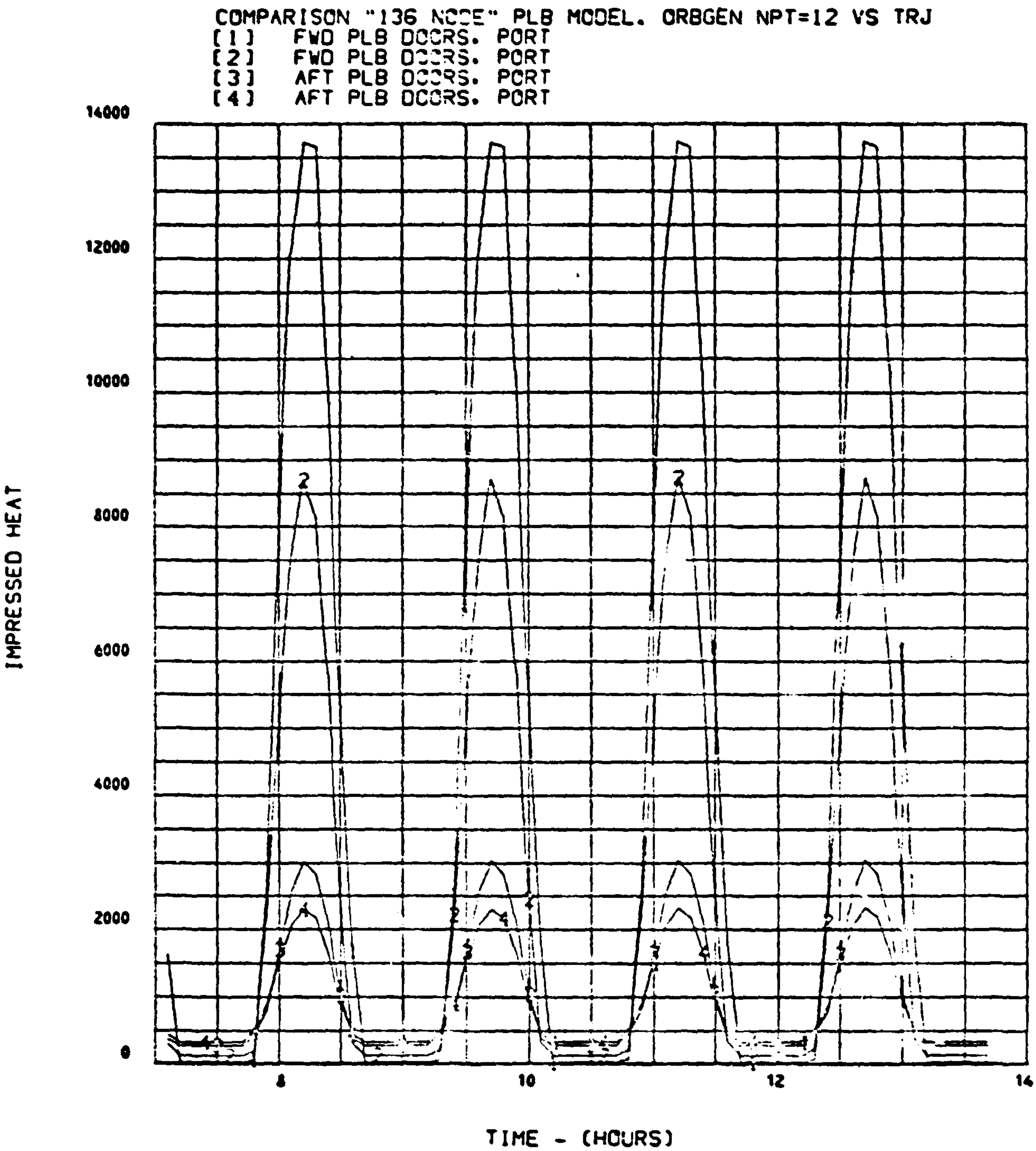

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD PLB DOORS. PORT
[2] FWD PLB DOORS. PORT
[3] AFT PLB DOORS. PORT
[4] AFT PLB DOORS. PORT
IMPRESSED HEAT
14000
12000
10000
8000
6000
4000
2000
0
8
10
12
14
TIME - (HOURS)

Figure 49

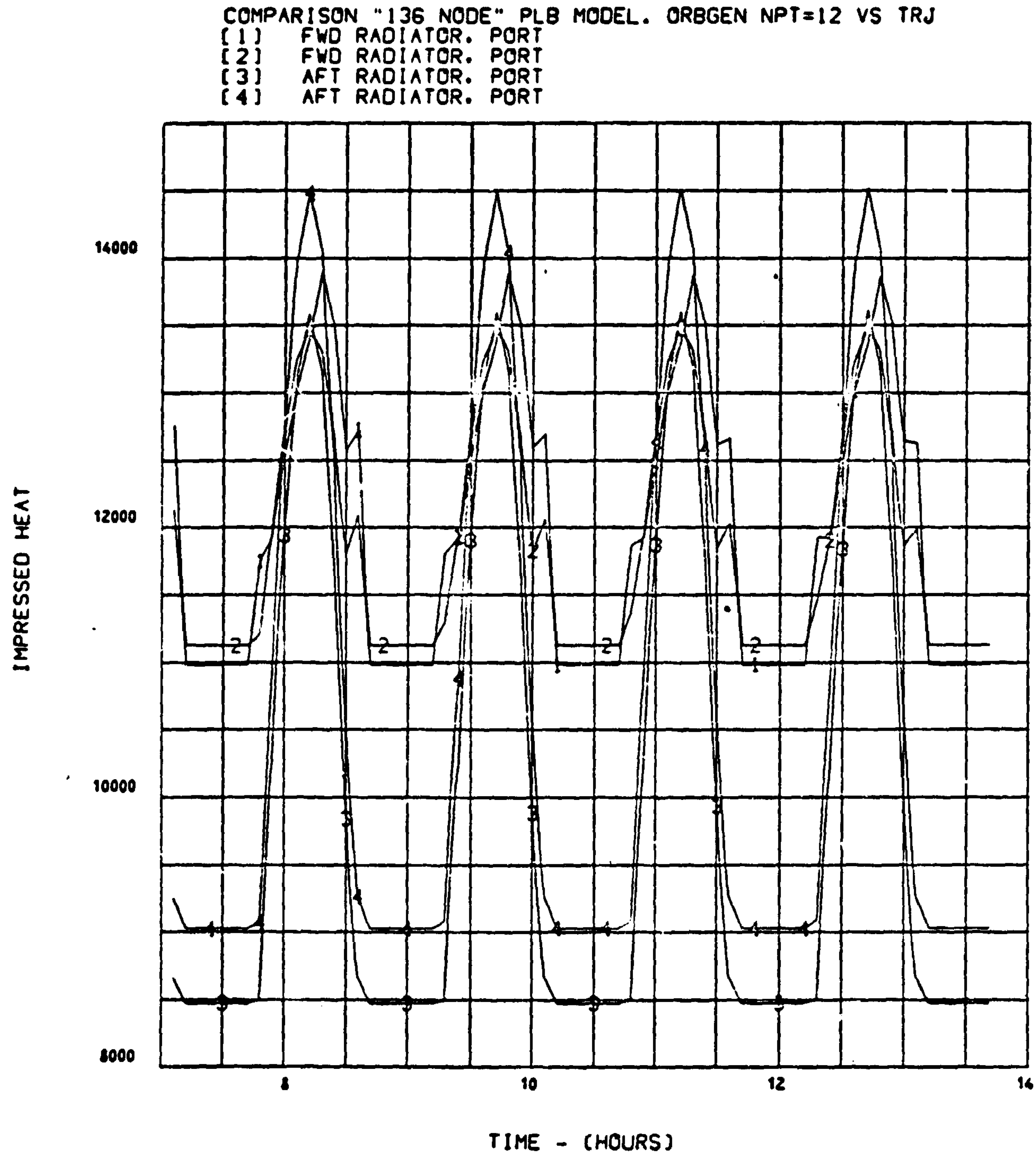

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD RADIATOR. PORT
[2] FWD RADIATOR. PORT
[3] AFT RADIATOR. PORT
[4] AFT RADIATOR. PORT
IMPRESSED HEAT
14000
12000
10000
8000
8
10
12
14
TIME - (HOURS)

Figure 50

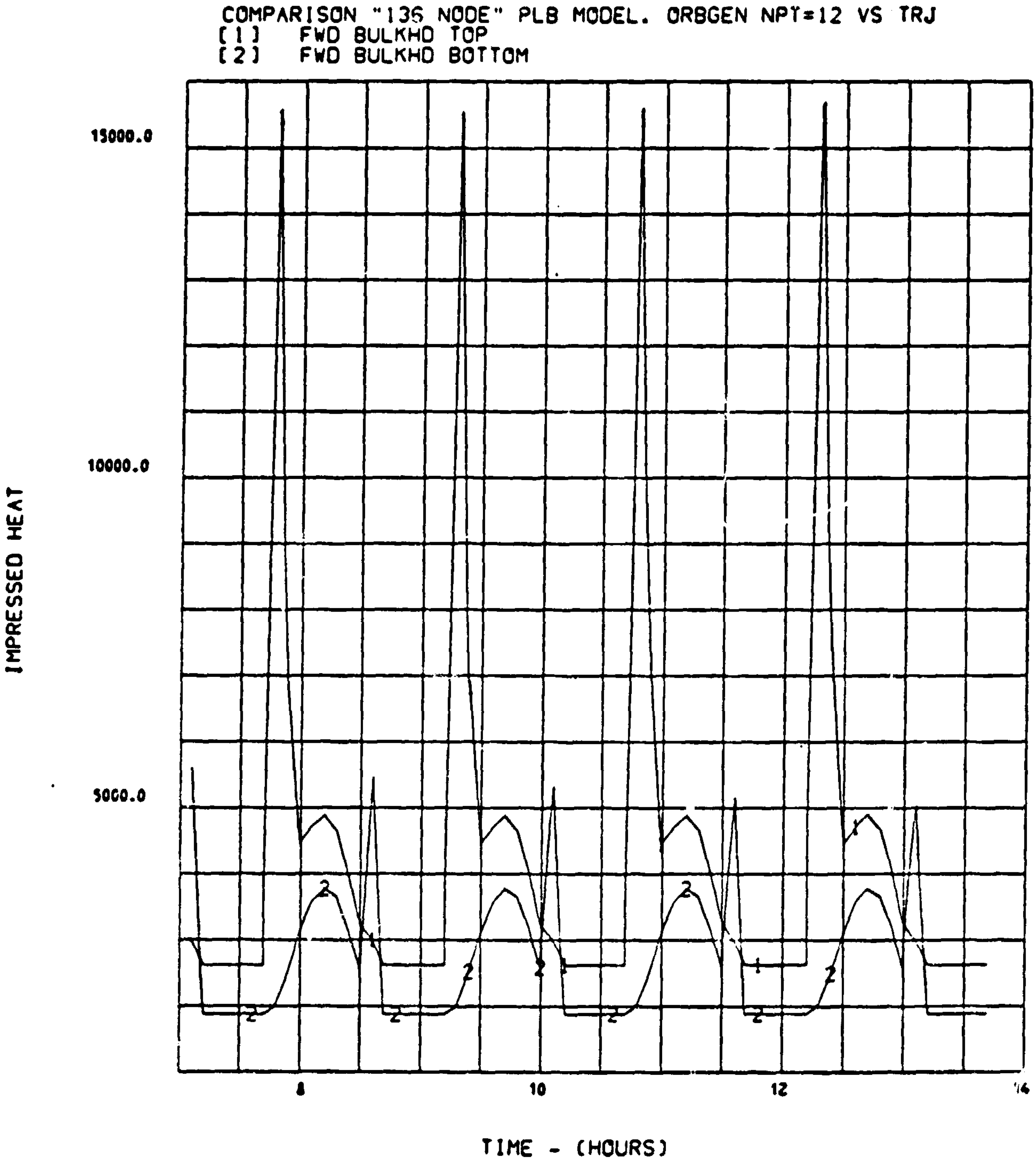
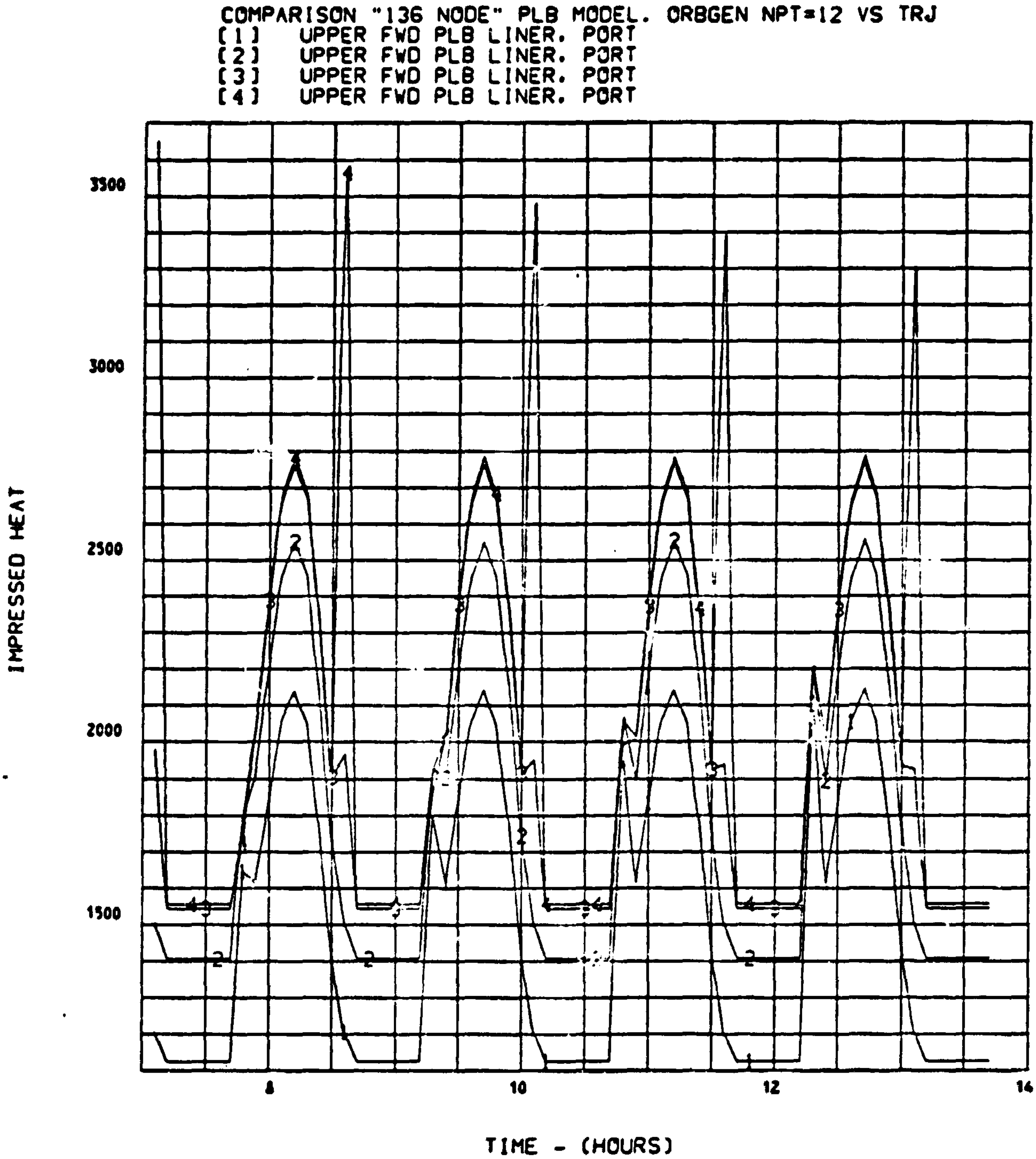
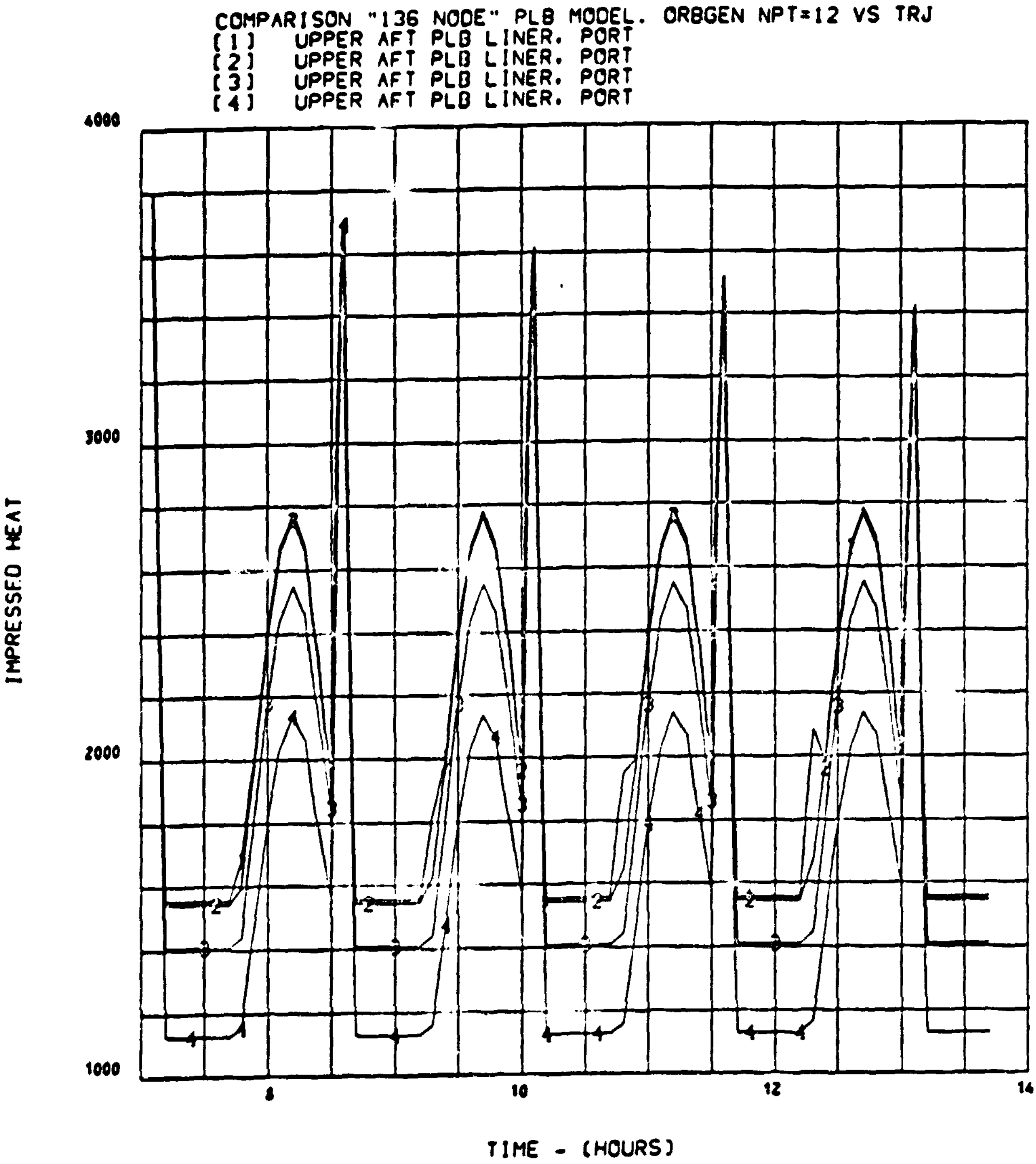

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD BULKHD TOP
[2] FWD BULKHD BOTTOM
15000.0
10000.0
5000.0
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 51



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] UPPER FWD PLB LINER. PORT
[2] UPPER FWD PLB LINER. PORT
[3] UPPER FWD PLB LINER. PORT
[4] UPPER FWD PLB LINER. PORT
IMPRESSED HEAT
3500
3000
2500
2000
1500
8
10
12
14
TIME - (HOURS)

Figure 52



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] UPPER AFT PLB LINER. PORT
[2] UPPER AFT PLB LINER. PORT
[3] UPPER AFT PLB LINER. PORT
[4] UPPER AFT PLB LINER. PORT
4000
3000
2000
1000
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 53

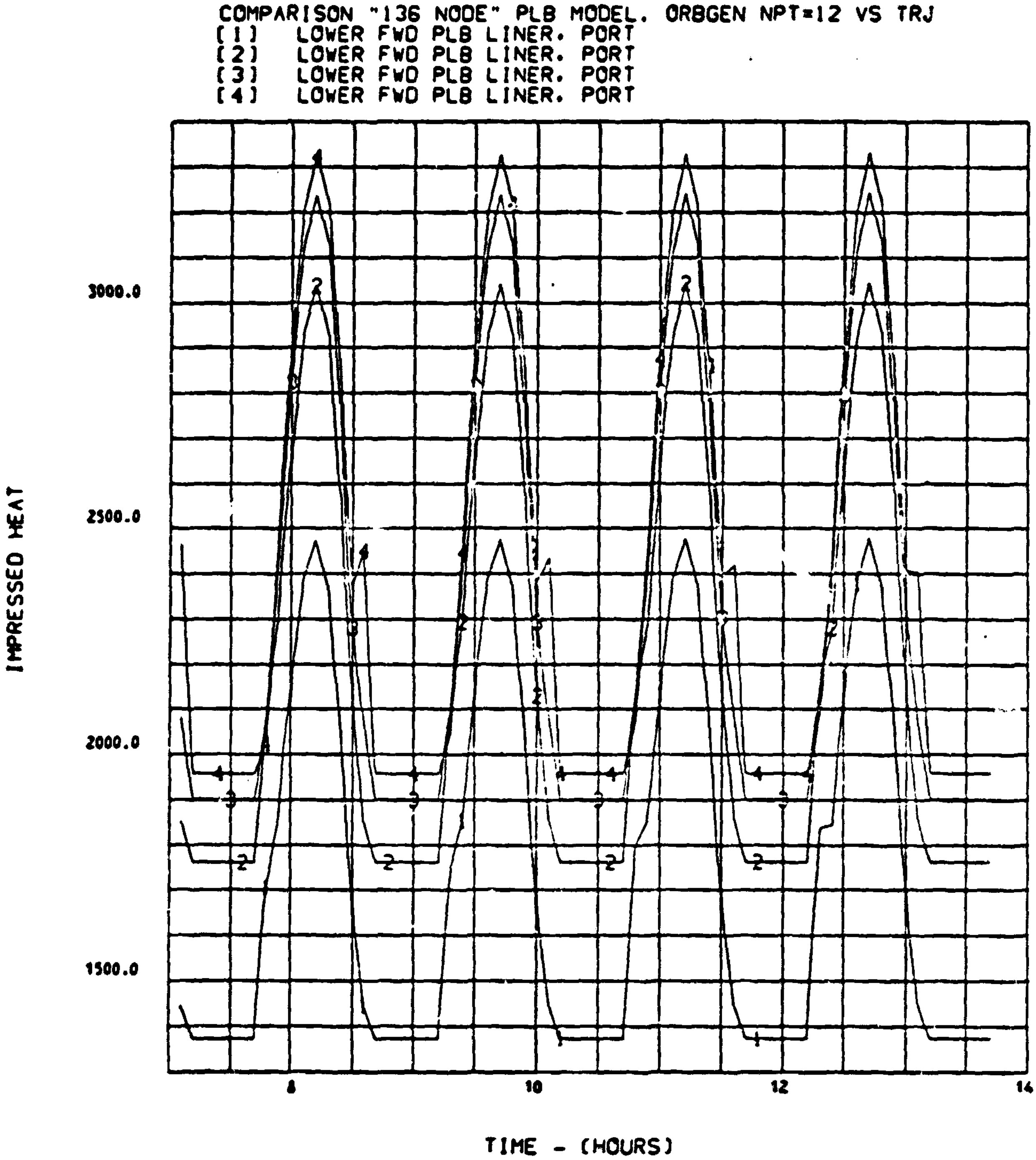

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] LOWER FWD PLB LINER. PORT
[2] LOWER FWD PLB LINER. PORT
[3] LOWER FWD PLB LINER. PORT
[4] LOWER FWD PLB LINER. PORT
IMPRESSED HEAT
3000.0
2500.0
2000.0
1500.0
8
10
12
14
TIME - (HOURS)

Figure 54

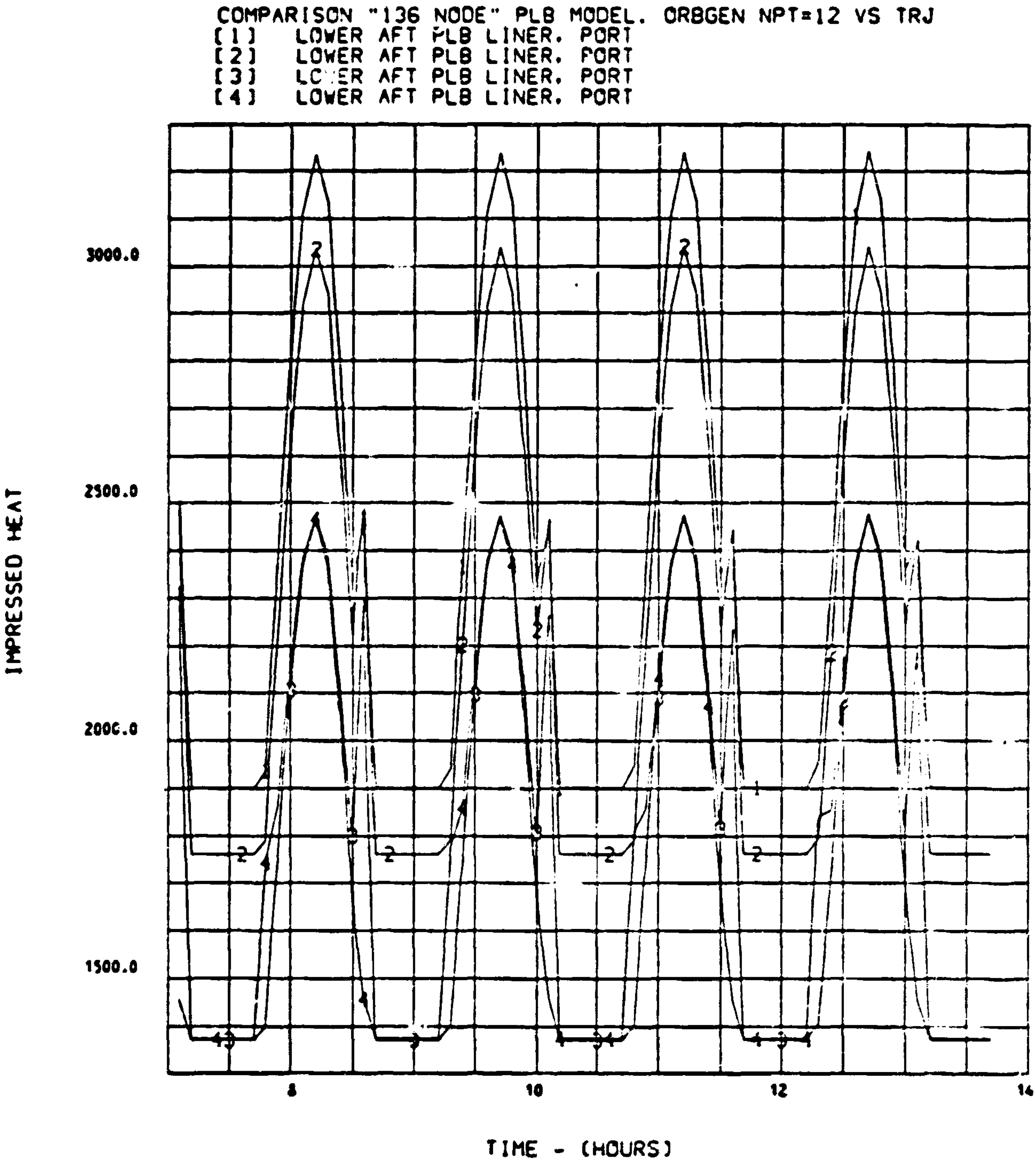

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] LOWER AFT PLB LINER. PORT
[2] LOWER AFT PLB LINER. PORT
[3] LOWER AFT PLB LINER. PORT
[4] LOWER AFT PLB LINER. PORT
3000.0
2500.0
2000.0
1500.0
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 55

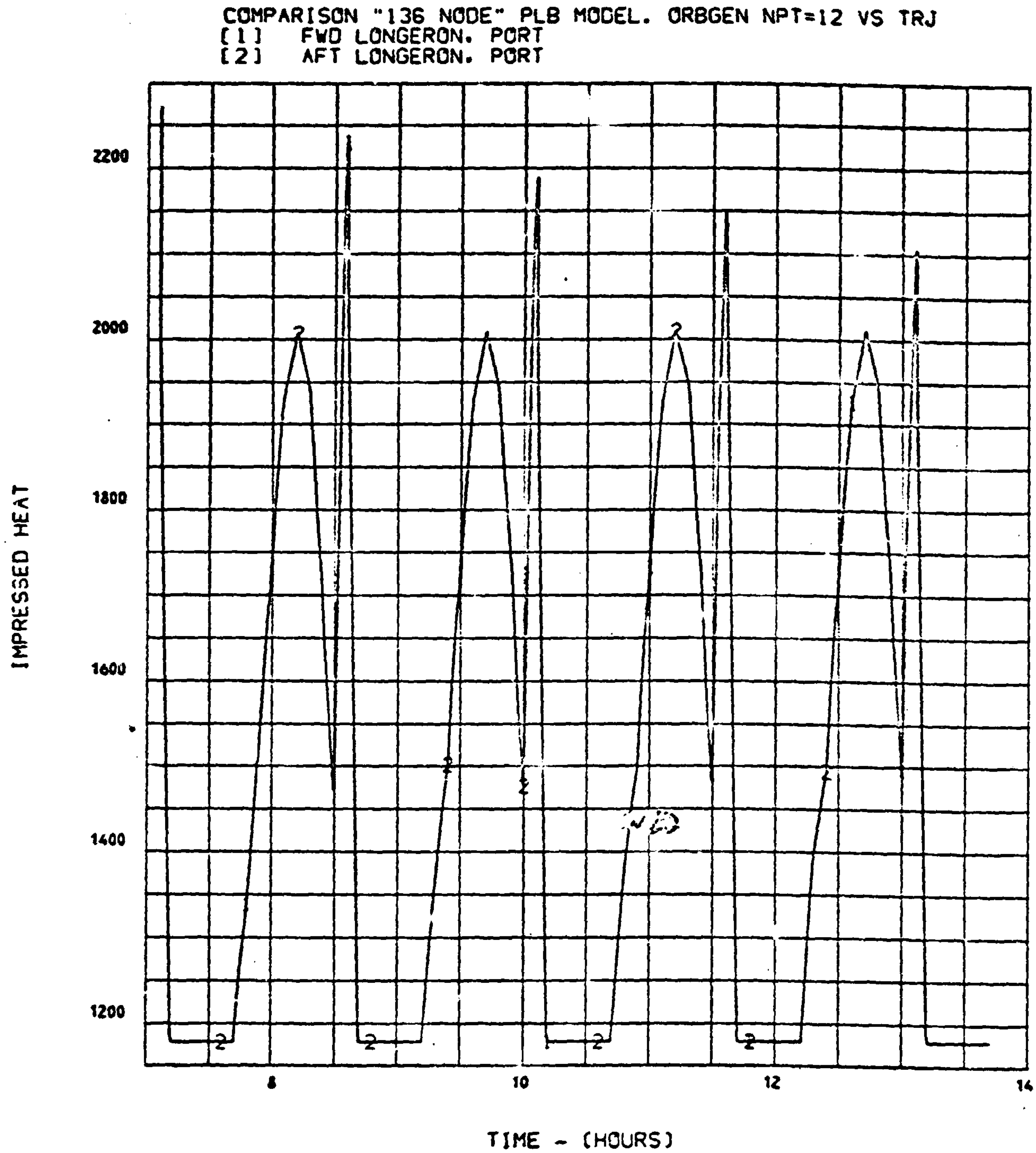

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=12 VS TRJ
[1] FWD LONGERON. PORT
[2] AFT LONGERON. PORT
IMPRESSED HEAT
2200
2000
1800
1600
1400
1200
8
10
12
14
TIME - (HOURS)

Figure 56

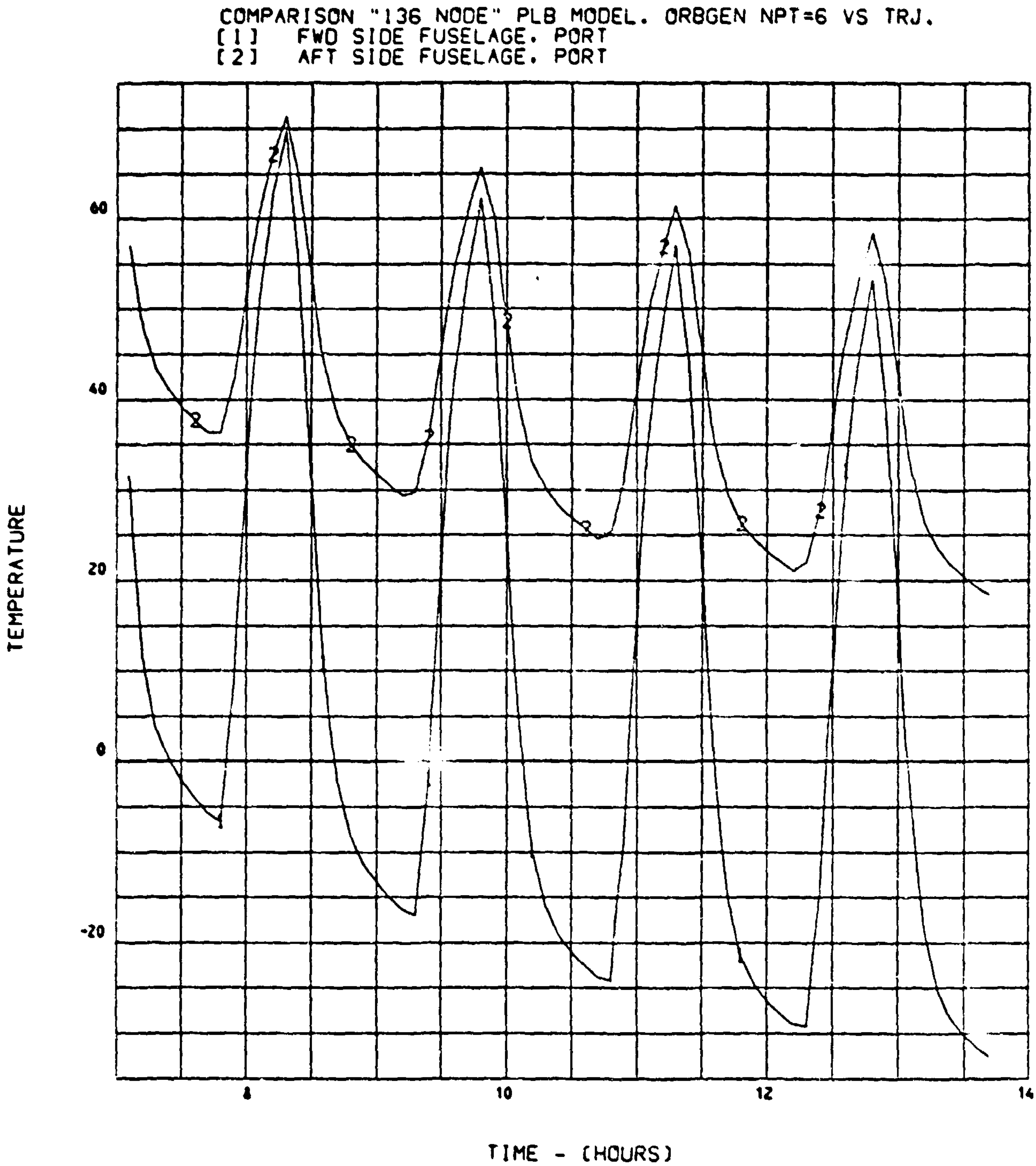

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD SIDE FUSELAGE. PORT
[2] AFT SIDE FUSELAGE. PORT
TEMPERATURE
60
40
20
0
-20
8
10
12
14
TIME - (HOURS)

Figure 57

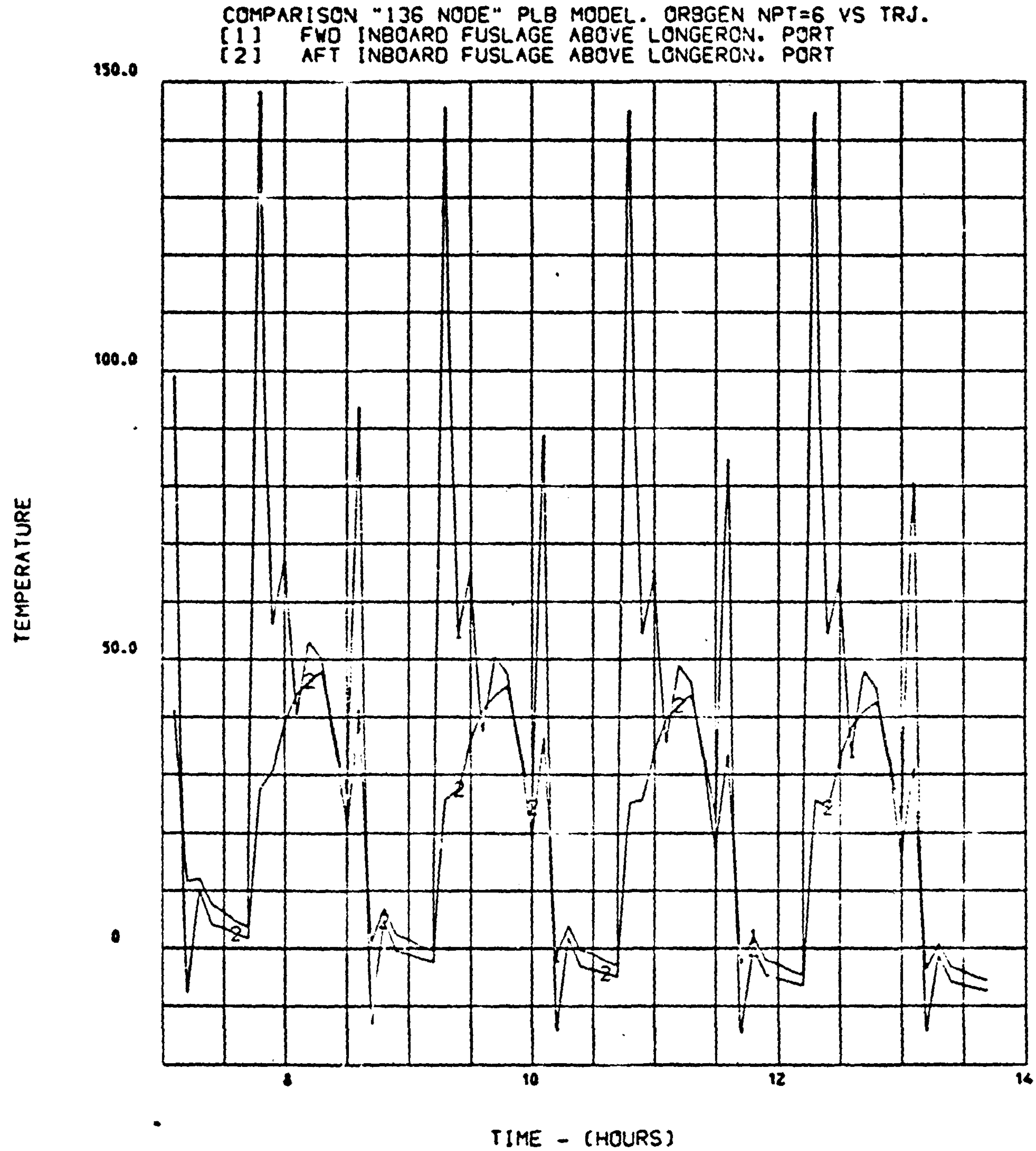
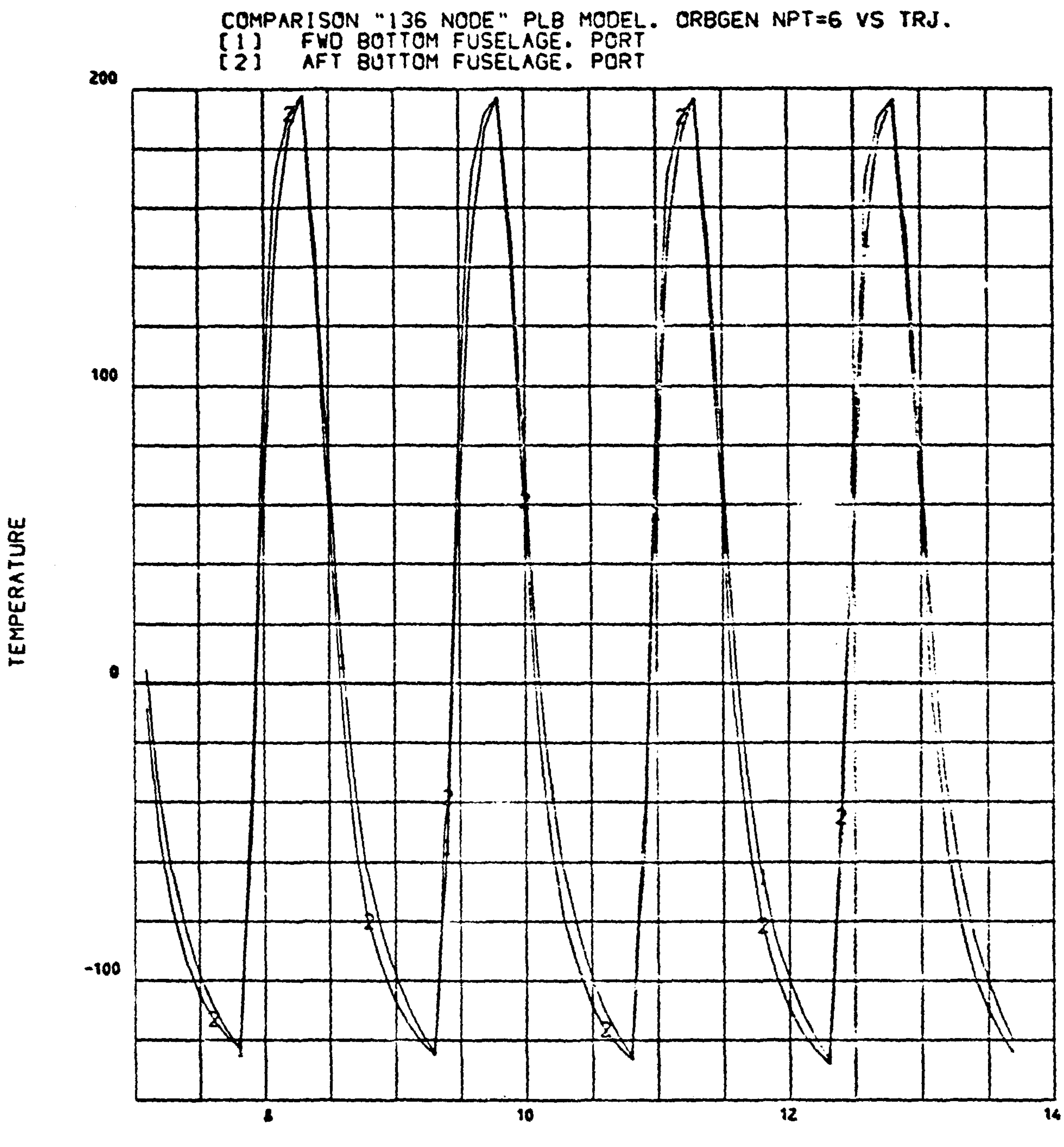

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD INBOARD FUSLAGE ABOVE LONGERON. PORT
[2] AFT INBOARD FUSLAGE ABOVE LONGERON. PORT
150.0
100.0
50.0
0
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 58



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD BOTTOM FUSELAGE. PORT
[2] AFT BOTTOM FUSELAGE. PORT
200
100
0
-100
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 59

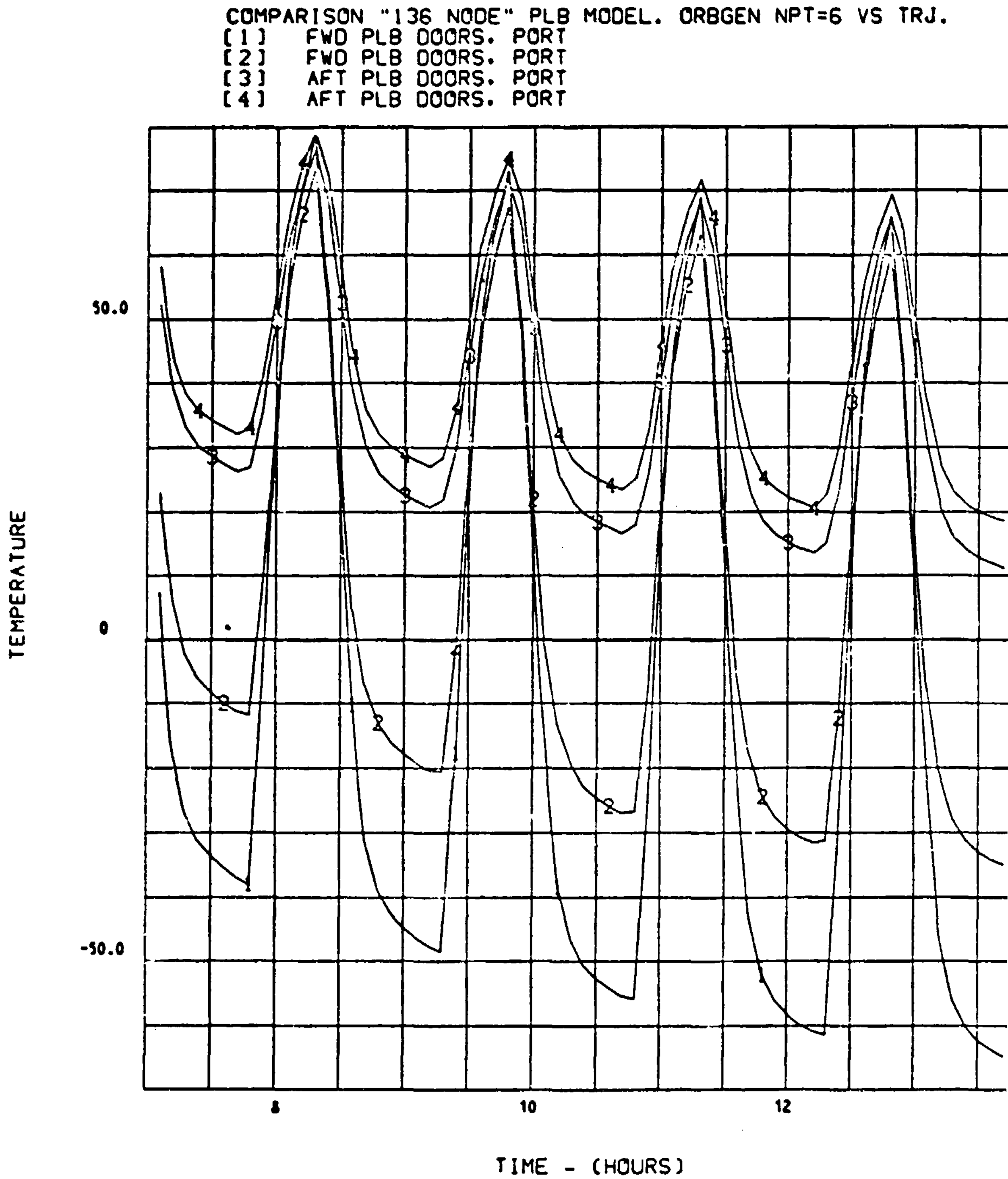

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD PLB DOORS. PORT
[2] FWD PLB DOORS. PORT
[3] AFT PLB DOORS. PORT
[4] AFT PLB DOORS. PORT
TEMPERATURE
50.0
0
-50.0
8
10
12
TIME - (HOURS)

Figure 60

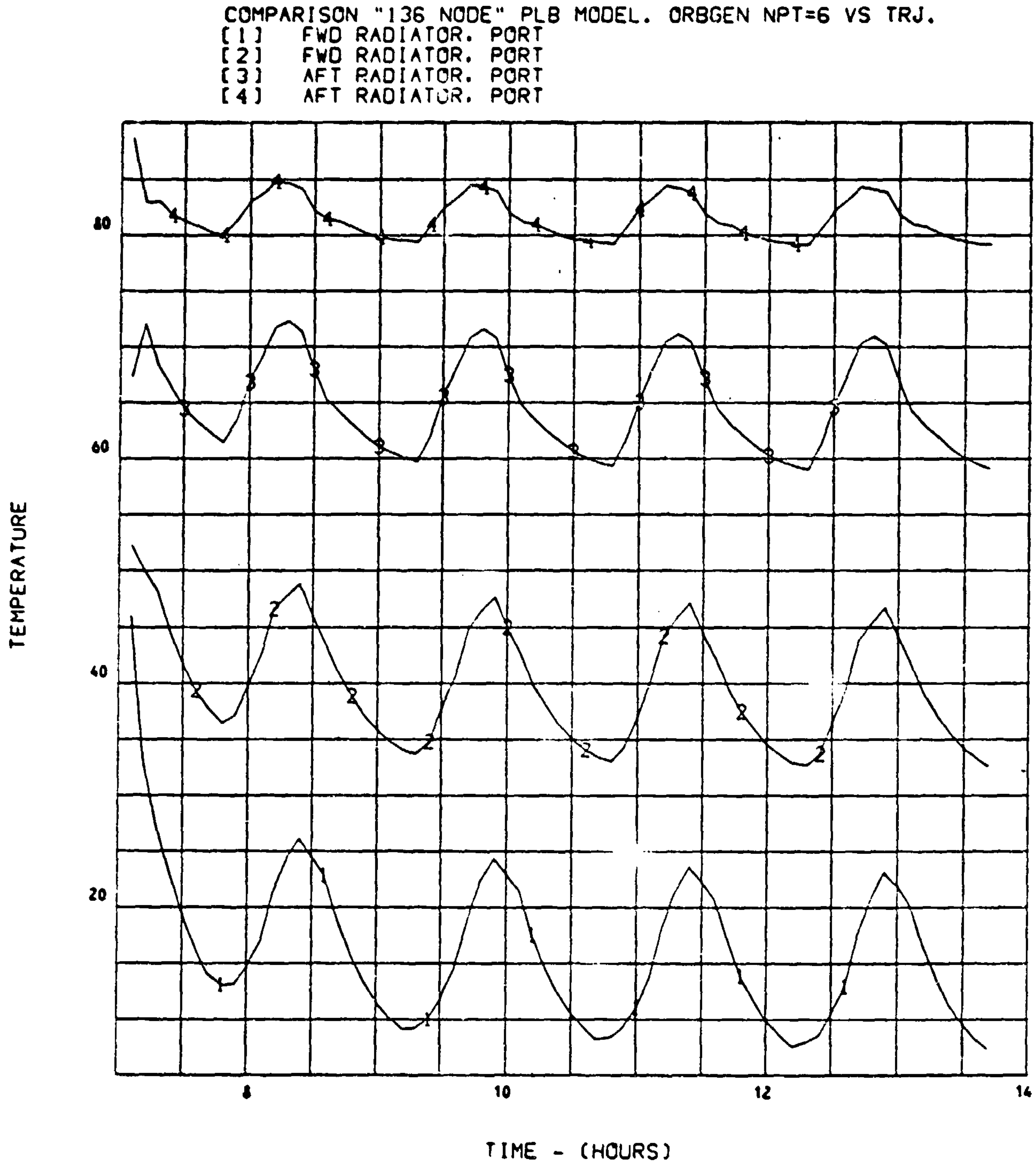

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD RADIATOR. PORT
[2] FWD RADIATOR. PORT
[3] AFT RADIATOR. PORT
[4] AFT RADIATOR. PORT
TEMPERATURE
80
60
40
20
8
10
12
14
TIME - (HOURS)

Figure 61

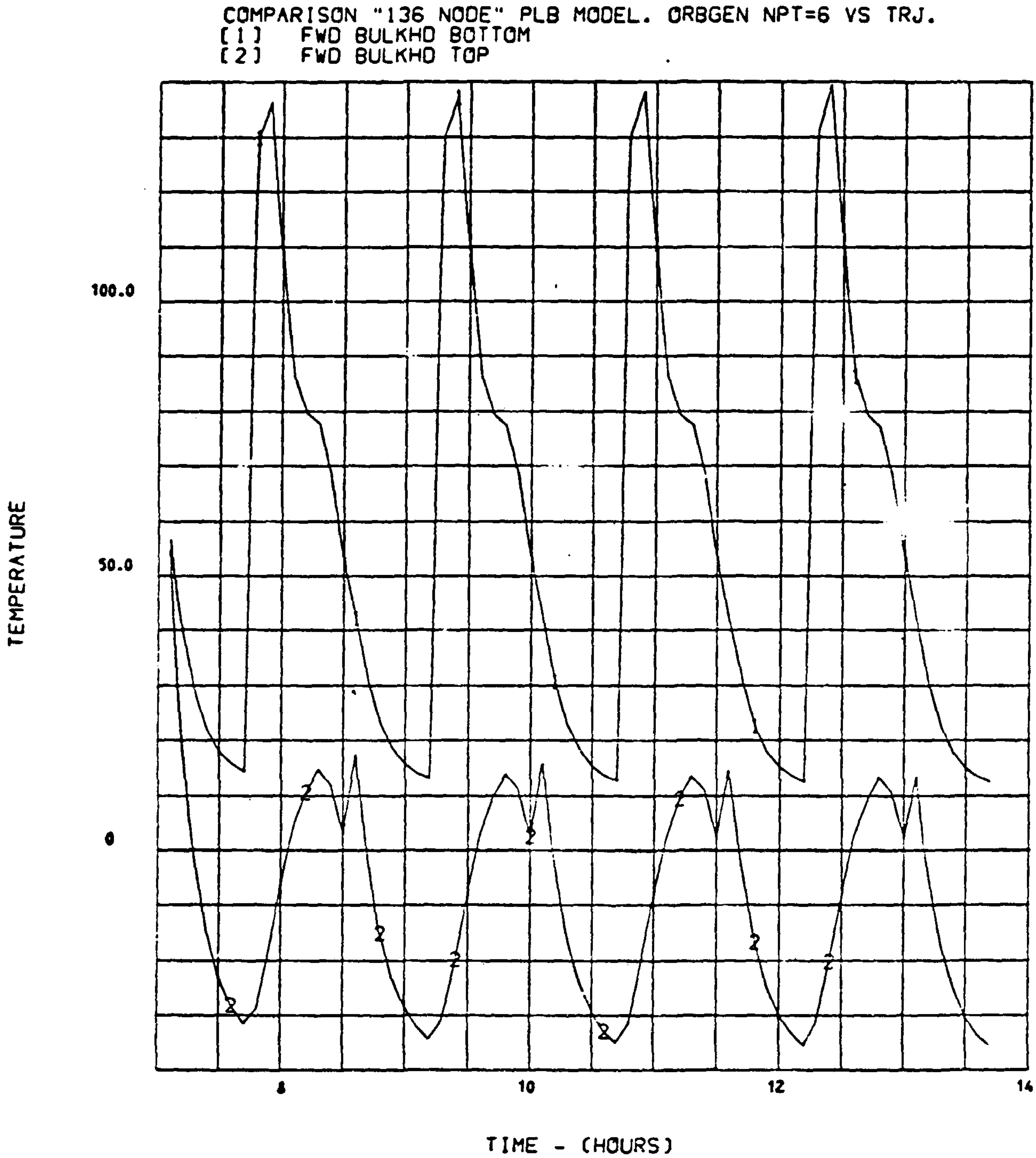

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD BULKHD BOTTOM
[2] FWD BULKHD TOP
TEMPERATURE
100.0
50.0
0
8
10
12
14
TIME - (HOURS)

Figure 62

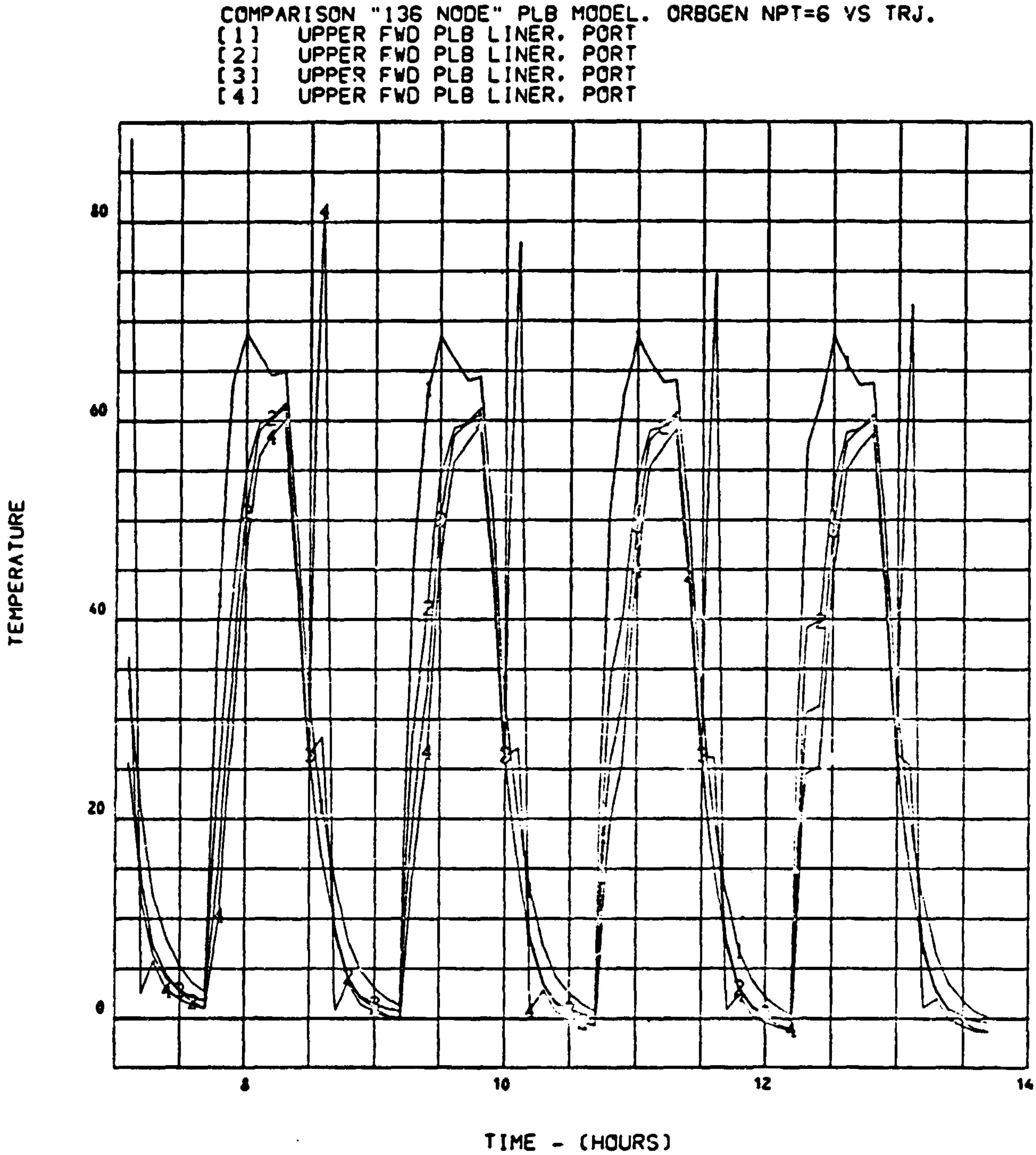

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] UPPER FWD PLB LINER, PORT
[2] UPPER FWD PLB LINER, PORT
[3] UPPER FWD PLB LINER, PORT
[4] UPPER FWD PLB LINER, PORT
TEMPERATURE
80
60
40
20
0
8
10
12
14
TIME - (HOURS)

Figure 63

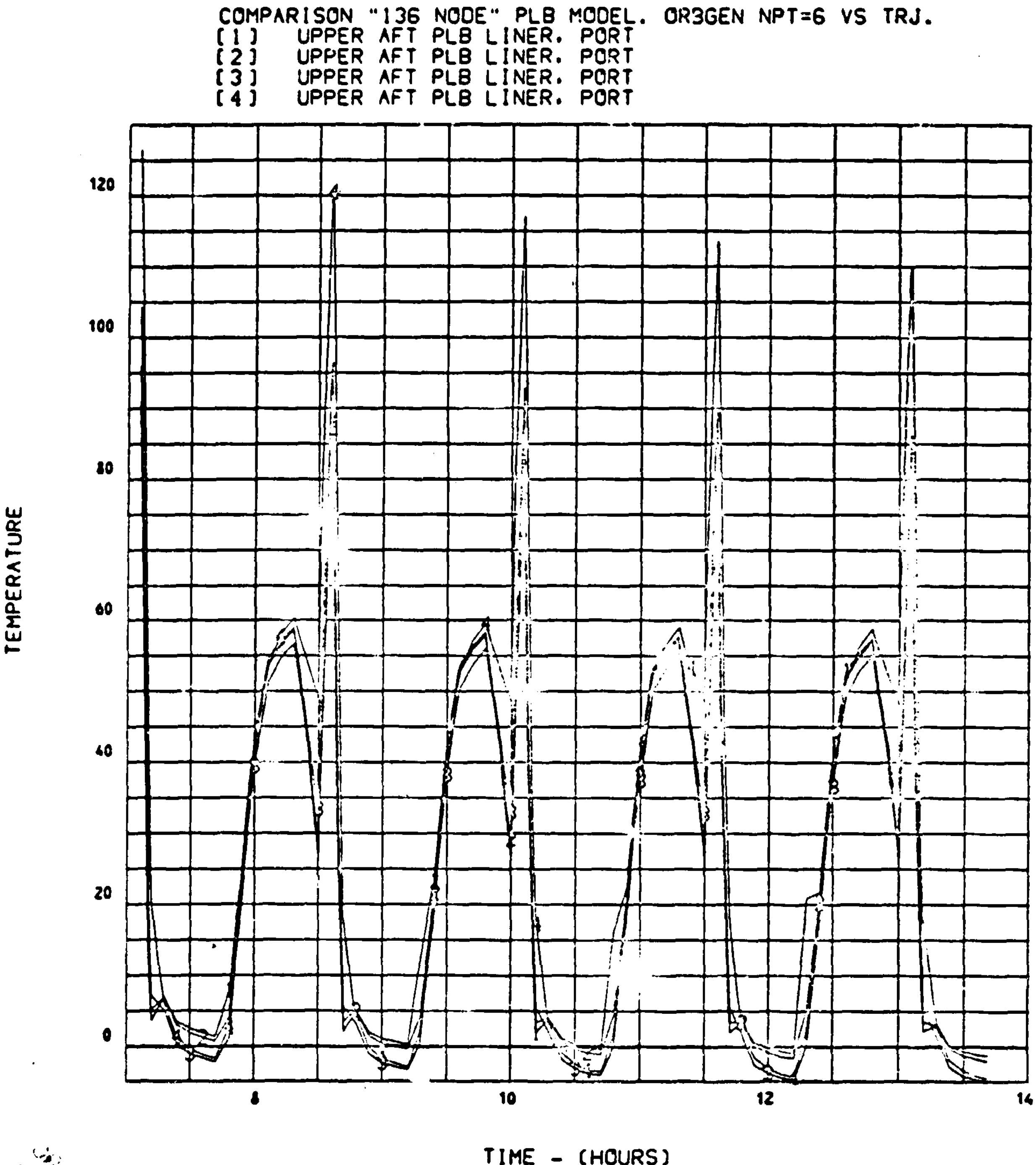

COMPARISON "136 NODE" PLB MODEL. OR3GEN NPT=6 VS TRJ.
[1] UPPER AFT PLB LINER. PORT
[2] UPPER AFT PLB LINER. PORT
[3] UPPER AFT PLB LINER. PORT
[4] UPPER AFT PLB LINER. PORT
120
100
80
60
40
20
0
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 64

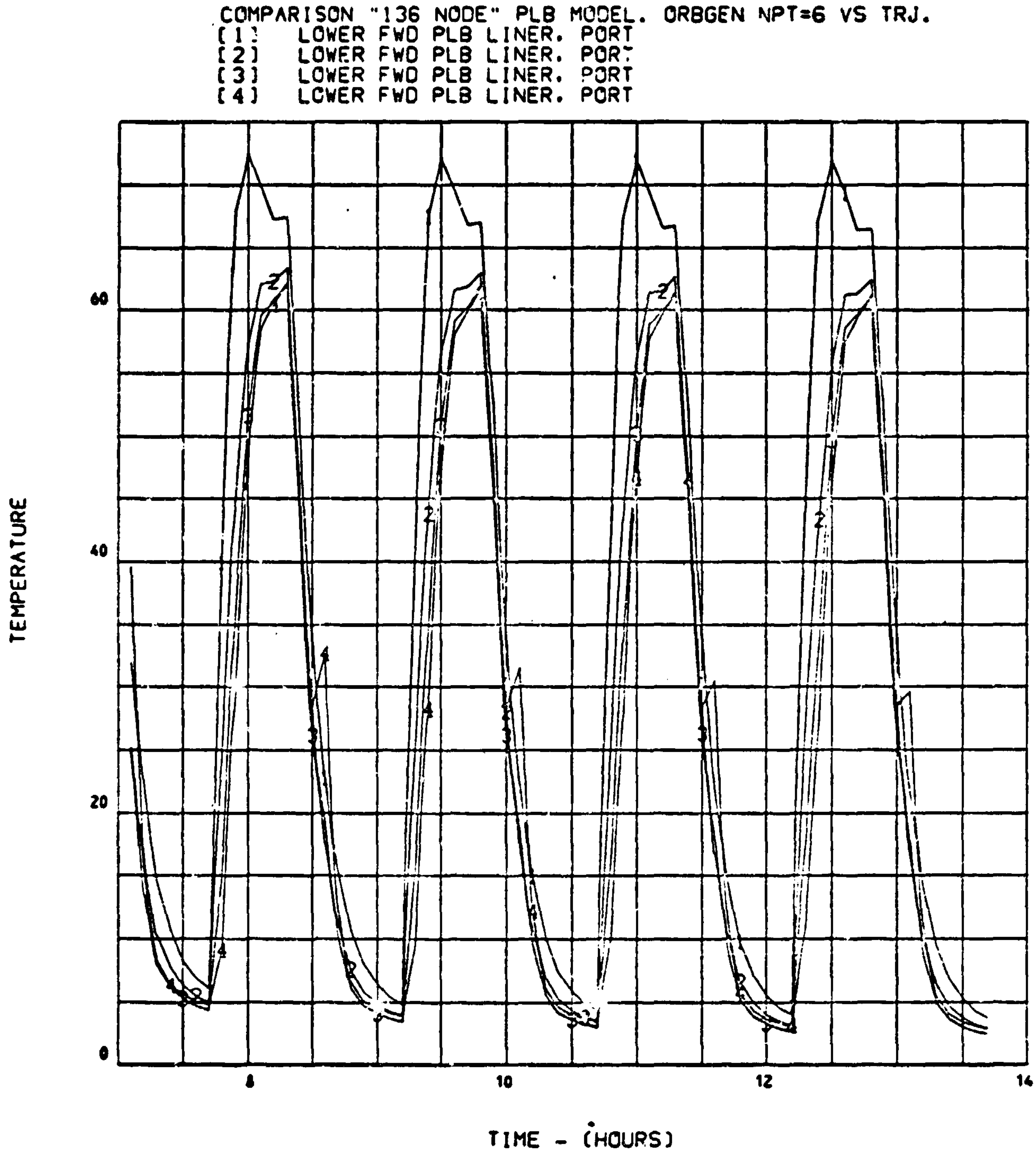
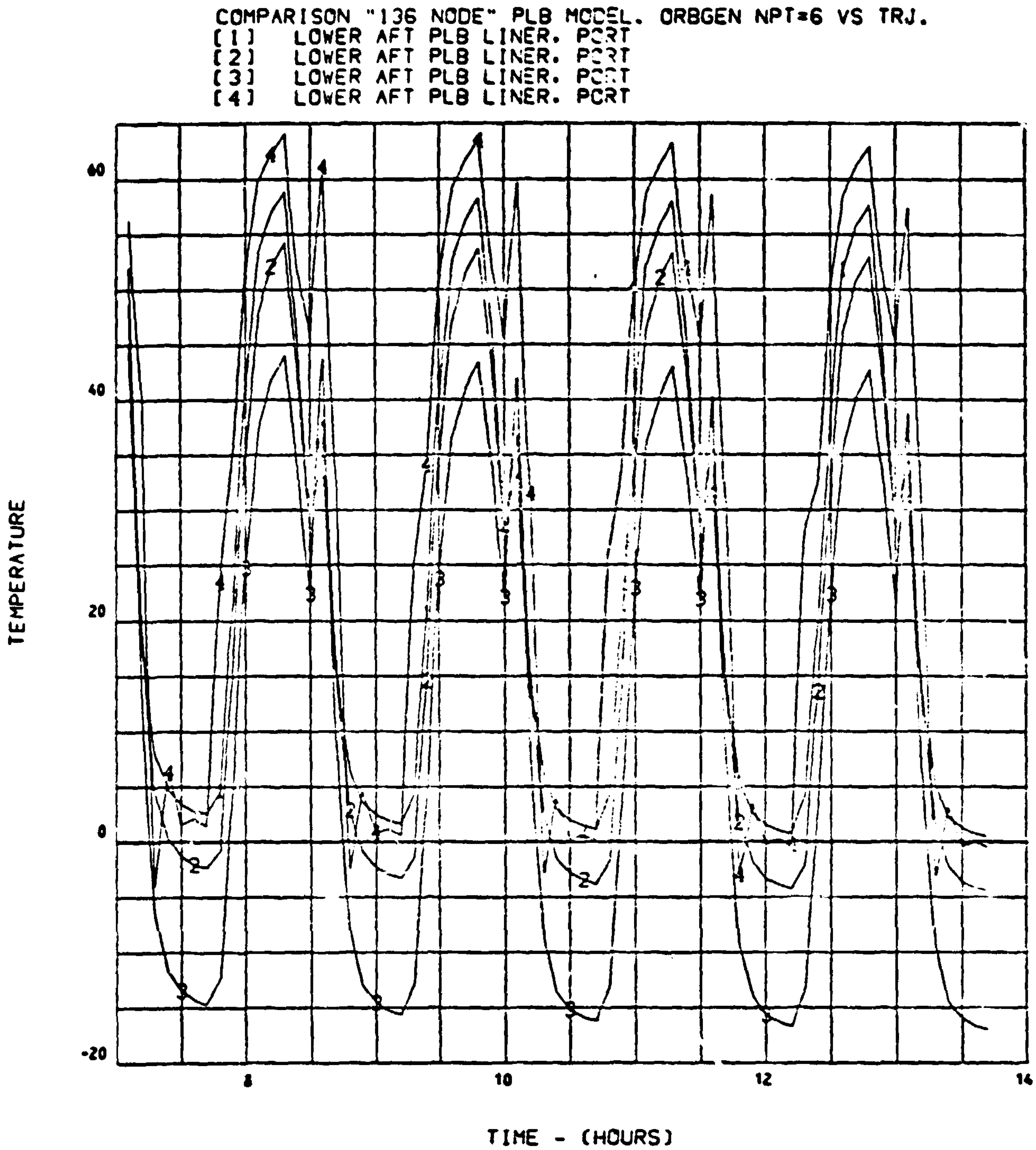

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] LOWER FWD PLB LINER. PORT
[2] LOWER FWD PLB LINER. PORT
[3] LOWER FWD PLB LINER. PORT
[4] LOWER FWD PLB LINER. PORT
TEMPERATURE
0
20
40
60
8
10
12
14
TIME - (HOURS)

Figure 65



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] LOWER AFT PLB LINER. PORT
[2] LOWER AFT PLB LINER. PORT
[3] LOWER AFT PLB LINER. PORT
[4] LOWER AFT PLB LINER. PORT
TEMPERATURE
60
40
20
0
-20
8
10
12
14
TIME - (HOURS)

Figure 66

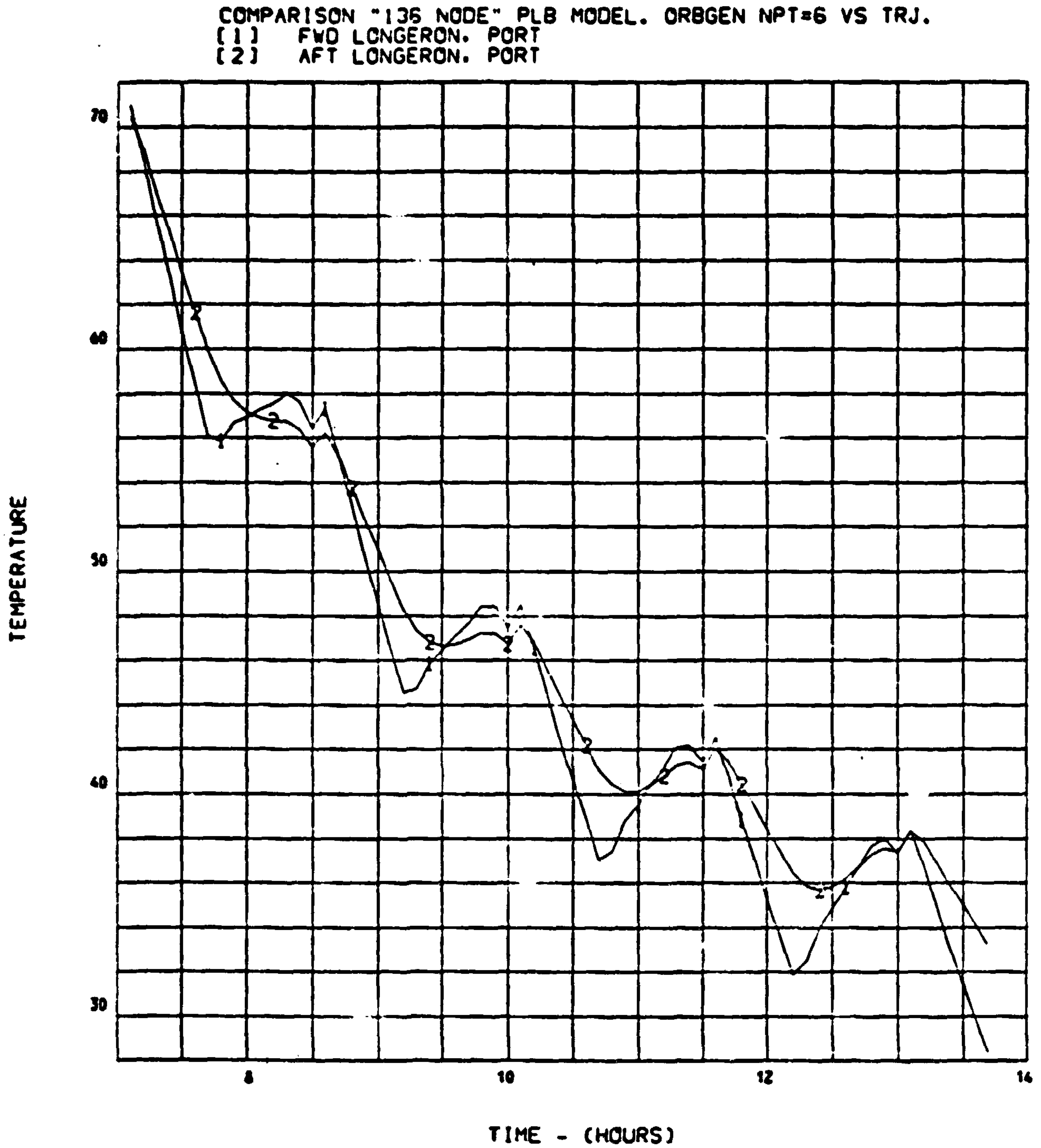

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD LONGERON. PORT
[2] AFT LONGERON. PORT
TEMPERATURE
70
60
50
40
30
8
10
12
14
TIME - (HOURS)

Figure 67

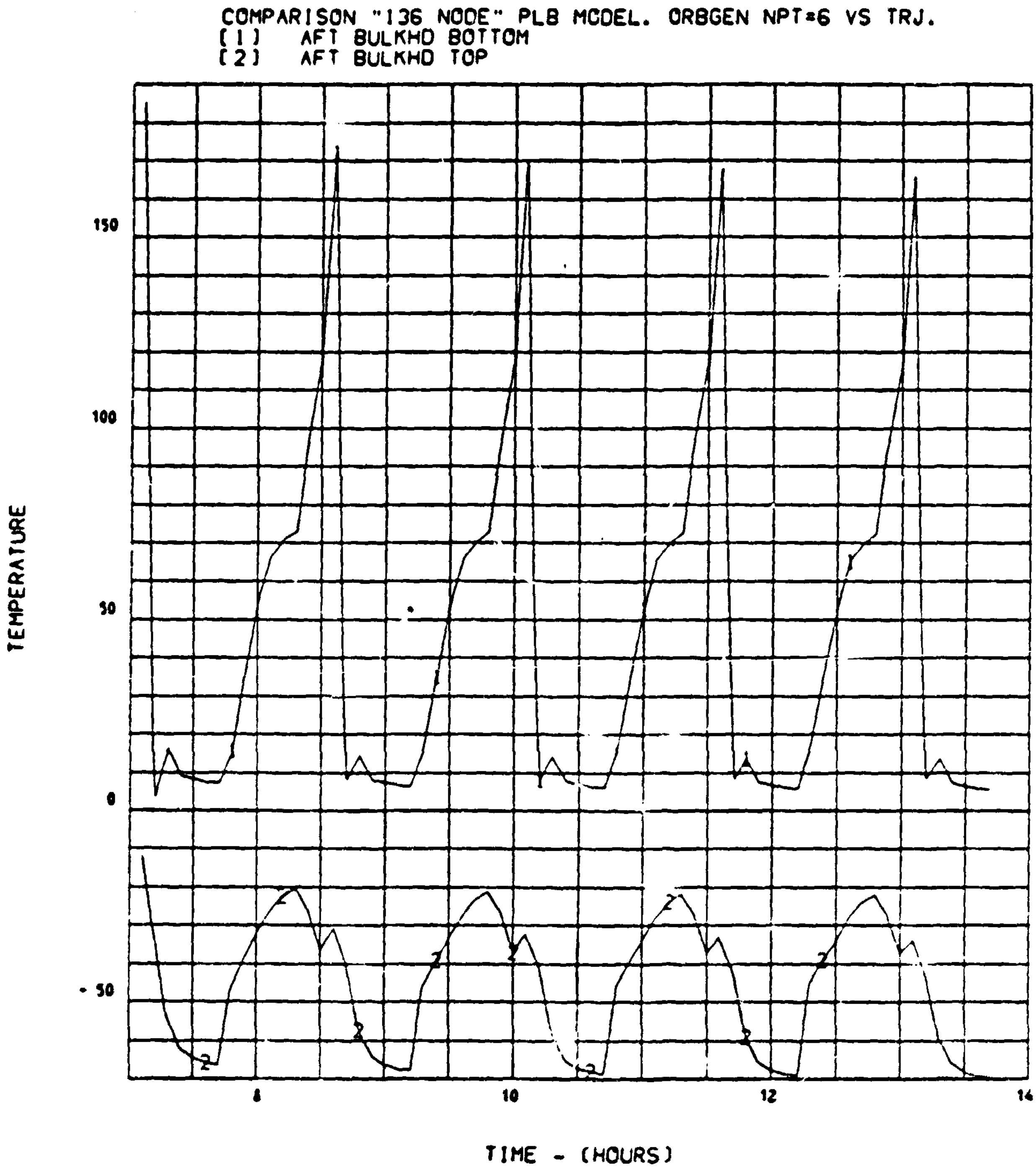
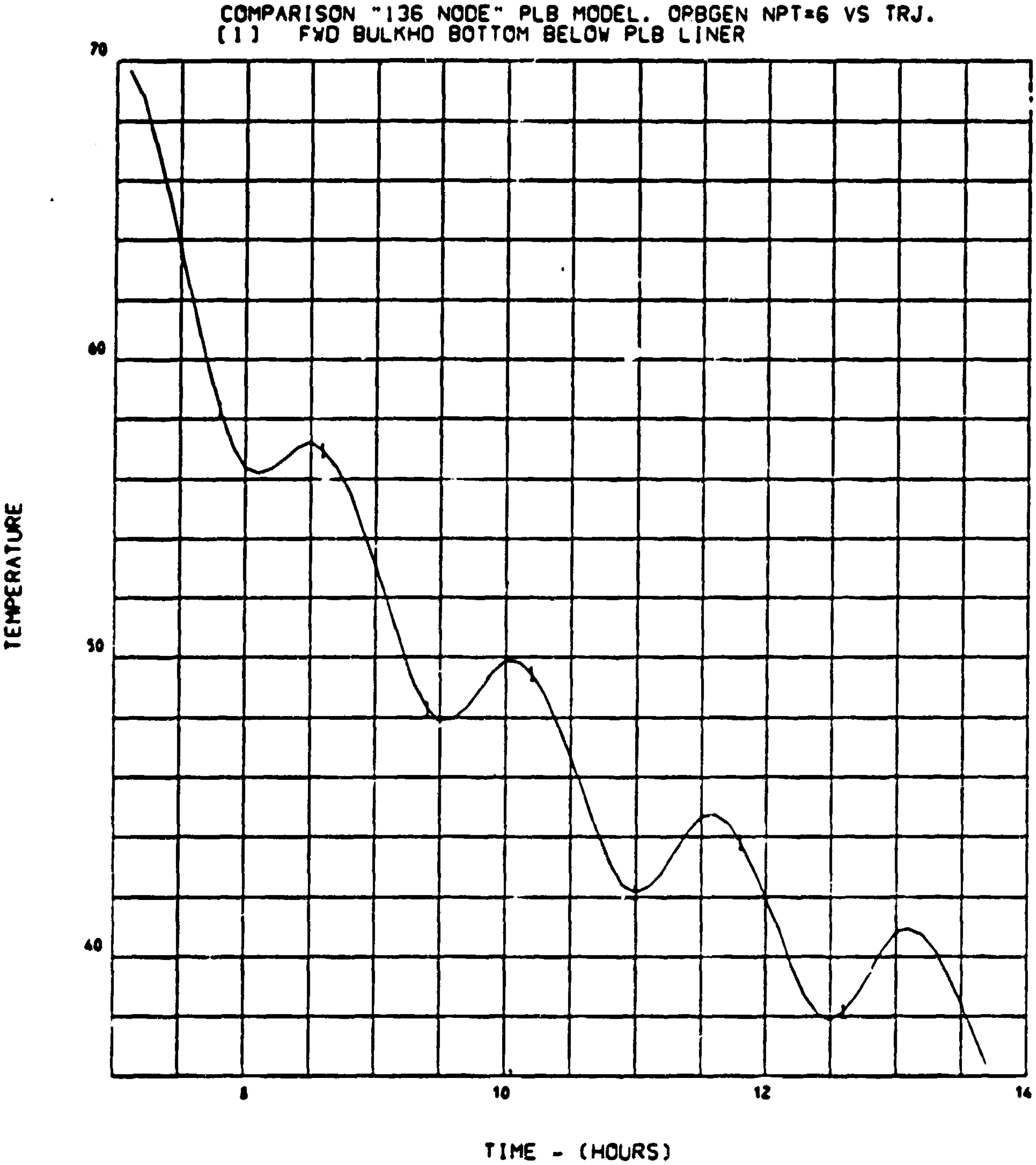

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] AFT BULKHD BOTTOM
[2] AFT BULKHD TOP
150
100
50
0
- 50
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 68



COMPARISON "136 NODE" PLB MODEL. OPBGEN NPT=6 VS TRJ.
[1] FWD BULKHD BOTTOM BELOW PLB LINER
70
60
50
40
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 69

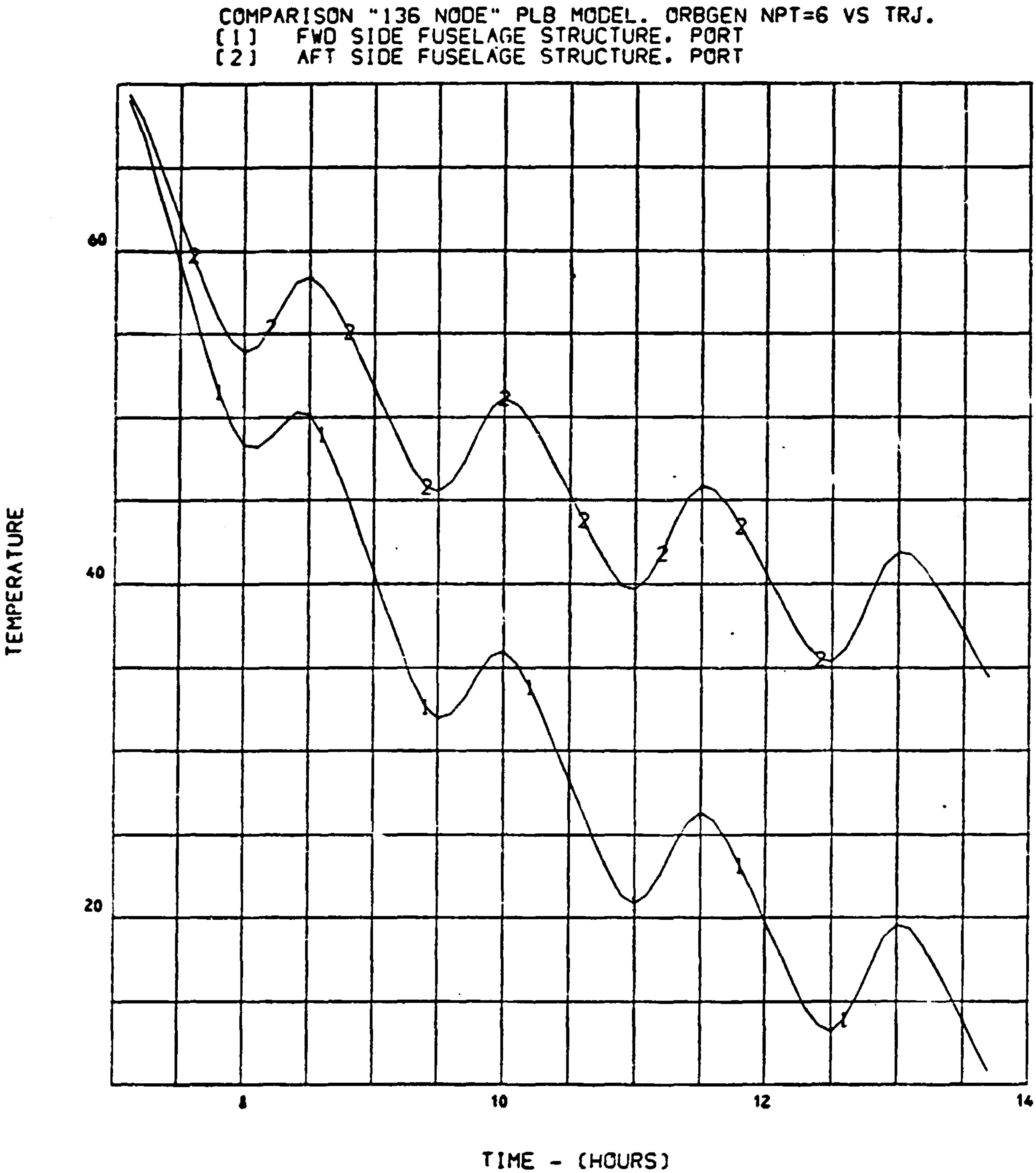

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD SIDE FUSELAGE STRUCTURE. PORT
[2] AFT SIDE FUSELAGE STRUCTURE. PORT
TEMPERATURE
60
40
20
8
10
12
14
TIME - (HOURS)

Figure 70

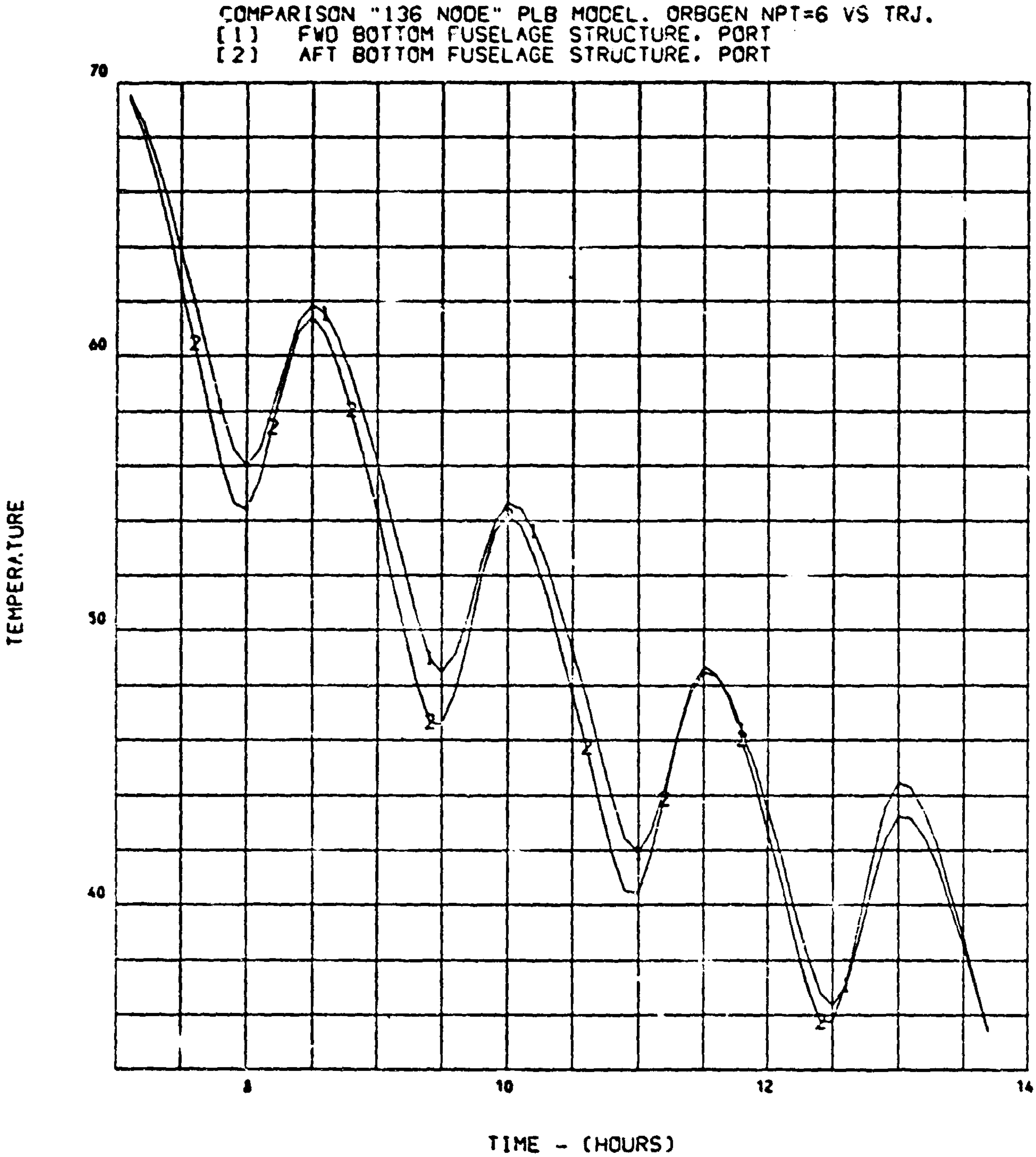

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD BOTTOM FUSELAGE STRUCTURE. PORT
[2] AFT BOTTOM FUSELAGE STRUCTURE. PORT
70
60
50
40
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 71

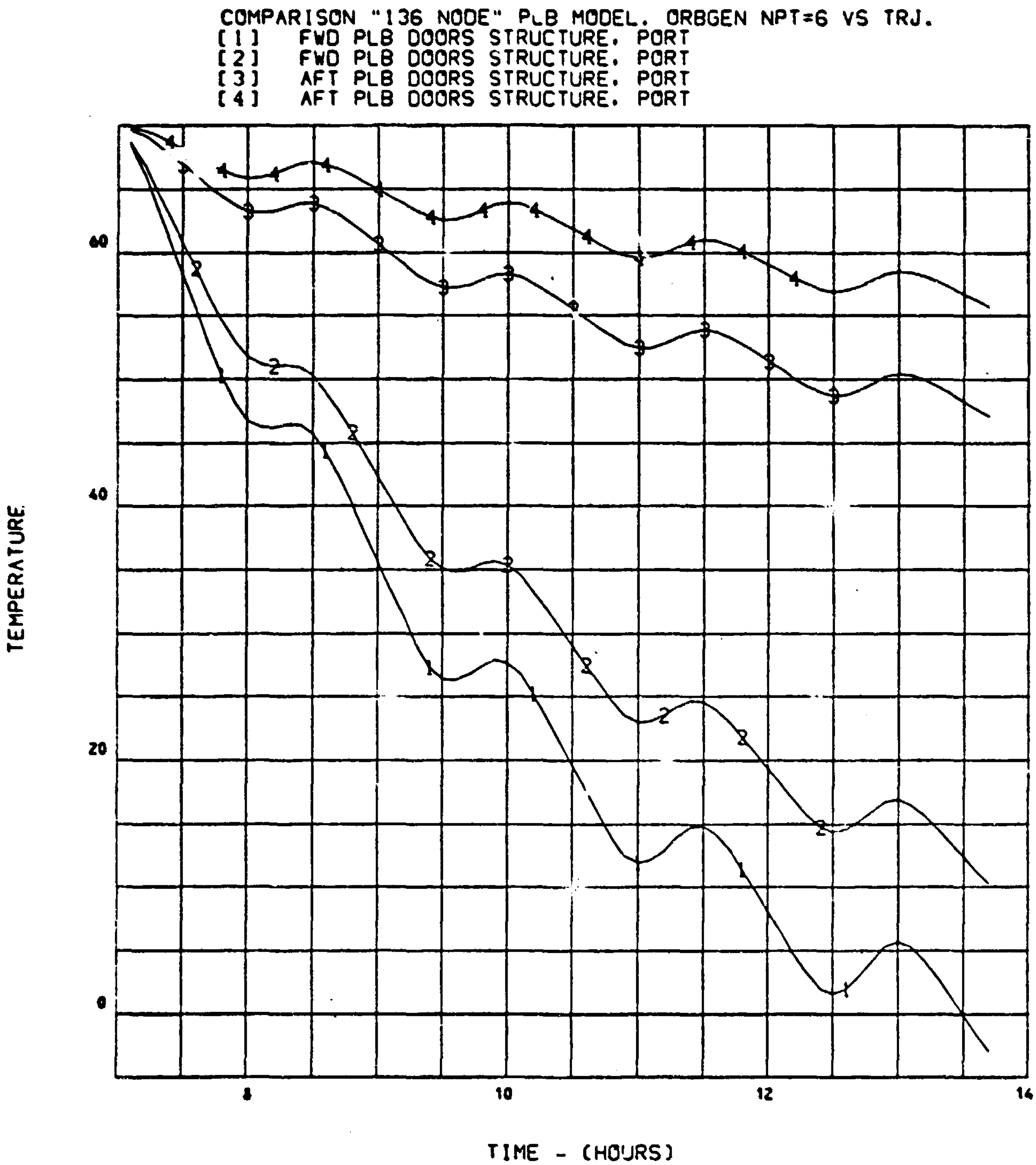

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD PLB DOORS STRUCTURE. PORT
[2] FWD PLB DOORS STRUCTURE. PORT
[3] AFT PLB DOORS STRUCTURE. PORT
[4] AFT PLB DOORS STRUCTURE. PORT
TEMPERATURE
60
40
20
0
8
10
12
14
TIME - (HOURS)

Figure 72

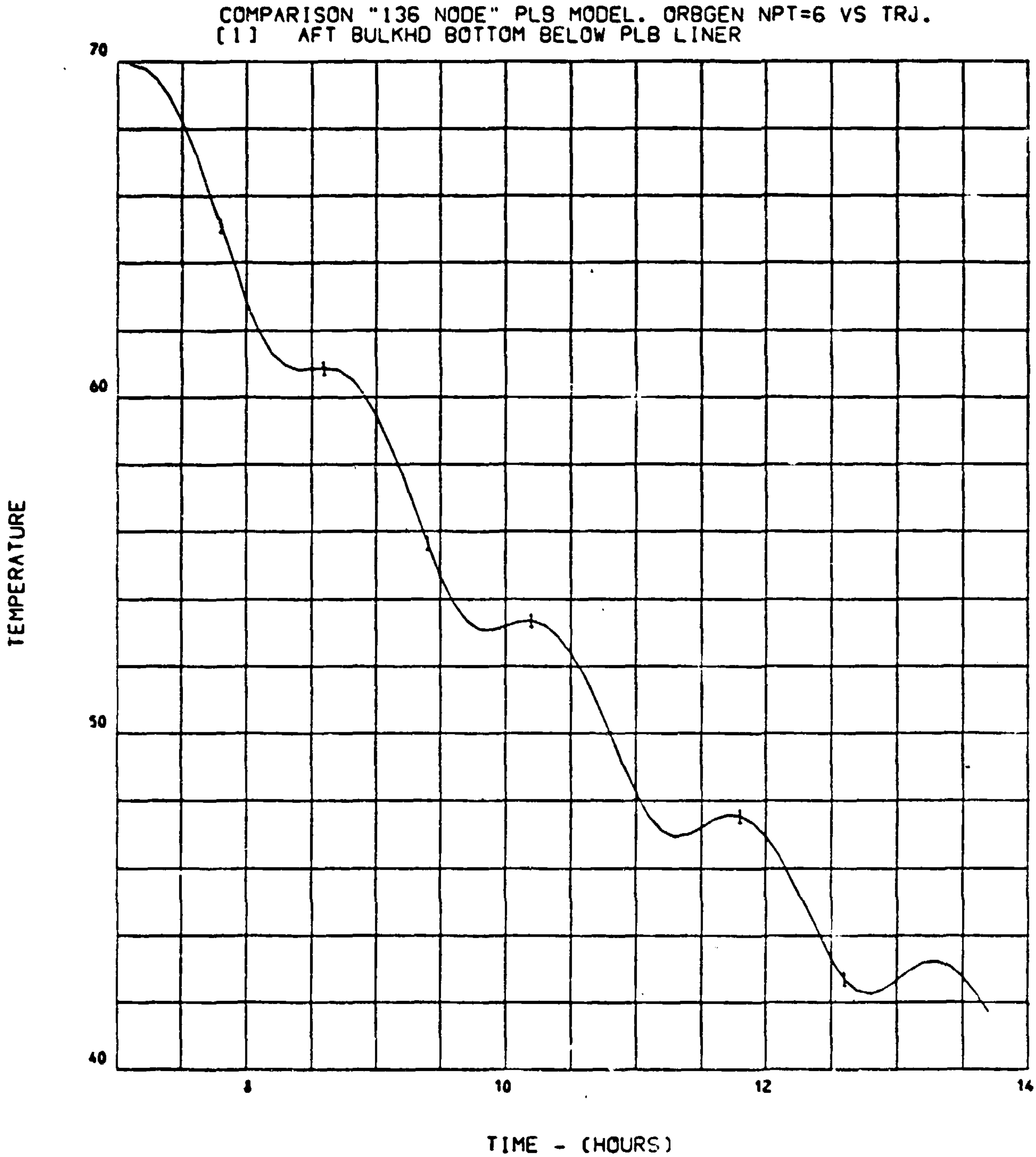

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] AFT BULKHD BOTTOM BELOW PLB LINER
70
60
50
40
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 73

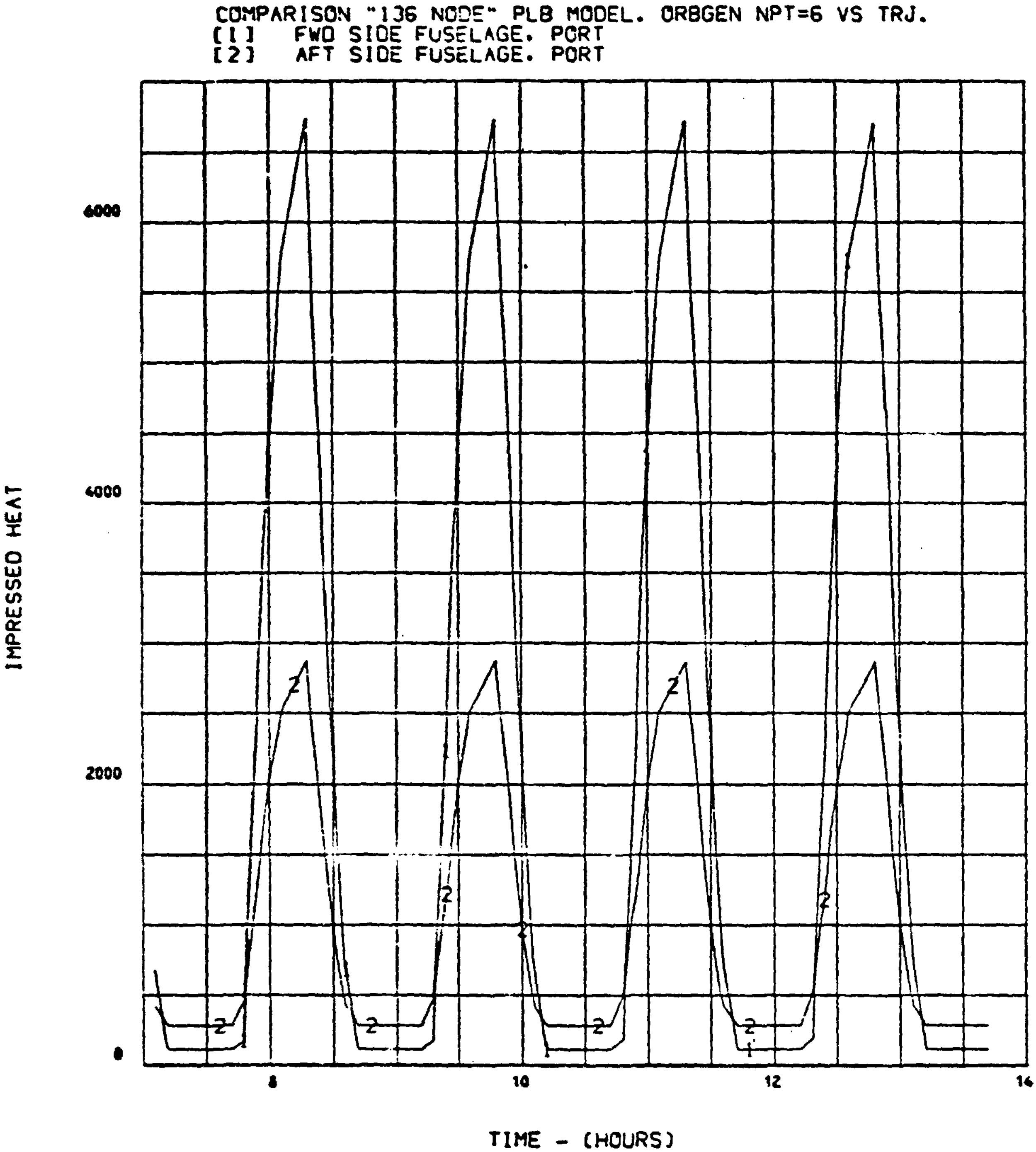
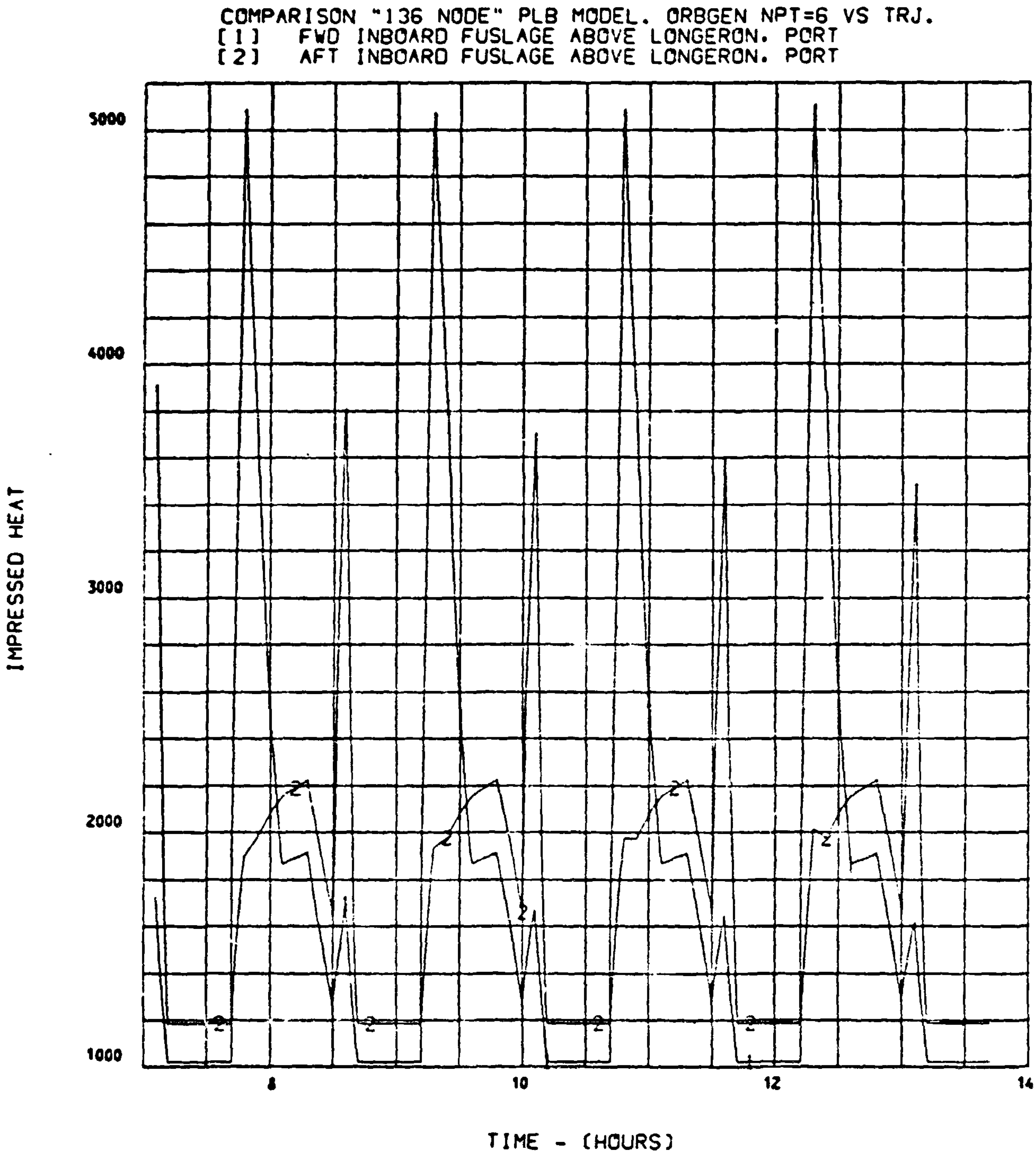

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD SIDE FUSELAGE. PORT
[2] AFT SIDE FUSELAGE. PORT
IMPRESSED HEAT
6000
4000
2000
0
8
10
12
14
TIME - (HOURS)

Figure 74



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD INBOARD FUSLAGE ABOVE LONGERON. PORT
[2] AFT INBOARD FUSLAGE ABOVE LONGERON. PORT
IMPRESSED HEAT
5000
4000
3000
2000
1000
8
10
12
14
TIME - (HOURS)

Figure 75

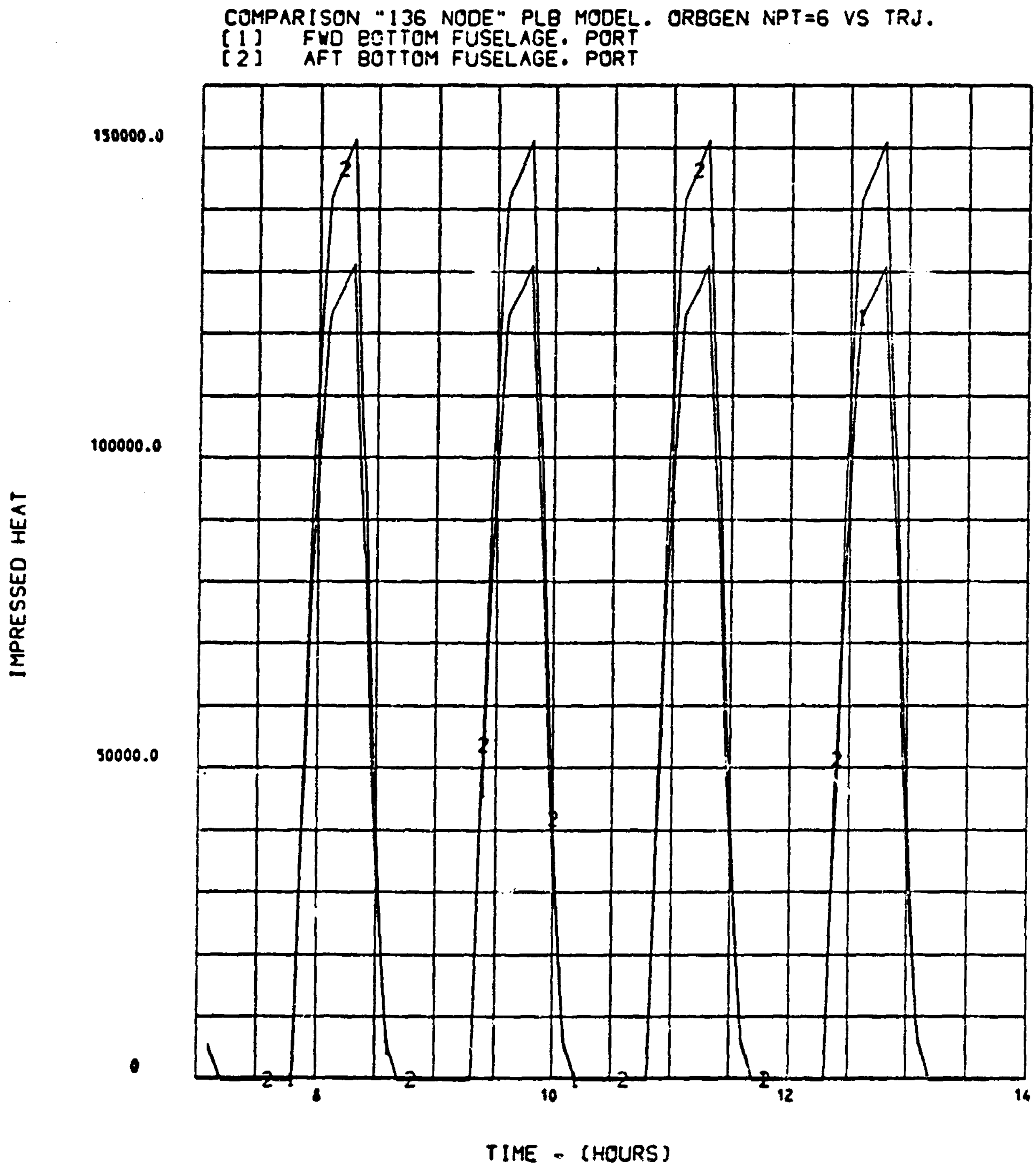

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD BOTTOM FUSELAGE. PORT
[2] AFT BOTTOM FUSELAGE. PORT
150000.0
100000.0
50000.0
0
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 76

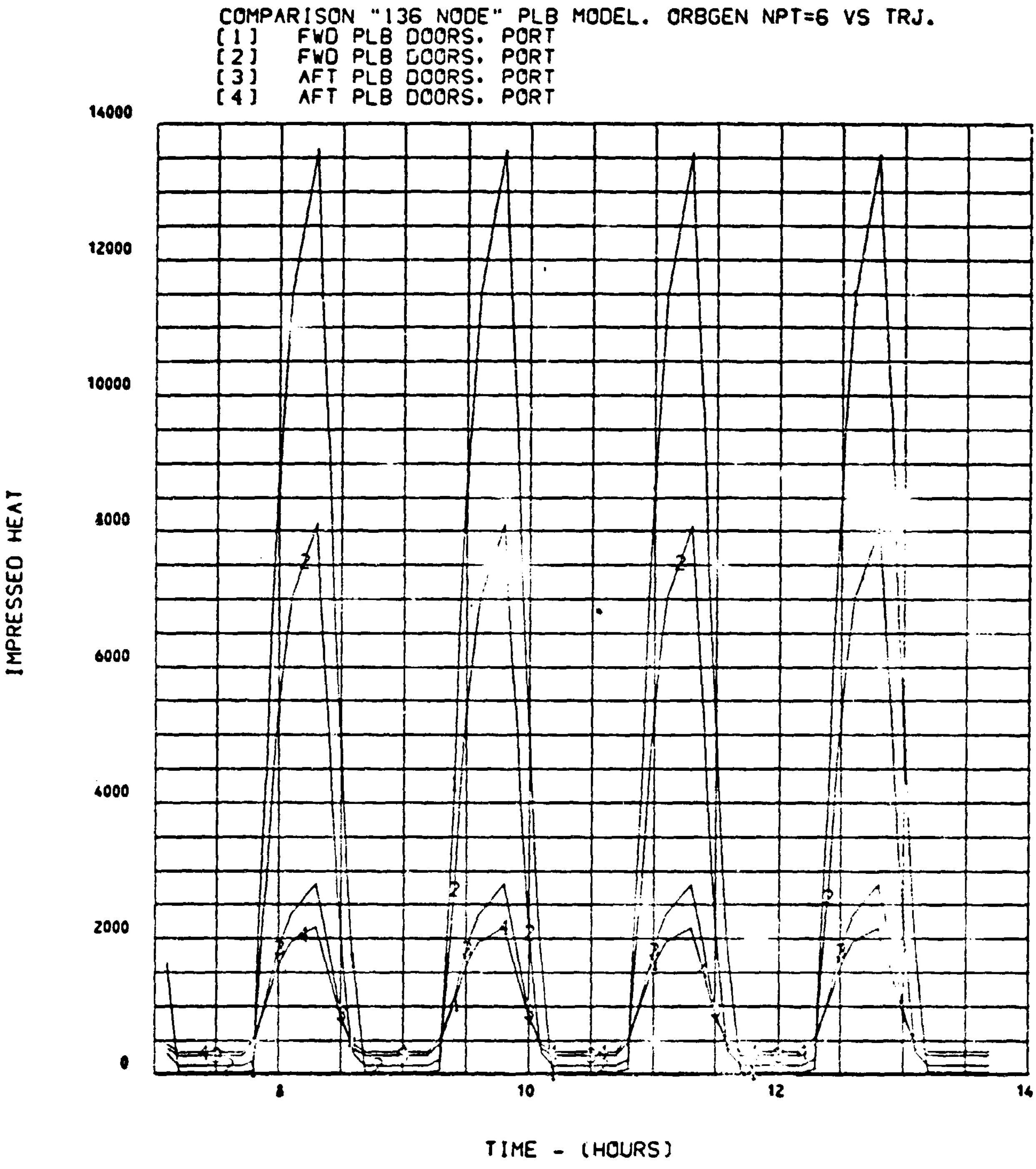

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD PLB DOORS. PORT
[2] FWD PLB DOORS. PORT
[3] AFT PLB DOORS. PORT
[4] AFT PLB DOORS. PORT
14000
12000
10000
8000
6000
4000
2000
0
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 77

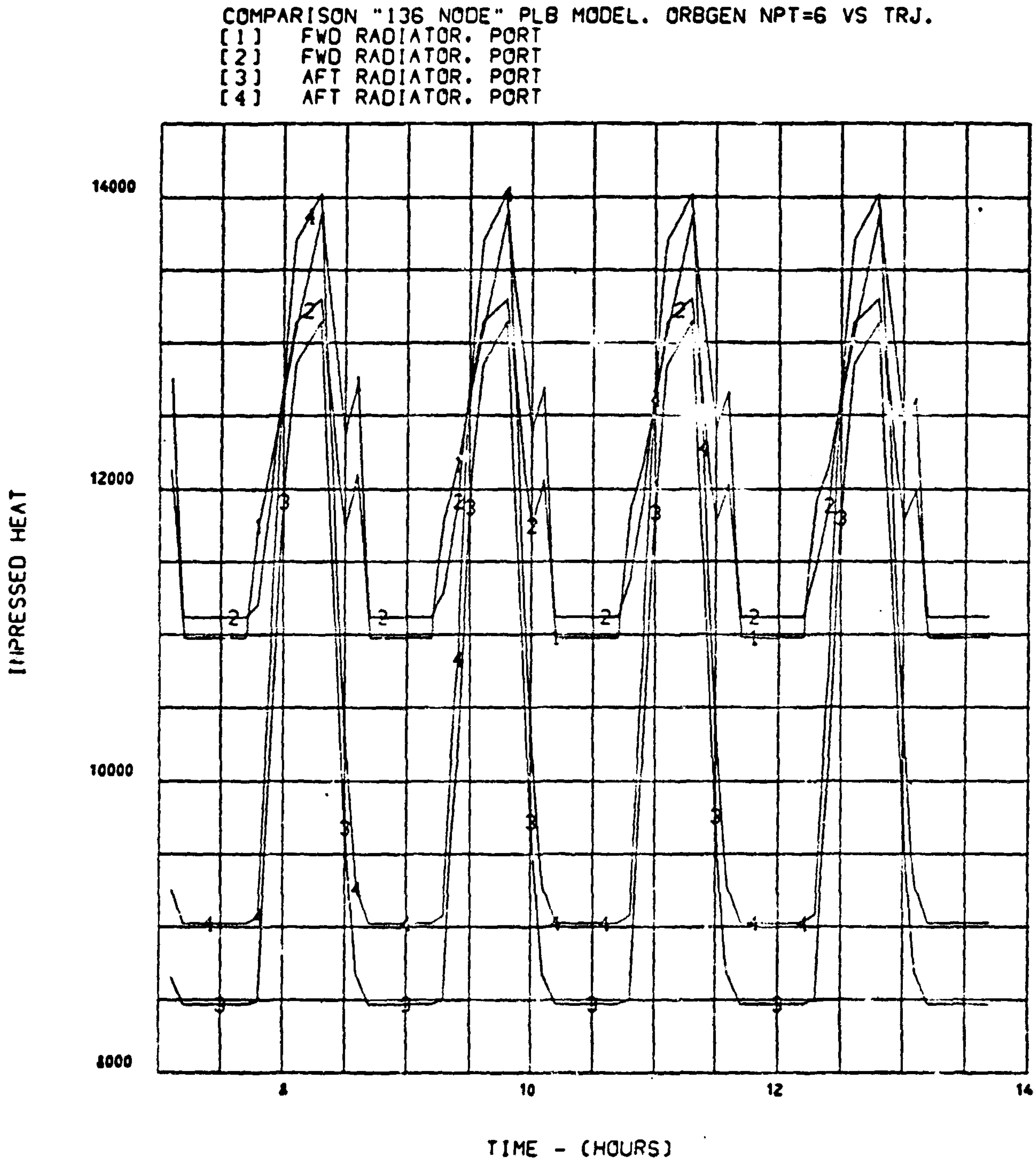

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD RADIATOR. PORT
[2] FWD RADIATOR. PORT
[3] AFT RADIATOR. PORT
[4] AFT RADIATOR. PORT
IMPRESSED HEAT
14000
12000
10000
8000
8
10
12
14
TIME - (HOURS)

Figure 78

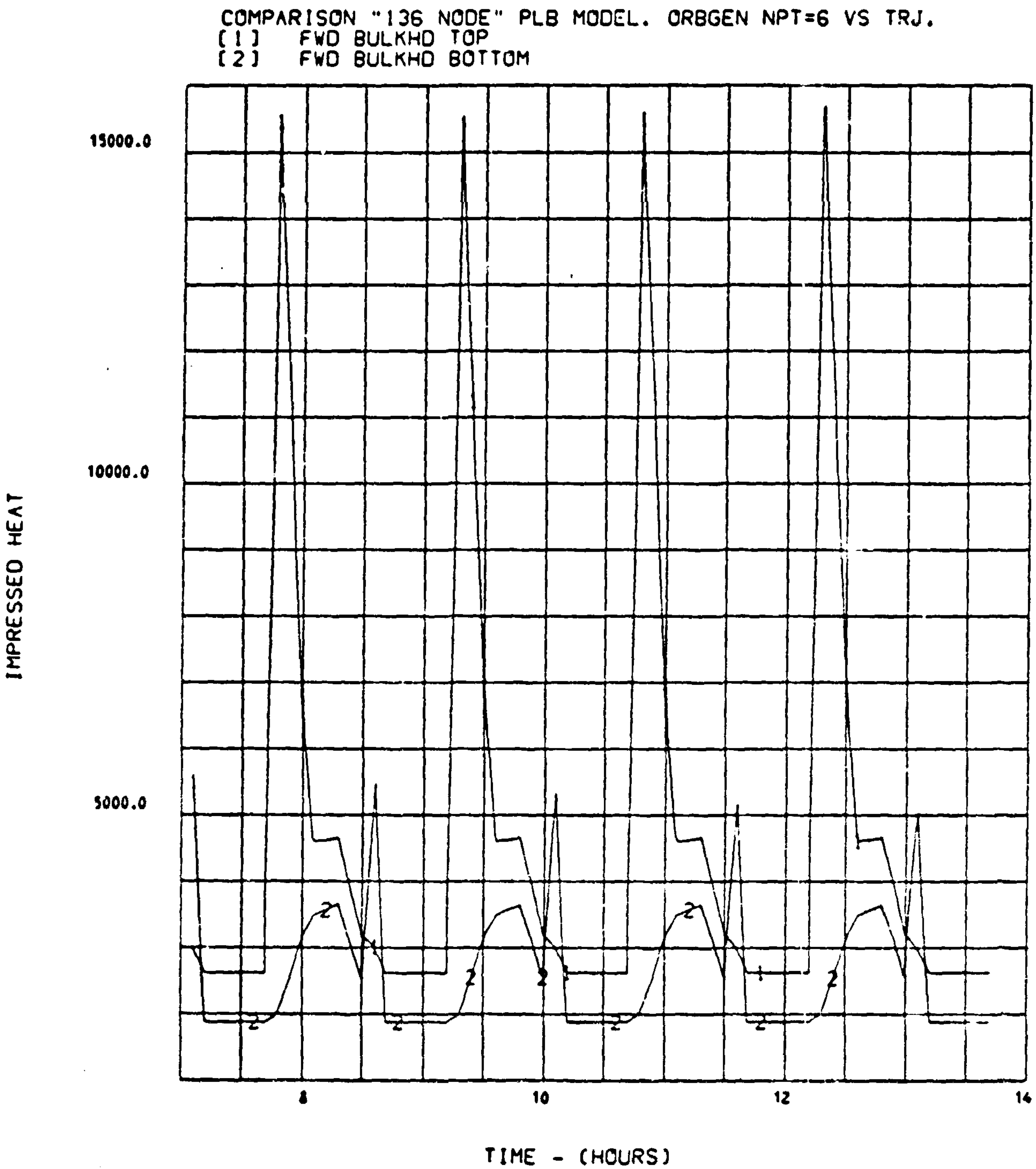

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD BULKHD TOP
[2] FWD BULKHD BOTTOM
15000.0
10000.0
5000.0
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 79

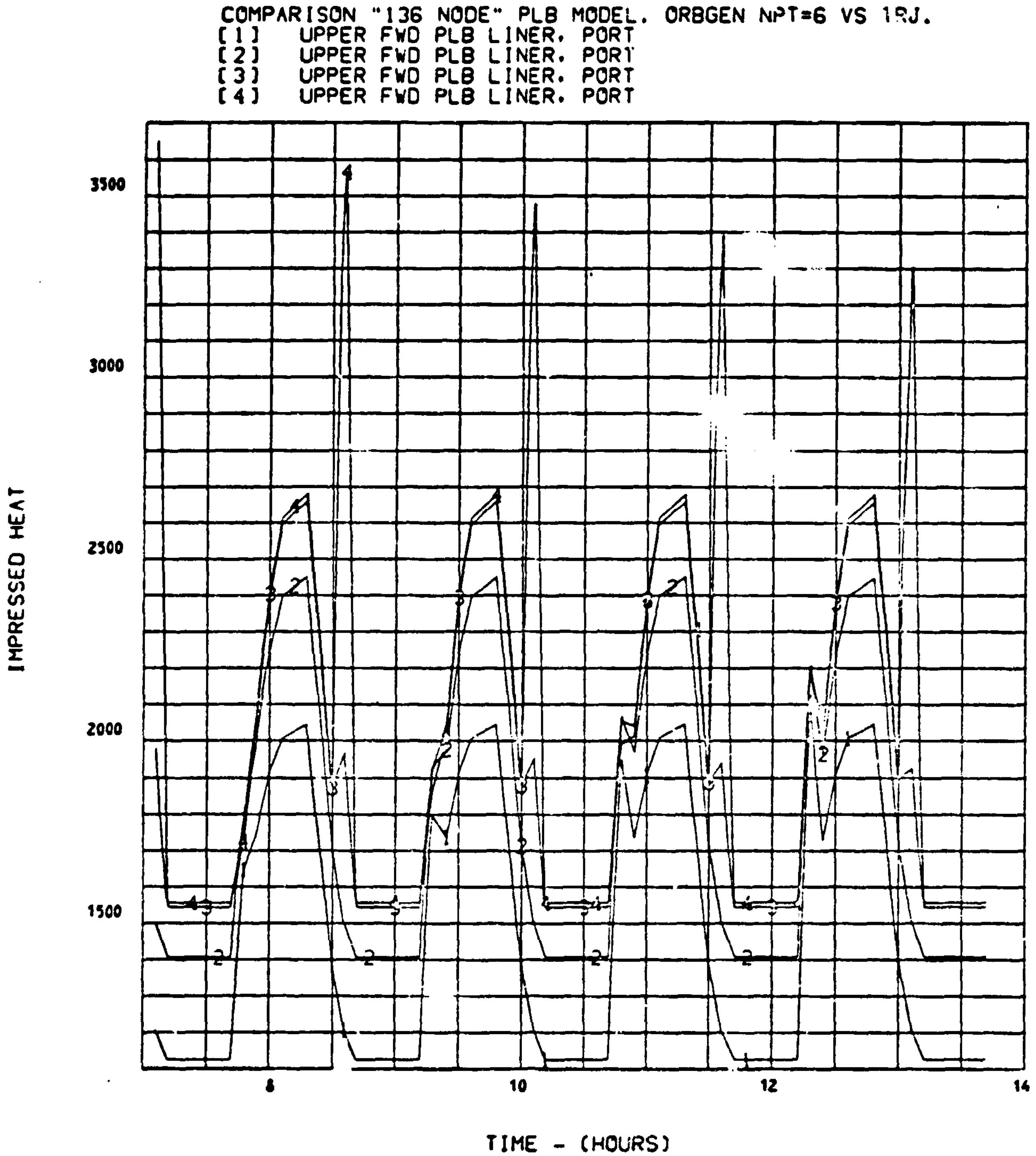
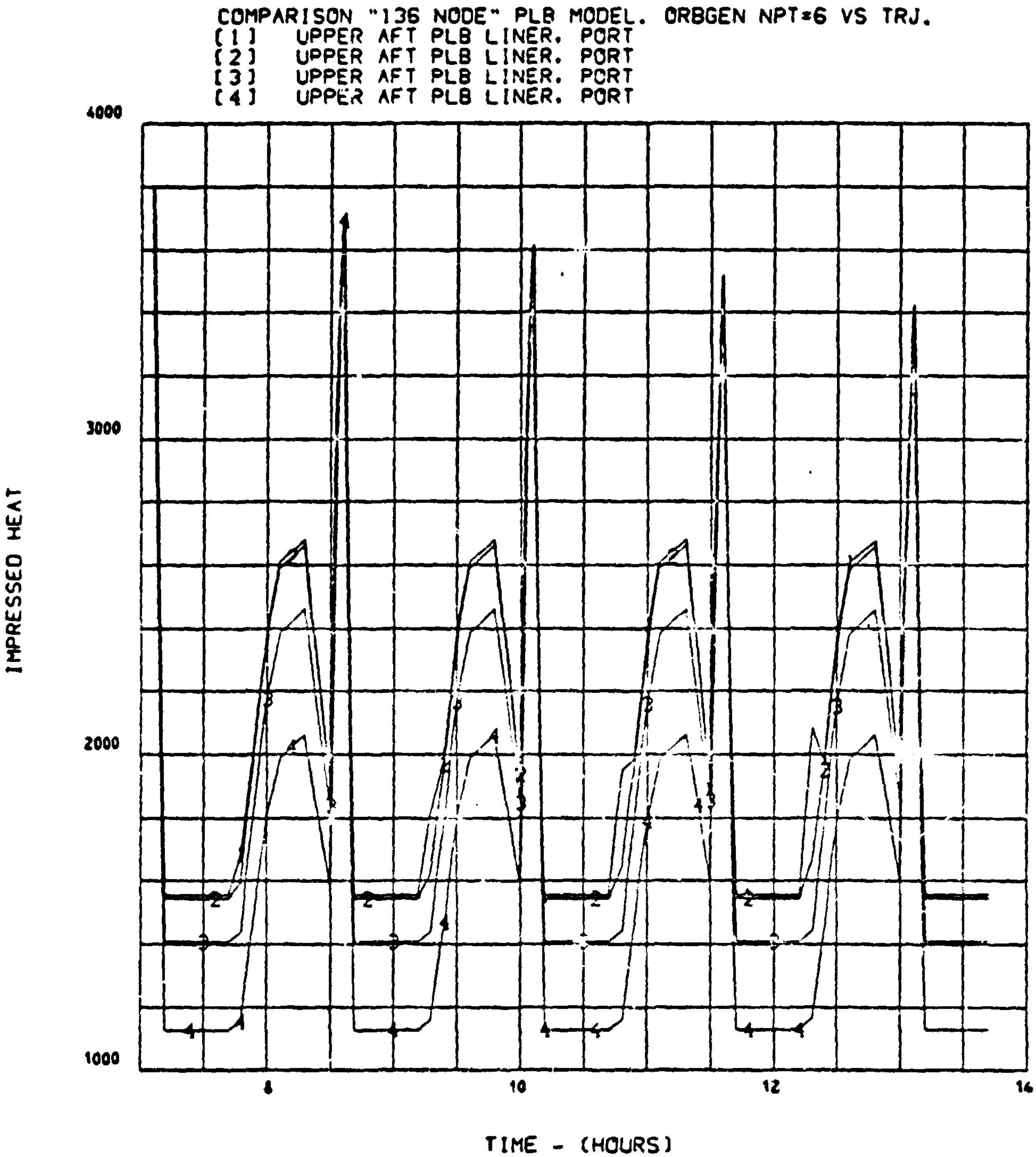
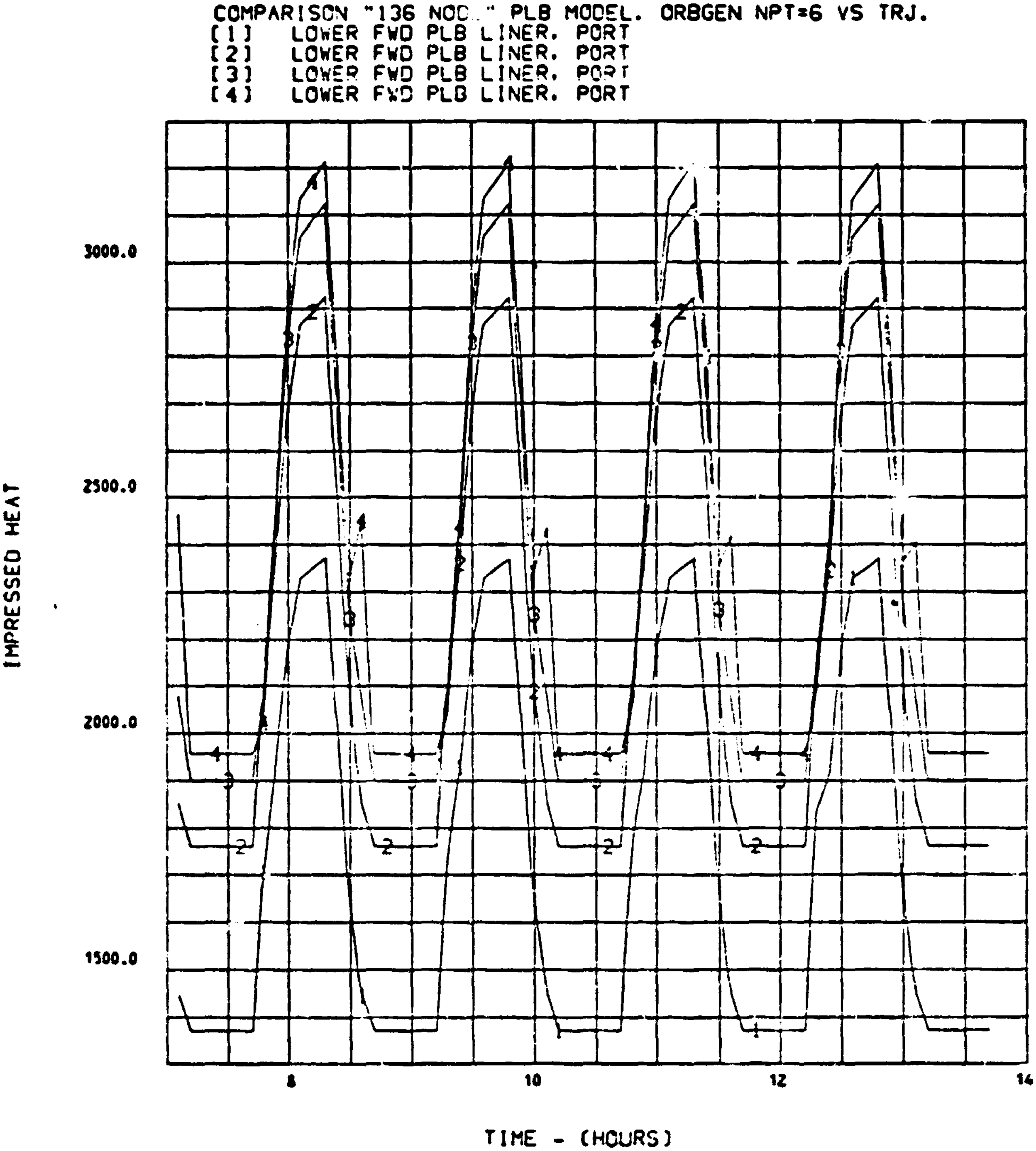

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS 1RJ.
[1] UPPER FWD PLB LINER, PORT
[2] UPPER FWD PLB LINER, PORT
[3] UPPER FWD PLB LINER, PORT
[4] UPPER FWD PLB LINER, PORT
3500
3000
2500
2000
1500
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 80



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] UPPER AFT PLB LINER. PORT
[2] UPPER AFT PLB LINER. PORT
[3] UPPER AFT PLB LINER. PORT
[4] UPPER AFT PLB LINER. PORT
4000
3000
2000
1000
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 81



COMPARISON "136 NOD." PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] LOWER FWD PLB LINER. PORT
[2] LOWER FWD PLB LINER. PORT
[3] LOWER FWD PLB LINER. PORT
[4] LOWER FWD PLB LINER. PORT
IMPRESSED HEAT
3000.0
2500.0
2000.0
1500.0
8
10
12
14
TIME - (HOURS)

Figure 82

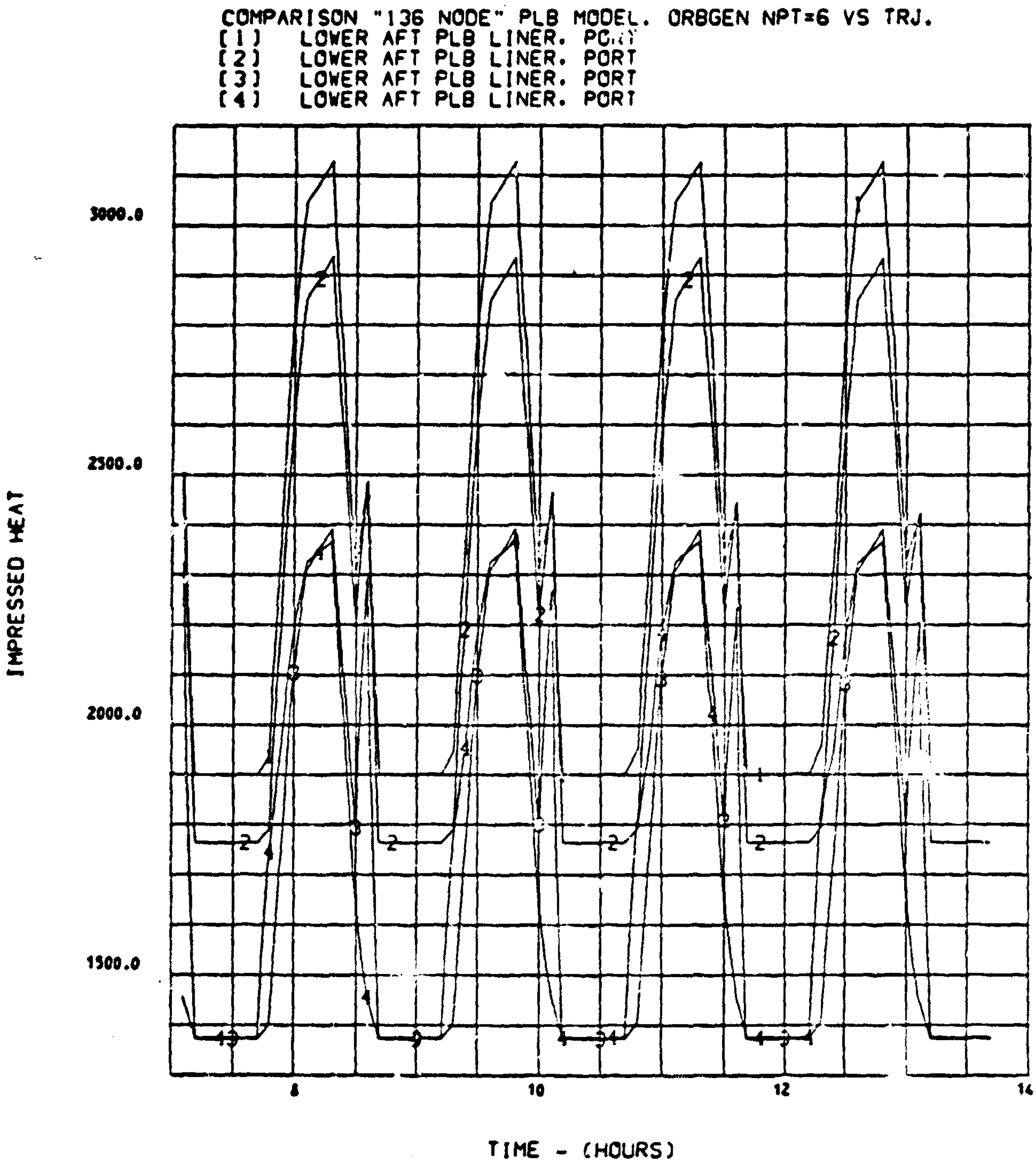

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] LOWER AFT PLB LINER. PORT
[2] LOWER AFT PLB LINER. PORT
[3] LOWER AFT PLB LINER. PORT
[4] LOWER AFT PLB LINER. PORT
IMPRESSED HEAT
3000.0
2500.0
2000.0
1500.0
8
10
12
14
TIME - (HOURS)

Figure 83

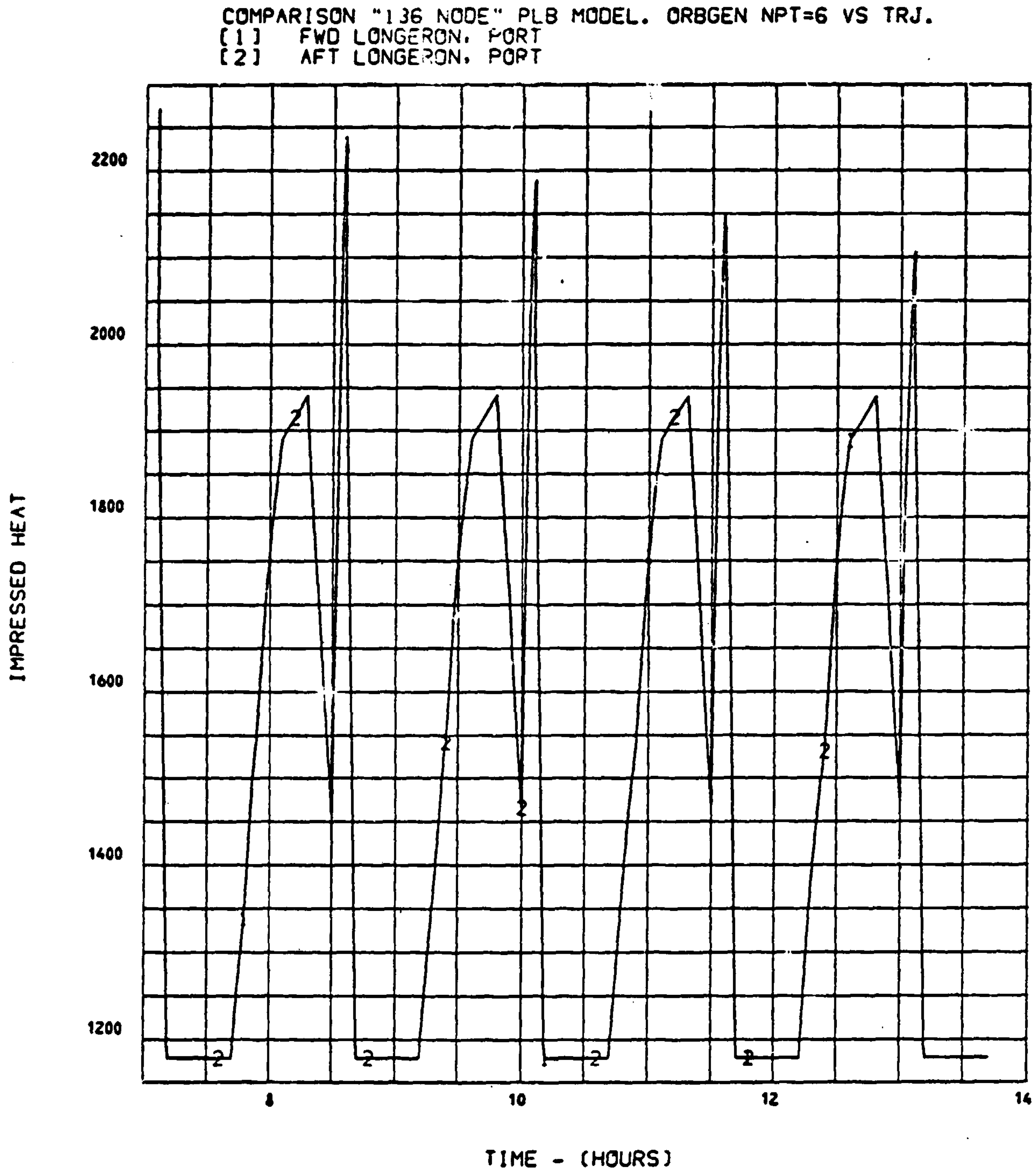

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=6 VS TRJ.
[1] FWD LONGERON, PORT
[2] AFT LONGERON, PORT
IMPRESSED HEAT
2200
2000
1800
1600
1400
1200
8
10
12
14
TIME - (HOURS)

Figure 84

C-2

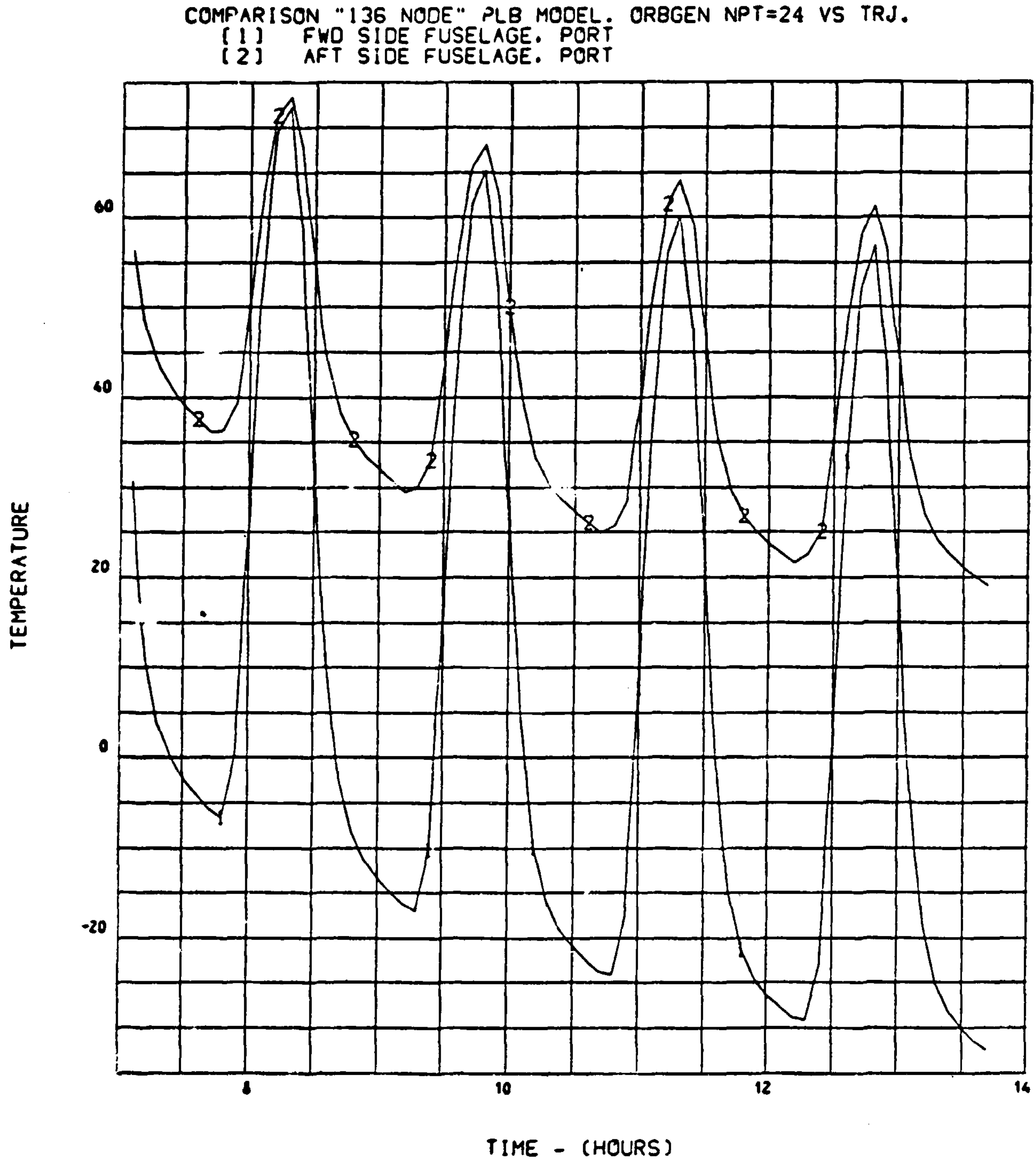

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD SIDE FUSELAGE. PORT
[2] AFT SIDE FUSELAGE. PORT
TEMPERATURE
60
40
20
0
-20
8
10
12
14
TIME - (HOURS)

Figure 85

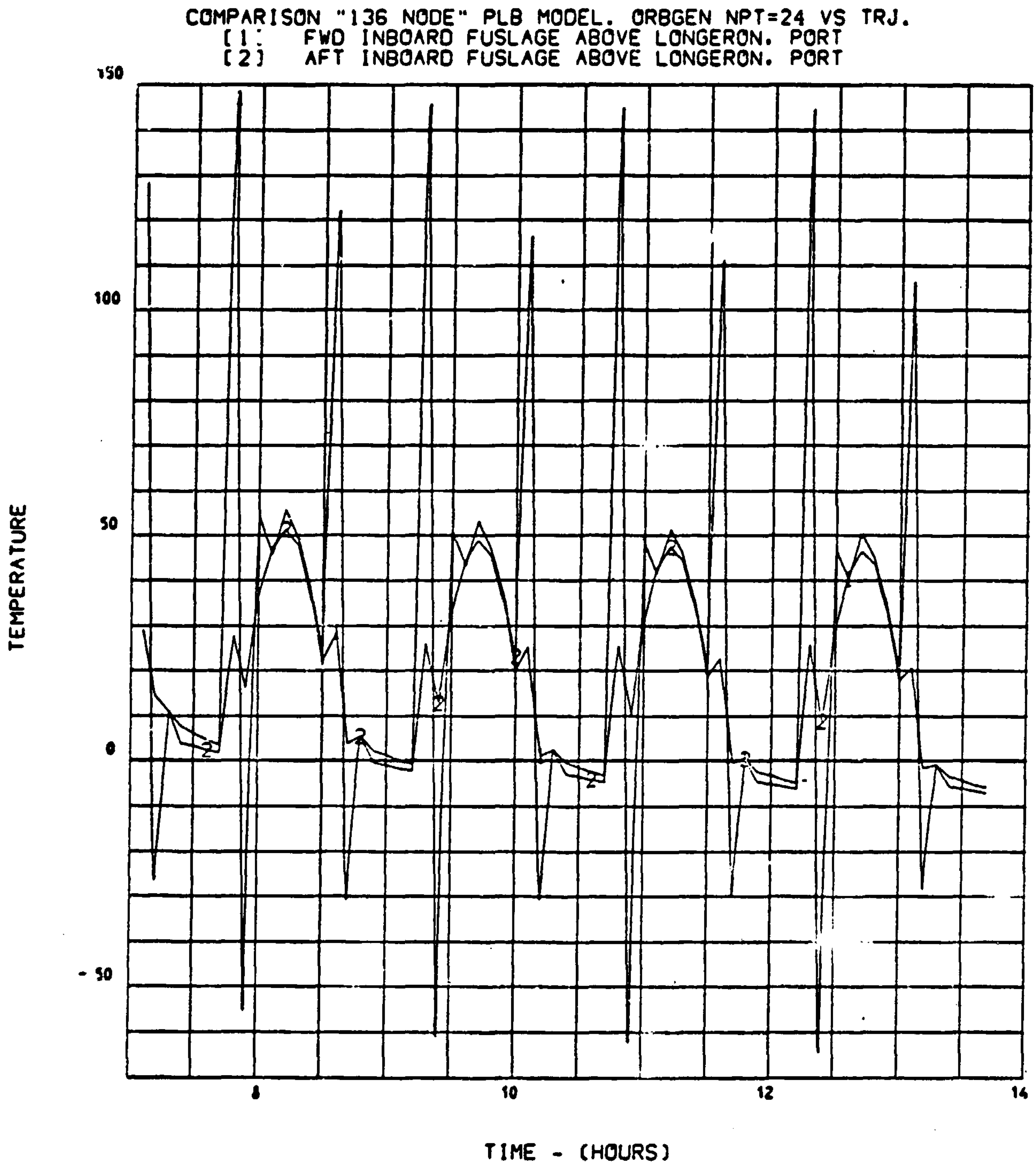

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD INBOARD FUSLAGE ABOVE LONGERON. PORT
[2] AFT INBOARD FUSLAGE ABOVE LONGERON. PORT
150
100
50
0
-50
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 86

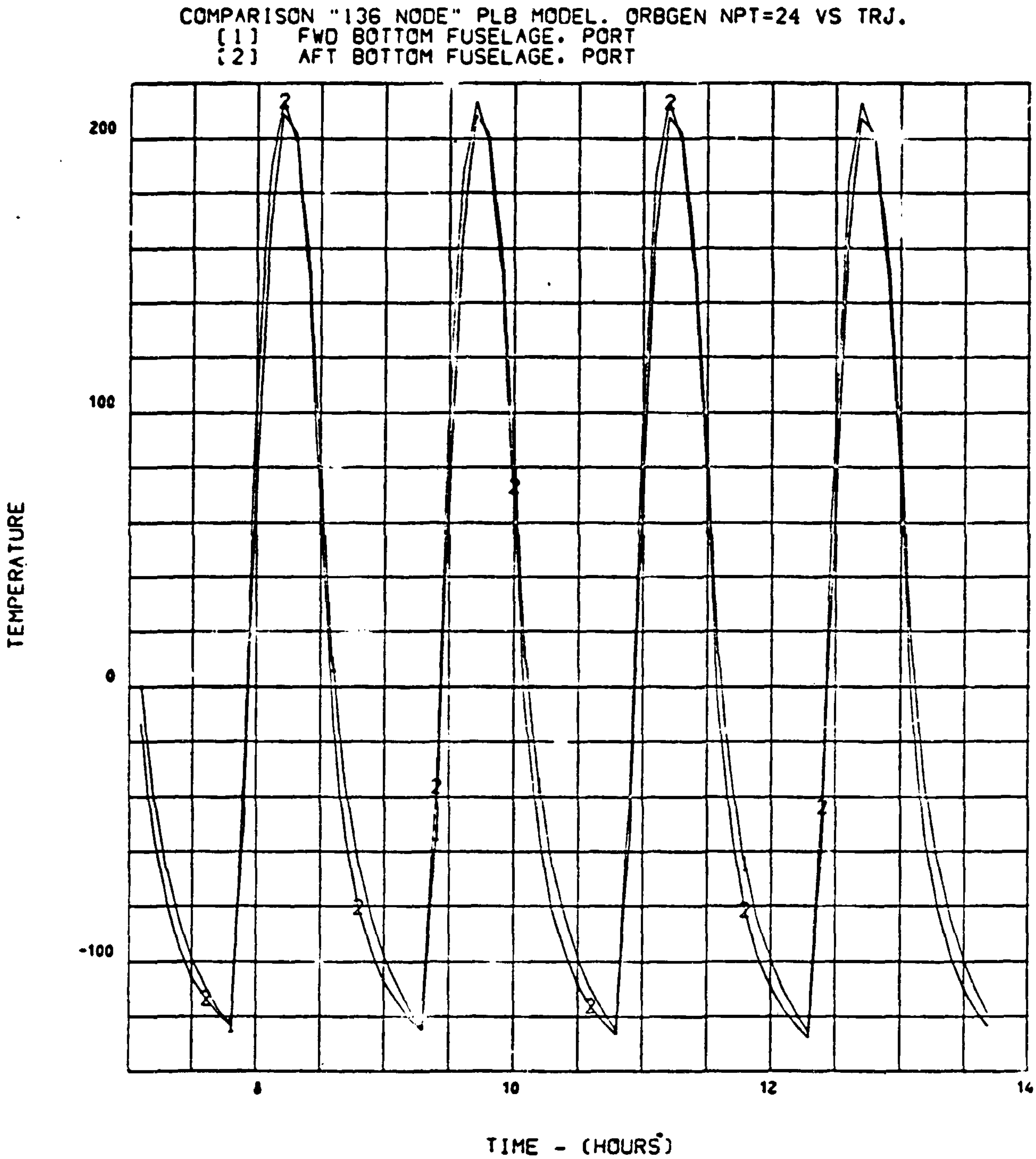

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD BOTTOM FUSELAGE. PORT
[2] AFT BOTTOM FUSELAGE. PORT
200
100
0
-100
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 87

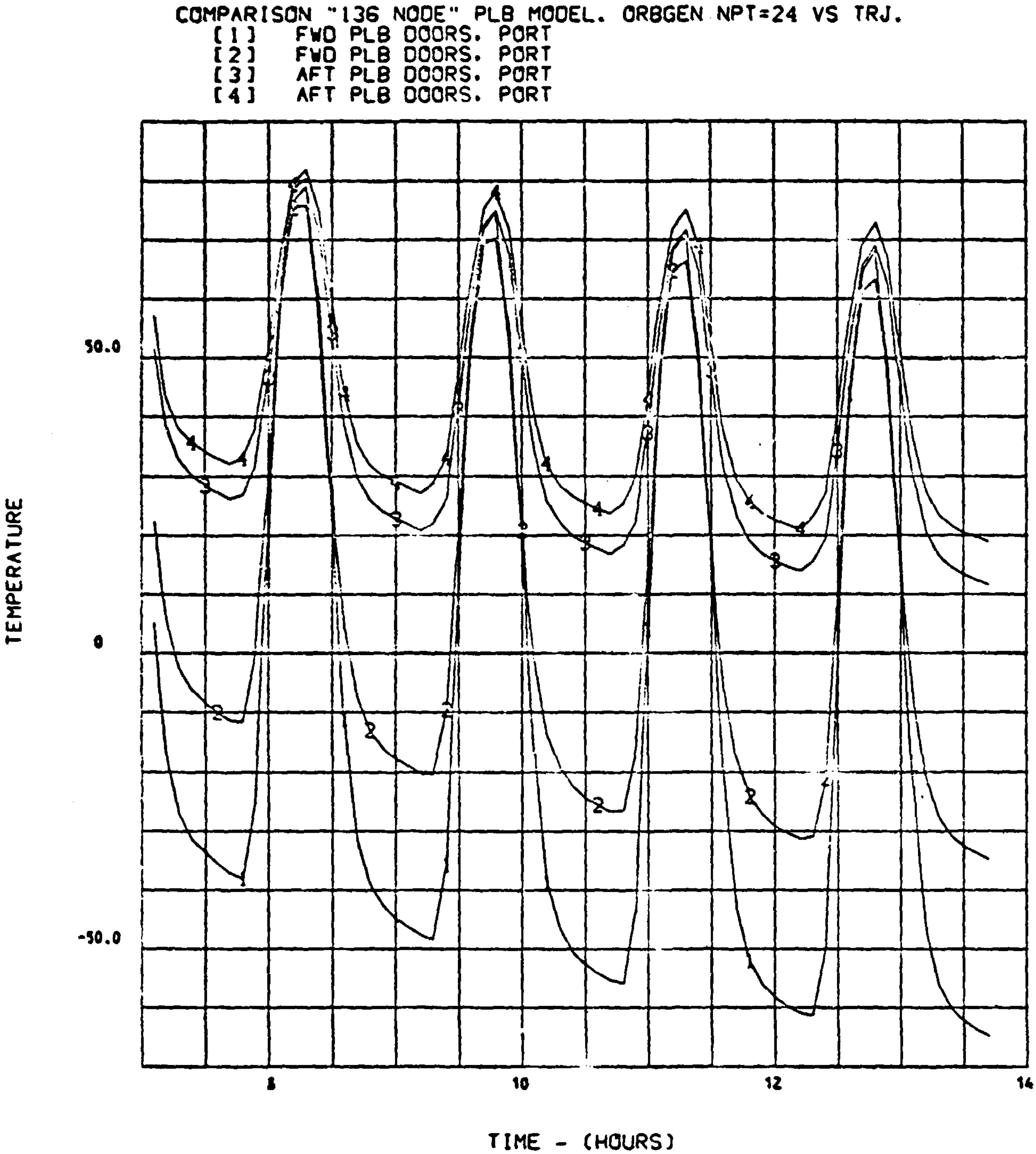

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD PLB DOORS. PORT
[2] FWD PLB DOORS. PORT
[3] AFT PLB DOORS. PORT
[4] AFT PLB DOORS. PORT
TEMPERATURE
50.0
0
-50.0
8
10
12
14
TIME - (HOURS)

Figure 88

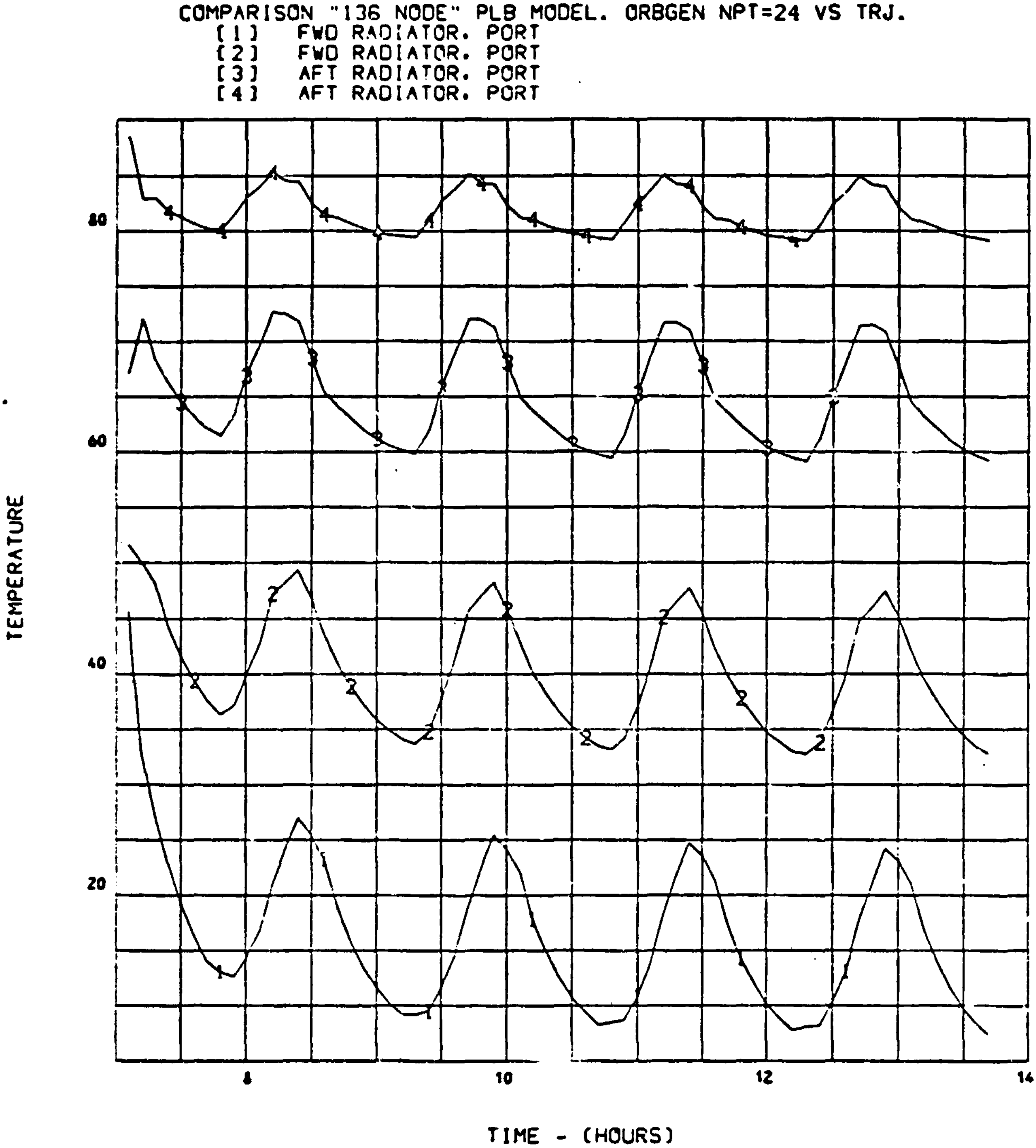

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD RADIATOR. PORT
[2] FWD RADIATOR. PORT
[3] AFT RADIATOR. PORT
[4] AFT RADIATOR. PORT
TEMPERATURE
80
60
40
20
8
10
12
14
TIME - (HOURS)

Figure 89

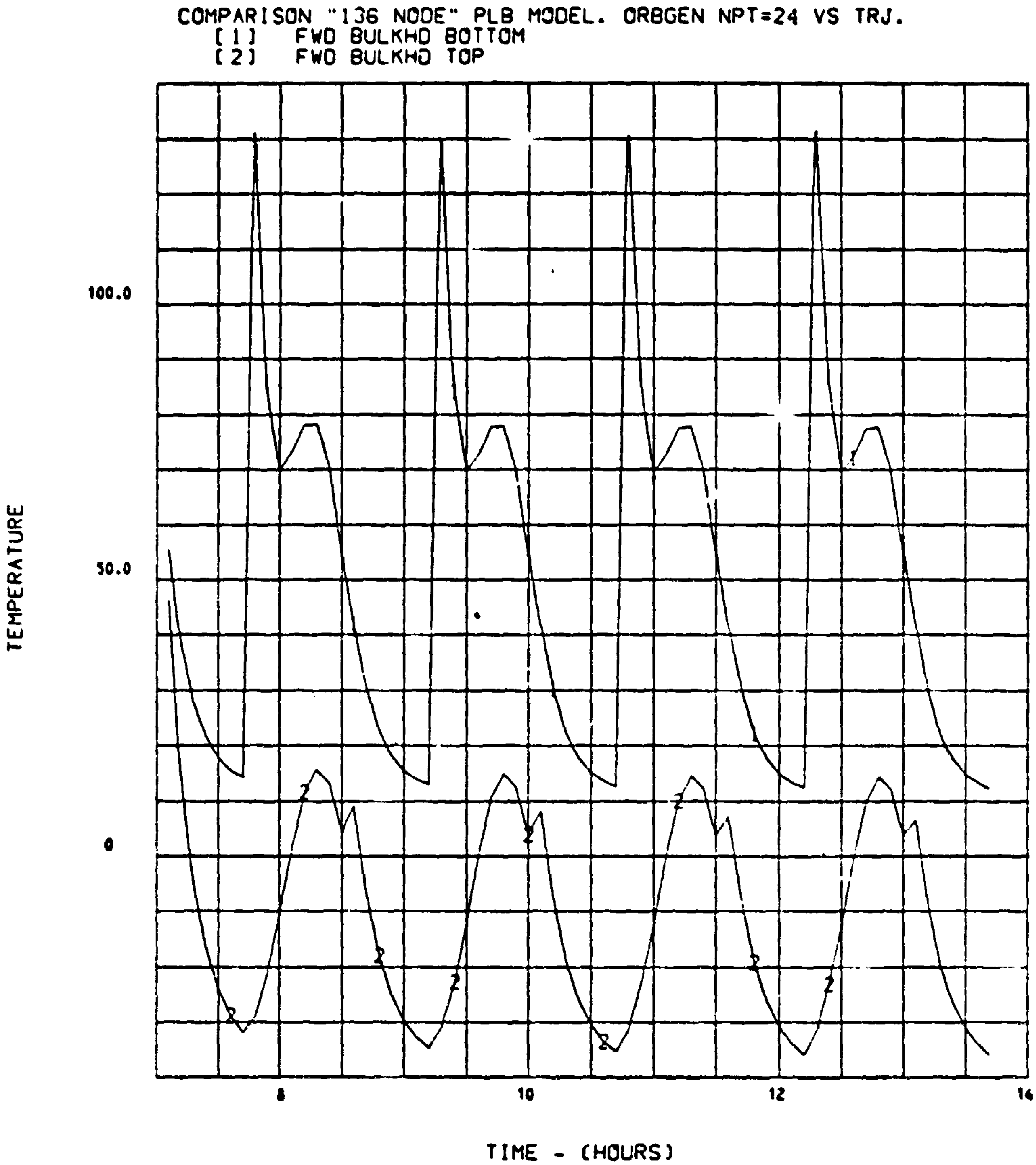

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD BULKHD BOTTOM
[2] FWD BULKHD TOP
TEMPERATURE
100.0
50.0
0
8
10
12
14
TIME - (HOURS)

Figure 90

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] UPPER FWD PLB LINER. PORT
[2] UPPER FWD PLB LINER. PORT
[3] UPPER FWD PLB LINER. PORT
[4] UPPER FWD PLB LINER. PORT

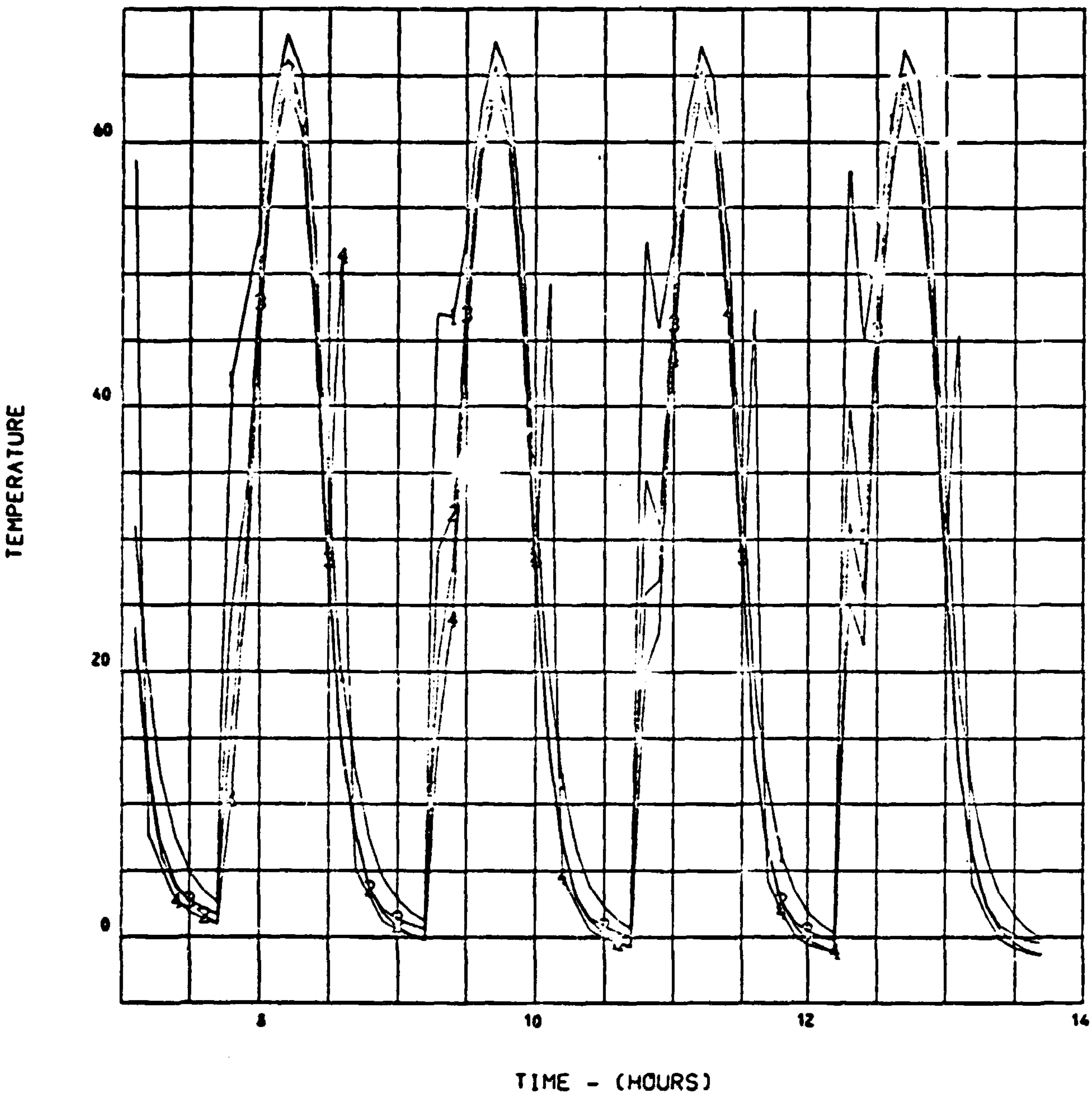
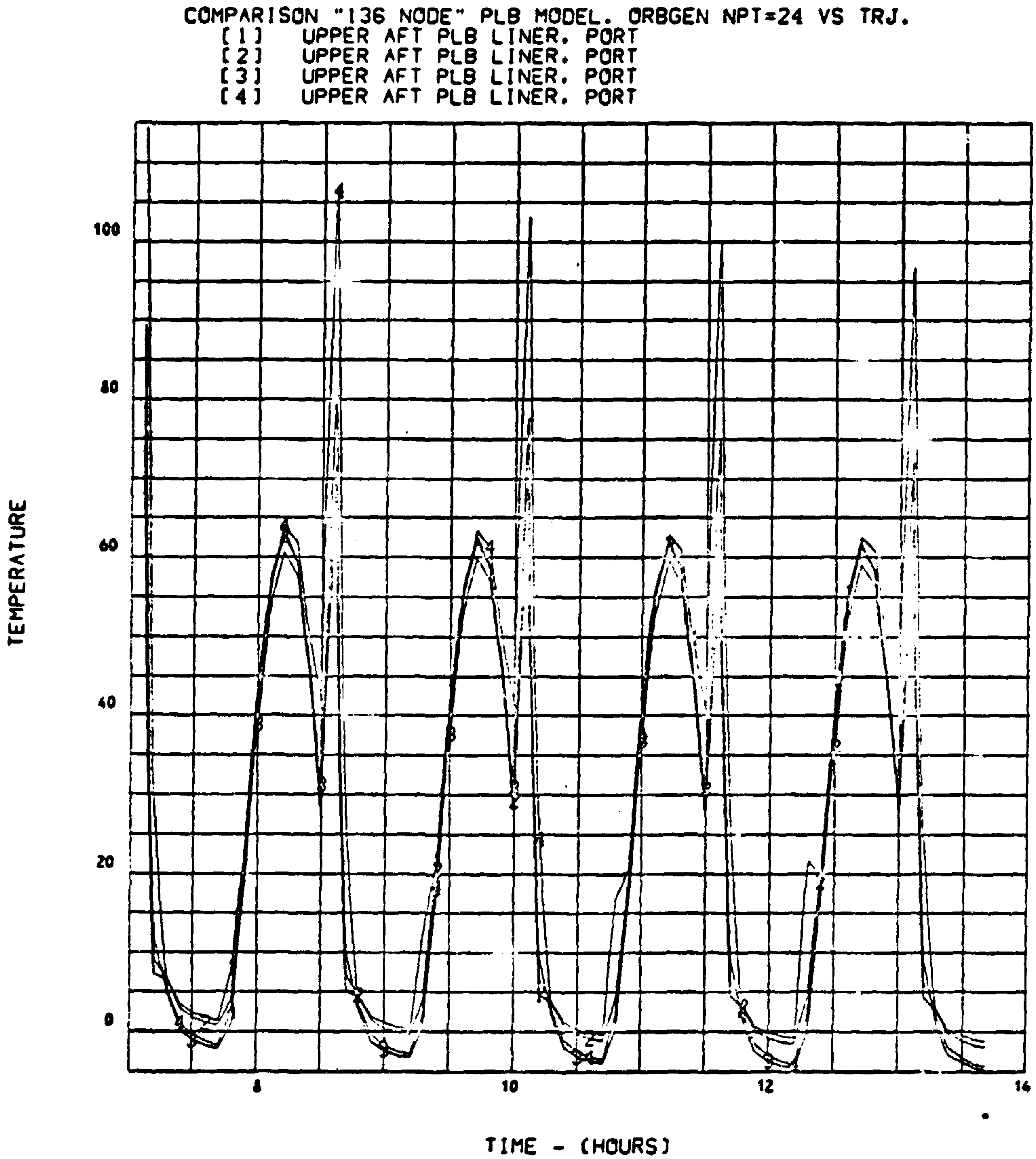


Figure 91



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] UPPER AFT PLB LINER. PORT
[2] UPPER AFT PLB LINER. PORT
[3] UPPER AFT PLB LINER. PORT
[4] UPPER AFT PLB LINER. PORT
TEMPERATURE
100
80
60
40
20
0
8
10
12
14
TIME - (HOURS)

Figure 92

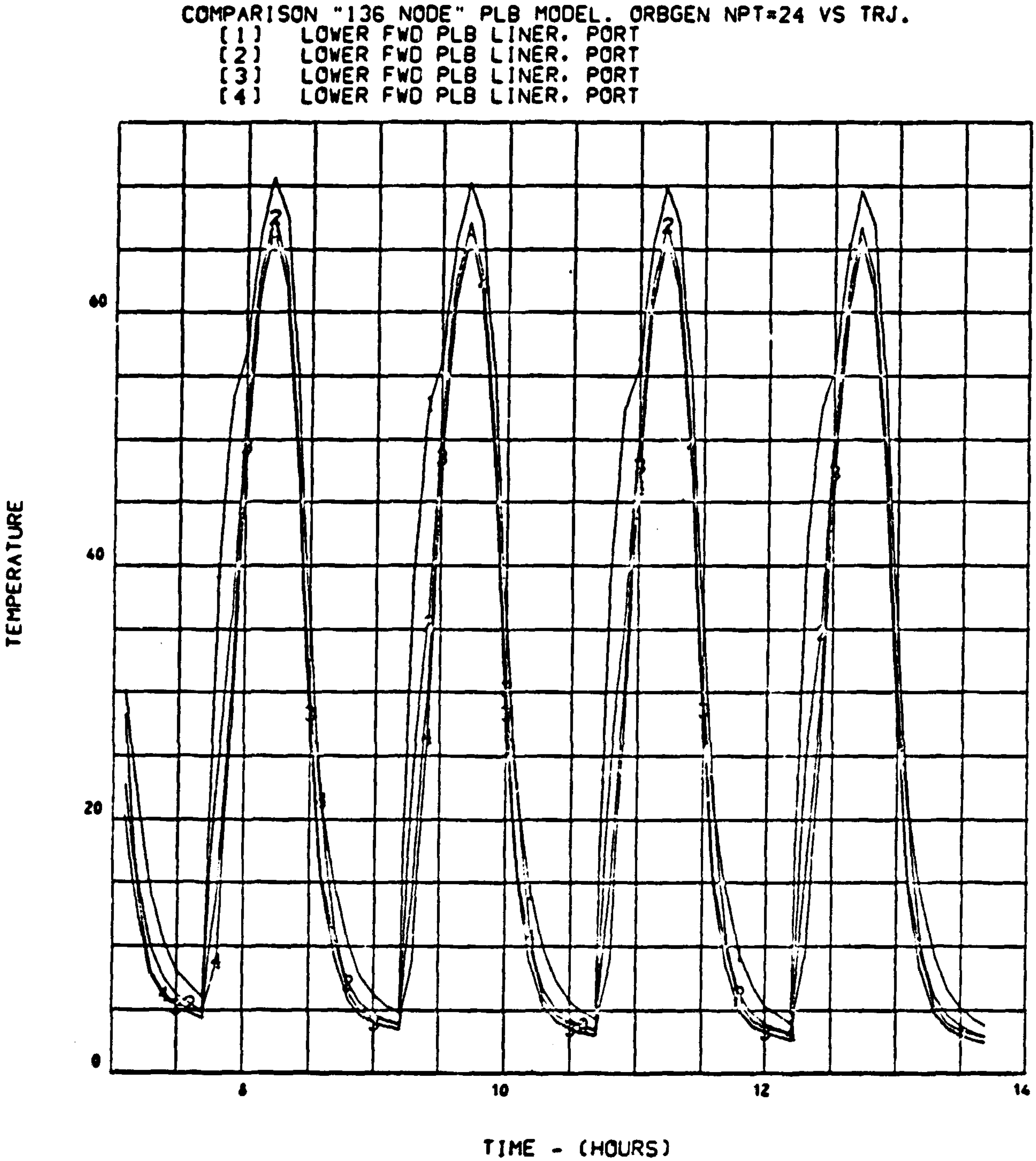
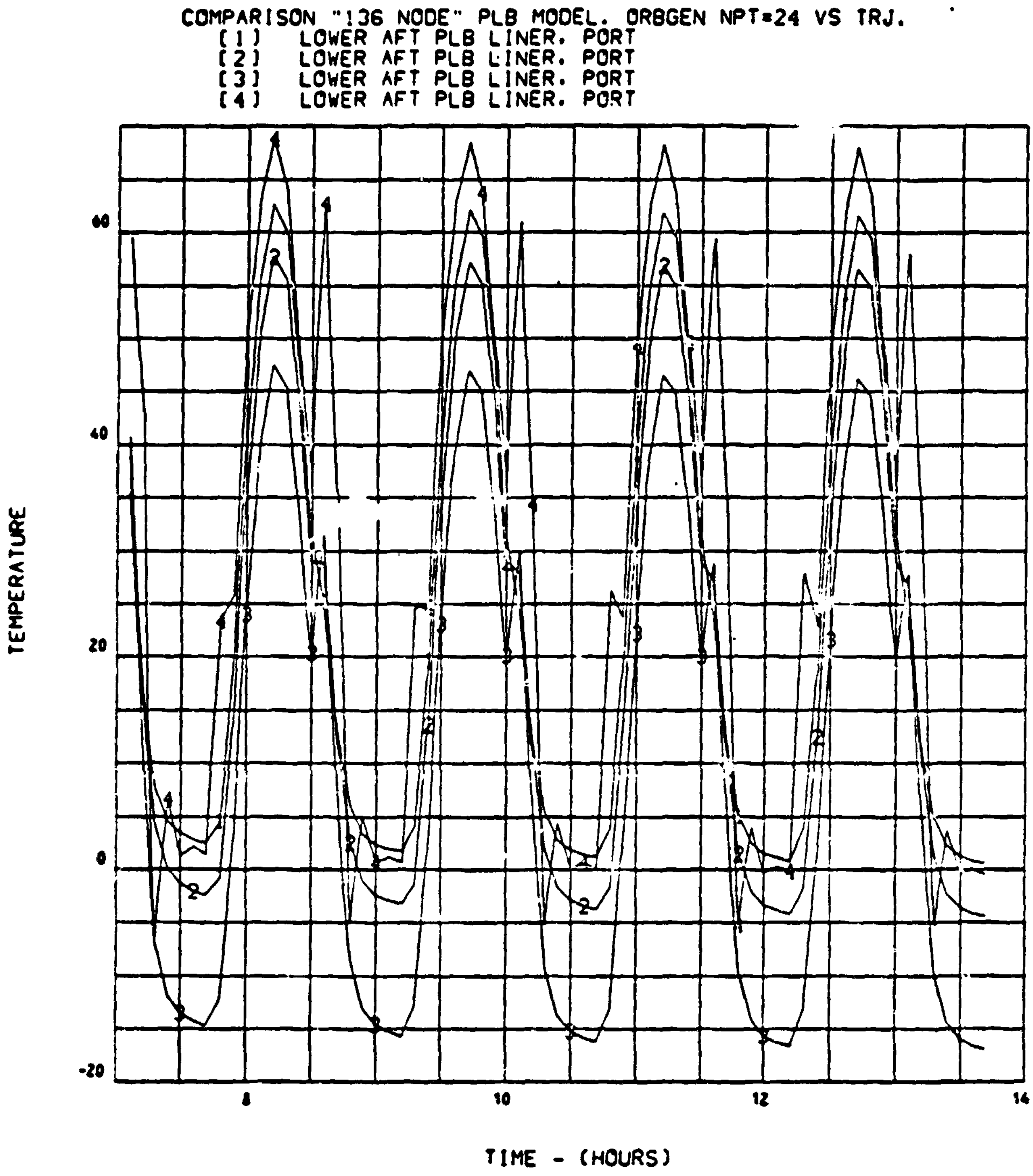
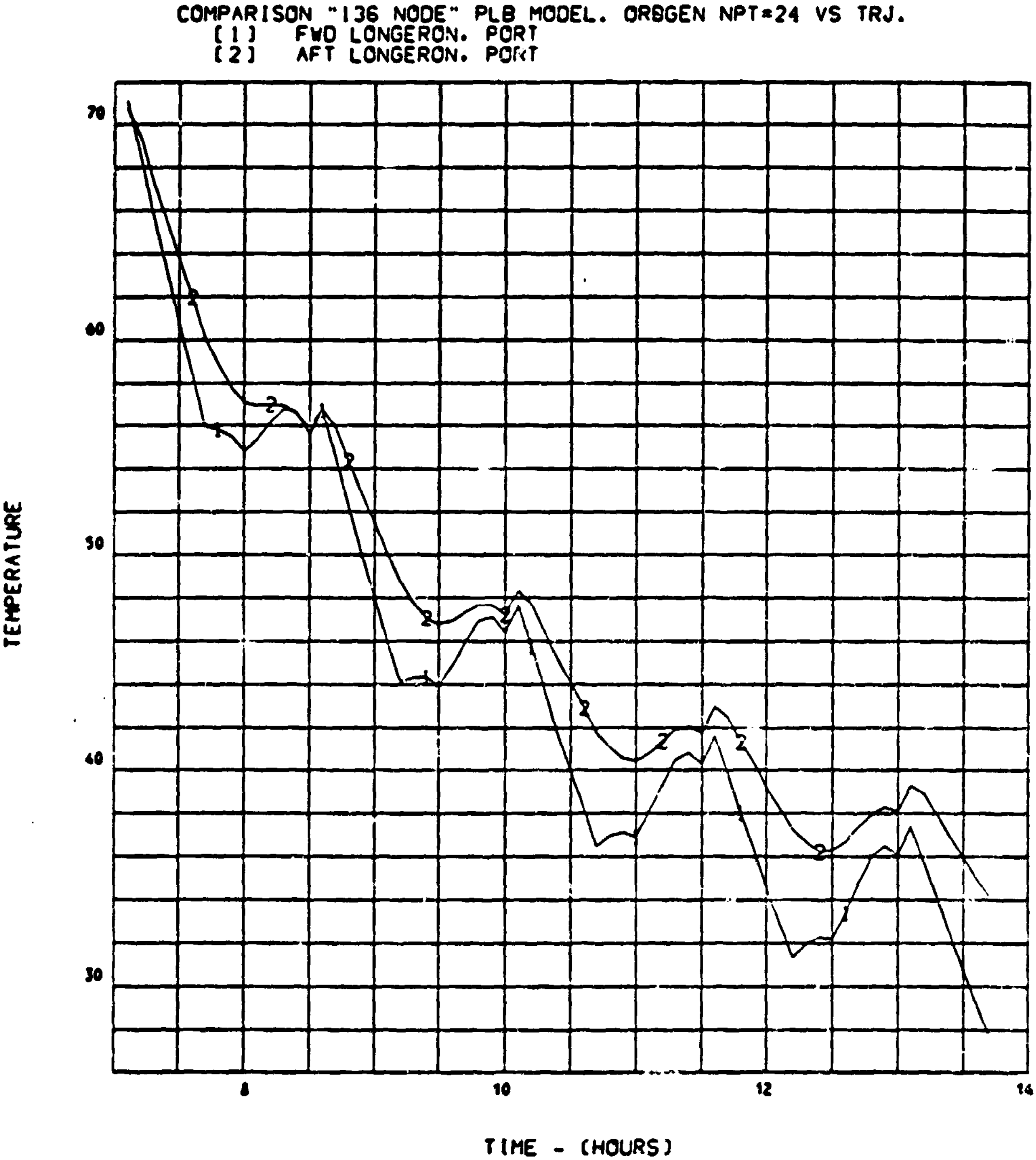

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] LOWER FWD PLB LINER. PORT
[2] LOWER FWD PLB LINER. PORT
[3] LOWER FWD PLB LINER. PORT
[4] LOWER FWD PLB LINER. PORT
TEMPERATURE
60
40
20
0
8
10
12
14
TIME - (HOURS)

Figure 93



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] LOWER AFT PLB LINER. PORT
[2] LOWER AFT PLB LINER. PORT
[3] LOWER AFT PLB LINER. PORT
[4] LOWER AFT PLB LINER. PORT
TEMPERATURE
60
40
20
0
-20
8
10
12
14
TIME - (HOURS)

Figure 94



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD LONGERON. PORT
[2] AFT LONGERON. PORT
70
60
50
40
30
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 95

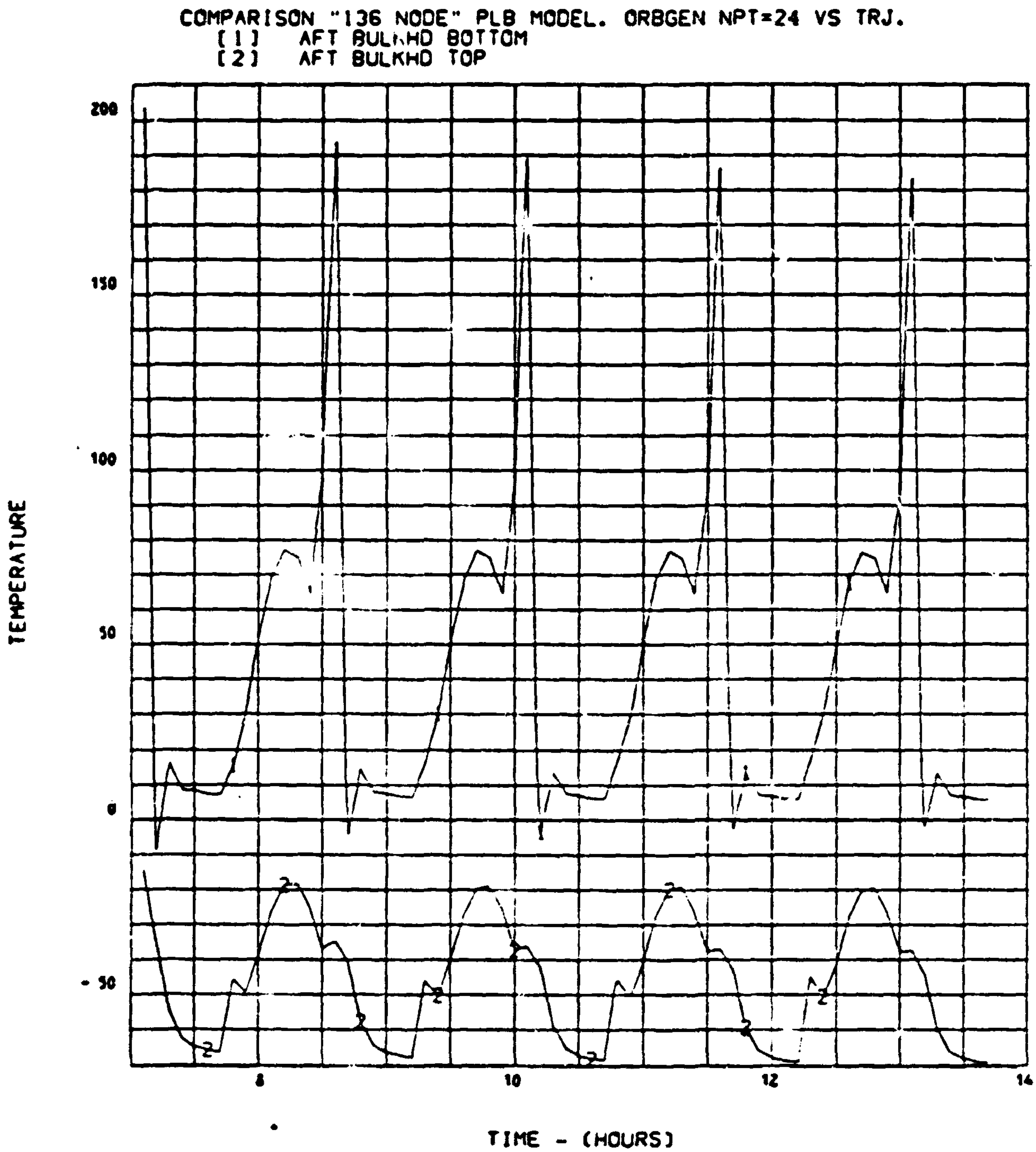

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] AFT BULKHD BOTTOM
[2] AFT BULKHD TOP
TEMPERATURE
200
150
100
50
0
-50
8
10
12
14
TIME - (HOURS)

Figure 96

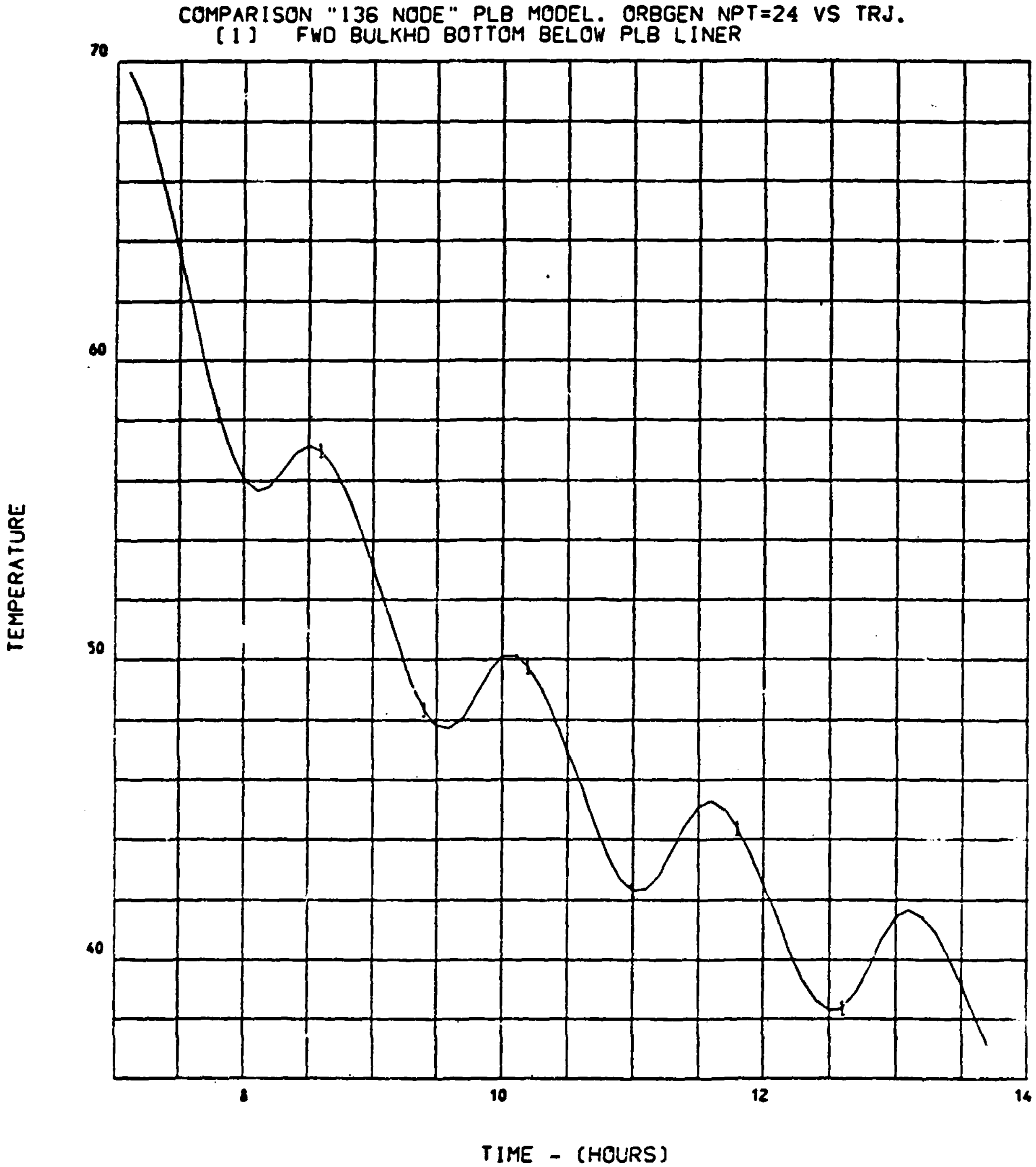

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD BULKHD BOTTOM BELOW PLB LINER
70
60
50
40
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 97

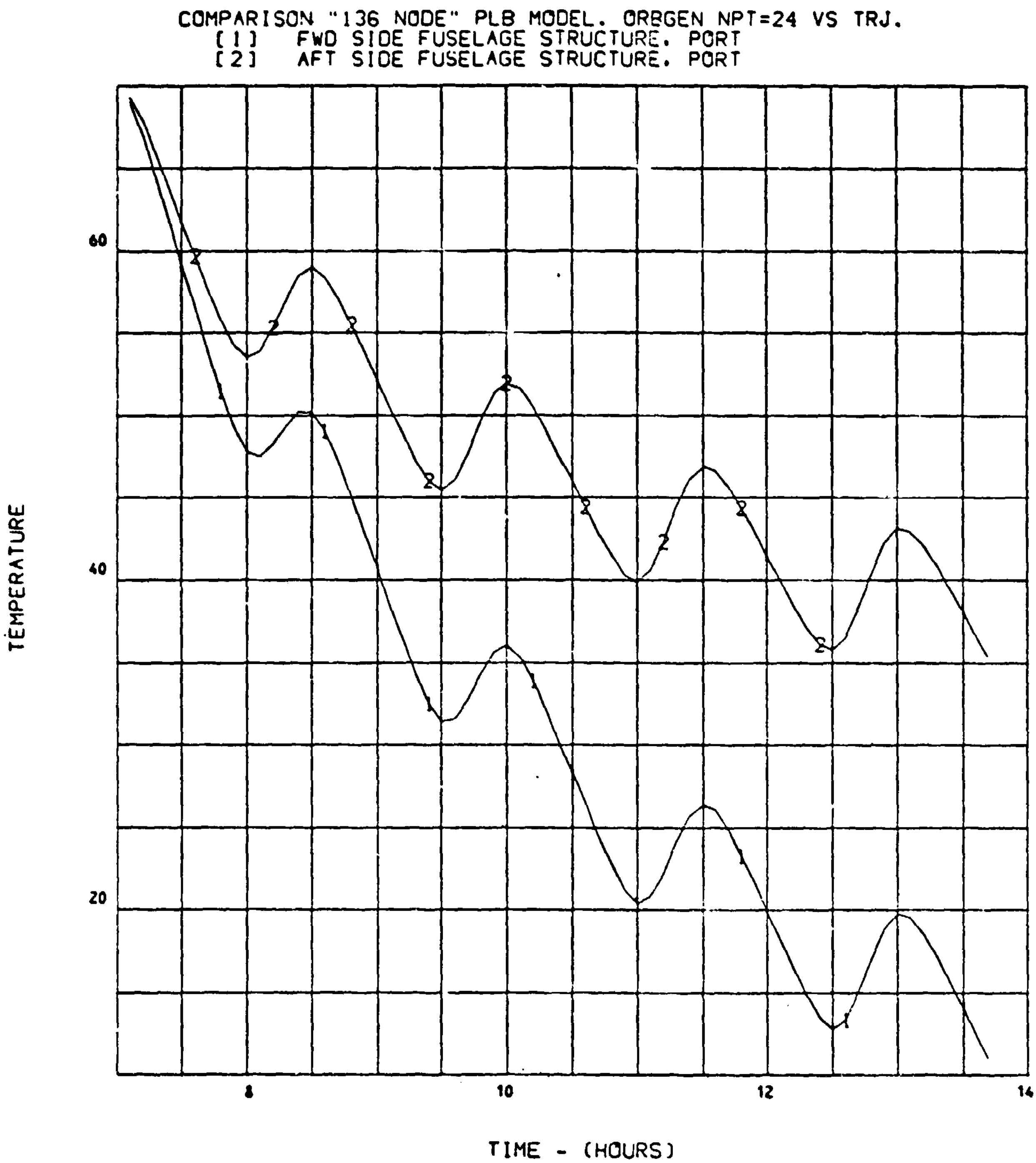
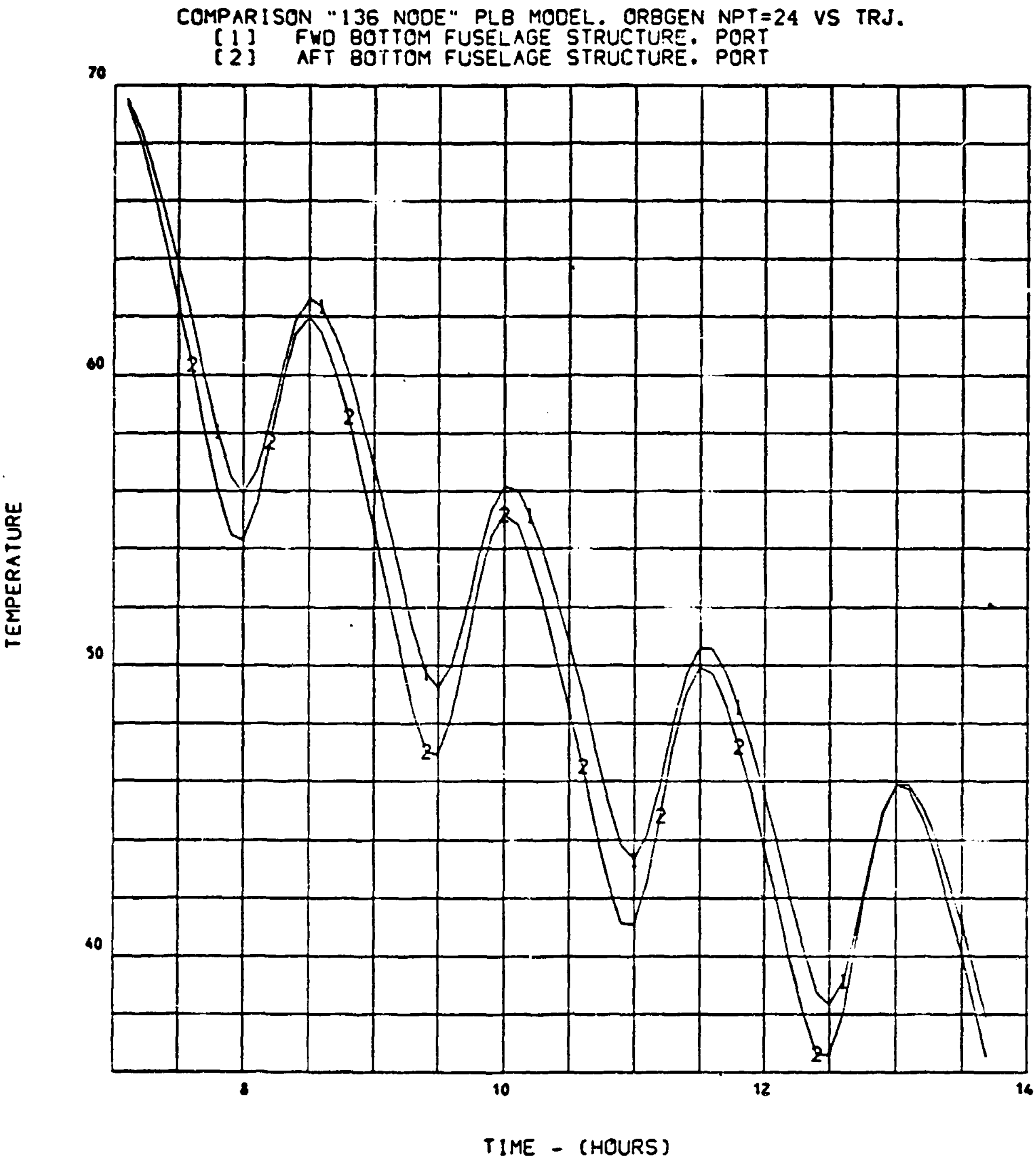
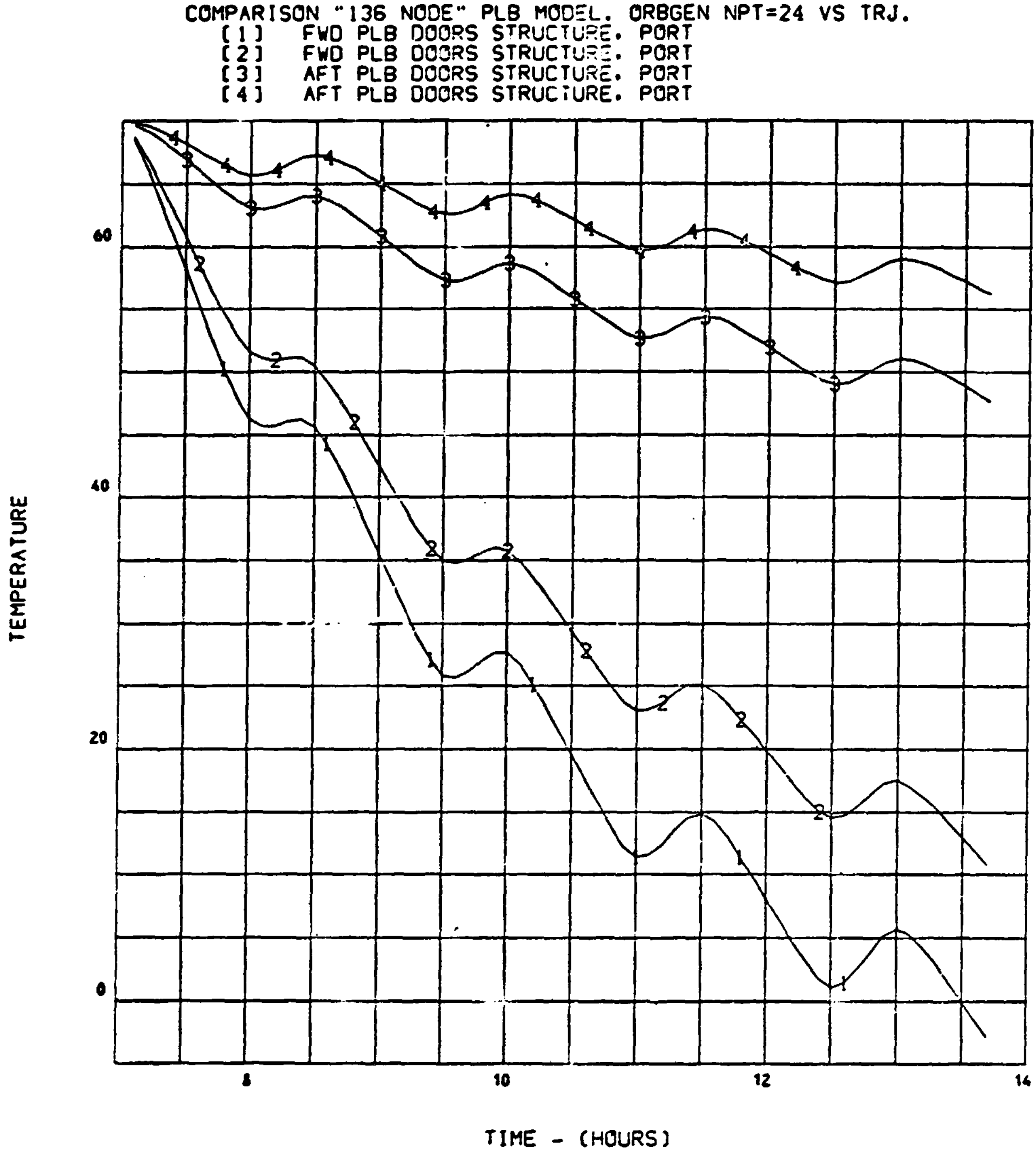

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD SIDE FUSELAGE STRUCTURE. PORT
[2] AFT SIDE FUSELAGE STRUCTURE. PORT
TEMPERATURE
60
40
20
8
10
12
14
TIME - (HOURS)

Figure 98



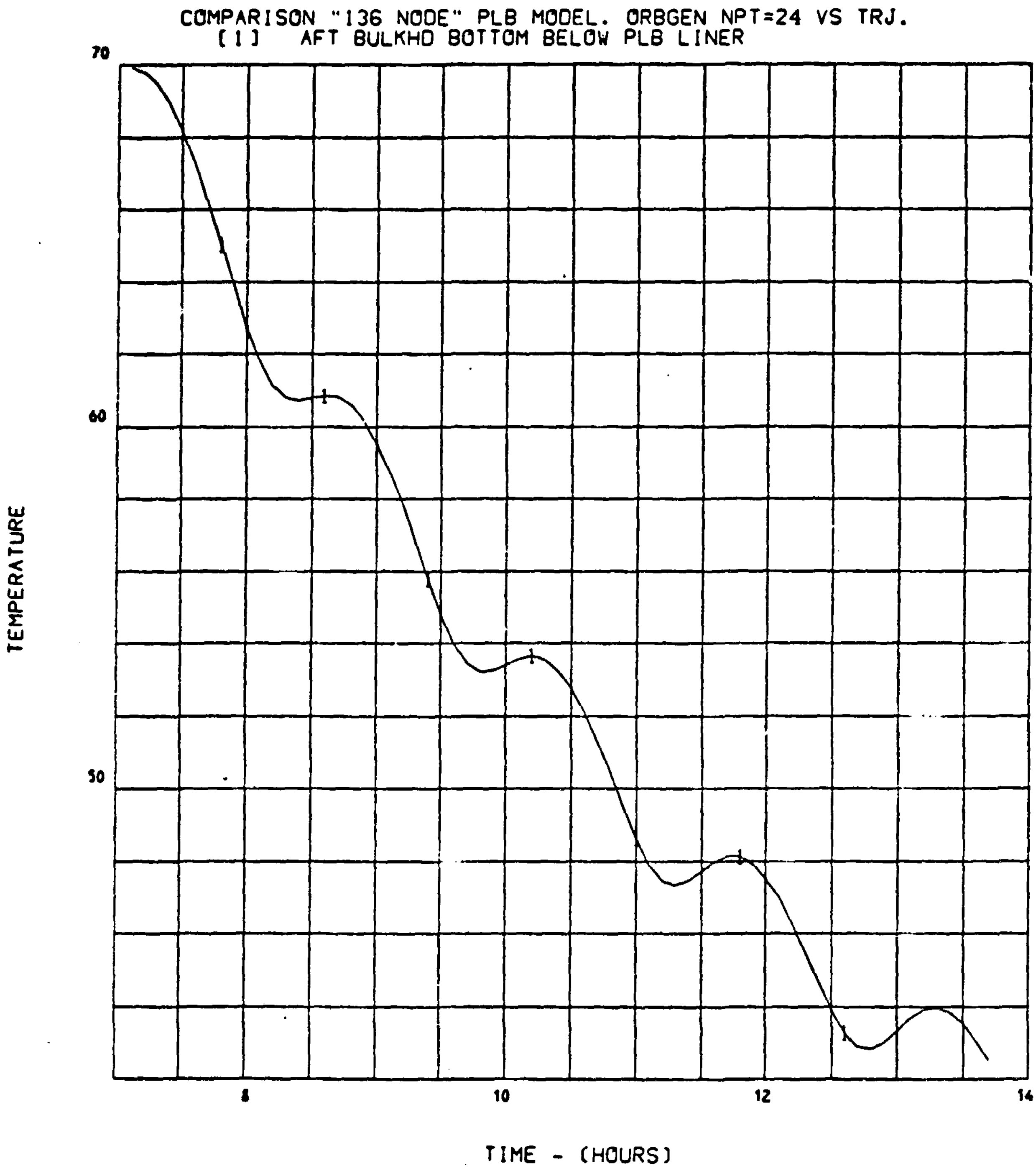
COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD BOTTOM FUSELAGE STRUCTURE. PORT
[2] AFT BOTTOM FUSELAGE STRUCTURE. PORT
70
60
50
40
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 99



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD PLB DOORS STRUCTURE. PORT
[2] FWD PLB DOORS STRUCTURE. PORT
[3] AFT PLB DOORS STRUCTURE. PORT
[4] AFT PLB DOORS STRUCTURE. PORT
TEMPERATURE
60
40
20
0
8
10
12
14
TIME - (HOURS)

Figure 100



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] AFT BULKHD BOTTOM BELOW PLB LINER
70
60
50
TEMPERATURE
8
10
12
14
TIME - (HOURS)

Figure 101

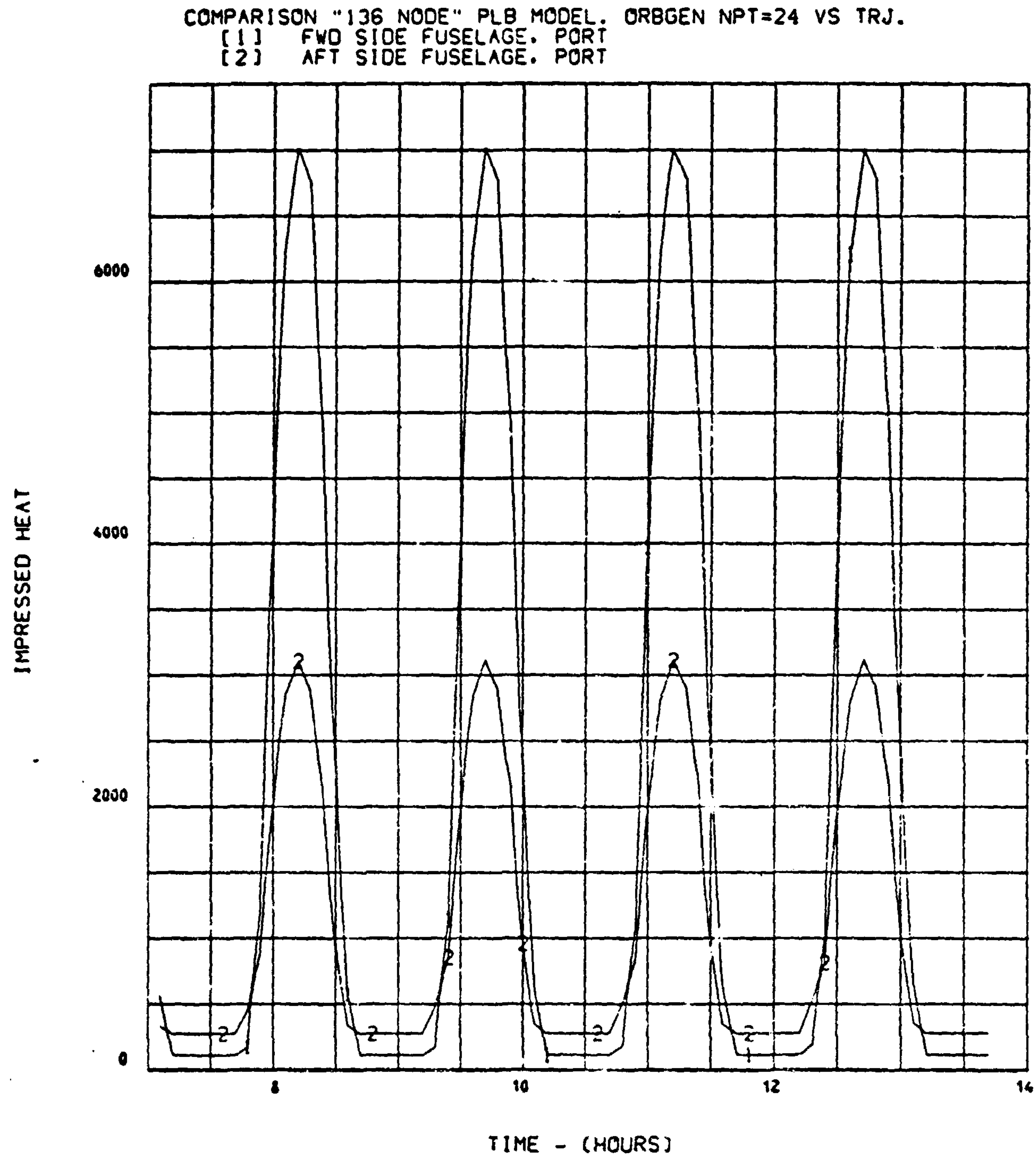
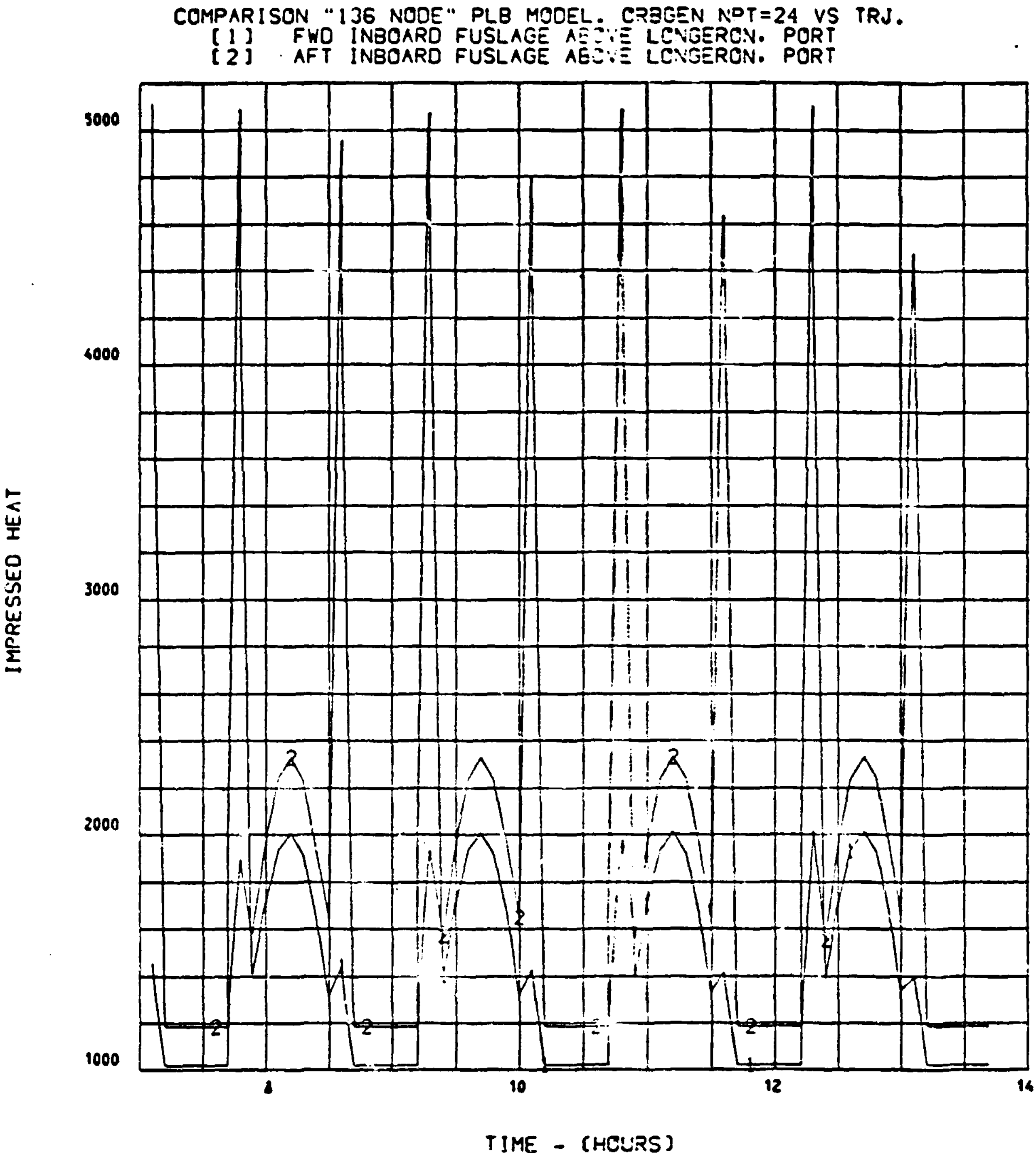

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD SIDE FUSELAGE. PORT
[2] AFT SIDE FUSELAGE. PORT
IMPRESSED HEAT
6000
4000
2000
0
8
10
12
14
TIME - (HOURS)

Figure 102



COMPARISON "136 NODE" PLB MODEL. CRBGEN NPT=24 VS TRJ.
[1] FWD INBOARD FUSLAGE ABOVE LONGERON. PORT
[2] AFT INBOARD FUSLAGE ABOVE LONGERON. PORT
IMPRESSED HEAT
5000
4000
3000
2000
1000
8
10
12
14
TIME - (HOURS)

Figure 103

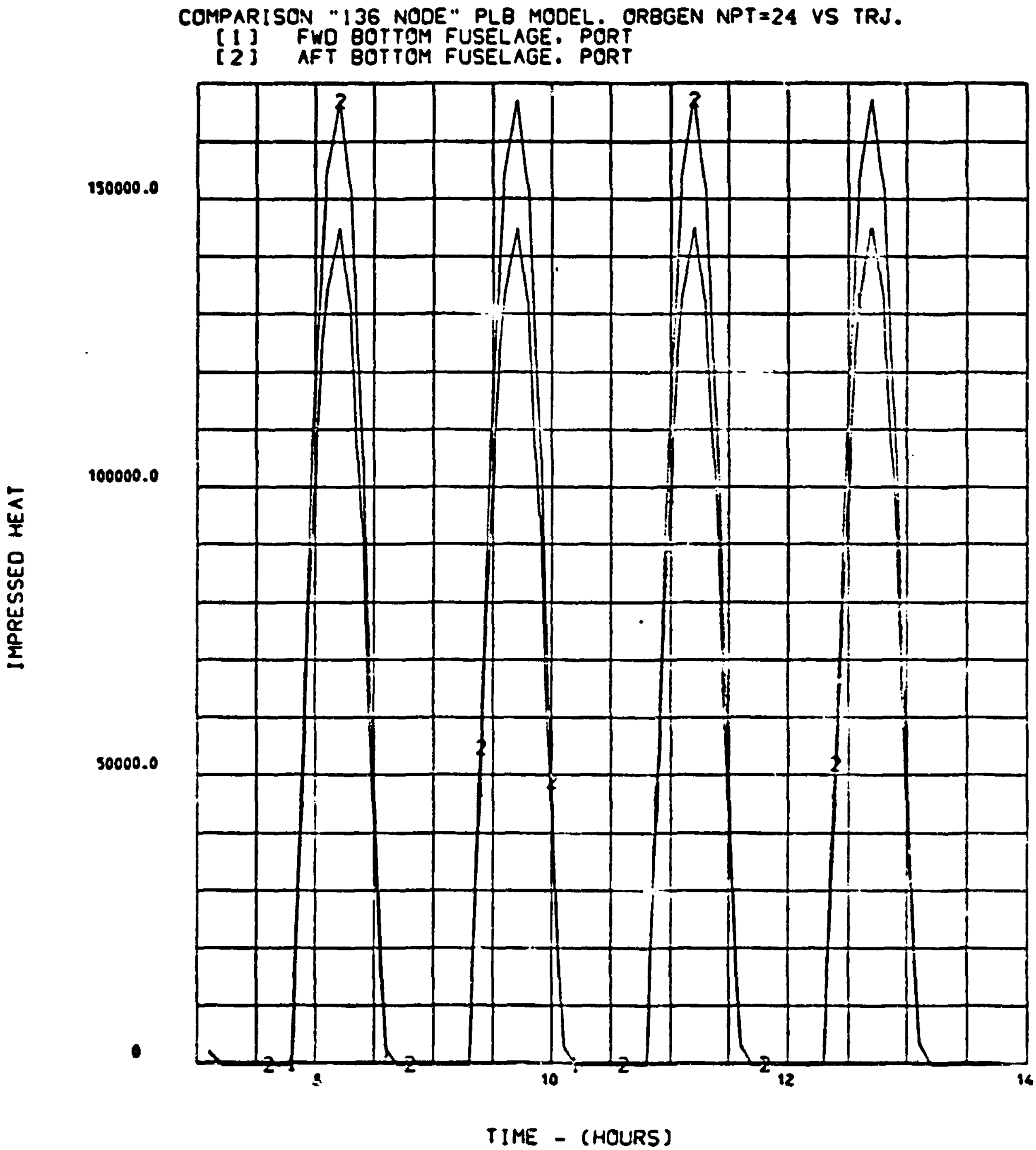
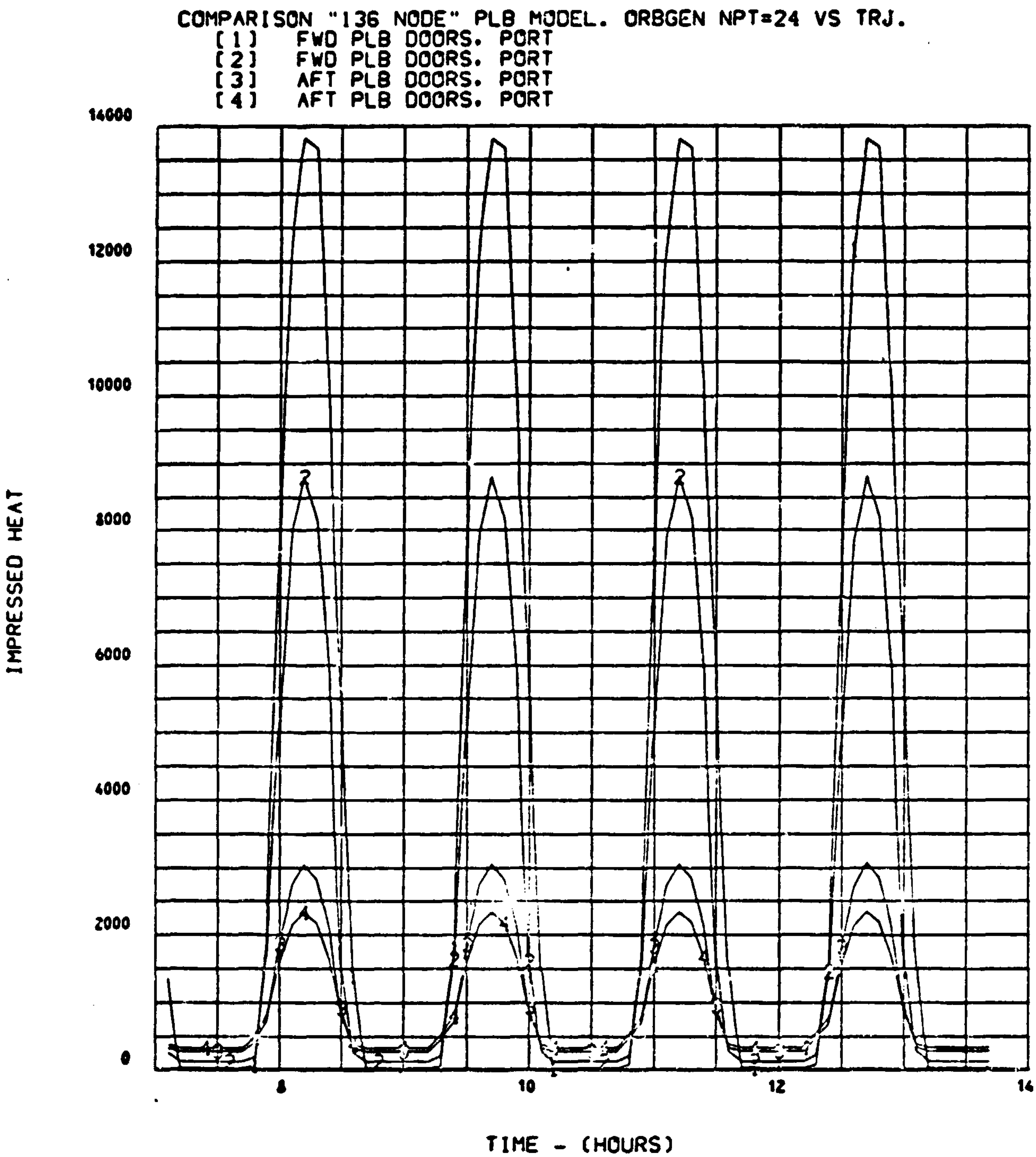

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD BOTTOM FUSELAGE. PORT
[2] AFT BOTTOM FUSELAGE. PORT
150000.0
100000.0
50000.0
0
IMPRESSED HEAT
10
12
14
TIME - (HOURS)

Figure 104



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD PLB DOORS. PORT
[2] FWD PLB DOORS. PORT
[3] AFT PLB DOORS. PORT
[4] AFT PLB DOORS. PORT
14000
12000
10000
8000
6000
4000
2000
0
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 105

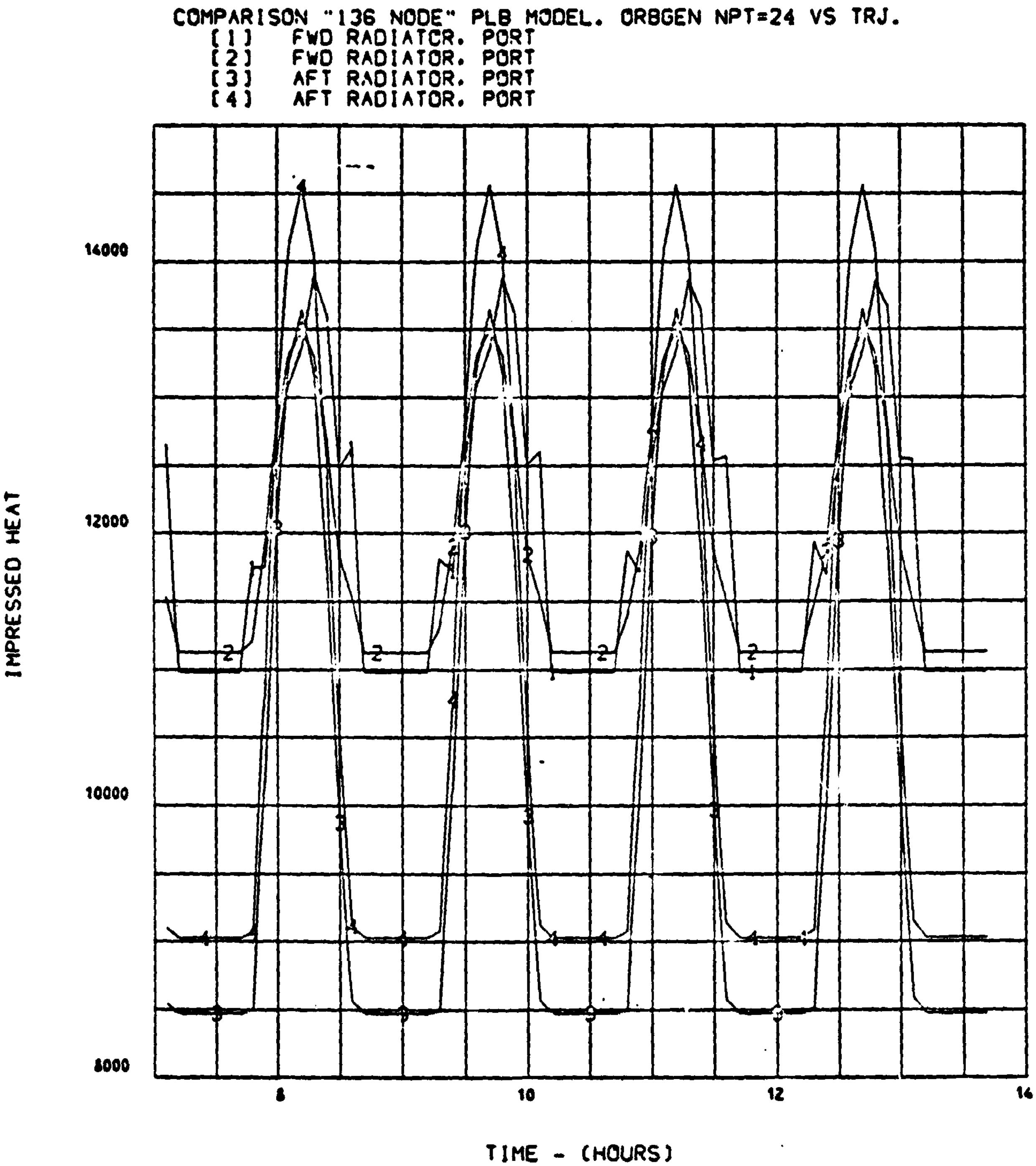

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD RADIATOR. PORT
[2] FWD RADIATOR. PORT
[3] AFT RADIATOR. PORT
[4] AFT RADIATOR. PORT
14000
12000
10000
8000
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 106

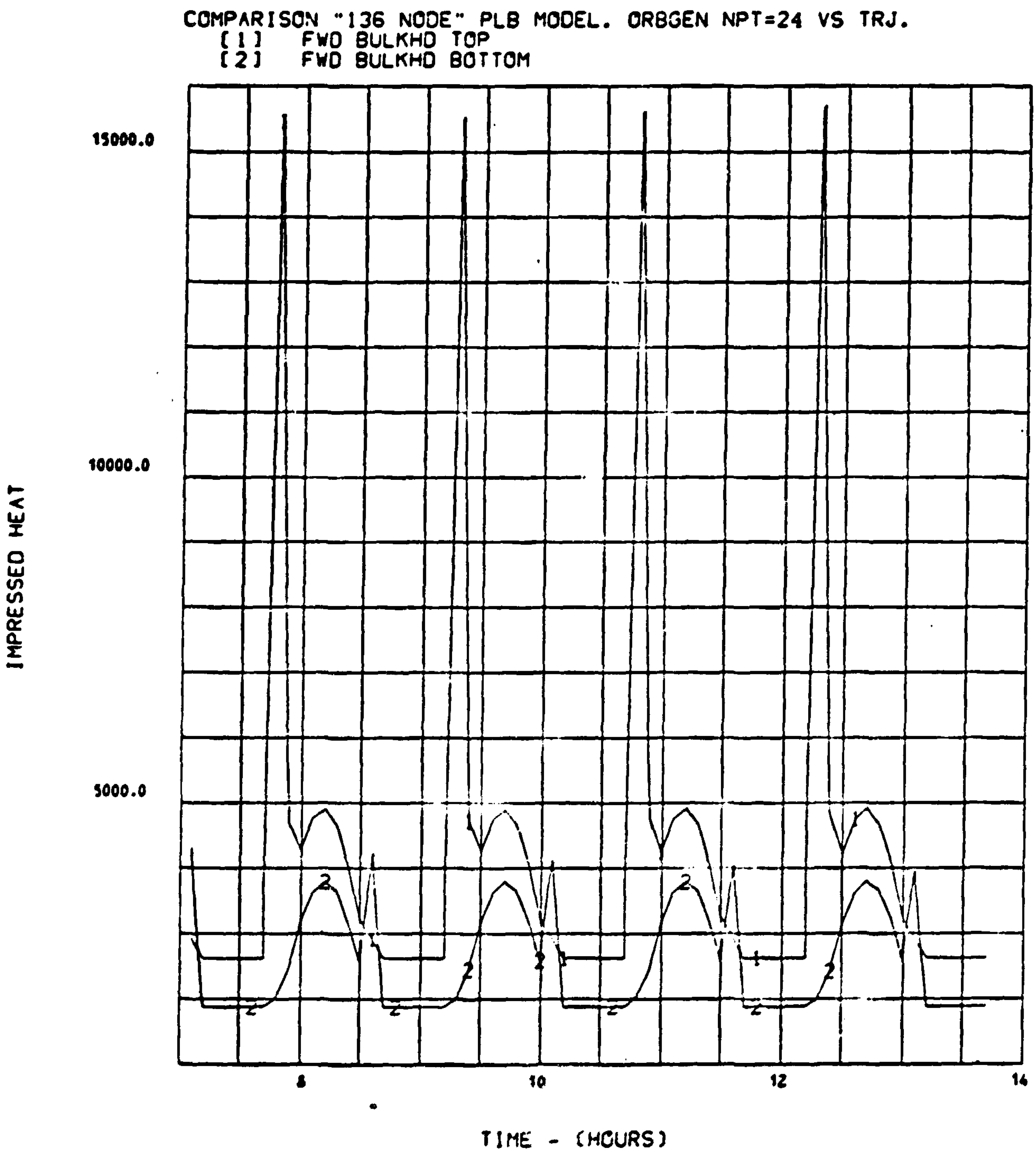
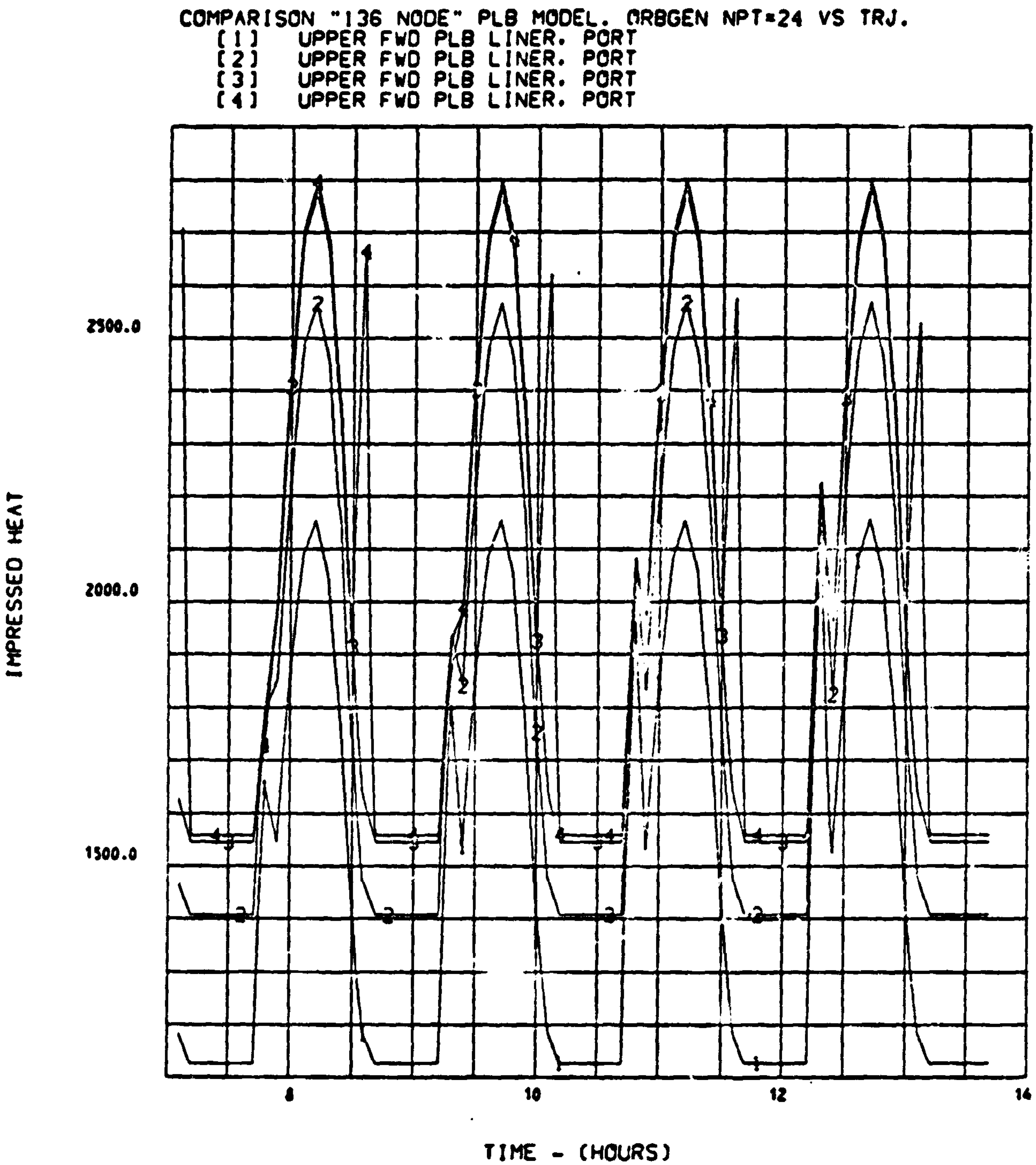

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] FWD BULKHD TOP
[2] FWD BULKHD BOTTOM
15000.0
10000.0
5000.0
IMPRESSED HEAT
8
10
12
14
TIME - (HOURS)

Figure 107



COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] UPPER FWD PLB LINER, PORT
[2] UPPER FWD PLB LINER, PORT
[3] UPPER FWD PLB LINER, PORT
[4] UPPER FWD PLB LINER, PORT
IMPRESSED HEAT
2500.0
2000.0
1500.0
8
10
12
14
TIME - (HOURS)

Figure 108

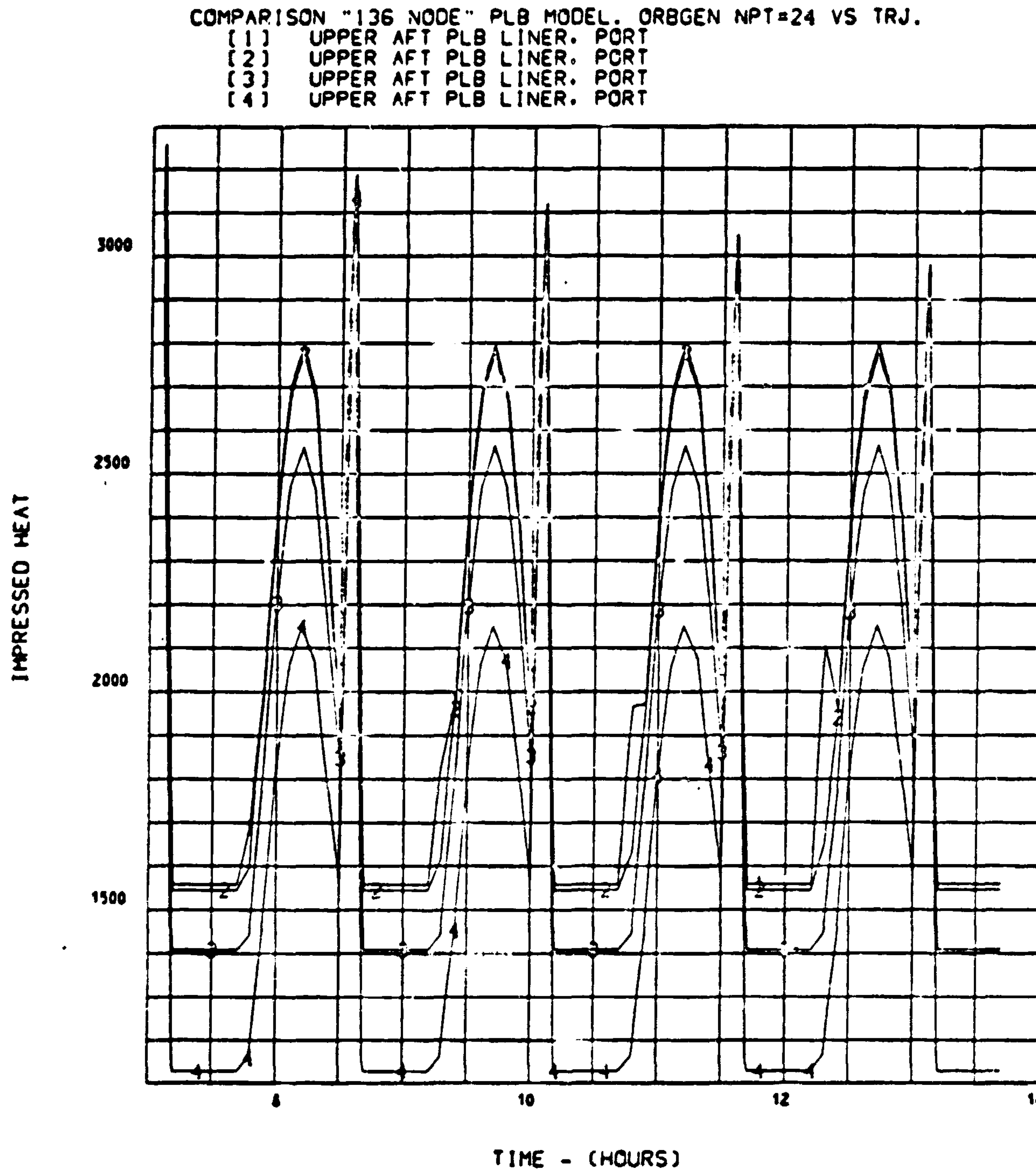

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] UPPER AFT PLB LINER. PORT
[2] UPPER AFT PLB LINER. PORT
[3] UPPER AFT PLB LINER. PORT
[4] UPPER AFT PLB LINER. PORT
IMPRESSED HEAT
3000
2500
2000
1500
8
10
12
14
TIME - (HOURS)

Figure 109

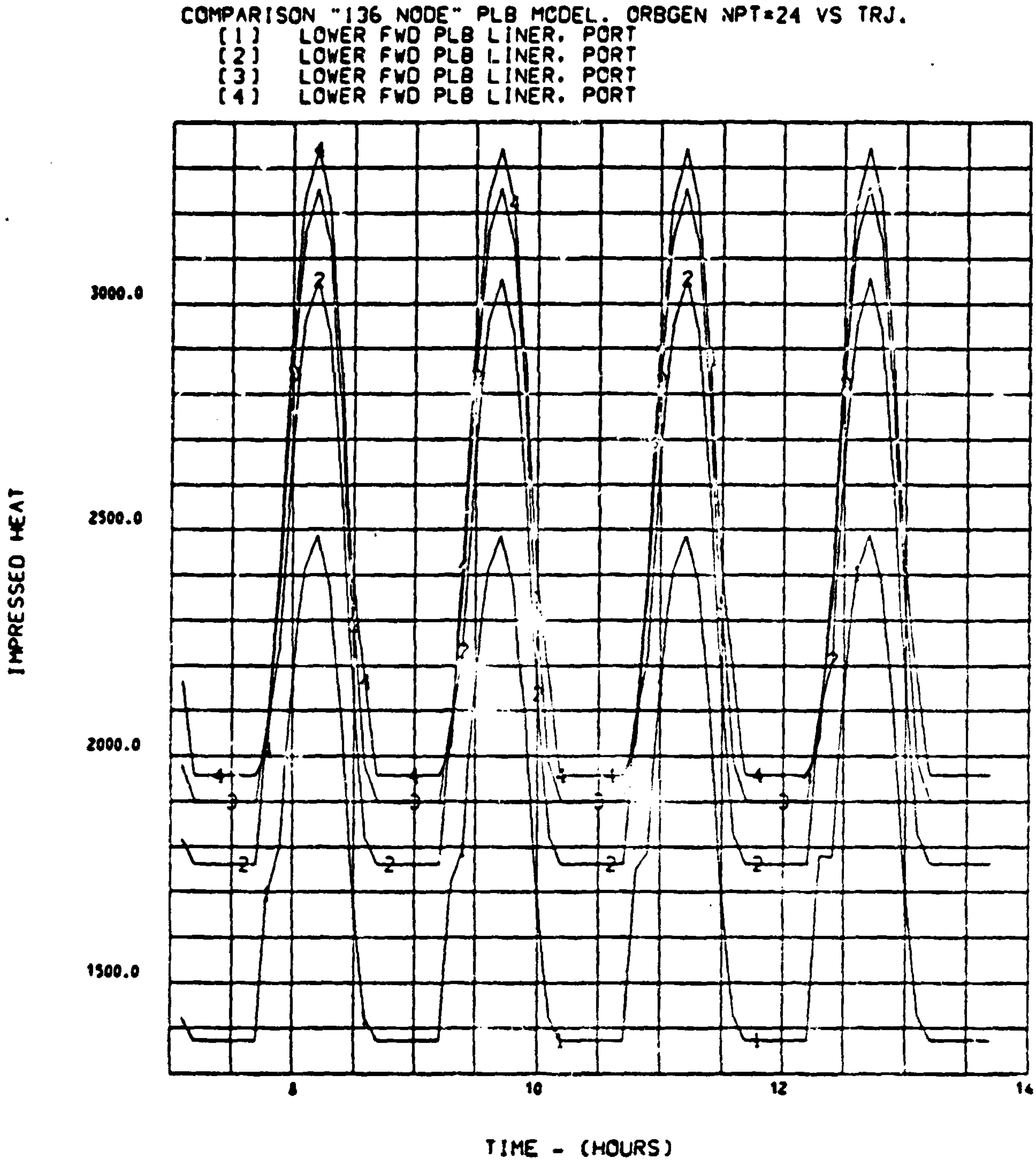

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] LOWER FWD PLB LINER, PORT
[2] LOWER FWD PLB LINER, PORT
[3] LOWER FWD PLB LINER, PORT
[4] LOWER FWD PLB LINER, PORT
IMPRESSED HEAT
3000.0
2500.0
2000.0
1500.0
8
10
12
14
TIME - (HOURS)

Figure 110

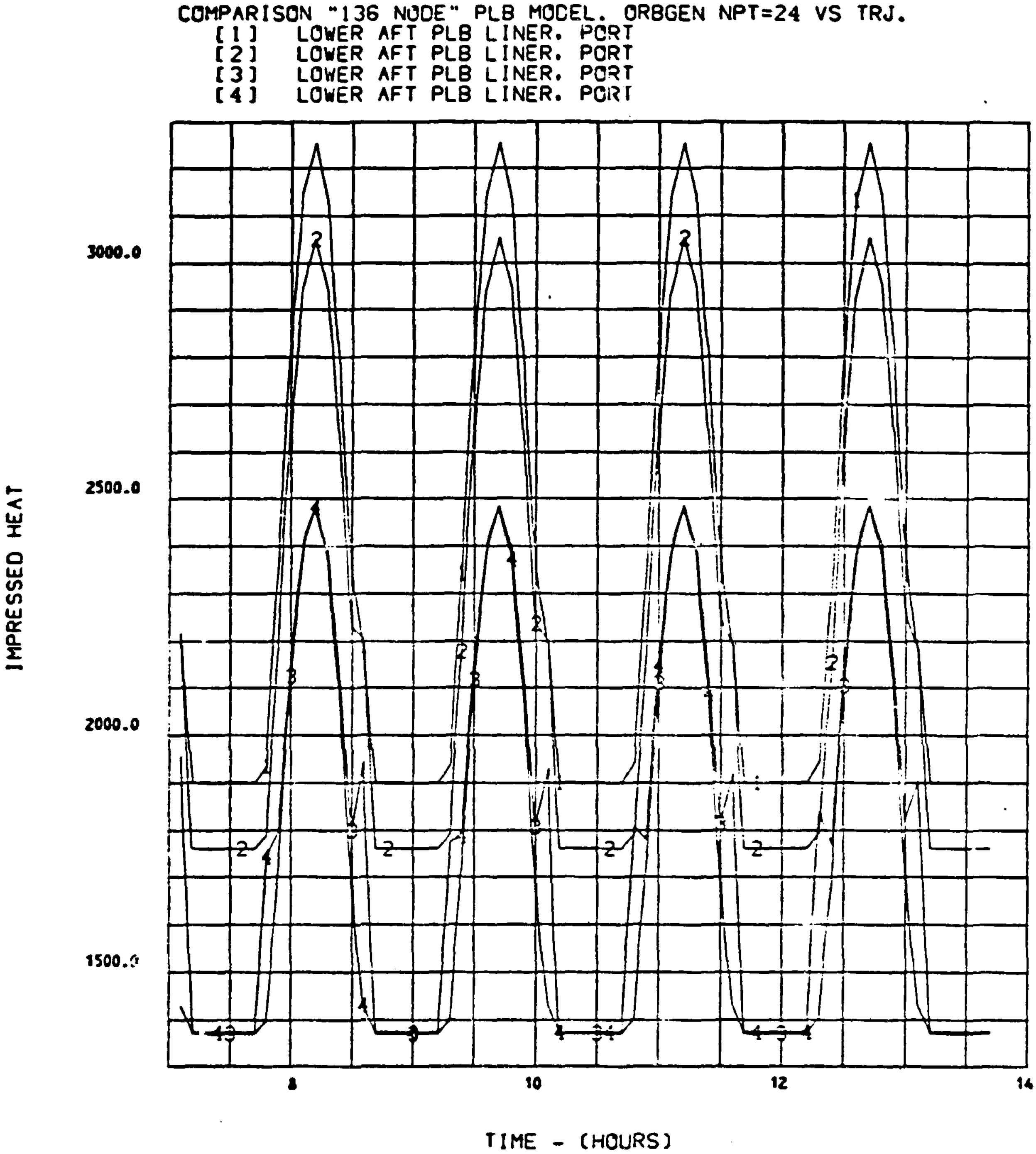
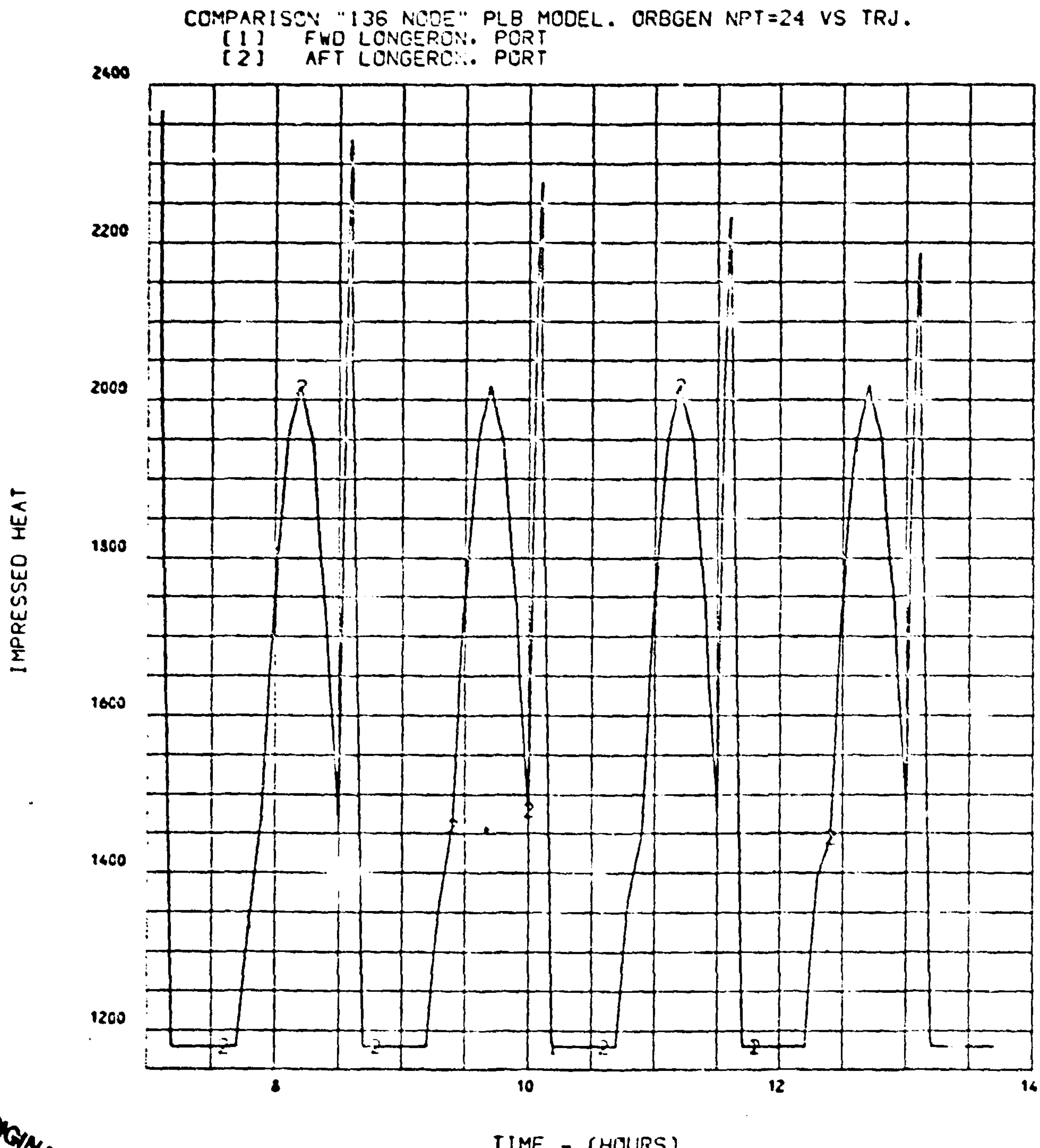

COMPARISON "136 NODE" PLB MODEL. ORBGEN NPT=24 VS TRJ.
[1] LOWER AFT PLB LINER. PORT
[2] LOWER AFT PLB LINER. PORT
[3] LOWER AFT PLB LINER. PORT
[4] LOWER AFT PLB LINER. PORT
IMPRESSED HEAT
3000.0
2500.0
2000.0
1500.0
8
10
12
14
TIME - (HOURS)

Figure 111



ORIGINAL PAGE IS OF POOR QUALITY

Figure 112

U.S. GOVERNMENT PRINTING OFFICE: 1980—671-099/ 62