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SHUTTLE ACTIVE THERMAL CONTROL SYSTEM

DEVELOPMENT TESTING

VOLUME III

MODULAR RADIATOR SYSTEM
TEST DATA CORRELATION WITH
THERMAL MODEL

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To

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FOREWORD

This volume is one of a series of reports describing the development tests conducted on a candidate Shuttle heat rejection system at the National Aeronautics and Space Administration - Johnson Space Center during the period from March to July 1973. The complete test series are reported in the following volumes:

Volume I	Overall Summary
Volume II	Modular Radiator System Tests
Volume III	Modular Radiator System Test Data Correlation With Thermal Model
Volume IV	Modular Radiator System Test Data
Volume V	Integrated Radiator/Expendable Cooling System Tests
Volume VI	Water Ejector Plume Tests
Volume VII	Improved Radiator Coating Adhesives Tests
Volume VIII	Tube Anomaly Investigation

The tests were conducted jointly by NASA and the Vought Systems Division of LTV Aerospace Corporation under Contract NAS9-10534. D. W. Morris of the NASA-JSC Crew Systems Division was the contract technical monitor. Mr. R. J. Tufte served as the VSD Project Engineer.

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1.0 SUMMARY

This volume presents the results of an analysis which compares the performance predictions of a thermal model of a multi-panel modular radiator system (MRS) with thermal vacuum test data. The correlation of the thermal model is one of the objectives of the MRS test phase of the Shuttle heat rejection system development tests conducted at NASA-JSC from March to July 1973.

Comparisons between measured and predicted individual panel outlet temperatures and pressure drops and system outlet temperatures have been made over the full range of heat loads, environments and plumbing arrangements expected for the Shuttle radiators. Both two sided and one sided radiation have been included. The model predictions show excellent agreement with the test data for the maximum design conditions of high load and hot environment. Predictions under minimum design conditions of low load-cold environments indicate good agreement with the measured data, but evaluation of low load predictions should consider the possibility of parallel flow instabilities due to main system freezing. Performance predictions under intermediate conditions in which the majority of the flow is not in either the main or prime system are adequate although model improvements in this area may be desired. The primary modeling objective of providing an analytical technique for performance predictions of a multi-panel radiator system under the design conditions has been met.

2.0 INTRODUCTION

Accurate predictions of the Space Shuttle radiator system performance is of prime importance in the design and development of this heat rejection system. The proposed location of the radiators attached to and/or deployed from the cargo bay doors introduces many design variables such as radiation from one side only, two-sided radiation or back-to-back panels. The worst case orbit and vehicle attitude must be determined analytically for each of these configurations to optimize the radiator design. The use of flow reversal or flow proportioning valves introduces more variables which must be considered. Due to the size of the radiator system (up to 1440 ft^2) it is impractical to determine the optimum radiator system by test. An accurate model is needed to parametrically study all design variables and insure optimum radiator performance.

The uniqueness of the modular panel concept, the valve stagnation method of heat load control and the large size of the radiator system present several modeling criteria not encountered in previous radiator systems. The multi-panel configuration proposed for use on the Shuttle requires that the model predict interaction between the panels; thus, dictating a separate model for each panel. In order to maintain similarity between the models, accurate predictions are required over a wide range of inlet temperatures in addition to the usual environment and flow variations. The downstream panel performance predictions must be as good as the upstream panel predictions and the individual panel errors must not accumulate to compromise the total radiator system performance.

The developmental testing of the Modular Radiator System (MRS) discussed in Volume II, Modular Radiator System Tests, of this report provides approximately 300 hours of thermal vacuum test data for thermal model correlation. The test panels are of a different size (6' x 12') than the anticipated baseline panels (approximately 11' x 15') and the baseline panels will probably have a different number of tubes, tube spacing and fin thickness. However, the modeling techniques developed from the test panel correlation analyses can be used for the baseline system model, thus improving the confidence of baseline system performance predictions.

This volume of the report presents the results of an analysis to correlate the system thermal model with the test data. A description of the model is given in Section 3.0. Comparisons of pre-test predictions with test data and a discussion of the selection criteria for post test correlation are given in Section 4.0. Sections 5.0 and 6.0 present a discussion of the results and conclusions about the model adequacy.

3.0 MODEL DESCRIPTION

The primary objective of the thermal model is to provide a tool for performance predictions of the radiator system under the design conditions of maximum and minimum heat rejection. The maximum heat rejection capability must be in the most severe environment and the minimum heat rejection must be in the most favorable environment for heat rejection. Predictions of intermediate heat loads and environments are desirable, but are of secondary importance.

Each of the eight modular test panels consists of 12 tubes arranged in a "U" shaped pattern as shown in Figure 1. The innermost tube is designated the prime tube and the other eleven tubes comprise the main system. The heat rejection of the panel is regulated by controlling the flow split through the main system and the prime tube. At high heat loads approximately 99% of the flow is routed to the bank of main tubes and essentially all of the panel heat rejection is from the main system. The minimum panel heat rejection occurs when approximately 99% of the flow is routed to the prime tube. With a low flow and cold environment the main tubes begin to sequentially stagnate (freeze) with the outermost tube flow stoppage occurring first. In the minimum heat rejection condition most of the main system tubes are frozen and nearly all of the panel heat rejection is from the prime system. During the transition from the minimum to maximum heat load the stagnated tubes sequentially thaw from the inside to the outside tube as the heat load demands until all tubes are flowing and the maximum heat rejection is obtained.

The model objectives and system operating characteristics discussed above have been used in the construction of the thermal model. A single tube is used to model the bank of eleven main tubes as depicted in Figure 2. The single tube fluid-to-tube heat transfer and pressure drop characteristics are based on tube number 6 of the main system with a factor of 11 applied so that the total area for heat transfer between the fluid and tube in the model matches the main bank of tubes. Table 1 summarizes the test panel dimensions and the model parameters used. In order to conserve the number of nodes required in the model, only tube nodes are used. A tube node is defined as any node in contact with the fluid. Thus the tube node includes the tube and the radiating fin between each tube. The fluid-to-tube heat transfer computation uses the tube temperature.

$$Q = h\,A_T(T_T - T_F) \qquad (1)$$

where
Q = heat transfer rate BTU/hr
h = fluid heat transfer coefficient, BTU/hr-ft^2-°R
A_T = fluid-tube heat transfer area, ft^2
T_T = tube temperature, °R
T_F = fluid temperature, °R

However, use of the tube temperature in computing the net radiation heat transfer from the panel requires that the fin effectiveness be considered.

$$Q = \varepsilon\sigma\eta A\ T_T^{\ 4} - \eta A\ Q_{ABS} \qquad (2)$$

where
ε = panel emissivity, dimensionless
σ = Stephan Boltzmann constant, BTU/hr-ft^2-°R^4
η = fin radiation effectiveness, dimensionless
A = area for radiation, ft^2
Q_{ABS} = heat absorbed from the environment, BTU/hr-ft^2

Therefore, the product ηA is input to the model rather than the radiation area. As previously discussed, in some operating conditions one or more of the main tubes can stagnate, thus reducing the fin effectiveness. For the model to predict accurate results under all operating conditions a variable fin effectiveness is required. It is not practical to obtain performance data, by either testing or prediction with a detailed model, which would give the test panel effectiveness variation over a wide range of inlet temperatures, flowrates and environments. A main system η of 0.90 was calculated for the maximum heat load condition with all tubes flowing. This constant value was input to the model in accordance with the primary objective of providing a model for maximum heat load predictions.

For low load conditions the majority of heat rejection is from the prime tube with most of the main tubes stagnated. This condition is modeled by inputing an ηA product for the entire panel with the majority of the flow in the prime tube. The η calculated for this condition is 0.063.

The resulting model thus consists of two separate models - one for the main system for maximum heat rejection conditions and one for the prime system for minimum heat rejection conditions. There are no thermal connections between the two systems. It is realized that this technique will result in temperature predictions of the main system tube below -211°F (freezing point of R-21). This is due to the constant high main system fin effectiveness in the model, whereas the actual fin effectiveness is reduced as tubes stagnate. The frozen main tube should not have an adverse effect on steady-state low load predictions; however, transient predictions between maximum and minimum heat rejection is not possible since once the main tube stagnates the model will not predict destagnation. Figure 3 shows a typical system model schematic.

In order to correlate the model to the test data it is necessary to predict the flow split among the panels. The panel flows are influenced by the panel supply and return lines, valves and flowmeters as well as the panel characteristics and temperature. During the test the valves were manually adjusted (partially closed) at ambient conditions to give equal flow in each parallel path since there are different numbers of valves, flowmeters, and line lengths in each path. The thermal model includes the actual line lengths and estimated full open valve pressure drop characteristics. However the approach used in the correlation analysis was to artificially make the flow distribution match the test values. This was done since the flow distribution was manually adjusted during the test and the modeling of the partially closed test valves is not an objective of this analysis.

During the third week of testing the radiators were allowed to radiate from both sides with a simulated Shuttle cargo bay door on one side (see Figure 4). The test configuration was designed to yield an effective radiation area from the cavity, formed by the panel and simulated door of 0.67 times the panel area. This factor is based on analysis of the Shuttle configuration considering reflection between the curved radiator and door. The thermal model also used this factor. Verification of the model under the test conditions does not verify the model for flight use because the test configuration is based on analysis only.

4.0 CORRELATION ANALYSES

Pretest analyses were conducted for the originally planned 56 test points. This data was used for real time evaluation of the test conditions and results during the test. For most of the test points, deviations from the planned test flow rates, inlet temperatures and environments prevent the use of the pre-test analysis for correlation purposes. Also, as discussed in Volume II, several of the test conditions were altered considerably due to operational difficulties with the environment simulators. Figures 5 thru 14 show a comparison of test results and predictions for several test points for which the test conditions were close to those planned. As indicated, the model predictions agree well with the data with differences attributed to different test conditions. Appendix A presents the complete pre-test predictions, including a definition of the planned conditions. This data is of interest even though many of the test points were never run since it gives MRS performance predictions under typical Shuttle conditions.

The test points used for post test correlation were chosen to give comparisons over a wide range of operating conditions. It is not practical to run the entire test sequence; however proper selection of the test points for correlation will yield a model of known accuracy for any anticipated operating condition. The most important operating condition is at the maximum heat load and maximum design environment. Accurate performance predictions for this condition are required to insure that the radiator system capacity is sufficient to meet the load. A high heat load with a cold environment condition is best to determine model adequacy and highlight possible sources of error. Table 2 lists the test points chosen for correlation and the range of variables covered. As indicated low and high heat loads, low and high environments, skewed environments, various plumbing configurations, and one and two sided radiation conditions are considered in the correlation analyses.

The correlation analysis concentrated on steady state performance predictions. Transient predictions have been made for the two-sided radiation set point change test points to show the effect of transient inlet temperatures and panel flow rates. No correlation was done for the transient environment test points because only steady state environment data is available at this time.

Recovery transients (minimum-maximum) heat load transients were also not correlated since the model does not predict tube freezing.

5.0 RESULTS

5.1 High Load - Hot Environment

Figures 15 through 18 present temperature maps comparing the correlation analysis results and the test data for the four test points with high heat loads and a hot environment. Three different panel flow arrangements were examined with 2, 4 and 8 parallel flow paths. For these test points the majority of the flow is through the main system. Individual panel flows ranged from approximately 230 to 530 lb/hr. A nominal environment of 130 BTU/hr-ft^2 was imposed on all panels during these test points. This is representative of the maximum absorbed heat expected for the Space Shuttle radiators with a solar absorptivity of 0.25 and an emissivity of 0.90.

As shown on the temperature maps, the analysis and test data for the main system temperatures show excellent agreement. The maximum difference is 4.7°F with most of the differences 3.0°F or less. All mixed main system outlet temperatures agree within 2.0°F. The predicted prime system temperatures are consistently lower than the test temperatures. This is attributed to the modeling technique which does not account for the thermal interaction between the prime and main system. The test data indicate that with full main system flow the hot innermost main tube (adjacent of the prime tube) affects the prime tube temperature. The test conditions had the prime inlet lower than the main system inlet resulting the prime system having a temperature rise in the first panels. For example TP-1A has a prime inlet temperature of 91.5°F and the prime outlet of panels 1 and 5 are 105°F and 108°F. The model does not consider the hot main tube adjacent to the prime tube and thus predicts a lower prime temperature. However, due to the low prime flow, the prime temperatures do not influence total system performance as indicated by the mixed prime and main temperatures of Figures 15 through 18 . Thus prediction of the prime temperatures under these conditions are not important. This is further illustrated by the heat rejection rates presented in Tables 3 through 6 . Individual panel and total system heat rejection computed from the predicted and test data are compared for the four test points of interest. This data indicates that although the predicted prime heat rejection is in considerable error, there is negligible effect on the total panel heat rejection. The panel and system heat rejection data also indicate the good agreement between the analysis and test.

5.2 High Load - Cold Environment

Correlation to the high load - cold environment test results is a good indication of model adequacy since large temperature drops with relatively high flow rates occur under these conditions. The environment does not have a strong effect on panel temperatures and small model errors are amplified. Figures 19 and 20 present the comparative temperature maps for test points 10 and 51. Good correlation is shown for the main system with the exception of panel 1 outlet temperature for test point 10. No explanation is offerred for the approximately 9°F difference between the predicted and measured temperature other than a possible measurement error. The reported environment for panel 1 was higher than the other panels suggesting a possible error in the computed environment. However, the results of an environment pertubation analysis shown in Figure 21 indicates that environment errors much greater than 5% would be required to account for the temperature differences.

The prime system temperatures do not show as good agreement as the main system especially for test point 51. The discussion of the prime system predictions given in paragraph 5.1 also applies to this case. Although the prime system flow is high the temperature drop is small and the contribution to total heat rejection is small.

Although the predicted and measured main and prime system outlets of test point 10 are nearly identical, the measured prime and main mixed temperature is 5.7°F below the predicted value. This is attributed to either a measurement error or heat transfer to the system return line which is not considered in the model.

Tables 7 and 8 compare the panel and system heat rejection computed from the analysis and test data. The prime system predicted heat rejection deviates considerably from the test data, especially for test point 51. The main system heat rejection compares favorably and the prime system error is damped out in the total heat rejection. The predicted system heat rejection is within 4% of the test data for test point 51 and within 0.3% for test point 10.

5.3 Low Load - Cold Environment

As discussed in paragraph 3.0, the modeling technique does not allow accurate main system predictions under low load conditions. The correlation analysis under low load conditions was conducted to determine the severity of the low load modeling restrictions and to give an indication of when the low load predictions become unacceptable. The general poor correlation of the main system is reflected in the temperature maps shown in Figures 22 through 24 for test points 17, 17A and 36. The main system temperatures are consistently predicted lower than the test values. Predictions for test points 17A and 36 show main panel outlets below the freezing point of R-21 (-211°F). This is because the main panel efficiency is input at a constant value to obtain accurate predictions for the high heat load case. The test panel effectiveness is greatly reduced due to low flow in the outer tubes; thus, the test temperatures are above the predicted values. For test point 17A the panels with a predicted outlet below -211°F are in series and the only effect is a high panel pressure drop in addition to the cold temperature predictions. Test point 36 however, has 3 parallel flow paths and the prediction of frozen panels results in a main system flow instability with all main flow routed to one leg.

The predicted prime temperatures are in fair agreement with the test data. The predicted values are generally higher than the test values indicating that the previous agreement that the hot main temperatures caused the prime predictions to be low is valid. Under the low load conditions the main system has less effect on the prime system.

Since the prime system has a small temperature drop, even small differences in predicted and measured temperatures can cause large percentage differences in the heat rejection. This is illustrated by the heat rejection data in Tables 9 through 11 . Test point 17A prime system outlet is predicted only 0.4°F higher than the measured temperature but the predicted heat rejection is 11% lower than the test data. However, the heat rejection is only 115 BTU/hr lower than the test. The total system predicted and test heat rejection rates compare favorably for test points 17 and 17A even though the main system predicted heat rejection is high.

5.3 High Load - Skewed Environment

Figures 25 through 31 present temperature maps comparing the predicted and measured data for high load conditions with hot environments on some panels and cold environments on others. This data is also for two sided radiation, except for Figure 30 , with a simulated cargo bay door on one side as shown in Figure 4. The predicated temperatures are in fair agreement for all test points in this group. Test points 53-56 and 59 are part of the transient correlation analysis (paragraph 5.5). For these test points the predictions used a temperature control valve to predict the flow split between the prime and main systems. All other analysis used test values for the main and prime systems flow since correlation under known conditions is required. The flow split predictions are dependent on the temperature predictions and small errors tend to be amplified by different flow rates. The predicted flows are in general agreement with the test values, but errors as large as 117 lb/hr do occur (Figure 27 , test point 55 total main flow). It should be noted that the individual leg measured flow rates do not sum to the total measured flow. The correlation analysis assumed the total flow measurements were more accurate and the leg flow rate measurements were used only to estimate the percentage of the total flow in each leg.

The main temperature predictions correlate adequately with the test data with the best agreement for test points 27 and 49. The prime temperature predictions are low for the reasons previously discussed in addition to the fact that the prime tube is located at the junction of the radiator and cargo bay door simulator and the effective radiation area may be less than the analytically determined factor of 0.67.

Tables 12 through 18 show the heat rejection computed from the predicted and test data. The predicted main system heat rejection agrees closely with the test data. The prime heat rejection is in considerable error. As in previous cases the prime system has a small affect on the total heat rejection and the total predicted and test values show good agreement.

5.4 Low Load - Skewed Environment

During some Shuttle operating conditions, it is possible that some radiator panels could absorb heat while others are rejecting heat. A comparison of predicted and test temperature maps under this condition are shown in Figures 32 and 33 . The temperature map for test point 14 (Figure 32) indicates the same general trend for those panels with a low environment as previously discussed, i.e., the main and prime temperature predictions are low. Panels 4 and 2 have a high environment (180 BTU/hr-ft^2) and absorb heat. As indicated, the temperature rise across panel 4 (33.5°F predicted vs 32.8°F measured) and panel 2 (26°F predicted vs 25.3°F measured) shows good correlation.

The temperature map for test point 47 (Figure 33) is another illustration of the low load prediction capabilities of the model. The cold environment on panels 5, 7, 8 and 6 results in a predicted main system outlet below -211°F and flow stoppage in this leg. The prime temperature predictions are in good agreement with the measured data for this test point.

Tables 19 and 20 show the comparative heat rejection of the individual panels and systems. The total main heat rejection for test point 14 is in considerable error, but panels 2 and 4 predictions match the test data indicating the model correctly predicts heat absorption. As in previous analyses the prime system heat rejection for both test points have large percentage errors even though the prime temperatures agree.

5.5 Transient Correlation

Transient environment data was not available at the time of this analysis, so the model could not be verified in this area. However, test points 53-56 and 59 examined the radiator response to changes in the outlet temperature control point, which resulted in transient prime and main system flows. Between test points 55 and 56 there was also a transient in the prime inlet temperature (from approximately 162 to 135°F in a 1.5 hour period). The main inlet remained constant during this time. Figures 34 and 35 compare the analysis and test data for these test points. The predicted flow rates and outlet temperatures show good agreement throughout the transient. The outlet temperature transients for these test points are of the same order as expected for the orbital environment variations indicating that the model should provide good predictions with cyclical orbital environments.

5.6 Pressure Drop Correlation

The test systems contained numerous valves to allow the plumbing arrangements to be changed during the test. These valves and unequal supply and return lines resulted in unequal pressure drop characteristics of parallel flow paths. Also, flowmeters in some flow paths increased the flow resistance. During the test each flow system was artifically balanced under ambient conditions by partially closing one or more of the flow control valves. The correlation analysis was also conducted with artifically balanced flows to match the test data; thus the model flow distribution prediction has not been verified. Individual measured panel pressure drops can be compared to predicted values to verify the model. If panel pressure drops can be accurately predicted, the correct flow distribution should follow since pressure drop predictions of flow in adiabatic supply and return lines is straight forward.

A survey of all predicted and measured pressure drops shown on the temperature maps of Figures 15 through 33 indicates good correlation. Table 21 summarizes this data and gives the percentage error for each panel. Panel 1 measured pressure drop was consistently much higher than the other panels and the predicted values. This panel had a different tube restrictor design than the other panels and is not included in the pressure drop correlation analysis. The predicted pressure drops for those points which the model predicts a main system freeze-up are in considerable error as expected. Test points 53-59 pressure drops do not show as good agreement also because of differences in the main flow rates. For all other test points the maximum error is less than 1.0 psi. Panel flow rates ranged from approximately 800 to 6 lb/hr.

6.0 CONCLUSIONS

A thermal model of the Modular Radiator System proposed for use on the Space Shuttle has been developed and verified by comparison to thermal-vacuum test data. The test panel configuration is thermally similar to the anticipated flight hardware configuration, and application of the test panel modeling techniques to the flight panel should provide an accurate model for the radiator system performance evaluation.

The model predictions show excellent agreement with the test data for the high heat load-hot environment conditions; thus indicating that one of the primary objectives of the model (providing good predictions under maximum load design conditions) has been met. The second primary objective of providing good performance predictions under the minimum load design conditions has also been met, although low load correlations were generally not as good as the high load. Careful evaluation of the low load predictions are required to insure that flow instability in parallel flow paths caused by erroneous panel freeze predictions do not cause large errors in system performance. As expected, predictions under conditions in which the majority of the flow is not routed to either the prime or main system are the least accurate, but are considered adequate.

Transient performance predictions have been verified by comparisons to test data in which the flow split between the prime and main systems varied due to changes in the mixed outlet temperature control point. These flow variations are similar to expected orbital variations caused by changing environments.

Comparison of predicted and measured panel pressure drops over a wide range of flows and temperatures indicates accurate model predictions and should insure accurate panel flow rate predictions in any panel plumbing arrangement.

The correlation analyses indicated that improvements in the predictions of intermediate load and/or environment conditions could be made by considering the thermal interface between the prime and main system. The present model is adequate for the stated objectives and revisions for test panel correlation were not considered necessary at this time. As the flight configuration evolves and performance prediction criteria are more firmly established, consideration should be given to accounting for the prime/main interaction and developing a technique for modeling the variable panel effectiveness if so required.

TABLE 1

TEST PANEL DIMENSIONS AND MODEL INPUT PARAMETERS

TUBE NO.	TUBE LENGTH FT		WETTED PERIMETER FT		CROSS SECTIONAL FLOW AREA - FT^2		FLUID-TUBE AREA FOR HEAT TRANS. FT^2	
	PANEL	MODEL	PANEL	MODEL	PANEL	MODEL	PANEL	MODEL
1	3		.0327		8.52×10^{-5}		.0981	
2	5						.1635	
3	7						.2289	
4	9						.2943	
5	11						.3597	
6	13	13		.36		9.374×10^{-4}	.4251	4.68
7	15						.4905	
8	17						.5559	
9	19						.6213	
10	21						.6867	
11	23		.0327		8.52×10^{-5}			

TABLE 2 STEADY STATE CORRELATION TEST POINTS

CONDITIONS		NO. OF SIDES RADG.	TEST POINT	FLOW CONFIG.	INLET TEMP.		FLOW		PANEL ENVIRONMENT							
LOAD	ENVIRON.				MAIN	PRIME	MAIN	PRIME	1	2	3	4	5	6	7	8
High	Hot	1	1A	α	178.3	91.5	1094.	13.2	135.	136.6	133.6	135.6	136.4	136.6	135.4	135.5
		1	45	ε	150.8	128.7	2198.	16.	129.4	129.	130.1	128.9	128.3	127.2	129.3	128.1
		1	32	γ	165.25	111.5	2223.	47.1	130.5	129.3	130.8	130.2	129.1	128.5	130.8	129.6
		1	4	α	116.	86.	1106.	13.4	132.6	140.5	135.5	134.7	134.5	139.5	134.9	134.4
High	Cold	1	10	1/2 α	163.6	161.8	283.	268.	45.1	-	34.8	30.			32.6	
		1	51	γ	159.	158.5	1379.	884.	16.5	16.8	8.8	9.2	16.0	16.3	9.0	9.1
Low	Cold	1	17	1/2 α	55.3	53.2	17.1	549.	28.8		26.6	21.2			21.8	
		1	17A	β	51.6	52.6	11.6	1169.	26.4	5.1	25.1	3.4	22.0		21.7	
		1	36	γ	57.7	53.5	52.	1053.		4.8		2.9	4.8	4.6	3.0	3.1
High	Skewed	2	53	γ	164.1	134.25	974.	1268.9	126.5	125.7	120.7	114.2	14.	14.	7.4	7.2
		2	54	γ					130.2	128.6	124.1	123.4	17.5	17.6	10.7	10.6
		2	55	γ					129.9	128.2	123.7	123.8	17.6	18.2	10.5	10.5
		2	56	γ					124.8	124.8	119.8	121.5	13.9	13.7	7.3	7.0
		2	59	γ					130.2	128.6	124.1	123.4	17.5	17.6	10.7	10.6
		1	49	γ	100.	89.5	2161.	44.8	127.5	128.4	29.5	29.5	128.8	129.3	78.2	75.
		2	27	γ	164.6	114.5	2200.	16.4	170.	170.	172.	174.	66.	67.	68.8	67.
Low	Skewed	1	14	α	18.4	152.4	1615.	626.	30.	180.	30.	180.	30.	30.	30.	30.
		1	47	α	49.5	51.5	111.	988.	126.2	126.6	125.	129.6	5.8	2.8	3.5	2.95

TABLE 3

HEAT REJECTION

TEST POINT α 1A

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	4.4	5540.3	5544.7
	Test	-23.9	6100.5	6076.6
2	Predicted	0.8	[illegible]	1210.3
	Test	5.3	[illegible]	996.4
3	Predicted	3.8	3492.7	3496.5
	Test	8.9	3064.5	3073.4
4	Predicted	2.0	1997.1	1999.1
	Test	1.8	1863.5	1865.3
5	Predicted	3.7	5481.	5484.7
	Test	-26.7	5776.2	5749.5
6	Predicted	1.2	1175.4	1176.6
	Test	9.7	984.6	994.3
7	Predicted	3.3	3337.	3340.3
	Test	11.4	3241.2	3252.6
8	Predicted	2.3	1941.5	1943.8
	Test	-1.6	1996.	1994.4
SYSTEM				
	Predicted	21.1	24126.4	24147.5
	Test	38.4	24245.6	24284.

TABLE 4

HEAT REJECTION

TEST POINT ε 45

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	16.9	3436.9	3506.
	Test	3.1	3515.9	3519.
2	Predicted	17.2	3442.6	3459.8
	Test	2.6	3735.4	3738.
3	Predicted *			
	Test			
4	Predicted *			
	Test			
5	Predicted	16.8	3441.4	3458.2
	Test	4.6	3695.2	3699.8
6	Predicted	17.2	3477.1	3494.3
	Test	0.5	3777.5	3778.
7	Predicted*			
	Test			
8	Predicted*			
	Test			
SYSTEM				
	Predicted	128.3	28031.1	28159.4
	Test	53.8	29175.4	29229.2

*Data wasn't available for Panels 3,4,7,8, since flow splits were not measured.

TABLE 5

HEAT REJECTION

TEST POINT γ 32

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	20.4	4911.9	4932.3
	Test	-4.3	4869.2	4864.9
2	Predicted	20.4	4958.9	4979.3
	Test	-7.2	5229.0	5221.8
3	Predicted	12.4	2963.6	2976.
	Test	25.6	3006.9	3032.5
4	Predicted	12.7	2978.7	2991.4
	Test	25.7	3012.3	3038.
5	Predicted	21.7	4997.4	5019.1
	Test	-11.5	5397.8	5386.3
6	Predicted	21.8	5029.7	5051.5
	Test	-18.2	5407.7	5389.5
7	Predicted	14.4	2985.5	2999.9
	Test	32.9	3084.1	3417.
8	Predicted	14.6	3030.6	3045.2
	Test	26.4	2957.9	2984.3
SYSTEM				
	Predicted	137.8	31856.	31993.8
	Test	104.1	32465.1	32569.2

TABLE 6

HEAT REJECTION

TEST POINT α 4

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	3.1	1999.1	2002.2
	Test	-7.9	1941.4	1933.5
2	Predicted	- .8	209.9	209.1
	Test	1.6	140.	141.6
3	Predicted	1.2	1090.4	1091.6
	Test	-7.9	846.9	839.
4	Predicted	1.2	730.6	731.8
	Test	6.3	560.2	566.5
5	Predicted	2.2	1854.1	1856.3
	Test	-11.	1743.9	1732.9
6	Predicted	-0.7	267.8	267.1
	Test	0.0	0.0	0.0
7	Predicted	1.7	1155.3	1157.
	Test	3.7	1147.	1150.7
8	Predicted	1.4	764.2	765.6
	Test	3.7	710	713.7
SYSTEM				
	Predicted	9.8	7989.7	7999.5
	Test	30.4	7433.4	7463.8

TABLE 7

HEAT REJECTION

TEST POINT α 10

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	297.9	6641.9	6939.8
	Test	213.9	7251.5	7466.4
2	Predicted			
	Test			
3	Predicted	310.4	4034.4	4344.8
	Test	424.7	3695.	4120.7
4	Predicted	302.8	2348.6	2651.4
	Test	212.	2267.	2479.
5	Predicted			
	Test			
6	Predicted			
	Test			
7	Predicted	149.	1342.7	1491.7
	Test	150.1	1008.7	1158.5
8	Predicted			
	Test			
SYSTEM				
	Predicted	1199.5	13952.5	15152.
	Test	1199.5	13994.7	15194.2

TABLE 8

HEAT REJECTION

TEST POINT Y 51

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	535.0	11111.6	11646.6
	Test	264.6	11536.2	11800.8
2	Predicted	534.0	11102.8	11636.8
	Test	440.3	10802.5	11242.8
3	Predicted	518.5	5577.5	6096.
	Test	233.6	5431.9	5665.5
4	Predicted	519.4	5561.3	6080.7
	Test	58.2	5079.8	5138.
5	Predicted	537.9	11234.0	11771.9
	Test	231.8	11499.6	11731.4
6	Predicted	537.9	11225.1	11763.
	Test	166.2	11499.6	11665.8
7	Predicted	516.1	5578.9	6095.
	Test	229.7	5776.0	6005.7
8	Predicted	516.1	5653.	6169.1
	Test	303.8	5583.7	5887.5
SYSTEM				
	Predicted	4207.8	66791.0	70998.8
	Test	1969.4	66400.0	68369.4

TABLE 9

HEAT REJECTION

TEST POINT α 17

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	135.3	571.4	706.7
	Test	0.0	551.	551.
2	Predicted			
	Test			
3	Predicted	135.3	49.8	185.1
	Test	715.8	10.2	726.
4	Predicted	148.6	73.8	222.4
	Test	134.8	27.4	162.2
5	Predicted			
	Test			
6	Predicted			
	Test			
7	Predicted	135.1	-3.9	131.2
	Test	0.0	-7.4	-7.4
8	Predicted			
	Test			
SYSTEM				
	Predicted	553.7	691.	1244.7
	Test	850.8	424.4	1275.2

TABLE 10

HEAT REJECTION

TEST POINT β 17A

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	142.5	212.5	355.
	Test	213.1	106.1	319.2
2	Predicted	172.5	-7.0	165.5
	Test	287.6	87.6	375.2
3	Predicted	142.7	2.1	144.8
	Test	596.7	15.9	612.6
4	Predicted	172.5	273.9	446.4
	Test	-287.6	138.9	-148.7
5	Predicted	130.9	220.	350.9
	Test	218.7	197.1	415.8
6	Predicted			
	Test			
7	Predicted	145.4	7.0	152.4
	Test	769.6	33.3	802.9
8	Predicted			
	Test			
SYSTEM				
	Predicted	920.2	714.2	1634.4
	Test	1035.3	548.7	1584.

TABLE 11

HEAT REJECTION

TEST POINT γ 36

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted			
	Test			
2	Predicted	172.9	4.6	117.5
	Test	27.4	672.7	700.1
3	Predicted			
	Test			
4	Predicted	172.6	0.4	173.
	Test	673.9	144.5	818.4
5	Predicted	173.1	4.6	177.7
	Test	117.8	776.3	894.1
6	Predicted	173.1	1998.2	2171.3
	Test	117.8	653.6	771.4
7	Predicted	172.7	0.4	173.1
	Test	529.1	182.4	711.5
8	Predicted	172.7	708.7	881.4
	Test	176.5	157.2	333.7
SYSTEM				
	Predicted	1036.1	2739.8	3775.9
	Test	1709.7	2468.8	4178.5

TABLE 12

HEAT REJECTION

TEST POINT Y 53

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	311.3	6316.2	6628.2
	Test	103.0	6593.7	6696.7
2	Predicted	311.3	6343.9	6655.2
	Test	53.6	6472.7	6526.3
3	Predicted	297.4	2193.6	2491.0
	Test	123.6	1898.5	2022.1
4	Predicted	314.5	2371.6	2686.1
	Test	90.7	2069.3	2160.0
5	Predicted	484.3	9517.8	10002.1
	Test	200.1	9257.2	9457.3
6	Predicted	484.3	9517.8	10002.1
	Test	111.2	9976.3	10087.5
7	Predicted	466.7	4002.3	4469.0
	Test	44.3	3761.1	3805.4
8	Predicted	466.7	4008.1	4474.8
	Test	-536.5	3996.4	3459.9
SYSTEM				
	Predicted	3157.3	44007.0	47164.3
	Test	945.9	43911.3	44857.2

TABLE 13

HEAT REJECTION

TEST POINT Y 54

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	301.7	8945.3	9247.0
	Test	105.5	9435.9	9541.4
2	Predicted	304.2	8991.9	9296.1
	Test	78.8	8833.6	8912.4
3	Predicted	279.8	4444.5	4724.3
	Test	185.1	4449.9	4635.
4	Predicted	279.8	4410.2	4690.
	Test	194.9	4394.7	4589.6
5	Predicted	444.3	13113.4	13557.7
	Test	126.4	13053.7	13180.1
6	Predicted	446.4	13088.9	13535.3
	Test	87.8	13708.1	13796.7
7	Predicted	413.5	7311.2	7724.7
	Test	223.1	7204.5	7427.6
8	Predicted	413.5	7337.7	7751.2
	Test	79.3	7296.8	7376.1
SYSTEM				
	Predicted	2856.0	66757.7	69613.7
	Test	1411.8	67791.4	69203.2

TABLE 14

HEAT REJECTION

TEST POINT γ 55

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	362.0	8531.2	8893.2
	Test	116.6	9100.7	9217.3
2	Predicted	361.6	8547.3	8908.9
	Test	123.6	8411.5	8535.1
3	Predicted	340.5	3967.3	4307.8
	Test	196.3	3929.2	4125.5
4	Predicted	340.1	3921.7	4261.8
	Test	190.7	3885.2	4075.9
5	Predicted	517.4	12537.9	13055.3
	Test	123.3	12616.1	12739.4
6	Predicted	517.4	12528.2	13045.6
	Test	123.3	13135.9	13259.2
7	Predicted	492.8	6690.9	7183.7
	Test	278.2	6623.7	6901.9
8	Predicted	492.8	6710.8	7203.6
	Test	-33.6	6581.6	6548.
SYSTEM				
	Predicted	3399.7	62872.9	66272.6
	Test	1703.1	63774.6	65477.7

TABLE 15

HEAT REJECTION

TEST POINT γ 56

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	301.3	6278.4	6579.7
	Test	156.4	8831.3	8987.7
2	Predicted	301.3	6291.1	6592.4
	Test	17.4	7901.7	7919.1
3	Predicted	291.4	2131.1	2422.5
	Test	43.3	2419.4	2462.7
4	Predicted	291.4	2143.0	2434.4
	Test	181.7	2492.2	2673.9
5	Predicted	470.0	9506.1	9976.1
	Test	243.1	12666.9	12910.0
6	Predicted	470.0	9467.9	9937.9
	Test	156.8	13207.2	13364.0
7	Predicted	465.8	3946.1	4411.9
	Test	43.2	5164.1	5207.3
8	Predicted	465.8	3963.8	4429.6
	Test	-541.2	5329.5	4788.3
SYSTEM				
	Predicted	3043.7	43460.0	46503.7
	Test	1136.3	43366.9	44503.2

TABLE 16

HEAT REJECTION

TEST POINT Y 59

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	307.9	8994.5	9302.4
	Test	110.2	9494.5	9604.7
2	Predicted	307.9	9043.7	9351.6
	Test	82.7	8791.8	8874.5
3	Predicted	280.0	4470.7	4750.0
	Test	175.2	4411.8	4587.0
4	Predicted	285.1	4528.3	4813.4
	Test	186.2	4347.2	4533.4
5	Predicted	452.5	13240.9	13693.4
	Test	138.1	12999.0	13137.1
6	Predicted	452.5	13240.9	13693.4
	Test	100.3	13511.1	13611.4
7	Predicted	417.0	7372.2	7789.2
	Test	233.0	7125.6	7358.6
8	Predicted	417.0	7372.2	7789.2
	Test	110.3	7324.7	7434.7
SYSTEM				
	Predicted	2909.6	67489.6	70399.2
	Test	1416.9	68104.3	69521.2

TABLE 17

HEAT REJECTION

TEST POINT Y 49

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	7.3	1330.	1337.3
	Test	1.3	1130.5	1131.8
2	Predicted	6.8	1288.9	1295.7
	Test	-1.3	1101.8	1100.5
3	Predicted	60.7	5543.5	5604.2
	Test	46.9	4946.3	4993.2
4	Predicted	60.7	5556.9	5617.6
	Test	46.9	5783.5	5830.4
5	Predicted	6.6	1269.4	1276.
	Test	-1.5	1091.6	1090.1
6	Predicted	6.3	1255.4	1261.7
	Test	-4.6	1101.8	1097.2
7	Predicted	31.1	3240.6	3271.7
	Test	36.6	3116.1	3152.7
8	Predicted	33.0	3384.9	3417.9
	Test	30.5	3545.0	3575.5
SYSTEM				
	Predicted	212.2	22817.6	23029.8
	Test	175.3	22055.2	22230.5

TABLE 18

HEAT REJECTION

TEST POINT Y 27

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	28.7	8310.7	8339.4
	Test	-4.1	8581.7	8577.6
2	Predicted	28.7	8310.7	8339.4
	Test	-6.4	7638.0	7631.6
3	Predicted	18.	4020.7	4038.7
	Test	45.7	3783.9	3829.6
4	Predicted	17.3	3942.	3959.[illegible]
	Test	48.1	3554.2	3602.3
5	Predicted	62.8	12309.5	12372.3
	Test	19.6	11857.3	11876.9
6	Predicted	62.5	12265.3	12327.8
	Test	15.8	12629.3	12645.1
7	Predicted	40.2	6595.5	6635.7
	Test	48.4	6261.1	6309.5
8	Predicted	41.1	6705.2	6746.3
	Test	43.6	6447.9	6491.5
SYSTEM				
	Predicted	299.4	62128.4	62427.8
	Test	236.9	60464.[illegible]	60700.9

TABLE 19

HEAT REJECTION

TEST POINT α 14

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	307.5	2951.5	3259.
	Test	234.3	2245.7	2480.
2	Predicted	43.2	-1982.9	-1939.7
	Test	-170.8	-1910.	-2080.8
3	Predicted	296.	2394.6	2690.6
	Test	404.3	2133.3	2537.6
4	Predicted	52.1	-6393.5	-6341.4
	Test	170.8	-6189.8	-6019.
5	Predicted	306.5	2953.8	3260.3
	Test	159.9	2347.5	2507.4
6	Predicted	282.8	1428.2	1711.
	Test	262.1	1354.9	1617.
7	Predicted	296.2	2405.8	2702.
	Test	415.2	3787.	4202.2
8	Predicted	336.7	3726.	4062.7
	Test	-8.8	1807.7	1798.9
SYSTEM				
	Predicted	1910.9	4168.6	6079.5
	Test	2445.	2054.3	4499.3

TABLE 20

HEAT REJECTION

TEST POINT α 47

BTU/HR

PANEL		PRIME	MAIN	TOTAL
1	Predicted	- 48.6	-414.5	-463.1
	Test	-203.4	-370.1	-573.5
2	Predicted	- 24.4	25.	0.6
	Test	-371.	63.8	-307.2
3	Predicted	- 24.4	- 99.4	-123.8
	Test	251.3	0.0	251.3
4	Predicted	- 0.1	-124.8	-124.9
	Test	0.0	- 63.8	- 63.8
5	Predicted	157.9	7.5	165.4
	Test	49.5	1658.6	1708.1
6	Predicted	169.8	-0.02	169.78
	Test	135.7	65.7	201.4
7	Predicted	170.1	0.2	170.3
	Test	259.6	553.4	813.
8	Predicted	169.8	-.12	169.7
	Test	0.0	224.6	224.6
SYSTEM				
	Predicted	534.7	-523.	11.7
	Test	607.6	1543.	2150.6

TABLE 21 COMPARISON OF PRESSURE DROPS

PANEL NO. :	2		3		4		5		6		7		8	
	ERROR		ERROR		ERROR		ERROR		ERROR		ERROR		ERROR	
TEST POINT	PSI	%	PSI	%	PSI	%	PSI	%	PSI	%	PSI	%	PSI	%
1A	-0.4	- 7.5	0.0	0	-0.3	- 5.6	0.0	0	-0.3	- 5.6	-0.1	- 1.8	0.3	5.6
45	-0.1	- 7.8	0.4	10.3	-0.3	-23.1	-0.1	- 7.8	-0.1	- 7.8	-0.4	-28.6	-0.4	-40.0
32	0.0	0	-2.5	-44.6	-0.7	-12.5	-1.0	-17.0	0.8	13.6	0.2	35.1	0.6	10.5
4	-0.7	-13.0	-0.2	- 3.6	-0.4	- 7.2	-0.3	- 5.4	0.0	0	-0.4	- 7.3	-0.4	- 7.3
10	-	-	-0.2	-14.3	0.1	7.7	-	-	-	-	-0.6	-50.0	-	-
51	-1.2	-54.6	-0.7	-36.8	-0.7	-36.8	-0.7	-30.4	-0.3	-13.0	-0.8	-40.0	-0.8	-40.0
17	-	-	-0.2	-	0.0	-	-	-	-	-	-0.2	-	-	-
17A	25.6	99.3	-0.2	-	6.5	100.0	0.0	0	-	-	-0.2	-	-	-
36	0.0	0	-	-	0.0	0	0.0	0	-0.3	-300	0.0	0	0.0	0
53	-0.5	-45.5	-0.4	-40.0	-0.8	-80.0	-0.7	-63.6	-0.3	-36.4	-0.8	-80.0	-0.4	-40
54	-1.4	-35.8	-1.3	-34.2	-1.5	-39.5	-1.0	-24.4	-1.0	-24.4	-1.0	-25.6	-1.2	-30.8
55	-1.2	-38.7	-1.0	-300.0	-1.3	-43.3	-1.0	-31.2	-0.6	-18.8	-1.2	-40.0	-1.2	-40.0
56	-0.5	-45.5	-0.4	-40.0	-0.8	-80.0	-0.5	-45.5	-0.3	-27.3	-0.6	-60.0	-0.4	-40.0
59	-1.7	-42.5	-1.3	-34.2	-1.7	-44.7	-1.0	-24.4	-0.8	-19.5	-1.2	-30.8	-1.2	-30.8
49	-0.2	- 3.9	-2.6	-51.0	-0.8	-15.7	0.8	15.1	0.0	0	1.0	18.9	0.2	3.8
27	-1.0	-10.2	-0.8	-15.1	-0.8	-15.1	0.0	0	0.0	0	-0.5	- 9.3	-0.5	- 9.3
14	-1.2	-11.0	-0.9	- 8.5	-1.0	- 9.3	-1.1	-10.0	-1.4	-13.1	-1.4	-12.8	-1.5	-13.9
47	0.0	0	0.0	0	0.2	-	-0.2	-100.0	-0.1	-33.3	-0.1	-33.3	0.1	33.3

ERROR = PREDICTED - MEASURED

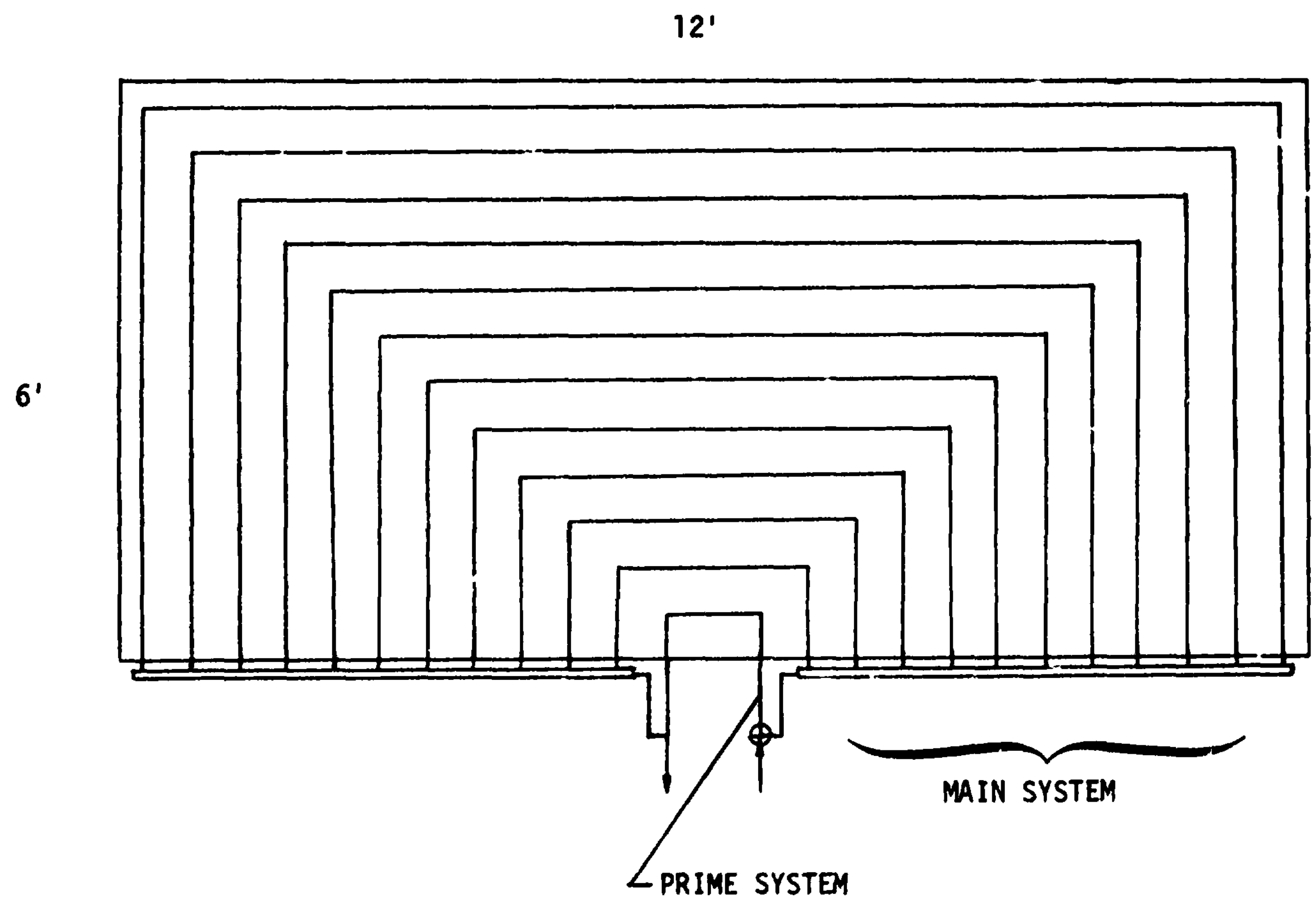


FIGURE 1 MODULAR RADIATOR PANEL CONFIGURATION

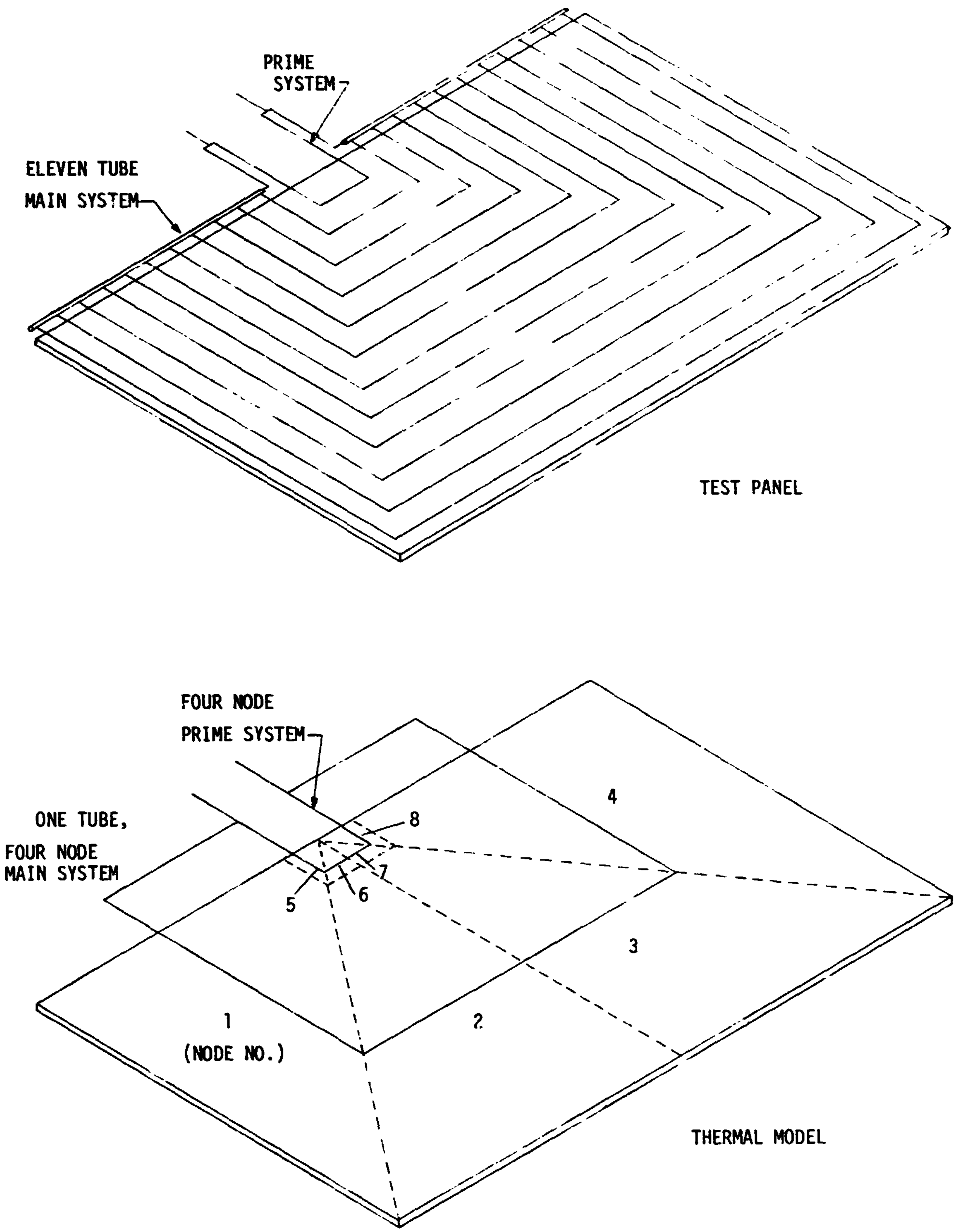


FIGURE 2 PANEL THERMAL MODEL

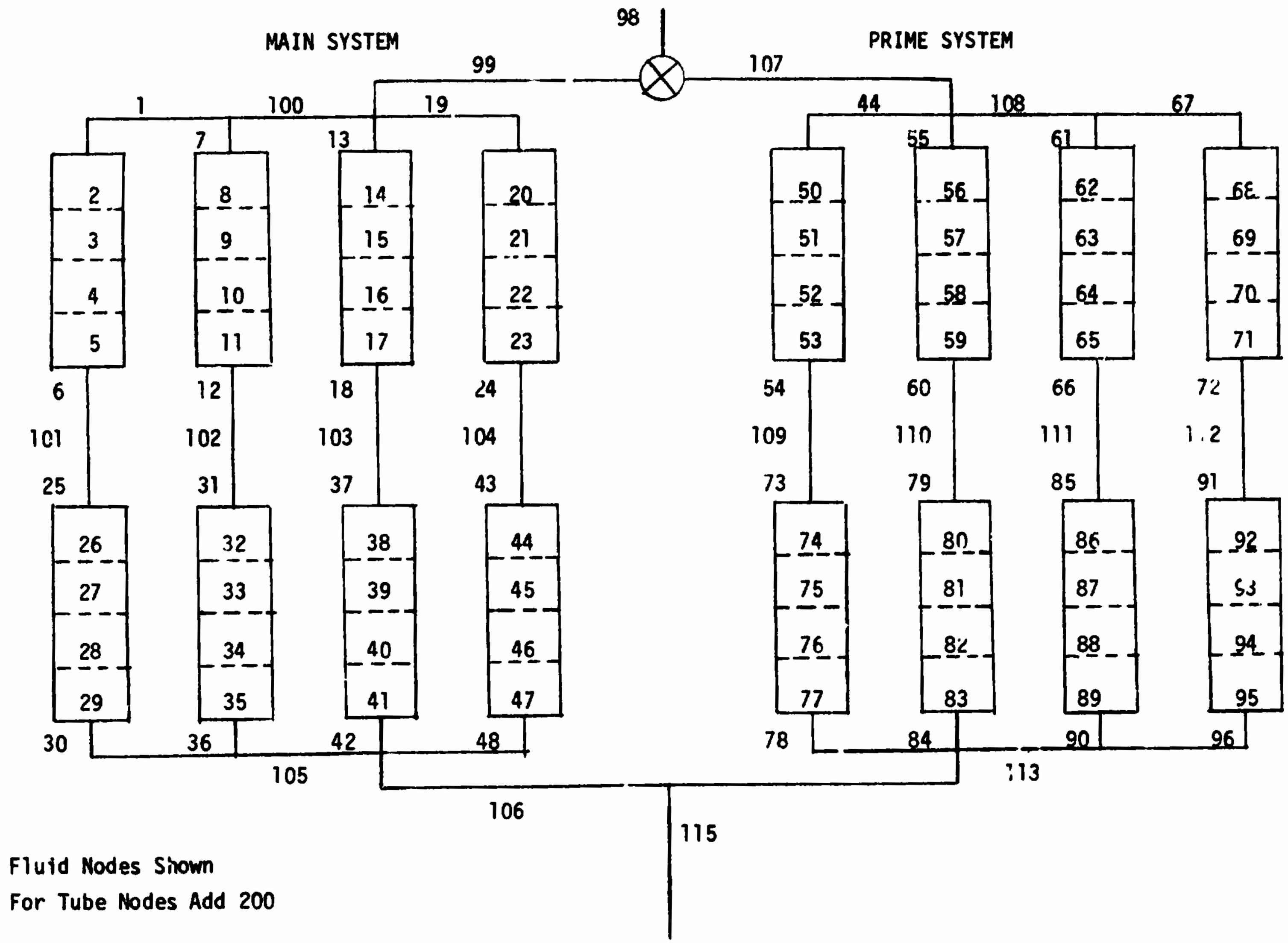


FIGURE 3 TYPICAL SYSTEM MODEL SCHEMATIC

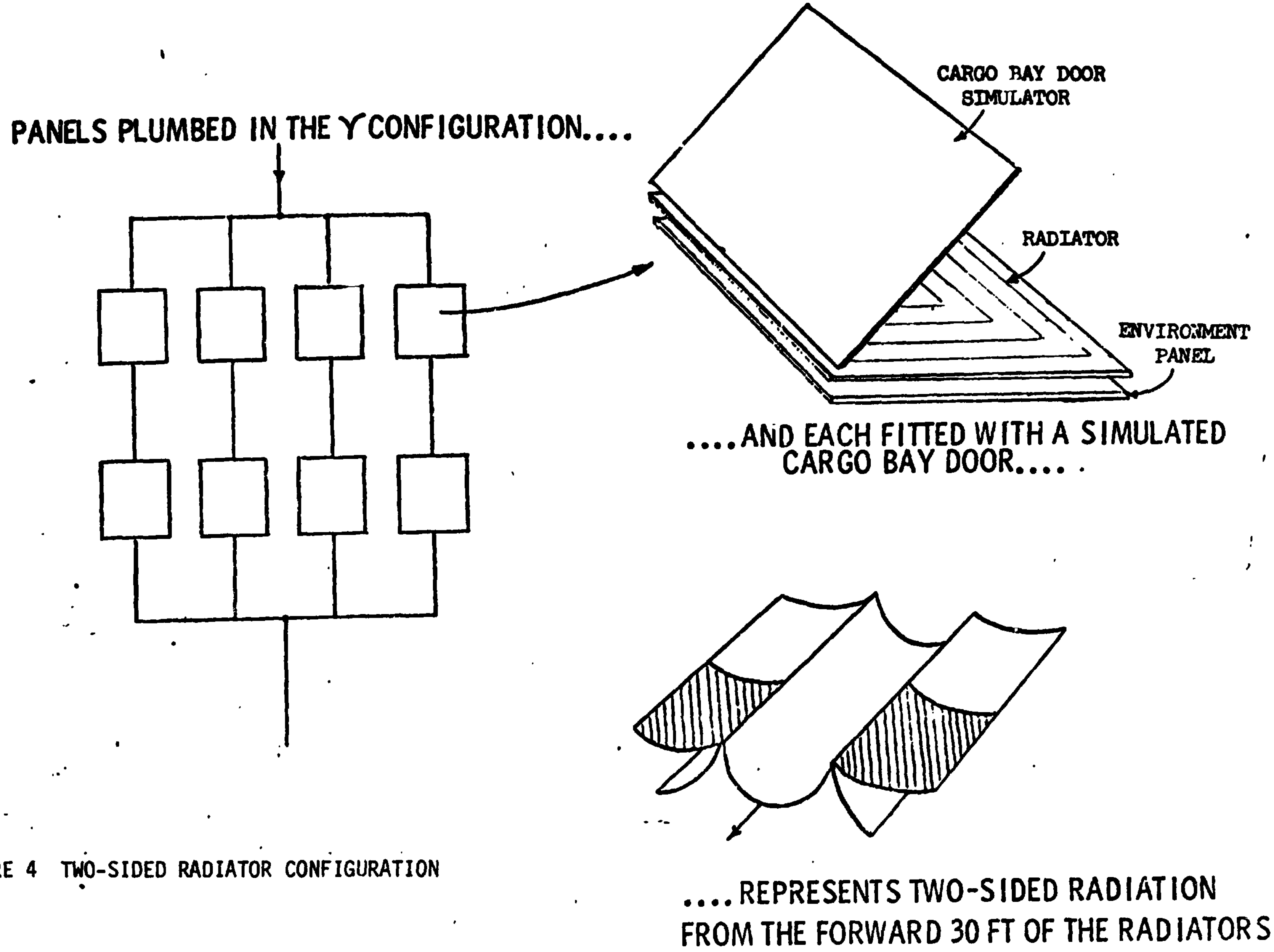
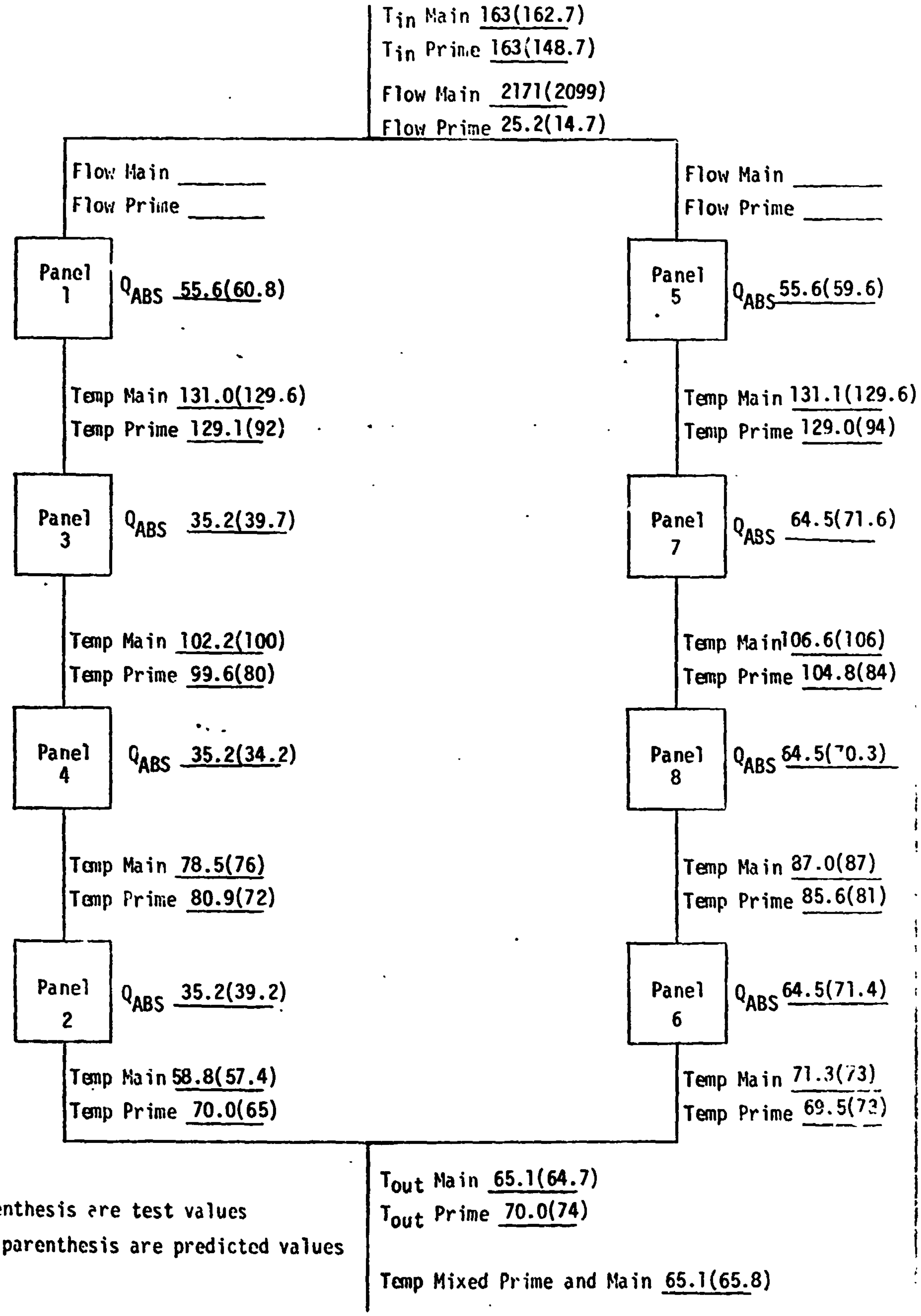


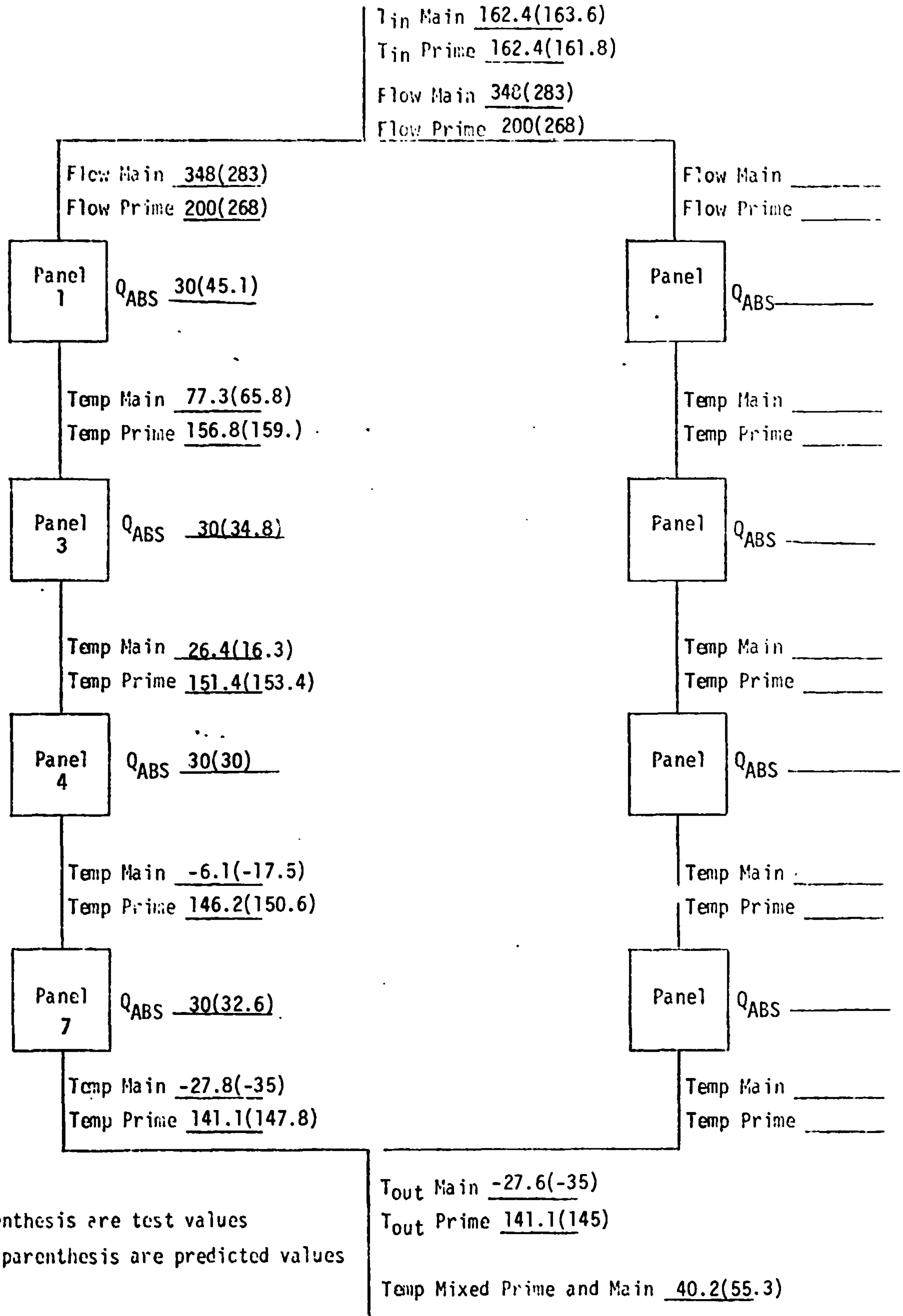
FIGURE 4 TWO-SIDED RADIATOR CONFIGURATION

FIGURE 5 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA
TEST POINT 2-1



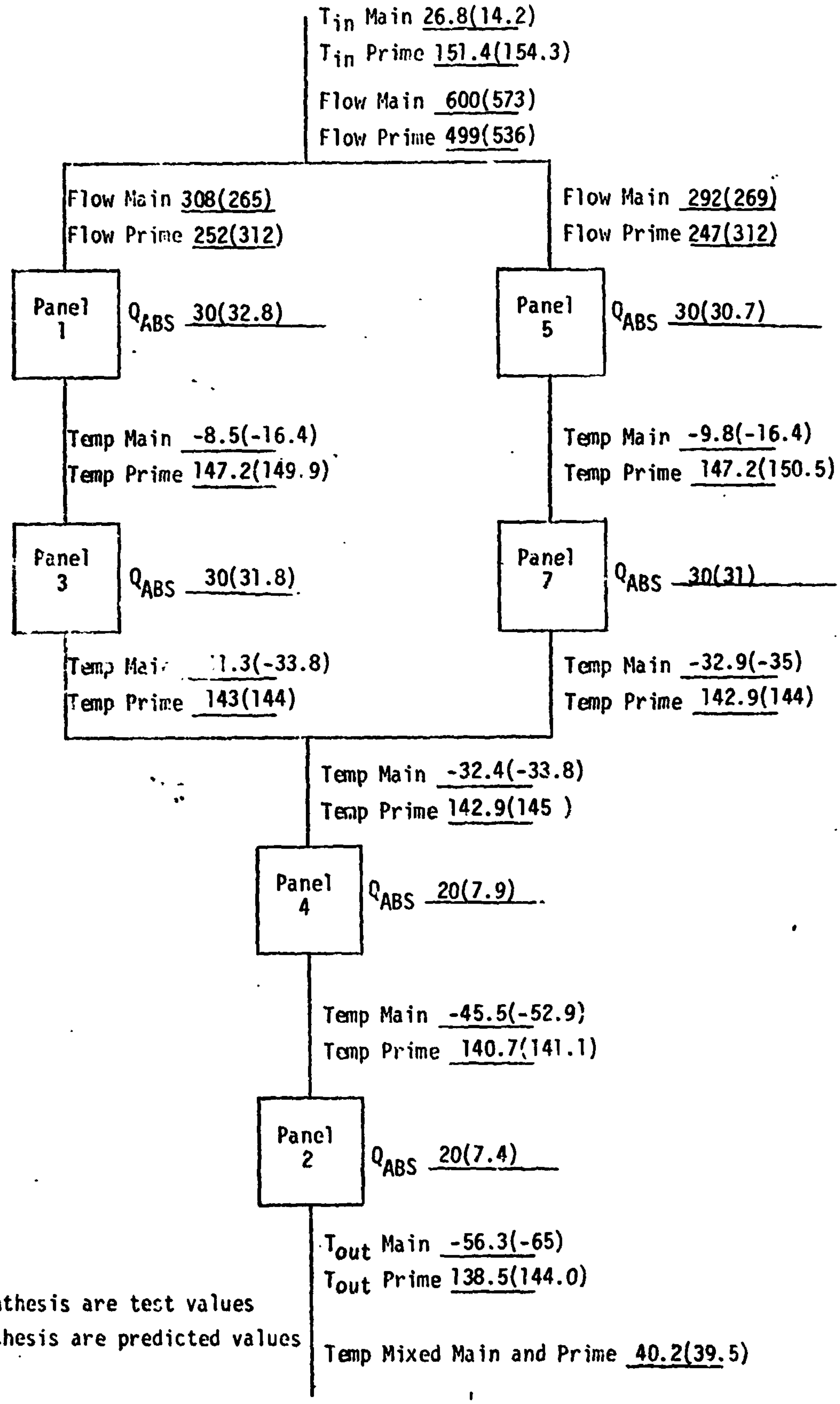
Numbers in parenthesis are test values
Numbers not in parenthesis are predicted values

FIGURE 6 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA
TEST POINT 10



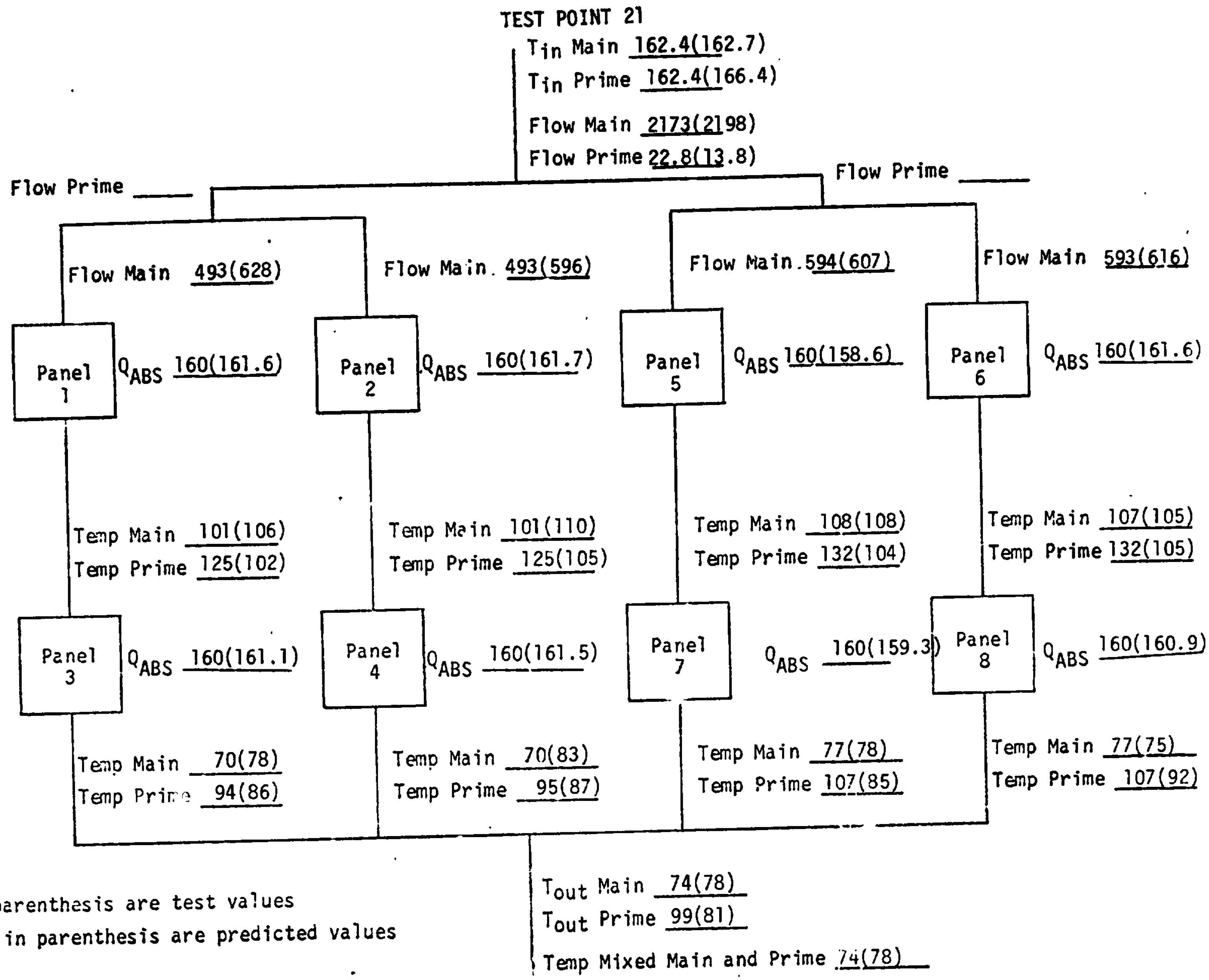
Numbers in parenthesis are test values
Numbers not in parenthesis are predicted values

FIGURE 7 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA
TEST POINT 12



Numbers in parenthesis are test values
Numbers not in parenthesis are predicted values

FIGURE 8 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA

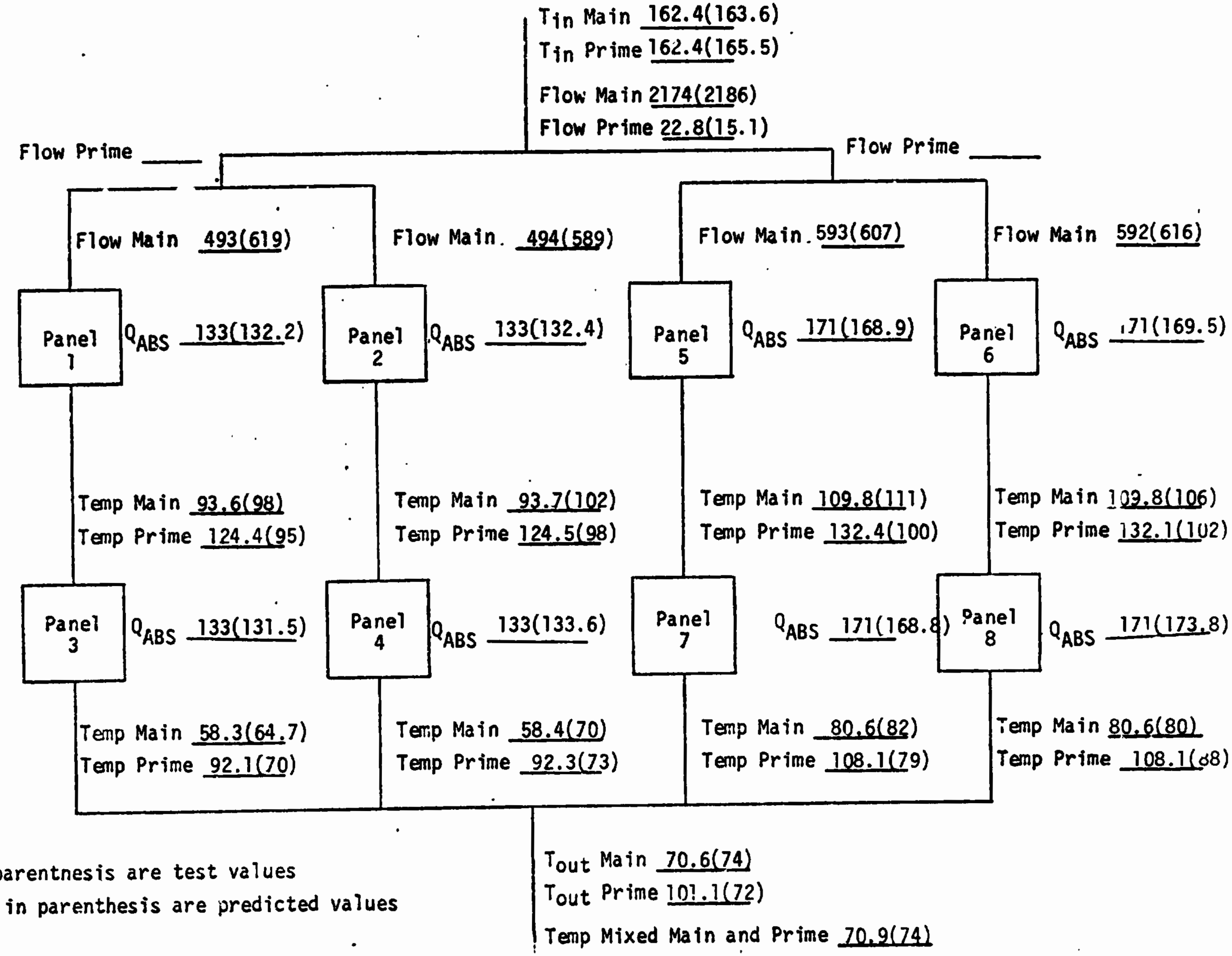


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

FIGURE 9 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA

TEST POINT 22-2

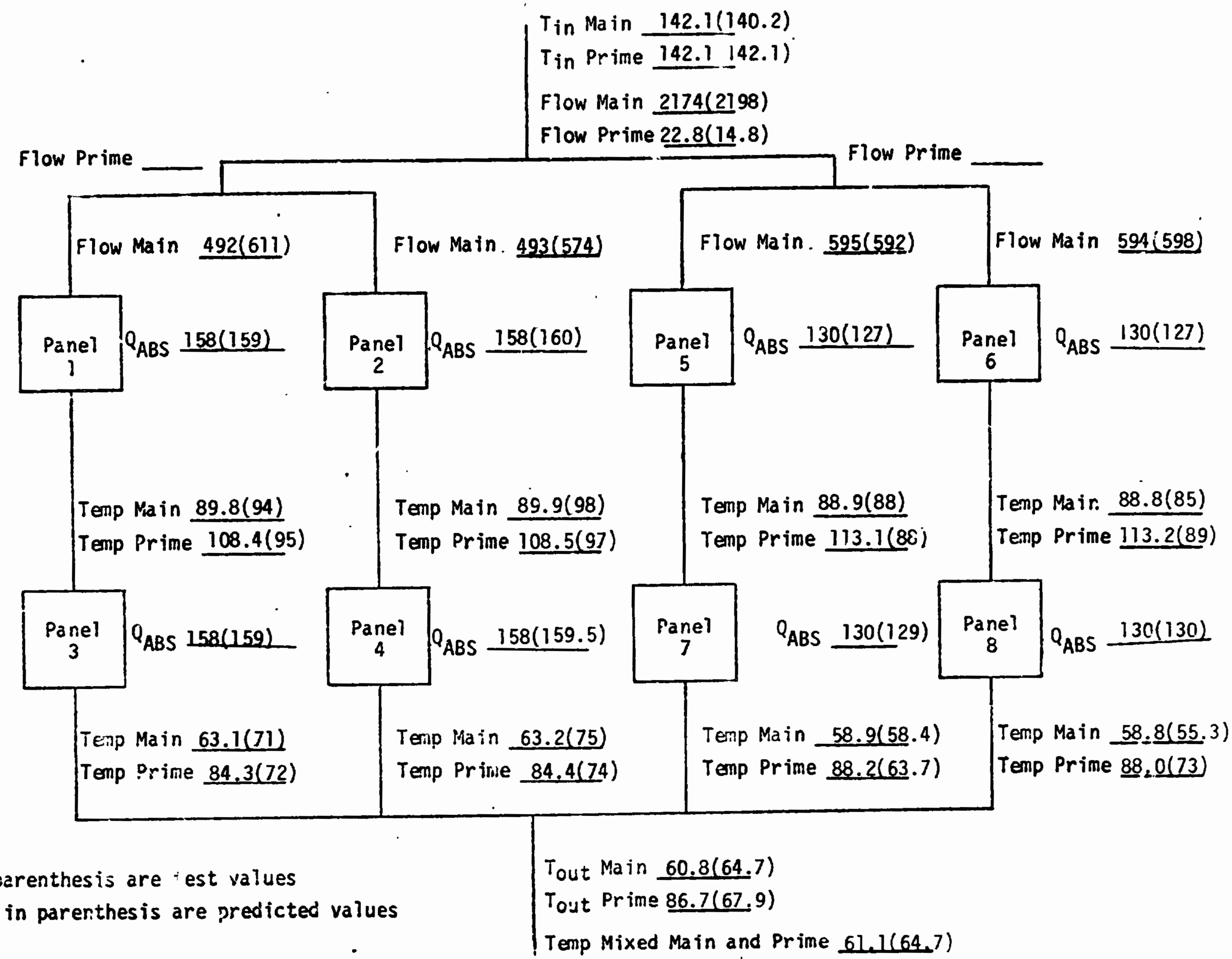


Numbers in parentnesis are test values

Numbers not in parenthesis are predicted values

FIGURE 10 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA

TEST POINT 23-1

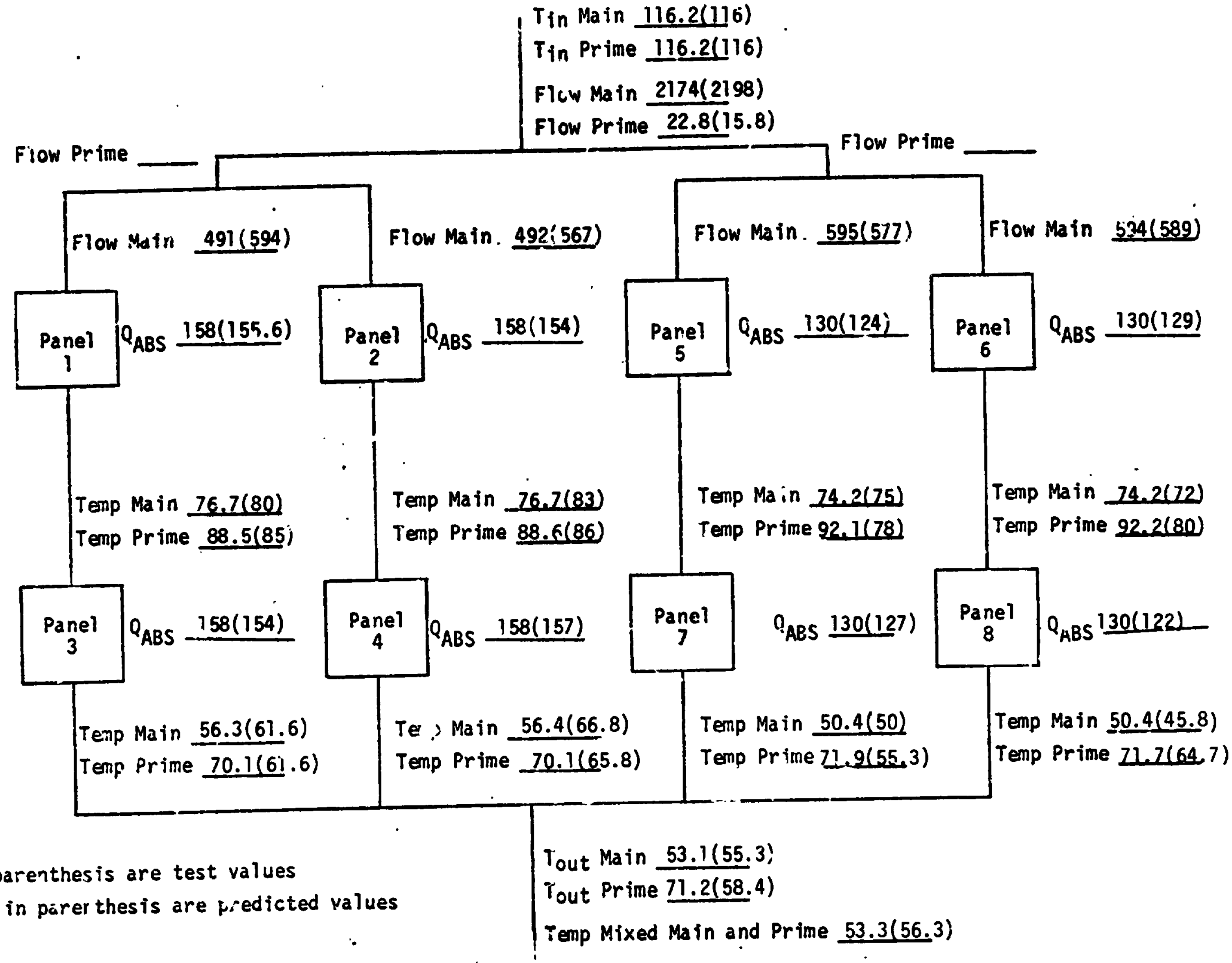


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

FIGURE 11 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA

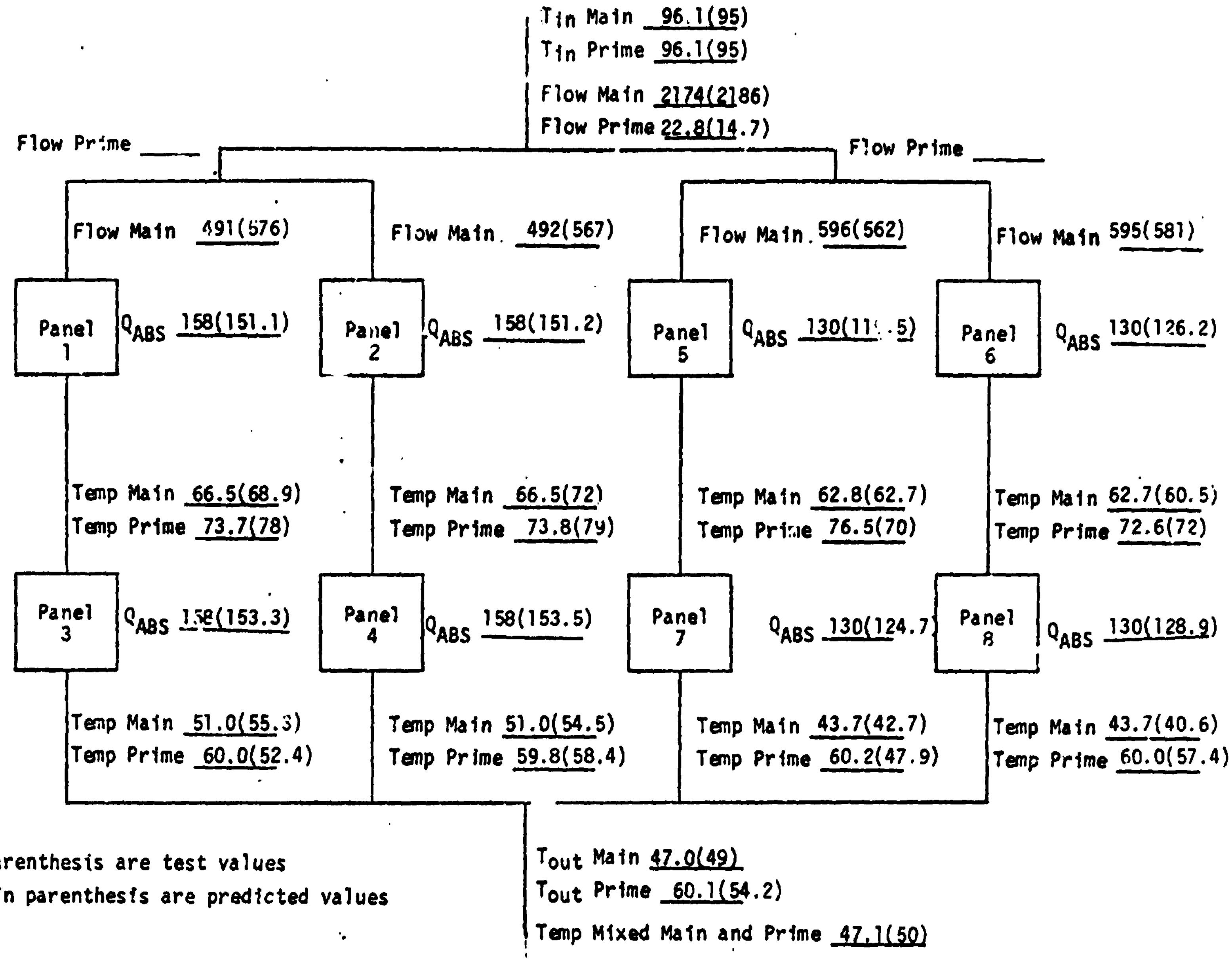
TEST POINT 24-1



Numbers in parenthesis are test values
Numbers not in parenthesis are predicted values

FIGURE 12 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA

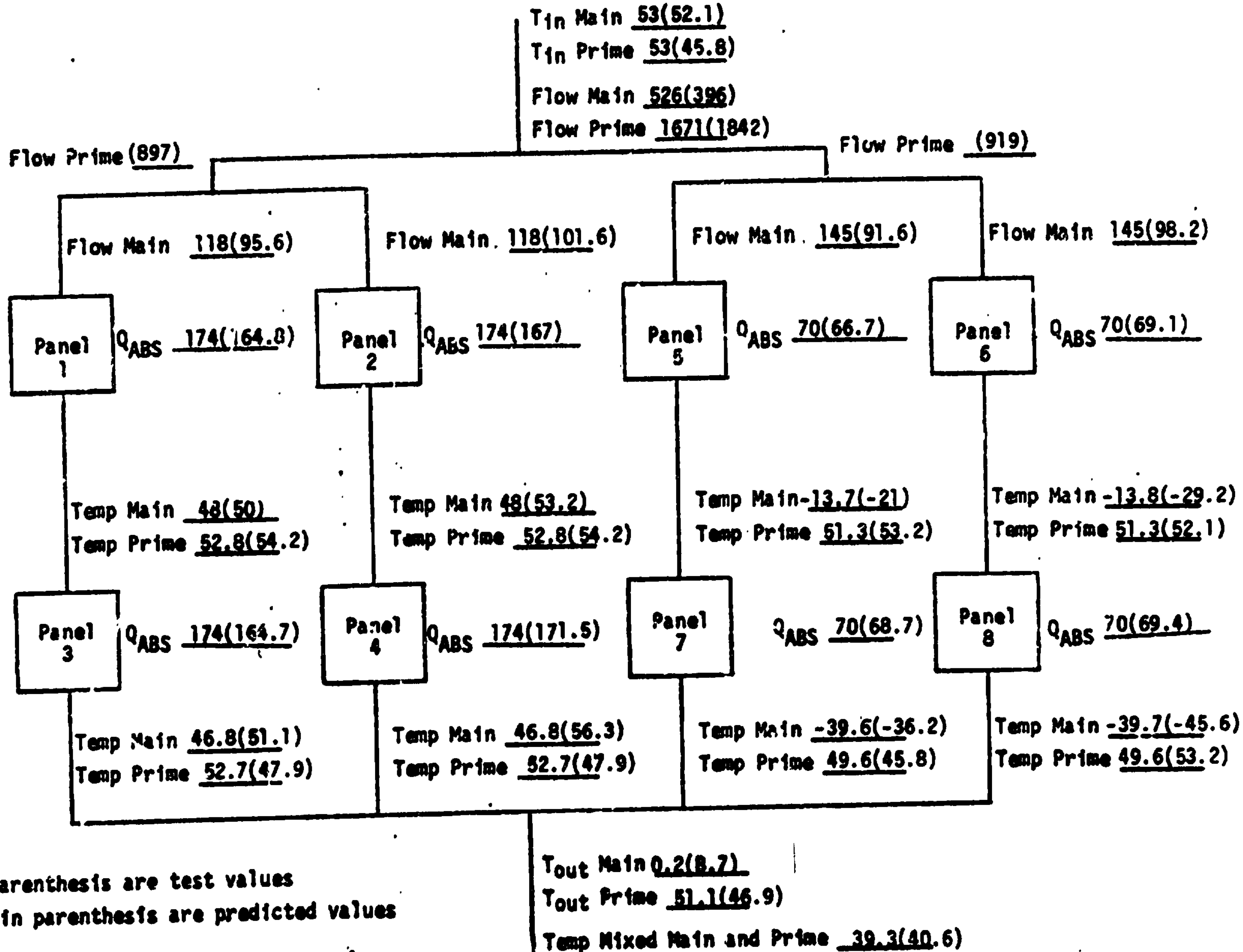
TEST POINT 25-1



Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

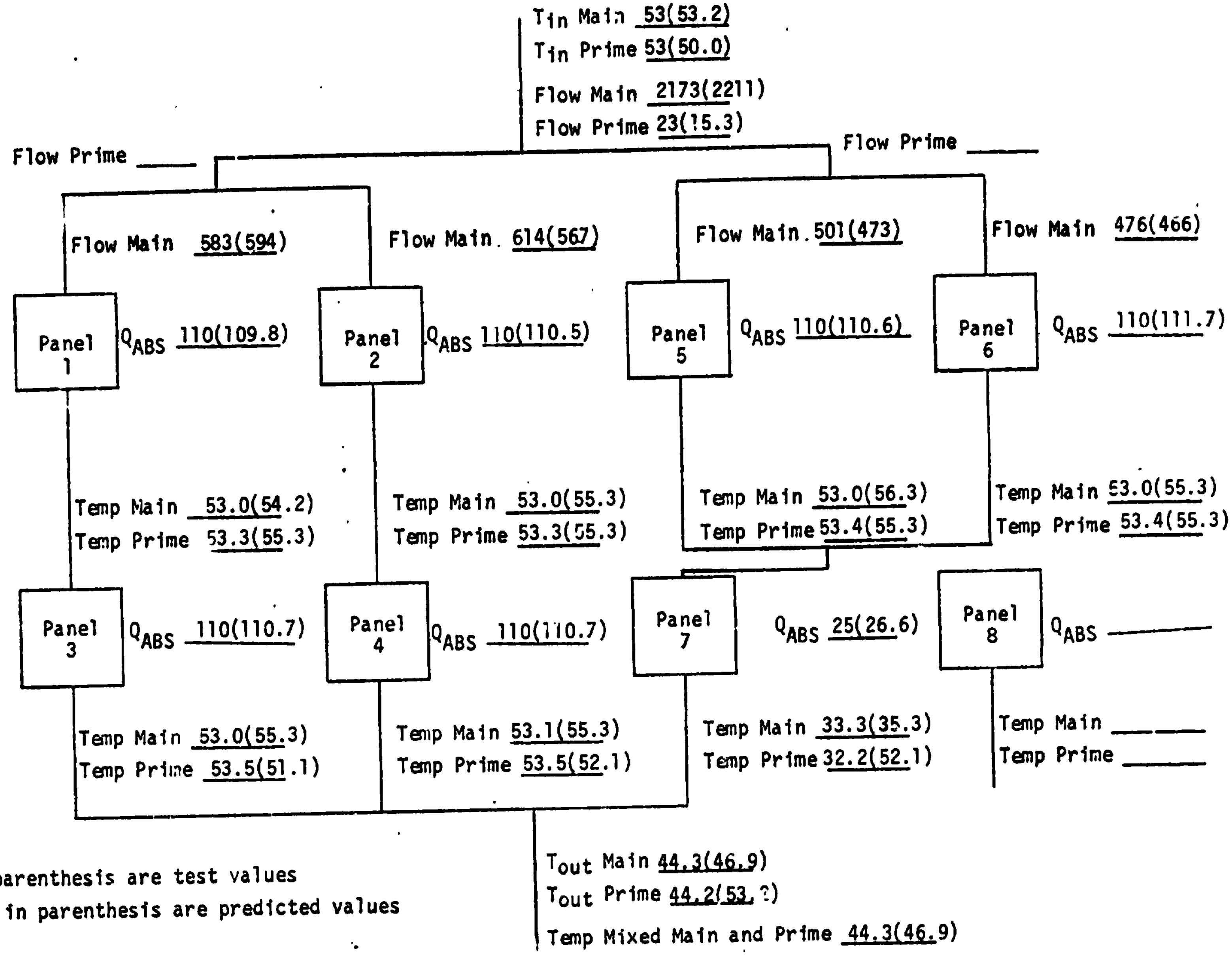
FIGURE 13 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA
TEST POINT 28



Numbers in parenthesis are test values
Numbers not in parenthesis are predicted values

FIGURE 14 COMPARISON OF PRE-TEST PREDICTIONS AND TEST DATA

TEST POINT 29

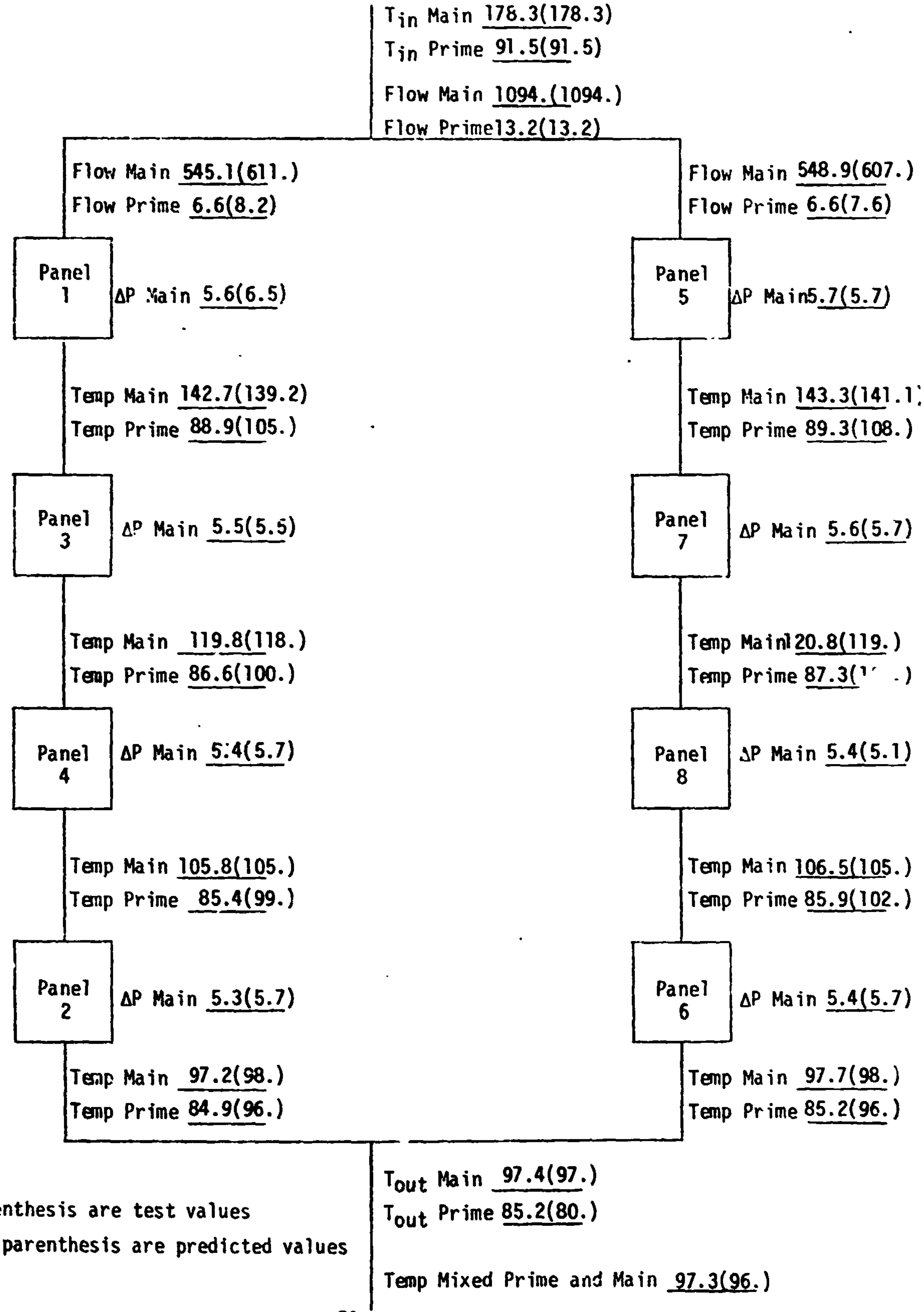


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION α

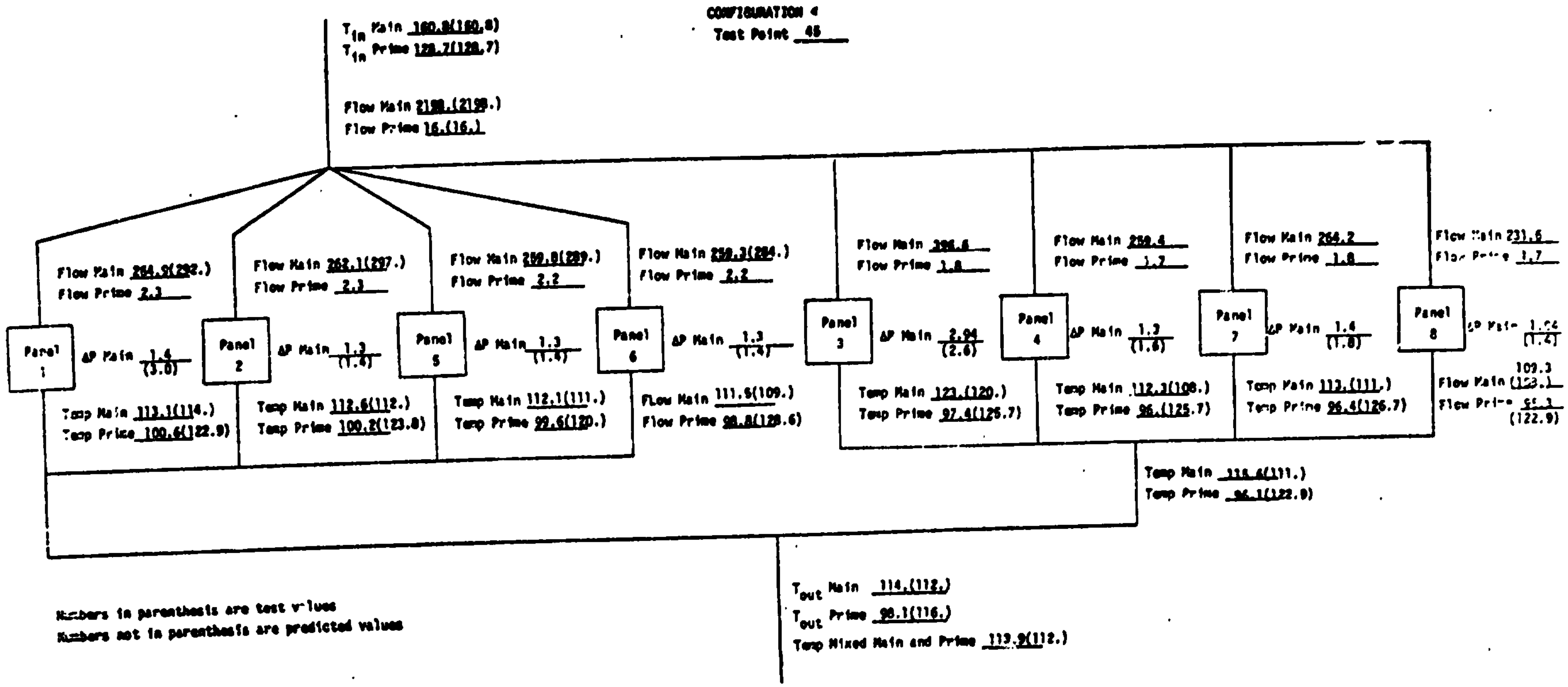
FIGURE 15 TEST POINT 1A CORRELATION



Numbers in parenthesis are test values

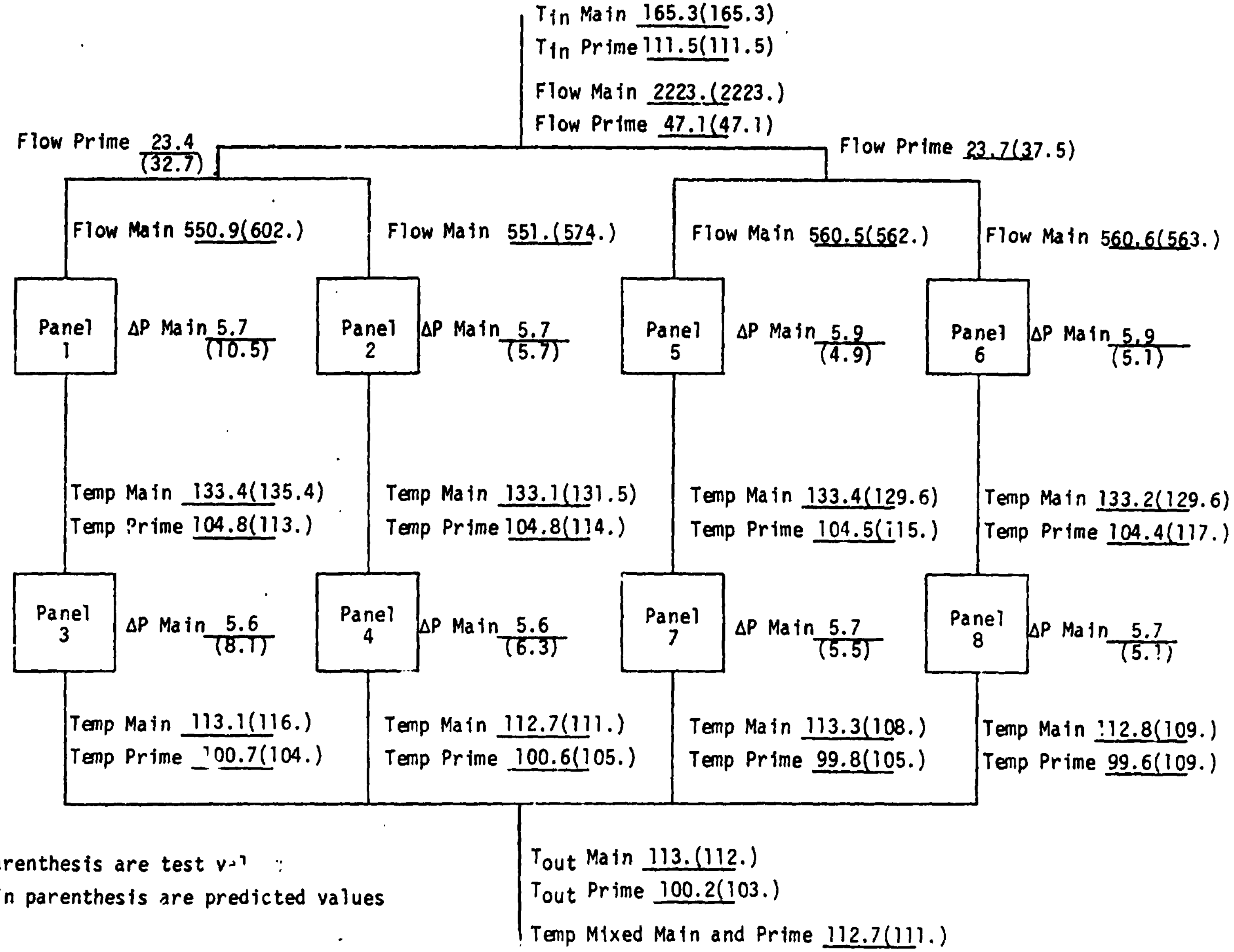
Numbers not in parenthesis are predicted values

FIGURE 16 TEST POINT 45 CORRELATION



CONFIGURATION Y

FIGURE 17 TEST POINT 32 CORRELATION

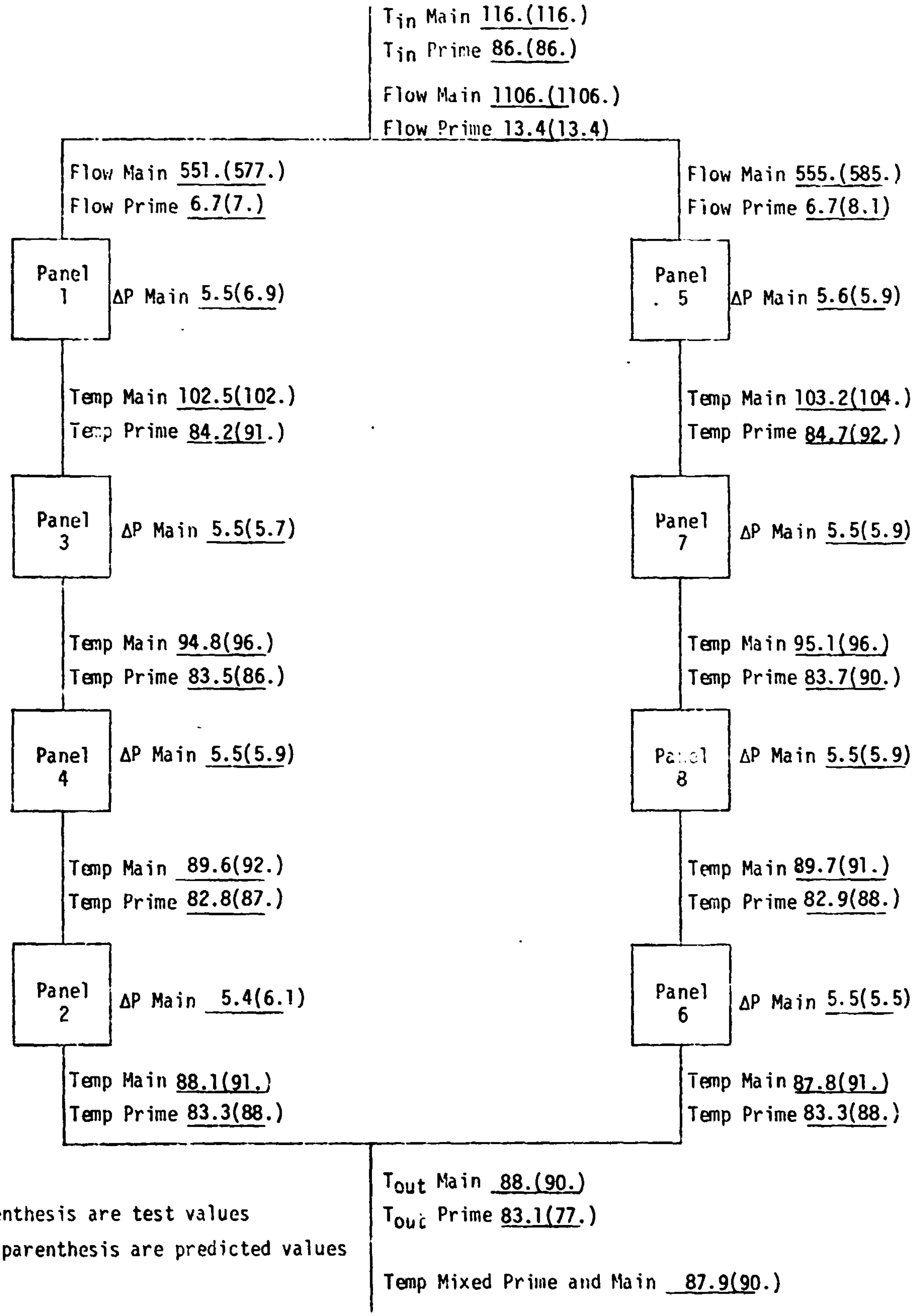


Numbers in parenthesis are test v-l

Numbers not in parenthesis are predicted values

CONFIGURATION α

FIGURE 18 TEST POINT 4 CORRELATION

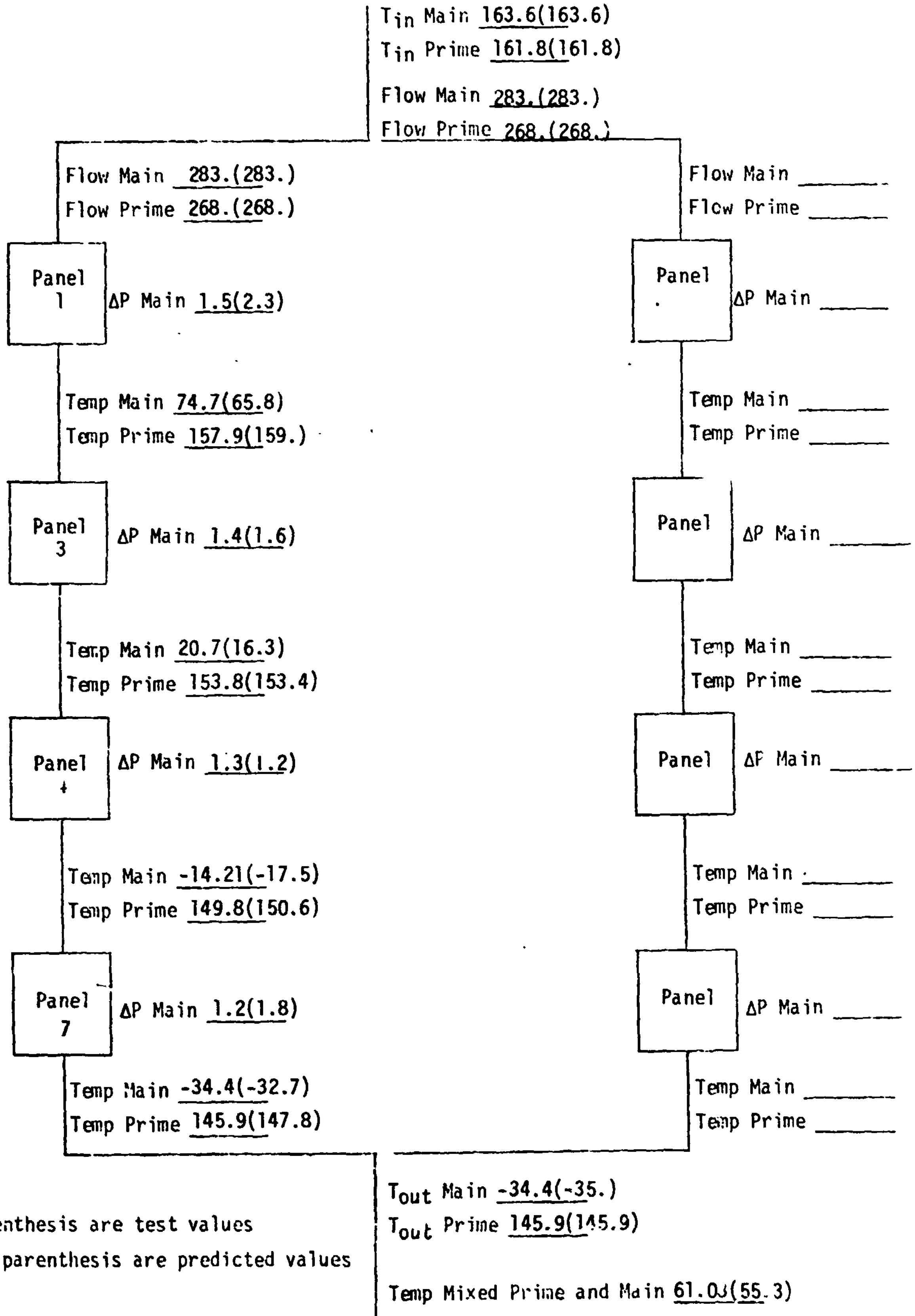


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION α

FIGURE 19 TEST POINT 10 CORRELATION

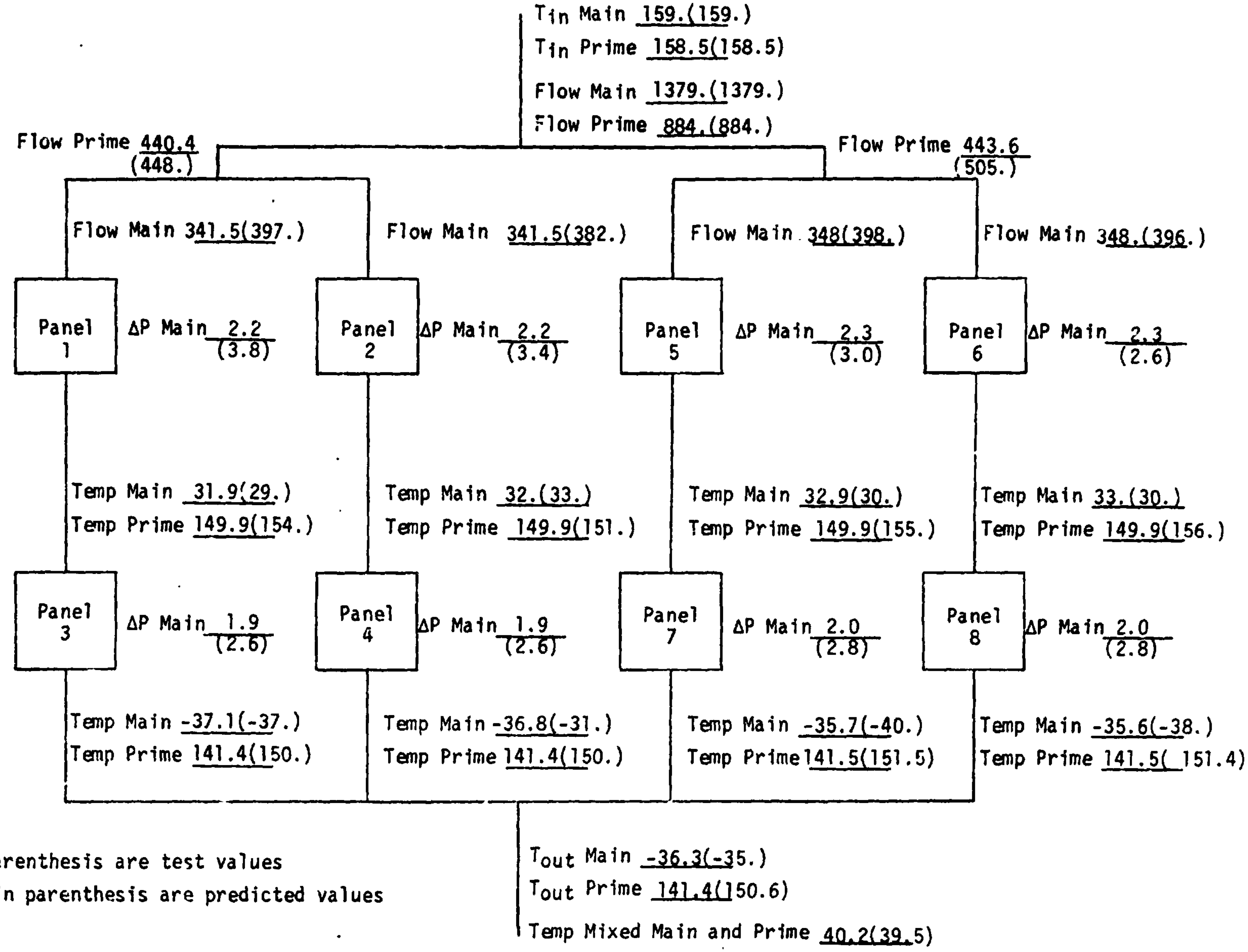


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION γ

FIGURE 20 TEST POINT 51 CORRELATION

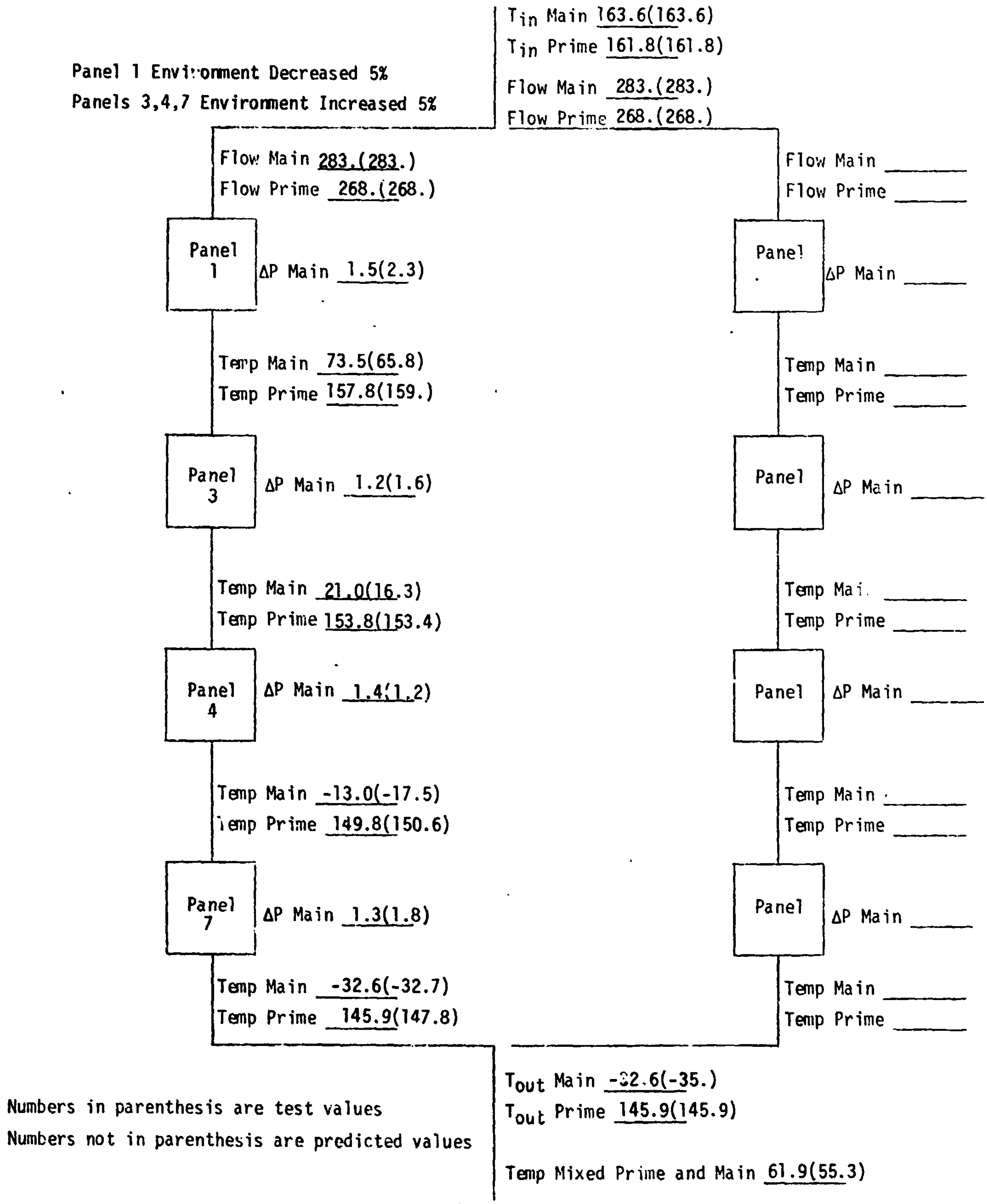


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION α

FIGURE 21 TEST POINT 10 CORRELATION



CONFIGURATION α

FIGURE 22 TEST POINT 17 CORRELATION

T_{in} Main 55.3(55.3)
T_{in} Prime 53.2(53.2)
Flow Main 17.1(17.1)
Flow Prime 549.(549.)

Flow Main 17.1(17.1)
Flow Prime 549.(549.)

Panel 1 ΔP Main 0.03(0.0)

Temp Main -86.6(-81.4)
Temp Prime 52.2(53.2)

Panel 3 ΔP Main 0.03(0.2)

Temp Main -99.4(-84.)
Temp Prime 51.2(47.9)

Panel 4 ΔP Main 0.04(0.0)

Temp Main -118.5(-91.)
Temp Prime 50.1(46.9)

Panel 7 ΔP Main 0.04(0.2)

Temp Main -117.5(-89.1)
Temp Prime 49.1(46.9)

Flow Main ______
Flow Prime ______

Panel ΔP Main ______

Temp Main ______
Temp Prime ______

Panel ΔP Main ______

Temp Main ______
Temp Prime ______

Panel ΔP Main ______

Temp Main ______
Temp Prime ______

Panel ΔP Main ______

Temp Main ______
Temp Prime ______

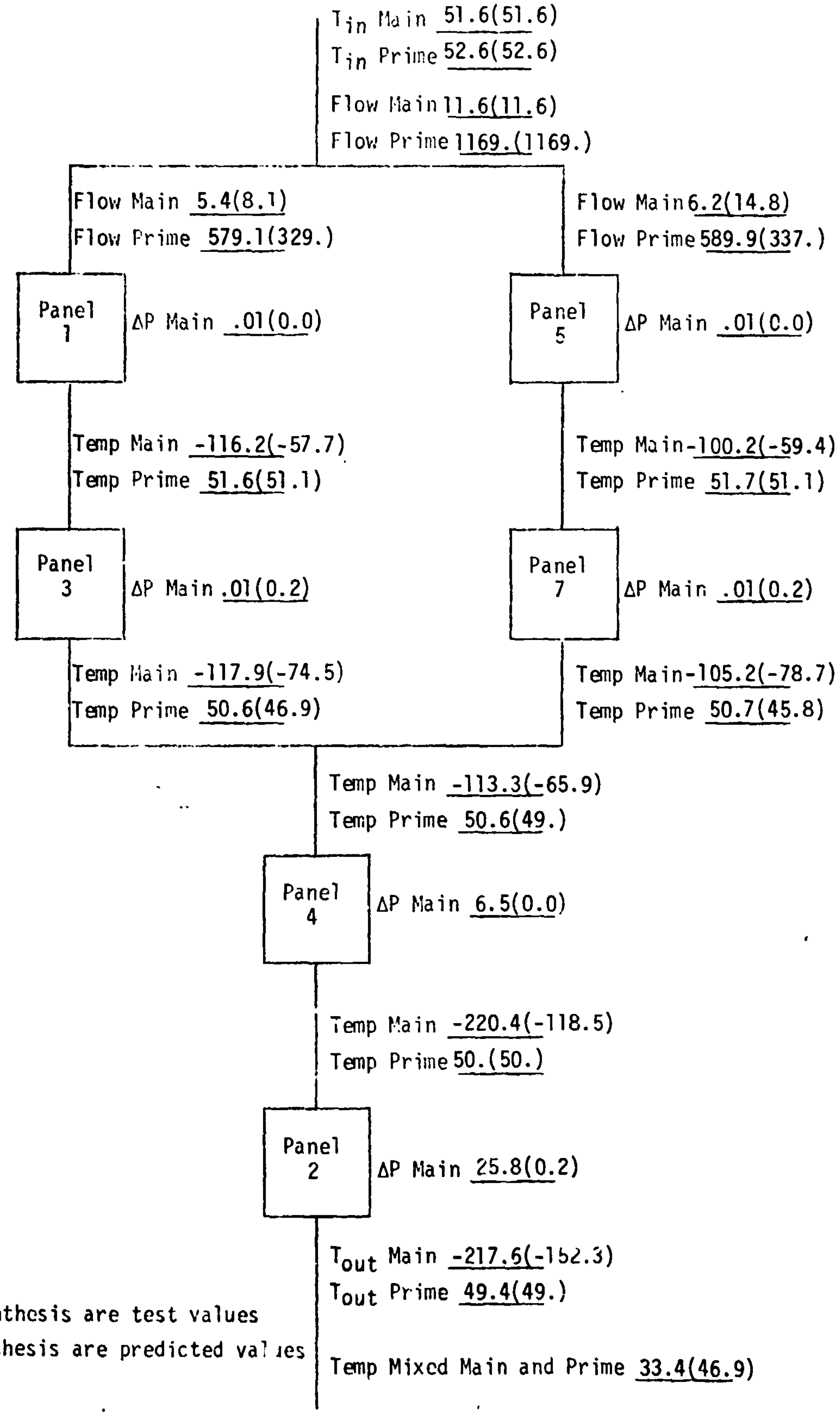
T_{out} Main -117.4(-49.2)
T_{out} Prime 49.1(46.9)

Temp Mixed Prime and Main 44.4(46.9)

Numbers in parenthesis are test values
Numbers not in parenthesis are predicted values

CONFIGURATION β

FIGURE 23 TEST POINT 17A CORRELATION

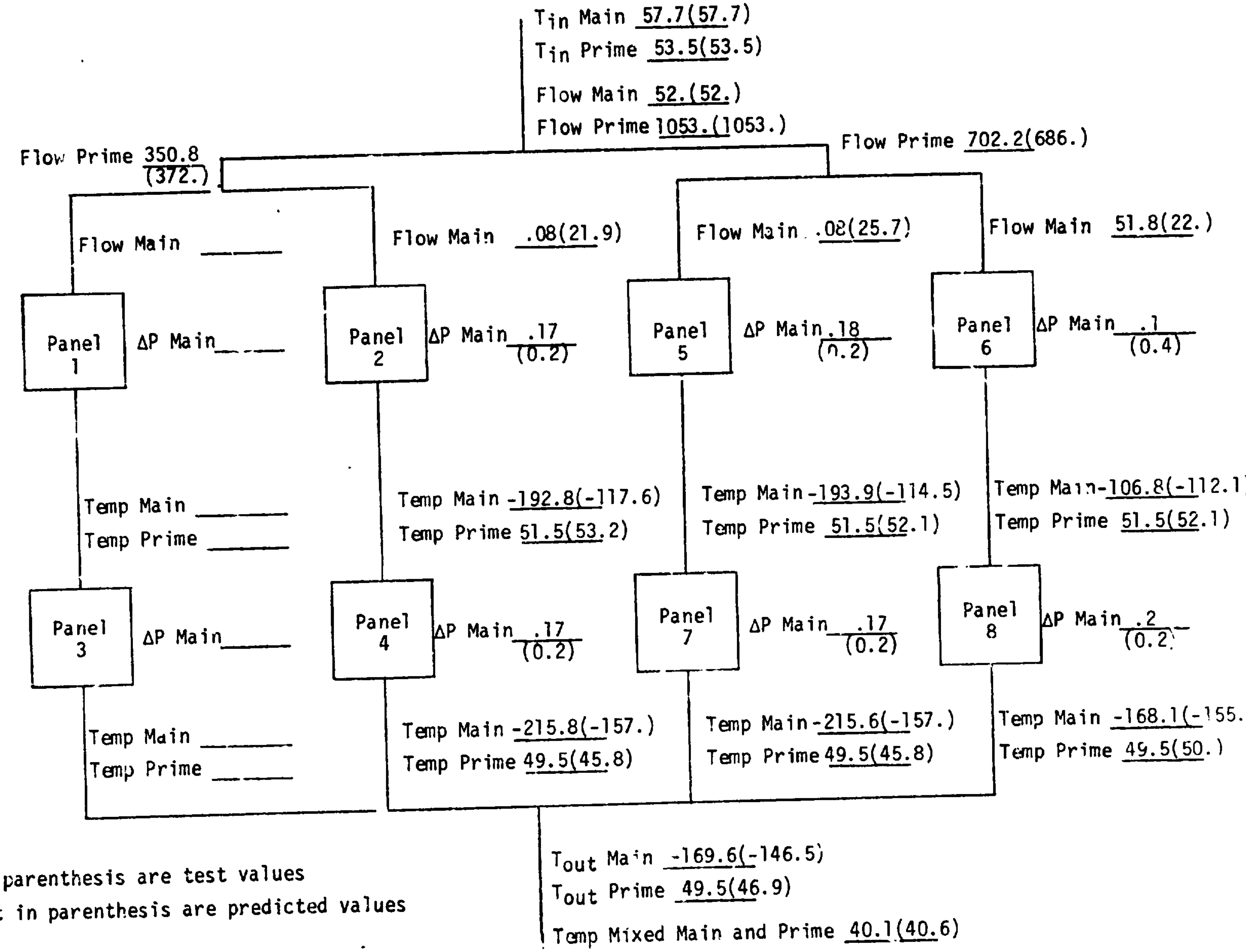


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION γ

FIGURE 24 TEST POINT 36 CORRELATION

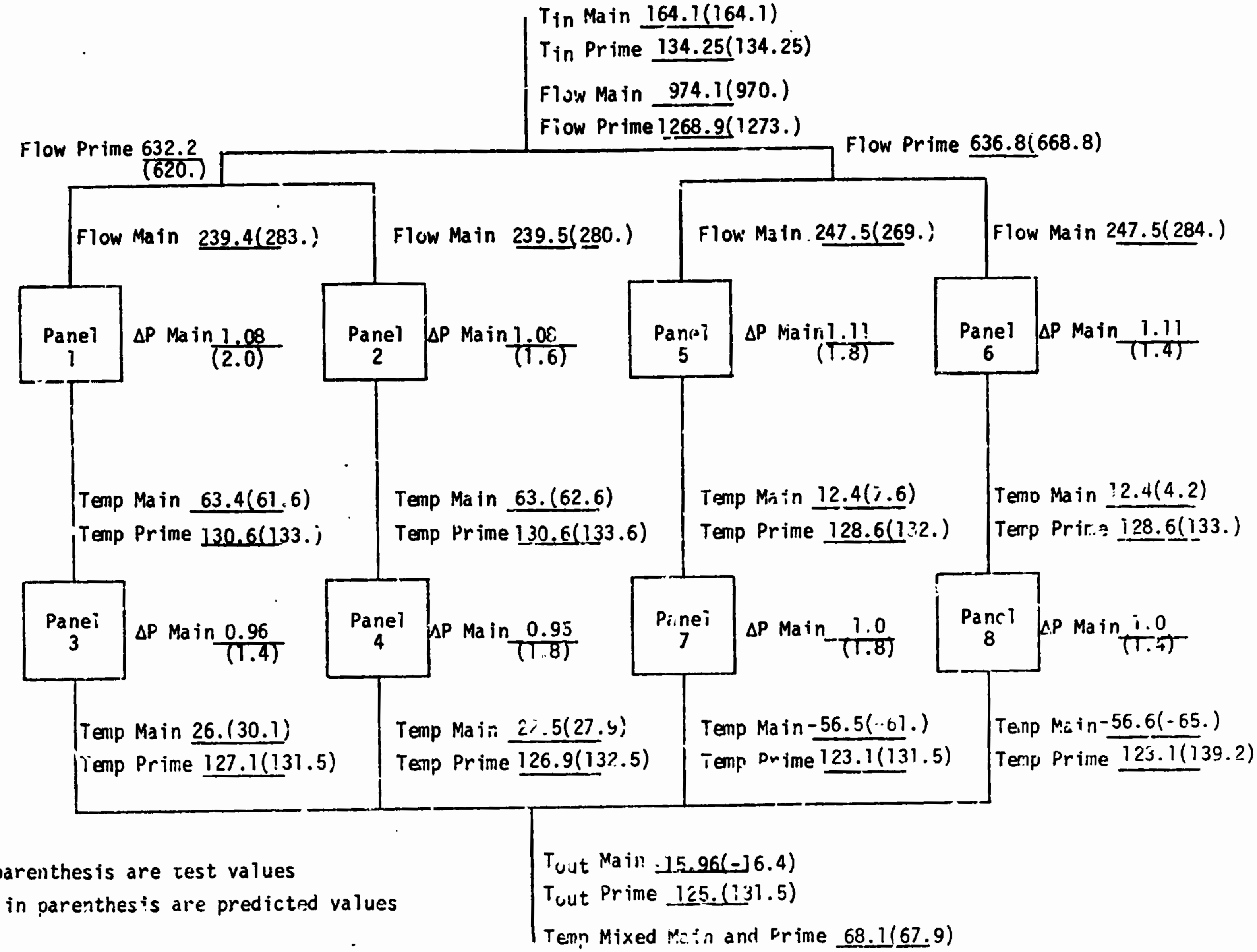


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION γ

FIGURE 25 TEST POINT 53 CORRELATION

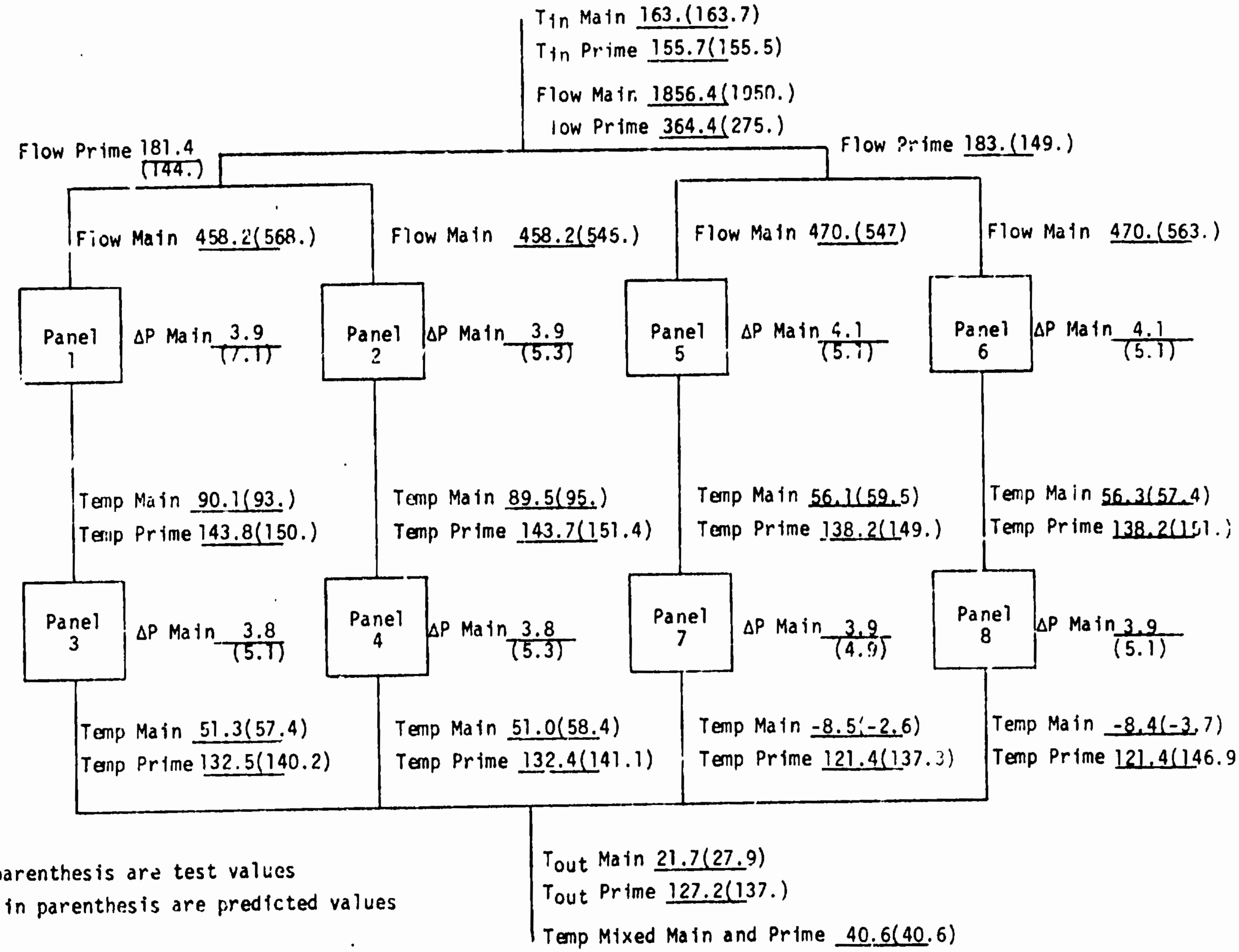


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION γ

FIGURE 26 TEST POINT 54 CORRELATION

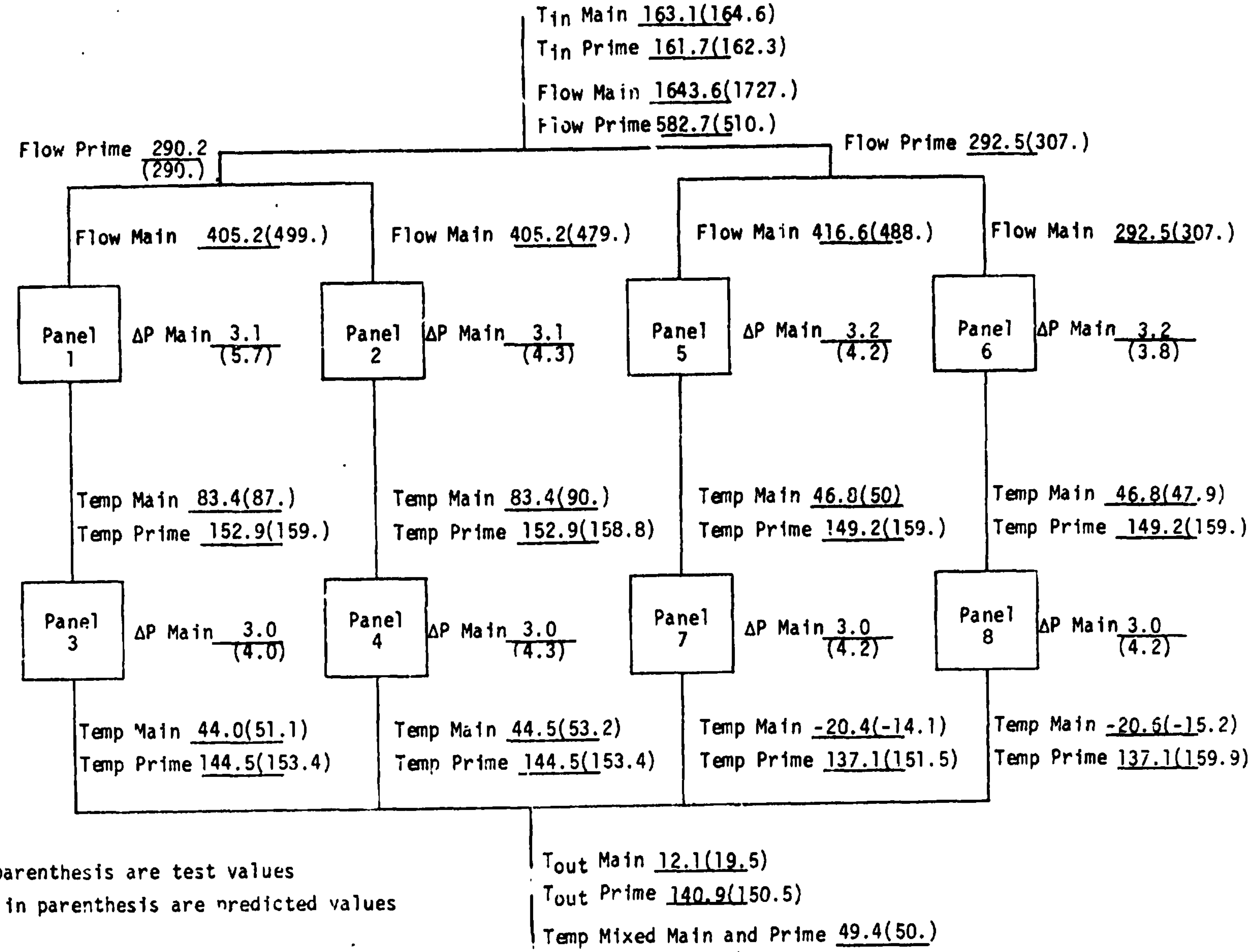


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION γ

FIGURE 27 TEST POINT 55 CORRELATION

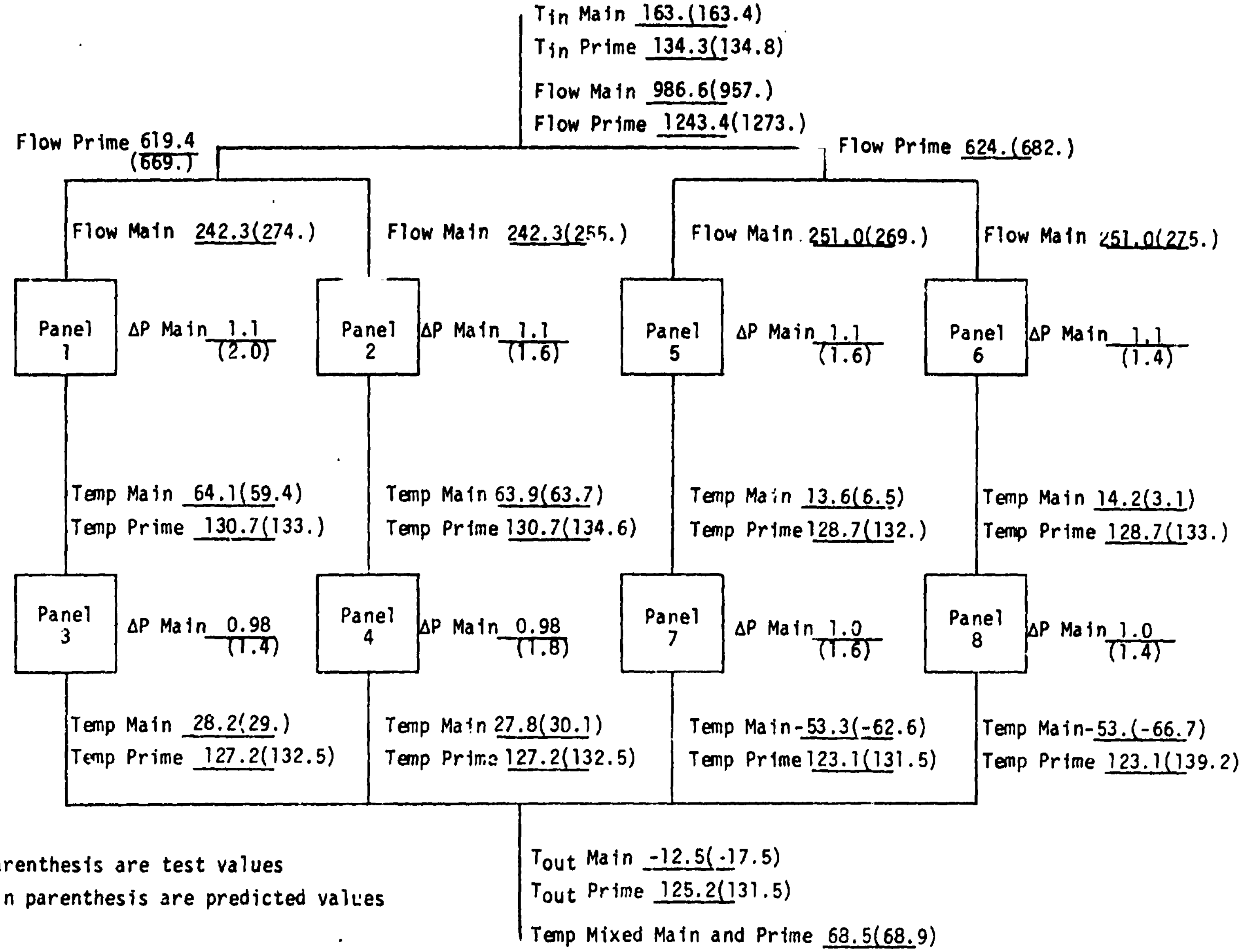


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

FIGURE 28 CONFIGURATION γ

TEST POINT 56 CORRELATION

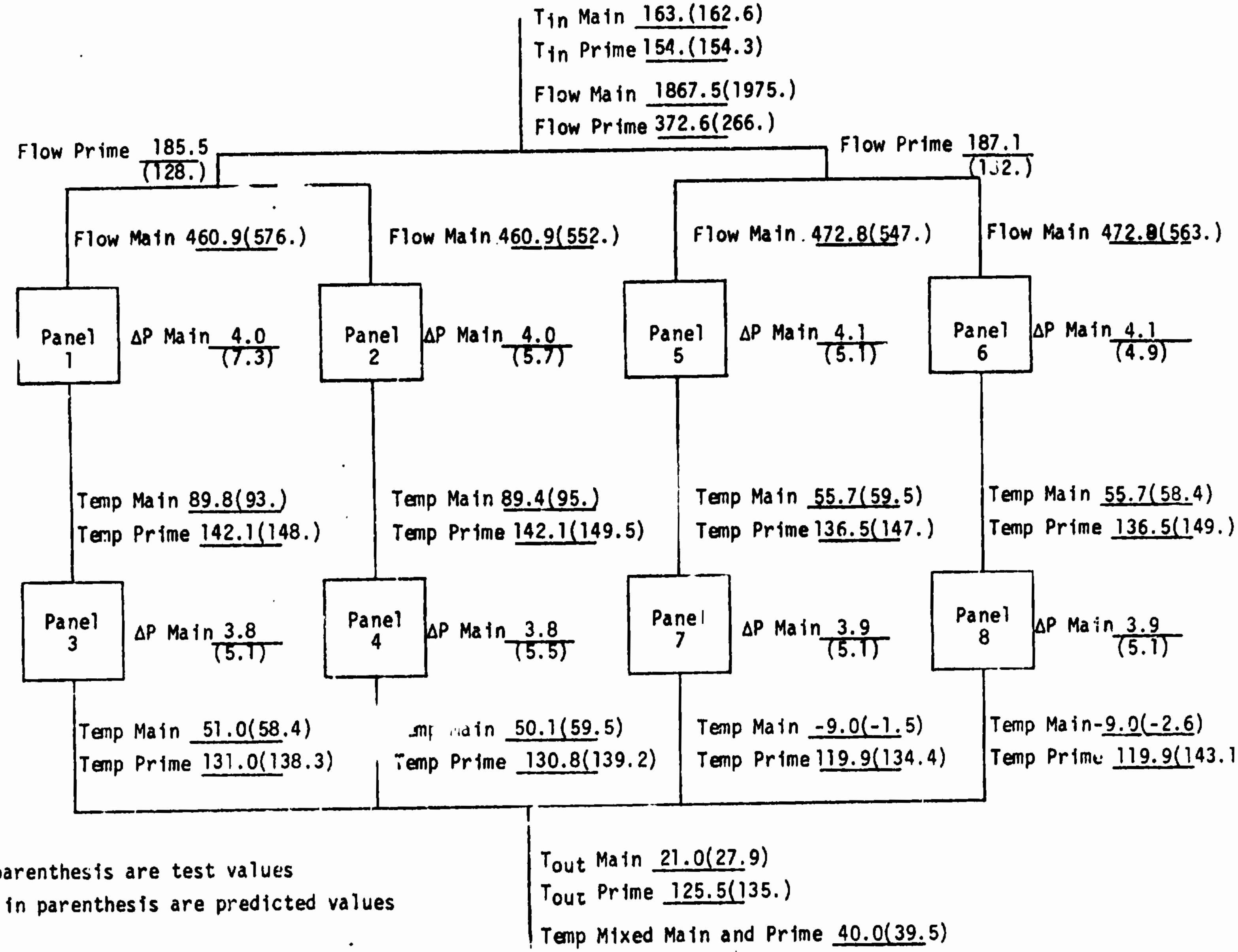


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION γ

FIGURE 29 TEST POINT 59 CORRELATION

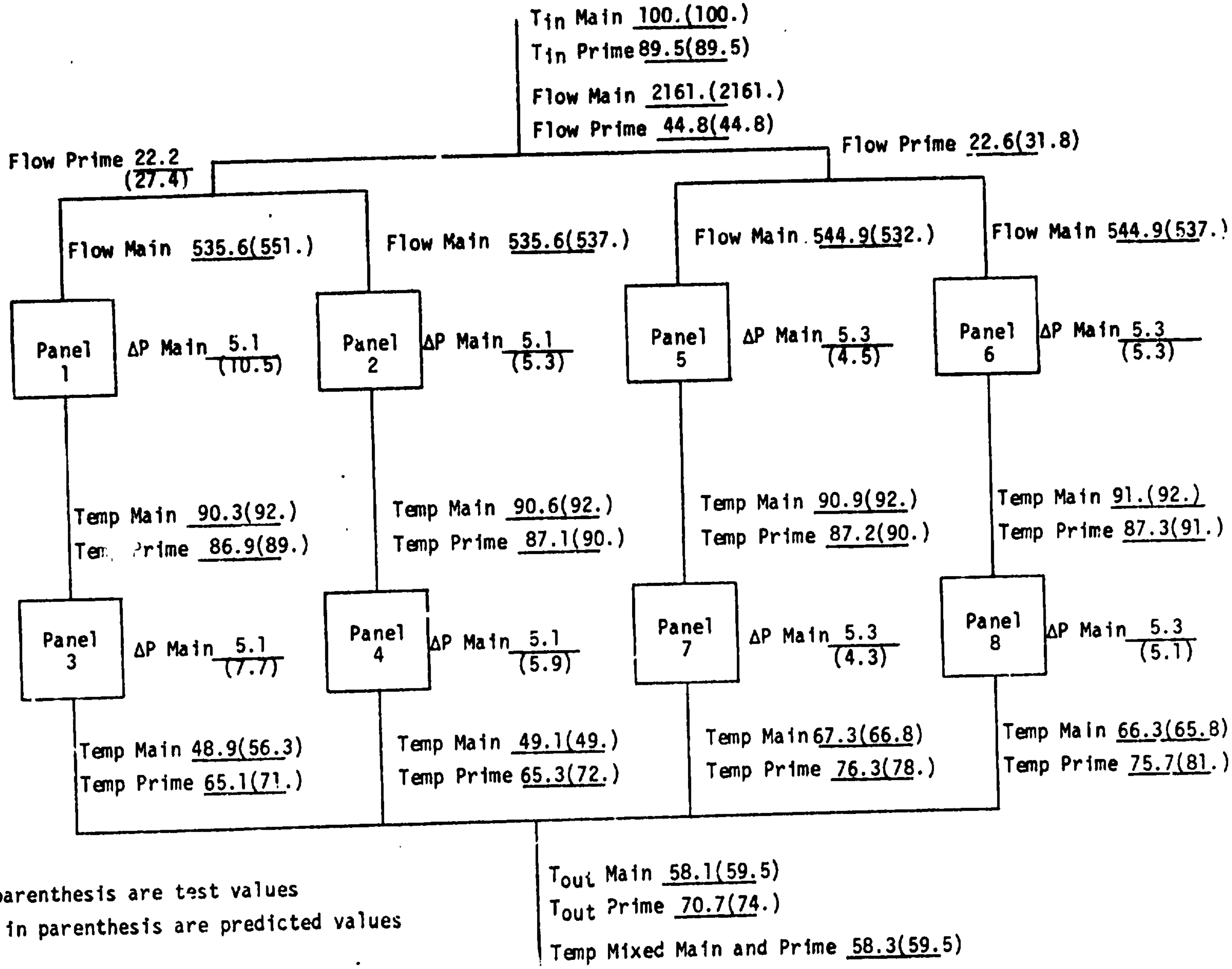


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION γ

FIGURE 30 TEST POINT 49 CORRELATION

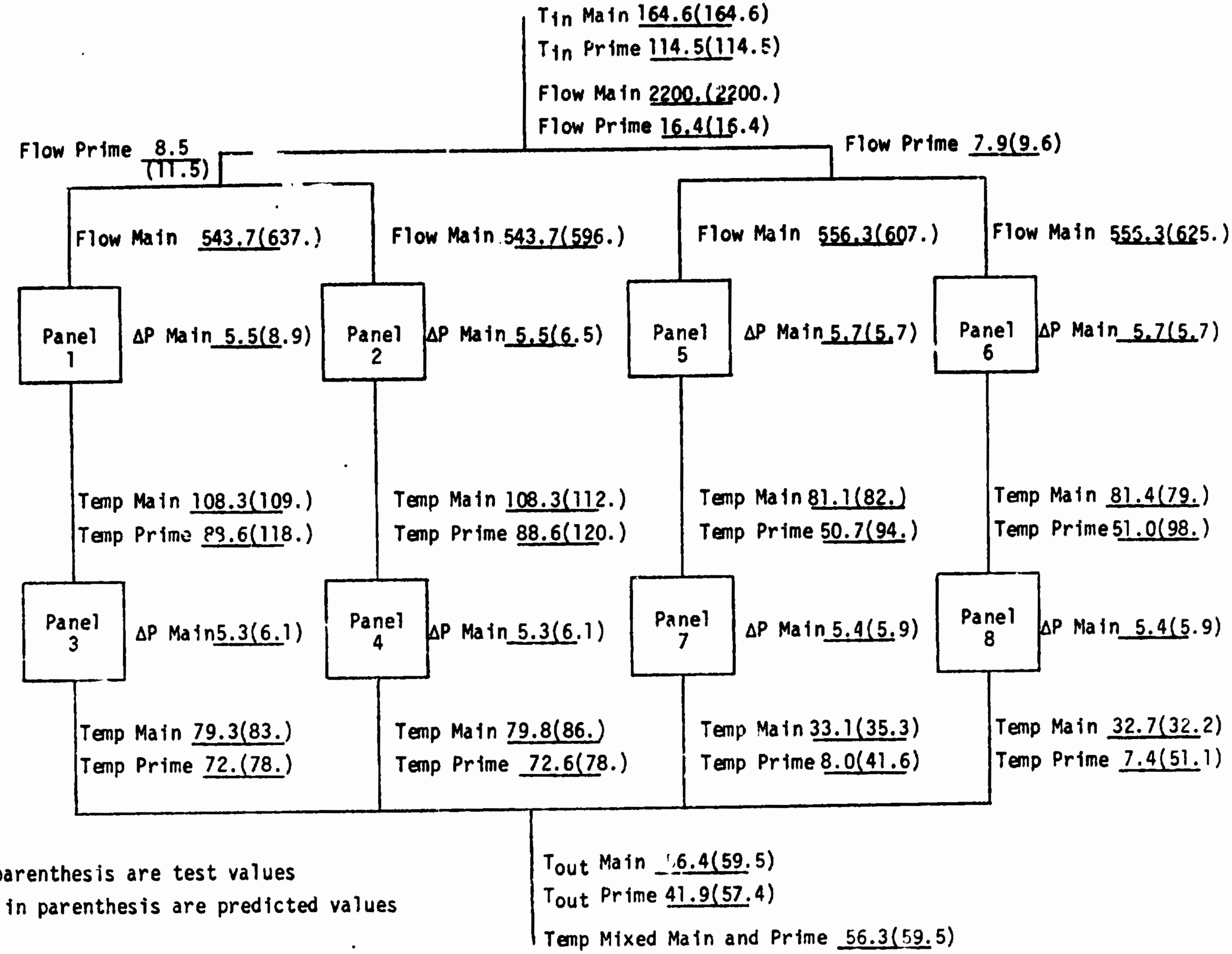


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION γ

FIGURE 31 TEST POINT 27 CORRELATION

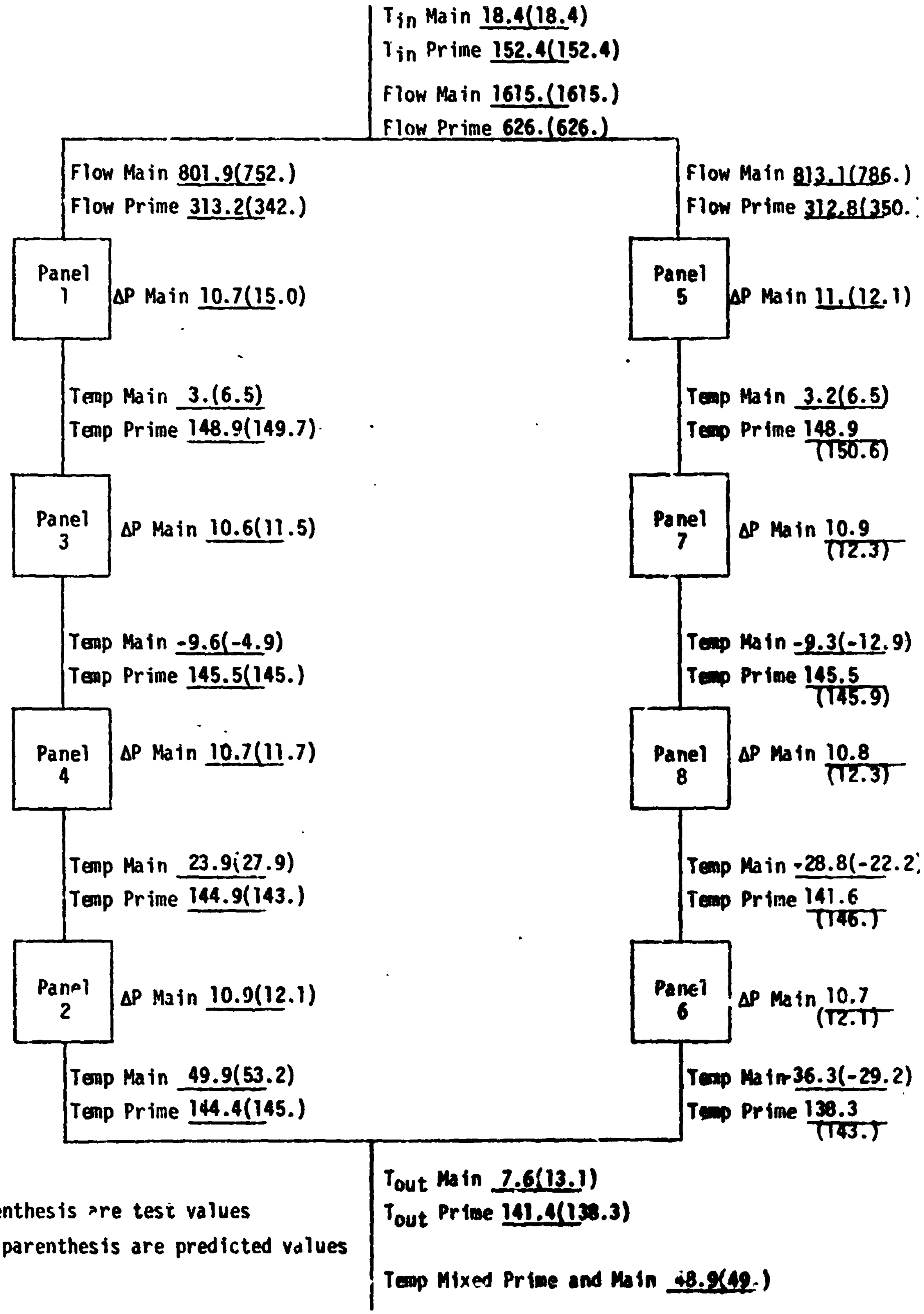


Numbers in parenthesis are test values

Numbers not in parenthesis are predicted values

CONFIGURATION α

FIGURE 32 TEST POINT 14 CORRELATION



Numbers in parenthesis are test values
Numbers not in parenthesis are predicted values

CONFIGURATION α

FIGURE 33 TEST POINT 47 CORRELATION

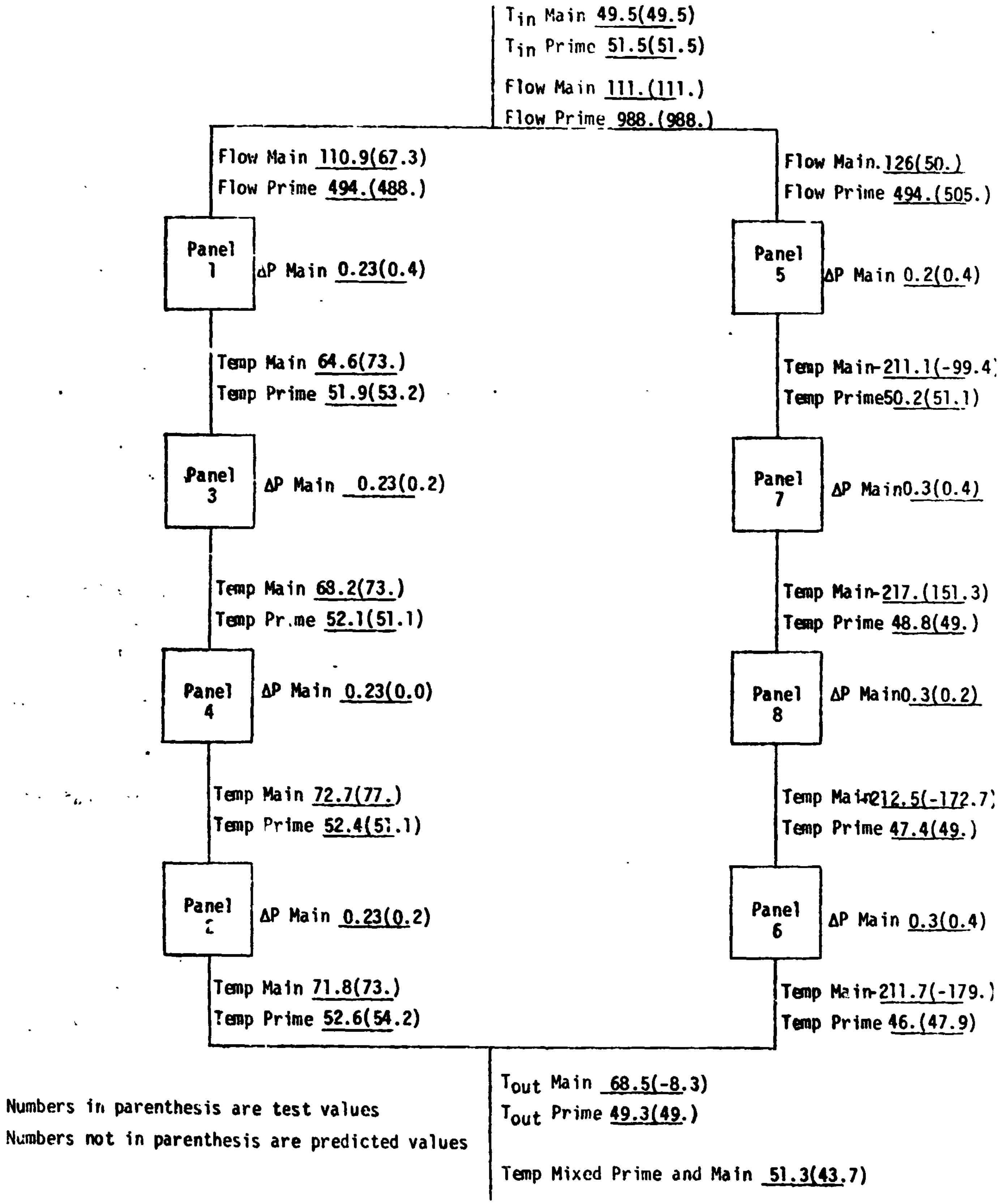


FIGURE 34 TRANSIENT TEMPERATUPE COMPARISONS

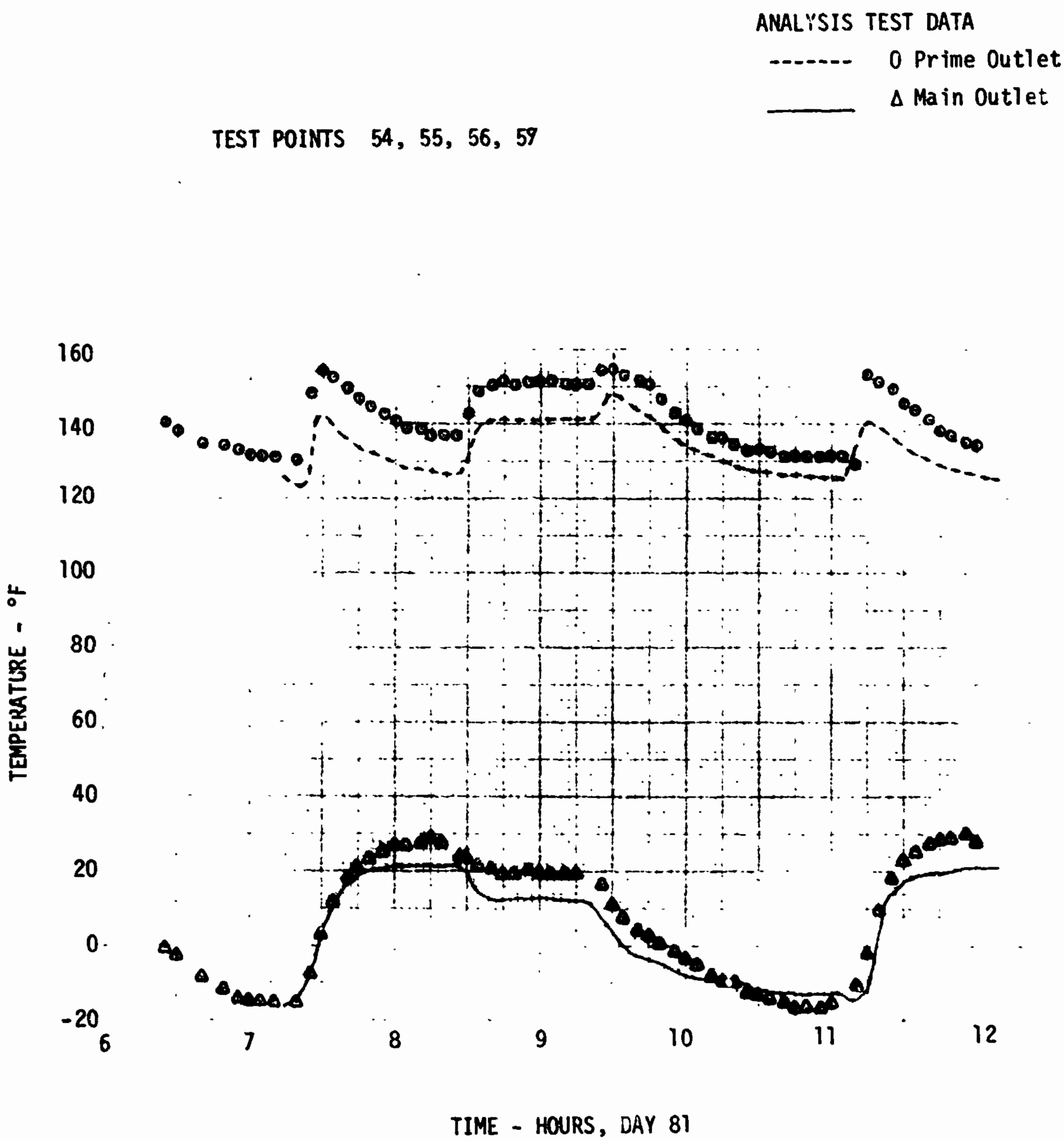
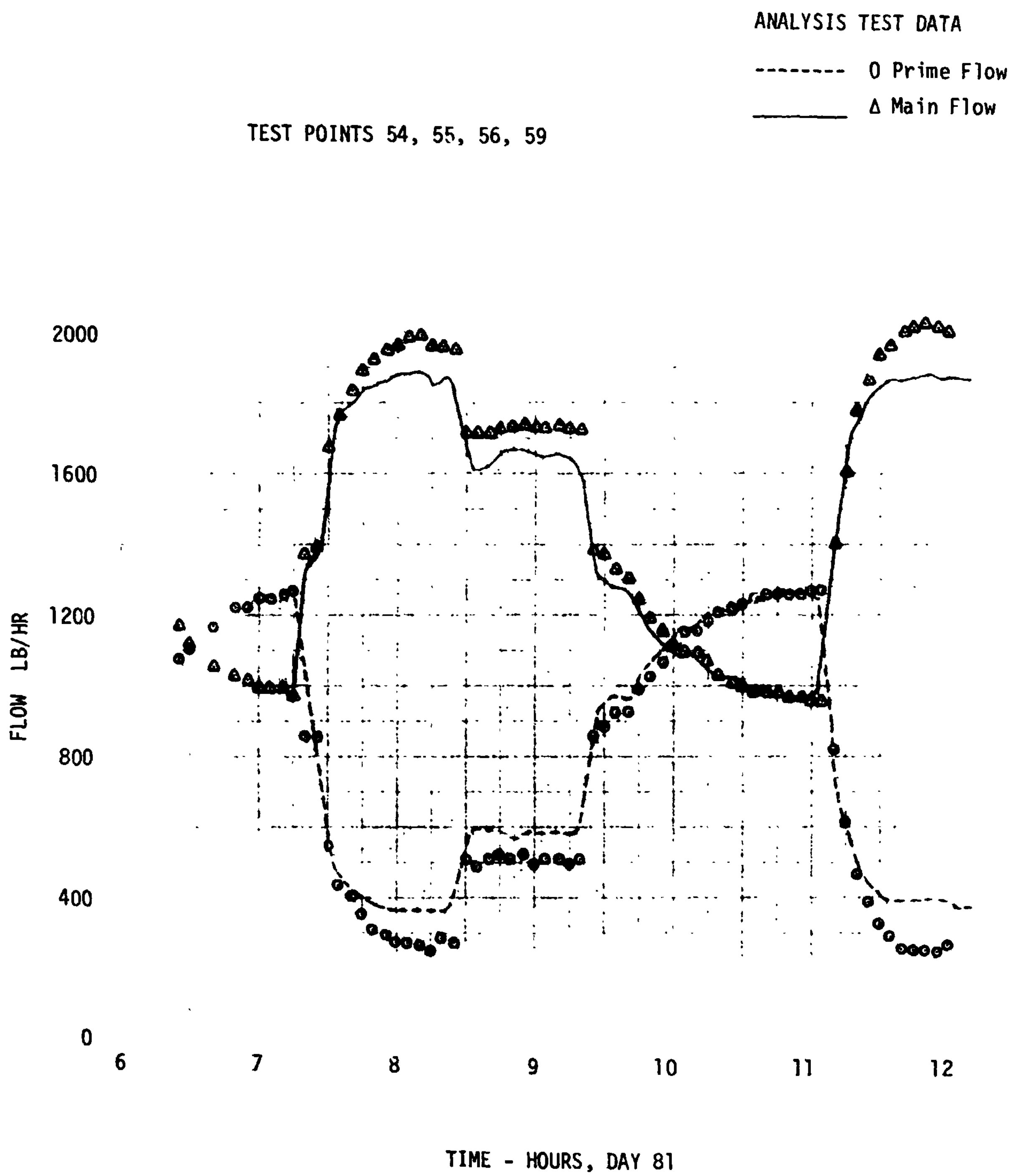


FIGURE 35 TRANSIENT FLOW COMPARISON



APPENDIX A

This appendix presents a summary of the MRS pre-test conditions and results. Tables A-1, A-2, and A-3 present the first, second and third week planned test conditions for each test point and an index to the results of the pre-test analyses. Tables A-4, A-5, and A-6 present environments on each of the eight panels for each test point. The pre-test results are shown on pages A-10 thru A-71.

TABLE A-1

FIRST WEEK PRE-TEST CONDITIONS (ONE SIDED OPERATION)

TEST POINT (TP)	FLOW LOOP	TOTAL FLOW (LB/HR)	INLET TEMP. °F OR FROM TP	SIMULATED SHUTTLE HEAT LOAD (BTU/HR)	ENVIRONMENT SIMULATES SUN DIRECTLY ON	PAGE
1	α_1	1100	162.4	70	Cargo Bay 1	A-10
1A	α_1	1100	178.	70	Cargo Bay 1	A-11
2	α_2 low α/ε	2200	162.4	70	Cargo Bay 2 (Cyclic)	A-12
3	α_1	1100	142.1	57.7	Cargo Bay 1	A-14
4	α_1		116.2	42	Cargo Bay 1	A-15
5	β		From TP-1	70	Cargo Bay 1 (Cyclic Cavity)	A-16
5A	β		From TP-1A	70	Cargo Bay 1 (Cyclic Cavity)	A-18
6	α_1	1100	96.1	31	Cargo Bay 1	A-20
7	α_2 low α/ε	2200	96.1	31	Cargo Bay 2 (Cyclic)	A-21
8	β	1100	From TP-3	57.7	Cargo Bay 1 (Cyclic Cavity)	A-23
9	α_1		116.2	42	Cavity	A-25
10	α_1		162.4	70	Cavity	A-26
11	β		From TP-10	70	Cavity	A-27
12	β		From TP-10	70	Opposite Cavity	A-28
13	β	1100	From TP-9	42	Cavity	A-29
14	α_3	2200	From TP-10	70	One Cavity	A-30
15	α_3		From TP-9	42	One Cavity	A-31
16	α_3	2200	53	-	Belly (Cyclic Cavity)	A-32

TABLE A-1 (CONTINUED)

TEST POINT (TP)	FLOW LOOP	TOTAL FLOW (LB/HR)	INLET TEMP. °F OR FROM TP	SIMULATED SHUTTLE HEAT LOAD (BTU/HR)	ENVIRONMENT SIMULATES SUN DIRECTLY ON	PAGE
17	α_1	1100	53	7	Belly	A-34
18	α_1	1100	162.4	70	Belly	A-35
19	α_3	2200	TP-1	70	Cargo Bay (Cyclic Cavity)	A-36
20	α_3	2200	TP-3	57.7	Cargo Bay (Cyclic Cavity)	A-38

TABLE A-2

SECOND WEEK PRE-TEST CONDITIONS (TWO SIDE OPERATION)

TEST POINT (TP)	FLOW LOOP	TOTAL FLOW (LB/HR)	INLET TEMP. °F OR FROM TP	SIMULATED SHUTTLE HEAT LOAD (BTU/HR)	ENVIRONMENT SIMULATES SUN DIRECTLY ON	PAGE
21	Y	2200	162.4	70	Cargo Bay	A-40
22	Y	2200	162.4	70	Cargo Bay (Cyclic Cavity)	A-41
23	Y	2200	142.1	57.7	Cargo Bay (Cyclic Cavity)	A-43
24	Y	2200	116.2	42	Cargo Bay (Cyclic Cavity)	A-45
25	Y	2200	96.1	31	Cargo Bay (Cyclic Cavity)	A-47
26	Y	2200	116.2	42	Cavity	A-49
27	Y	2200	162.4	70	Cavity	A-50
28	Y	2200	53	7	Cavity	A-51
29	Y	2200	53	7	Belly (Cyclic Cavity)	A-52
30	Y	2200	162.4	70	Belly (Cyclic Cavity)	A-54

TABLE A-3

THIRD WEEK PRE-TEST CONDITIONS (ONE SIDED OPERATION)

TEST POINT (TP)	FLOW LOOP	TOTAL FLOW (LB/HR)	INLET TEMP. F OR FROM TP	SIMULATED SHUTTLE HEAT LOAD (BTU/HR)	ENVIRONMENT SIMULATES SUN DIRECTLY ON	PAGE
31	γ-1&3	1100	162.4	70	Cargo Bay 2 OSR Simul.	A-56
32	γ	2200	From TP-1	70	Cargo Bay 1	A-57
33	δ	2200	From TP-1	70	Cargo Bay 1	A-58
34	δ-8	2200	From TP-1	70	Cargo Bay 1	A-59
35	γ	2200	From TP-6	31	Cargo Bay 1	A-60
37	γ	2200	53	-	45° to Cargo Bay, 7 & 8 shadowed	A-62
38	δ	2200	53	-		A-63
39	δ-8	2200	53	-		A-64
40	ε	2200	53	-		A-65
41	ε-4,7,8	2 00	53			A-66
42	γ	2200	53	-	45° to Cargo Bay, 7 & 8 shadowed	A-67
36	γ-1 & 3	1100	53	7	Belly OSR Simulation	A-61
43	γ	2200	53	-	Belly	A-68
44	γ	2200	From TP-1	70	Cargo Bay 1	A-69
45	ε	2200	From TP-1	70	Cargo Bay 1	A-70
46	ε-4,7,8	2200	From TP-1	70	Cargo Bay 1	A-71

TABLE A-4

FIRST WEEK PRE-TEST ENVIRONMENTS

TEST POINT	ENVIRONMENT ON PANEL (BTU/HR)							
	1	2	3	4	5	6	7	8
1	130	130	130	130	130	130	130	130
1A	130	130	130	130	130	130	130	130
2	55.6-65.1	35.2-75.7	35.2-75.7	35.2-75.7	55.6-65.1	64.5-40.4	64.5-40.4	64.5-40.4
3	130	130	130	130	130	130	130	130
4	130	130	130	130	130	130	130	130
5	130	0-61	130	0-61	130	>9	130	>9
5A	130	0-61	130	0-61	130	>9	130	>9
6	130	130	130	130	130	130	130	130
7	55.6-65.1	35.2-75.7	35.2-75.7	35.2-75.7	55.6-65.1	64.5-40.4	64.5-40.4	64.5-40.4
8	130	0-61	130	0-61	130	>9	130	>9
9	30	30	30	30	30	30	30	30
10	30	30	30	30	30	30	30	30
11	30	216	30	216	30	>9	30	>9
12	30	20	30	20	30	>9	30	>9
13	30	216	30	216	30	>9	30	>9
14	30	216	30	216	30	20	30	20
15	30	216	30	216	30	20	30	20

TABLE A-4 (CONTINUED)

TEST POINT	ENVIRONMENT ON PANEL (BTU/HR)							
	1	2	3	4	5	6	7	8
16	20	3-50	20	3-50	20	50-3	20	[illegible]-3
17	20	20	20	20	20	20	20	20
18	20	20	20	20	20	20	20	20
19	130	3-42	130	3-42	130	61-0	130	61-0
20	130	3-42	130	3-42	130	61-0	130	61-0

TABLE A-5

SECOND WEEK PRE-TEST ENVIRONMENTS

TEST POINT	ENVIRONMENT ON PANEL (BTU/HR)							
	1	2	3	4	5	6	7	8
21	160	160	160	160	160	160	160	160
22	133-158	133-158	133-158	133-158	171-130	171-130	171-130	171-130
23	133-158	133-158	133-158	133-158	171-130	171-130	171-130	171-130
24	133-158	133-158	133-158	133-158	171-130	171-130	171-130	171-130
25	133-158	133-158	133-158	133-158	171-130	171-130	171-130	171-130
26	174	174	174	174	174	174	174	174
27	174	174	174	174	174	174	174	174
28	174	174	174	174	174	174	174	174
29	22-40	22-40	22-40	22-40	40-22	40-22	40-22	40-22
30	22-40	22-40	22-40	22-40	40-22	40-22	40-22	40-22

TABLE A-6

THIRD WEEK PRE-TEST ENVIRONMENTS

TEST POINT	ENVIRONMENT ON PANEL (BTU/HR)							
	1	2	3	4	5	6	7	8
31	>9	60	>9	60	60	52	52	52
32	130	130	130	130	130	130	130	130
33	130	130	130	130	130	130	130	130
34	130	130	130	130	130	130	130	130
35	130	130	130	130	130	130	130	130
37	110	110	110	110	110	110	25	25
38	110	110	110	110	110	110	25	25
39	110	110	110	110	110	110	25	25
40	110	110	110	110	110	110	25	25
41	110	110	110	110	110	>9	>9	>9
42	25	25	25	25	110	25	25	25
36	>9	19.5	>9	19.5	19.5	23	23	23
43	20	20	20	20	20	20	20	20
44	130	130	130	130	130	130	130	130
45	130	130	130	130	130	130	130	130
46	130	130	130	>9	130	130	>9	>9

CONFIGURATION α

TEST POINTS 1

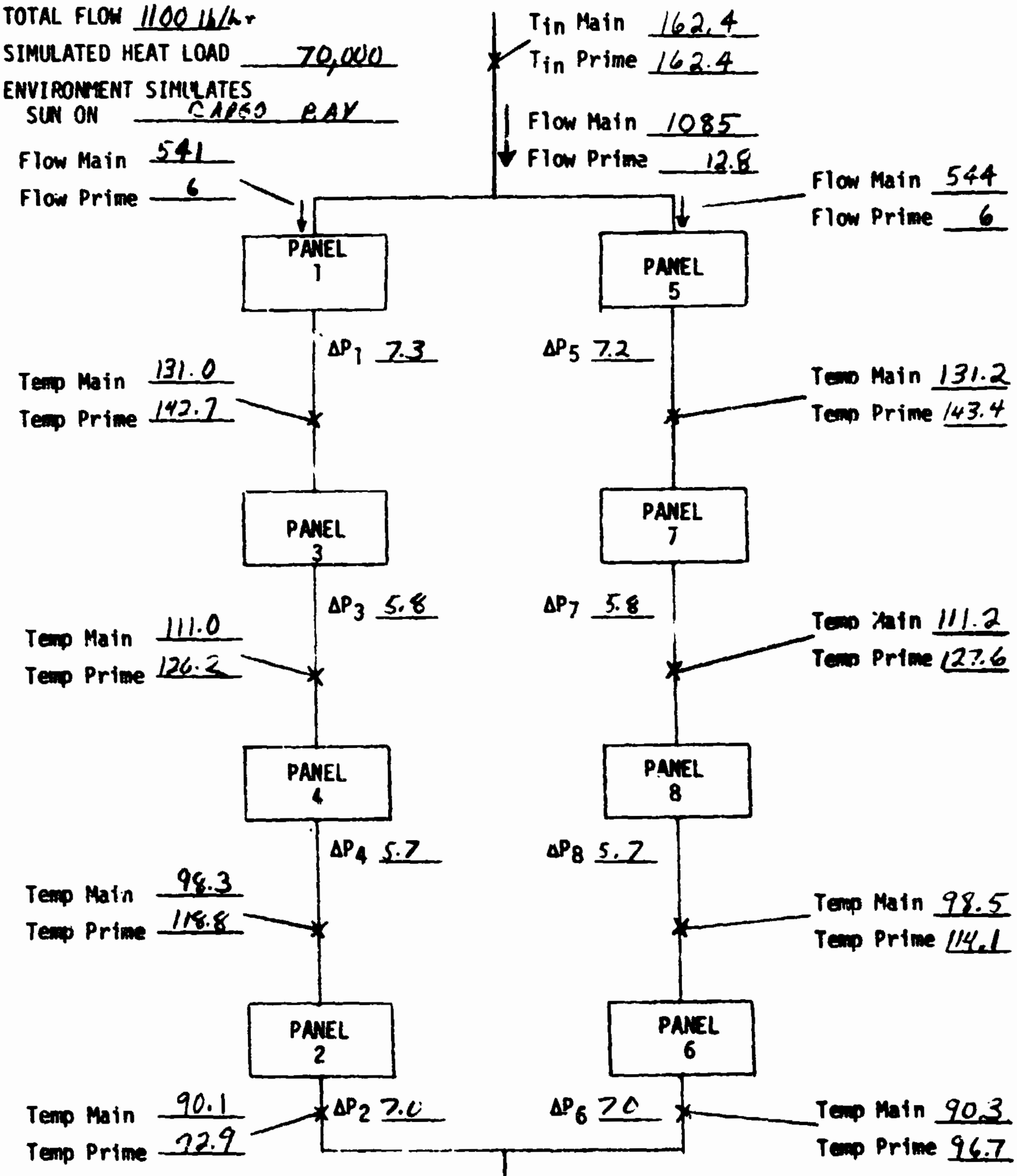
WEEK 1

TEST TIME 4.0 HRS.

TOTAL FLOW 1100 lb/hr

SIMULATED HEAT LOAD 70,000

ENVIRONMENT SIMULATES SUN ON CARGO BAY



MAIN $\underset{\text{FLOW}}{1085} \times \underset{(\text{Tin} - \text{Tout})}{(162.4 - 90.2)} \times \underset{\text{Cp at Tavg}}{.27} = \underset{\text{Qrej}}{21,151}$

Tout Main 90.2

Tout Prime 91.4

PRIME $\underset{\text{FLOW}}{12.8} \times \underset{(\text{Tin} - \text{Tout})}{(162.4 - 91.4)} \times \underset{\text{Cp at Tavg}}{.27} = \underset{\text{Qrej}}{245}$

Temp Mixed Prime and Main 90.4

21,396
Qtotal

CONFIGURATION α

TEST POINTS 1A

WEEK 1

TEST TIME ?

TOTAL FLOW 1100 lb/hr

SIMULATED HEAT LOAD 60 K

ENVIRONMENT SIMULATES SUN ON CARGO BAY

Tin Main 177.8

Tin Prime 177.8

Flow Main 1085

Flow Prime 12.8

Flow Main 541

Flow Prime 6.3

Flow Main 544

Flow Prime 6.4

PANEL 1

PANEL 5

ΔP1 7.3

ΔP5 7.3

Temp Main 140.7

Temp Prime 155.9

Temp Main 140.9

Temp Prime 156.6

PANEL 3

PANEL 7

ΔP3 5.6

ΔP7 5.8

Temp Main 117.3

Temp Prime 140.8

Temp Main 117.5

Temp Prime 138.6

PANEL 4

PANEL 8

ΔP4 5.2

ΔP8 5.7

Temp Main 102.3

Temp Prime 120.1

Temp Main 102.5

Temp Prime 122.7

PANEL 2

PANEL 6

Temp Main 92.7

Temp Prime 92.7

ΔP2 7.0

ΔP6 7.0

Temp Main 92.9

Temp Prime 102.2

Tout Main 92.8

Tout Prime 96.0

MAIN 1085 X (177.8 - 92.8) X .274 = 25269

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 12.8 X (177.8 - 96.0) X .274 = 287

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 92.8

25,556

Qtotal

CONFIGURATION α

TEST POINTS 2-1

WEEK 1

TEST TIME 8.1 ([illegible] main outlet)

TOTAL FLOW 2200 #/hr

SIMULATED HEAT LOAD 70 K

ENVIRONMENT SIMULATES SUN ON CARGO BAY

T_{in} Main 163

T_{in} Prime 163

Flow Main 2171

Flow Prime 25.2

Flow Main 1054

Flow Prime 12.6

PANEL 1

ΔP_1 26.6

Temp Main 131.0

Temp Prime 129.1

PANEL 3

ΔP_3 22.0

Temp Main 102.2

Temp Prime 99.6

PANEL 4

ΔP_4 21.5

Temp Main 78.5

Temp Prime 80.4

PANEL 2

ΔP_2 26.6

Temp Main 58.8

Temp Prime 70.0

Flow Main 1058

Flow Prime 12.7

PANEL 5

ΔP_5 26.6

Temp Main 131.1

Temp Prime 125.0

PANEL 7

ΔP_7 22.0

Temp Main 106.6

Temp Prime 104.6

PANEL 8

ΔP_8 21.4

Temp Main 87.0

Temp Prime 85.6

PANEL 6

ΔP_6 26.0

Temp Main 71 3

Temp Prime 65.5

Tout Main 65.1

Tout Prime 70.6

Temp Mixed Prime and Main 65.1

MAIN $2171(163-65.1)(.265)$ 56323

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME $25.2(163-70)(.265)$ 621

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

56944

Qtotal

CONFIGURATION α

TEST POINTS 2-2

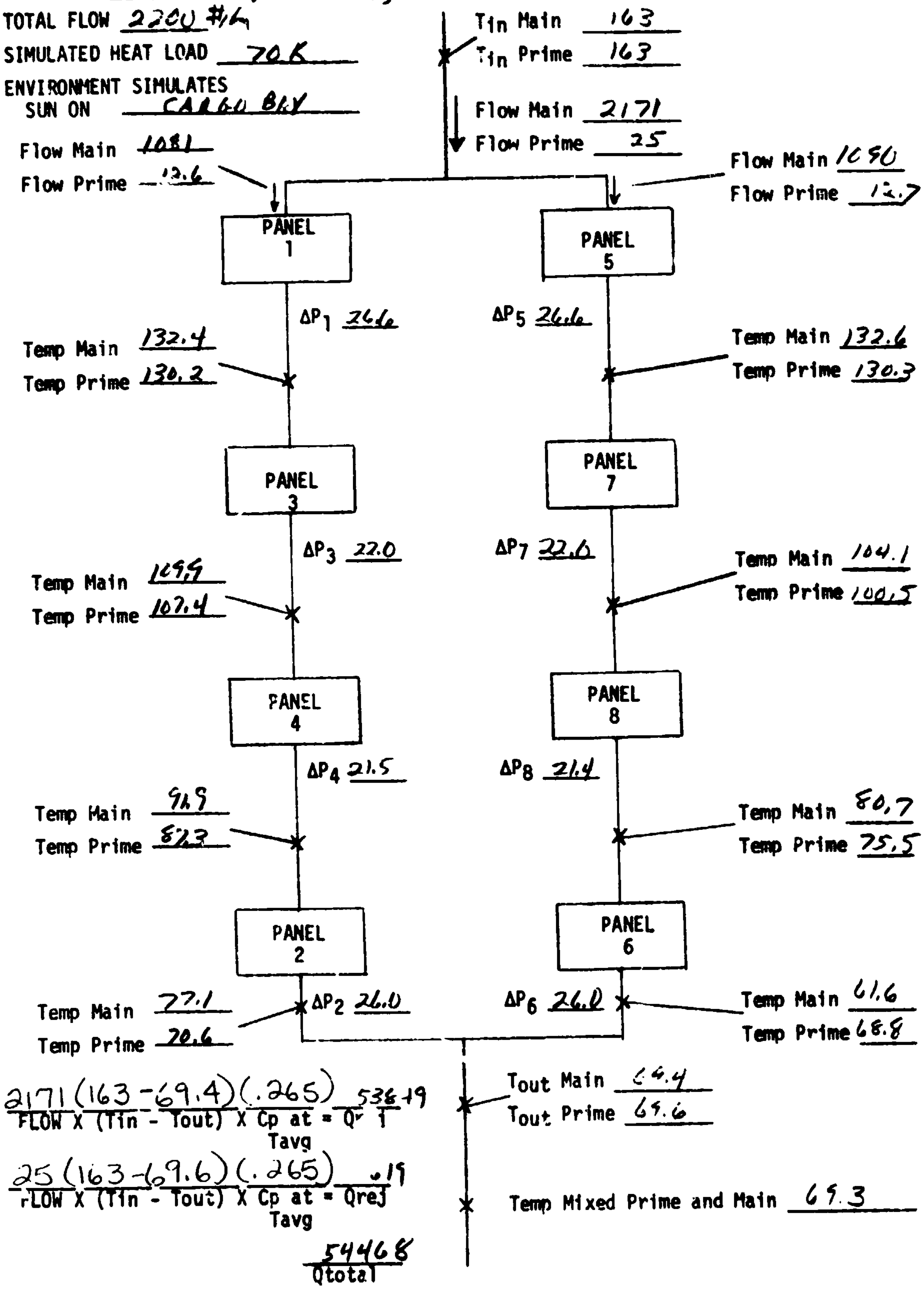
WEEK 1

TEST TIME 8.5 h (High Main outlet)

TOTAL FLOW 2200 #/h

SIMULATED HEAT LOAD 70 K

ENVIRONMENT SIMULATES SUN ON CARGO BAY



MAIN 2171 (163 - 69.4) (.265) 53849

FLOW X (Tin - Tout) X Cp at Tavg = Qr 1

PRIME 25 (163 - 69.6) (.265) .19

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

54468

Qtotal

CONFIGURATION α

TEST POINTS 3

WEEK 1

TEST TIME 13 hr.

TOTAL FLOW 1100 lb/hr

SIMULATED HEAT LOAD 57,700

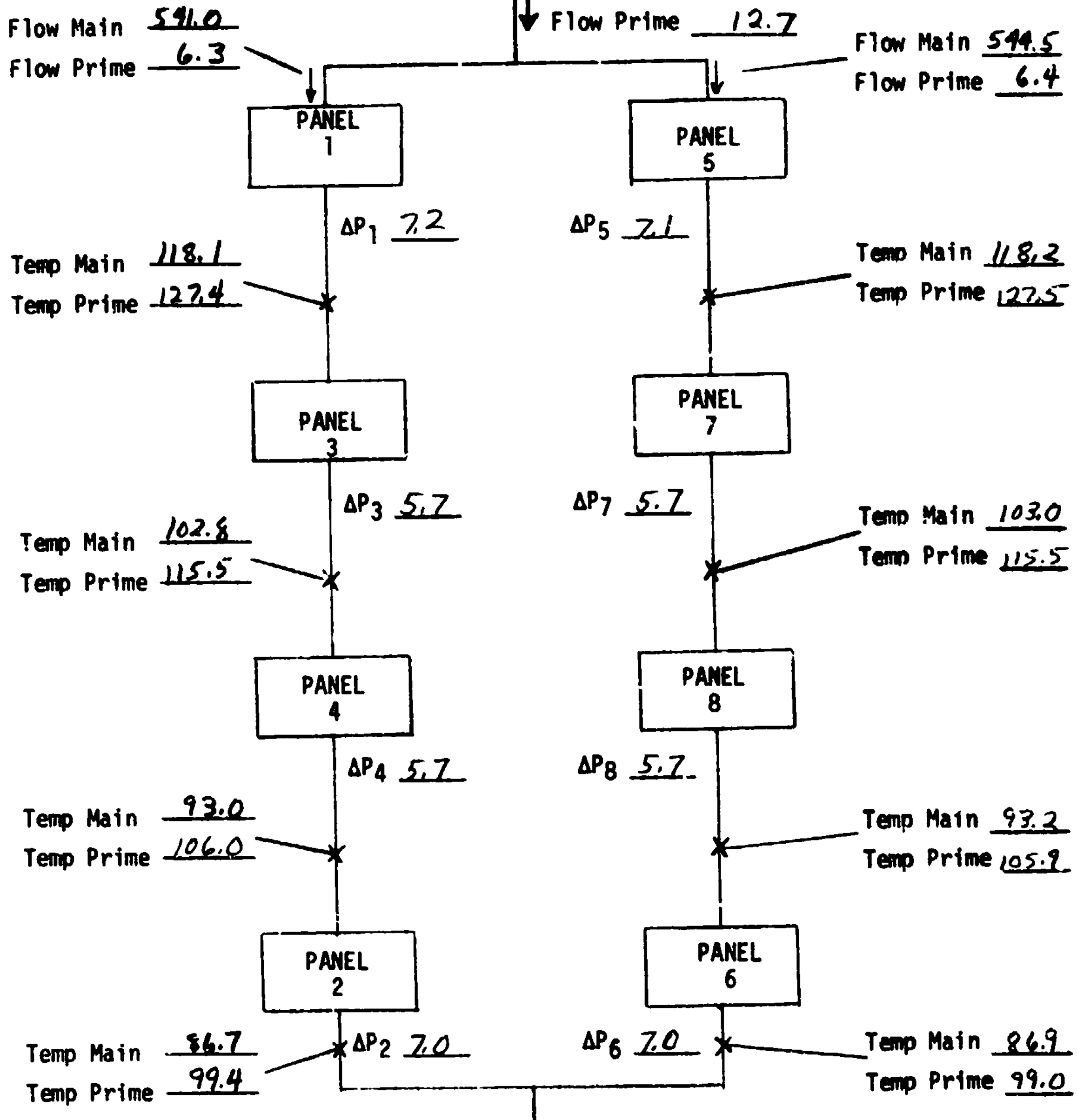
ENVIRONMENT SIMULATES SUN ON CARGO BAY

Tin Main 142.1

Tin Prime 142.1

Flow Main 1086

Flow Prime 12.7



Tout Main 86.8

Tout Prime 99.2

MAIN 1086 (142.1 − 86.8)(.265) 15915

FLOW X (Tin − Tout) X Cp at Tavg = Qrej

PRIME 12.7 (142.1 − 99.2)(.267) 145

FLOW X (Tin − Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 86.9

16060

Total

CONFIGURATION α

TEST POINTS 4

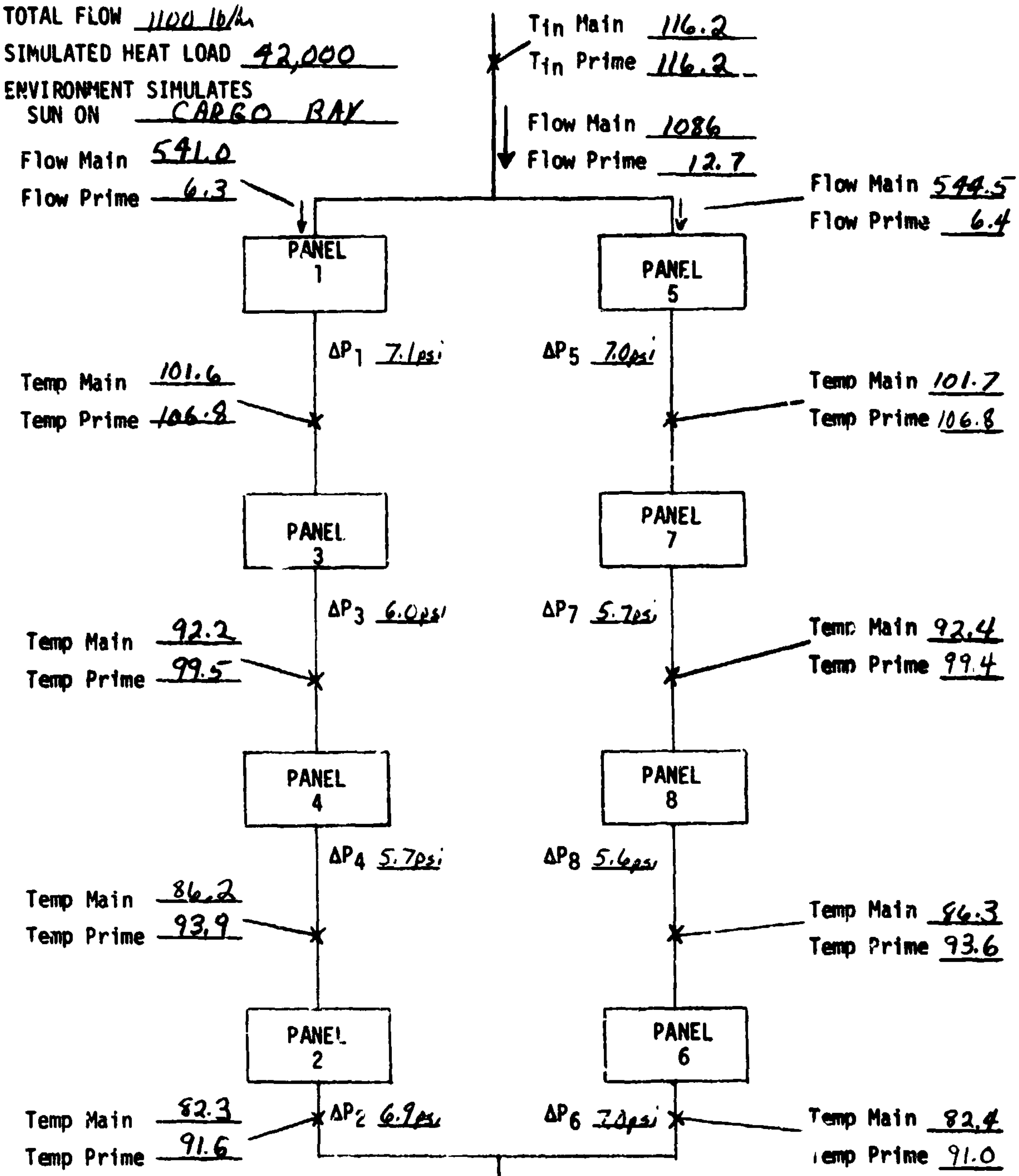
WEEK 1

TEST TIME 17 hr.

TOTAL FLOW 1100 lb/hr

SIMULATED HEAT LOAD 42,000

ENVIRONMENT SIMULATES SUN ON CARGO BAY



MAIN 1086 (116.2 - 82.4) .26 = 9544

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Tout Main 82.4

Tout Prime 92.0

PRIME 12.7 (116.2 - 92) .262 = 80.5

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 82.5

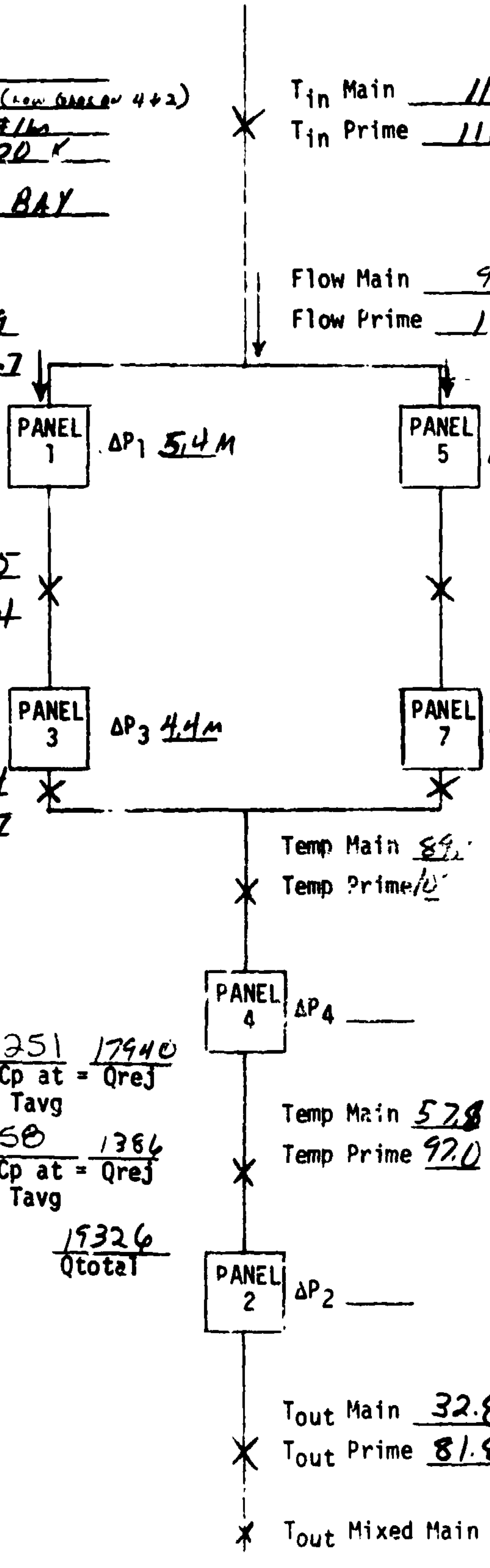
9624

Qtotal

CONFIGURATION B

TEST POINTS 5-1

WEEK 1
TEST TIME 20.1 (low [illegible] 4+2)
TOTAL FLOW 1100 #/hr
SIMULATED HEAT LOAD 20 K
ENVIRONMENT SIMULATES
SUN ON CARGO BAY



MAIN 914 (111 - 32.8) .251 = 17940
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 184 (111 - 81.8) .258 = 1386
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

19326
Qtotal

ΔP 4+2 = 35.4

CONFIGURATION β

TEST POINTS 5 - 2

WEEK 1
TEST TIME 20.9 (High Wave on 2,4)
TOTAL FLOW 1100
SIMULATED HEAT LOAD 70 K
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

T_{in} Main 111
T_{in} Prime 111

Flow Main 1083
Flow Prime 14.6

Flow Main 555
Flow Prime 7.5

Flow Main 528
Flow Prime 7.1

PANEL 1 ΔP_1 7.4

PANEL 5 ΔP_5 6.7

Temp Main 98.7
Temp Prime 104.6

Temp Main 98.2
Temp Prime 104.3

PANEL 3 ΔP_3 6.0

PANEL 7 ΔP_7 6.7

Temp Main 90.5
Temp Prime 99.6

Temp Main 89.4
Temp Prime 99.1

Temp Main 98.2
Temp Prime 101.0

PANEL 4 ΔP_4 ____

MAIN $1083(111-58.5).255 = 14555$
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME $14.6(111-72.3).258 = 146$
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

14701
Qtotal

Temp Main 72.7
Temp Prime 80.9

$\Delta P_{4+2} =$ 55

PANEL 2 ΔP_2 ____

Tout Main 58.5
Tout Prime 72.3

Tout Mixed Main and Prime 58.9

CONFIGURATION B

TEST POINTS 5A

WEEK 1
TEST TIME 20.8 (HIGH MAIN OUTLET)
TOTAL FLOW 1100 #/h
SIMULATED HEAT LOAD 801C
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

T_{in} Main 117.4
T_{in} Prime 117.4

Flow Main 1063
Flow Prime 14.6

Flow Main 5[illegible]
Flow Prime 7.5

Flow Main 528
Flow Prime 7.1

PANEL 1 ΔP_1 6.8

PANEL 5 ΔP_5 6.7

Temp Main 102.6
Temp Prime 108.7

Temp Main 102.1
Temp Prime 108.3

PANEL 3 ΔP_3 6.6

PANEL 7 ΔP_7 6.7

Temp Main 93.1
Temp Prime 101.7

Temp Main 92.4
Temp Prime 101.1

Temp Main 92.7
Temp Prime 101.5

PANEL 4 ΔP_4 ____

MAIN 1063 × (117.4 − 60.3) × .257 = 15,900
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 14.6 × (117.4 − 57.9) × .257 = 225
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

16,125
Qtotal

Temp Main 74.8
Temp Prime 79.9

ΔP_{4+2} = 49.4

PANEL 2 ΔP_2 ____

T_{out} Main 60.3
T_{out} Prime 57.5

T_{out} [illegible] Main and Prime 60.1

CONFIGURATION B

TEST POINTS 5A (LOW MAIN OUTLET)

WEEK 1
TEST TIME 20.0
TOTAL FLOW 1100 LBM/hr
SIMULATED HEAT LOAD 60,000 BTU/HR
ENVIRONMENT SIMULATES
SUN ON C 60 B

T_{in} Main 117.4
T_{in} Prime 117.4

Flow Main 1064
Flow Prime 14.4

Flow Main 555
Flow Prime 7.5

Flow Main 528
Flow Prime 7.1

PANEL 1 ΔP_1 6.8

PANEL 5 ΔP_5 6.7

Temp Main 102.6
Temp Prime 108.7

Temp Main 102.1
Temp Prime 108.3

PANEL 3 ΔP_3 6.6

PANEL 7 ΔP_7 6.7

Temp Main 93
Temp Prime 101.7

Temp Main 92.4
Temp Prime 101.0

Temp Main 92.7
Temp Prime 101.7

PANEL 4 ΔP_4 ____

MAIN 1054 X 112.4 - 39.3 X .254 = 21,500
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 14.8 X 112.4 - 55.6 X .256 = 244
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

21744
Qtotal

Temp Main 63.3
Temp Prime 72.0

ΔP_{4+2} = 39.0

PANEL 2 ΔP_2 ____

T_{out} Main 39.3
T_{out} Prime 55.6

T_{out} Mixed Main and Prime 40.0

C-2

CONFIGURATION α

TEST POINTS 6

WEEK 1

TEST TIME 25 hr

TOTAL FLOW 1100 lb/hr

SIMULATED HEAT LOAD 31,000

ENVIRONMENT SIMULATES SUN ON CARGO BAY

T_{in} Main 96.1

T_{in} Prime 96.1

Flow Main 1085

Flow Prime 12.7

Flow Main 541

Flow Prime 6.3

Flow Main 545

Flow Prime 6.4

PANEL 1

PANEL 5

ΔP_1 7.0

ΔP_5 6.8

Temp Main 88.7

Temp Prime 90.3

Temp Main 88.8

Temp Prime 90.6

PANEL 3

PANEL 7

ΔP_3 5.6

ΔP_7 5.6

Temp Main 83.9

Temp Prime 86.0

Temp Main 84.0

Temp Prime 86.5

PANEL 4

PANEL 8

ΔP_4 5.6

ΔP_8 5.6

Temp Main 80.8

Temp Prime 82.5

Temp Main 80.9

Temp Prime 83.3

PANEL 2

PANEL 6

ΔP_2 6.9

ΔP_6 7.0

Temp Main 78.8

Temp Prime 76.7

Temp Main 78.9

Temp Prime 78.1

MAIN 1085 (96.1 - 78.8) .257 4824

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 12.7 (96.1 - 76) .256 65

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

4889

Qtotal

Tout Main 78.8

Tout Prime 76.0

Temp Mixed Prime and Main 78.8

CONFIGURATION α

TEST POINTS 7 LOW MAIN OUTLET

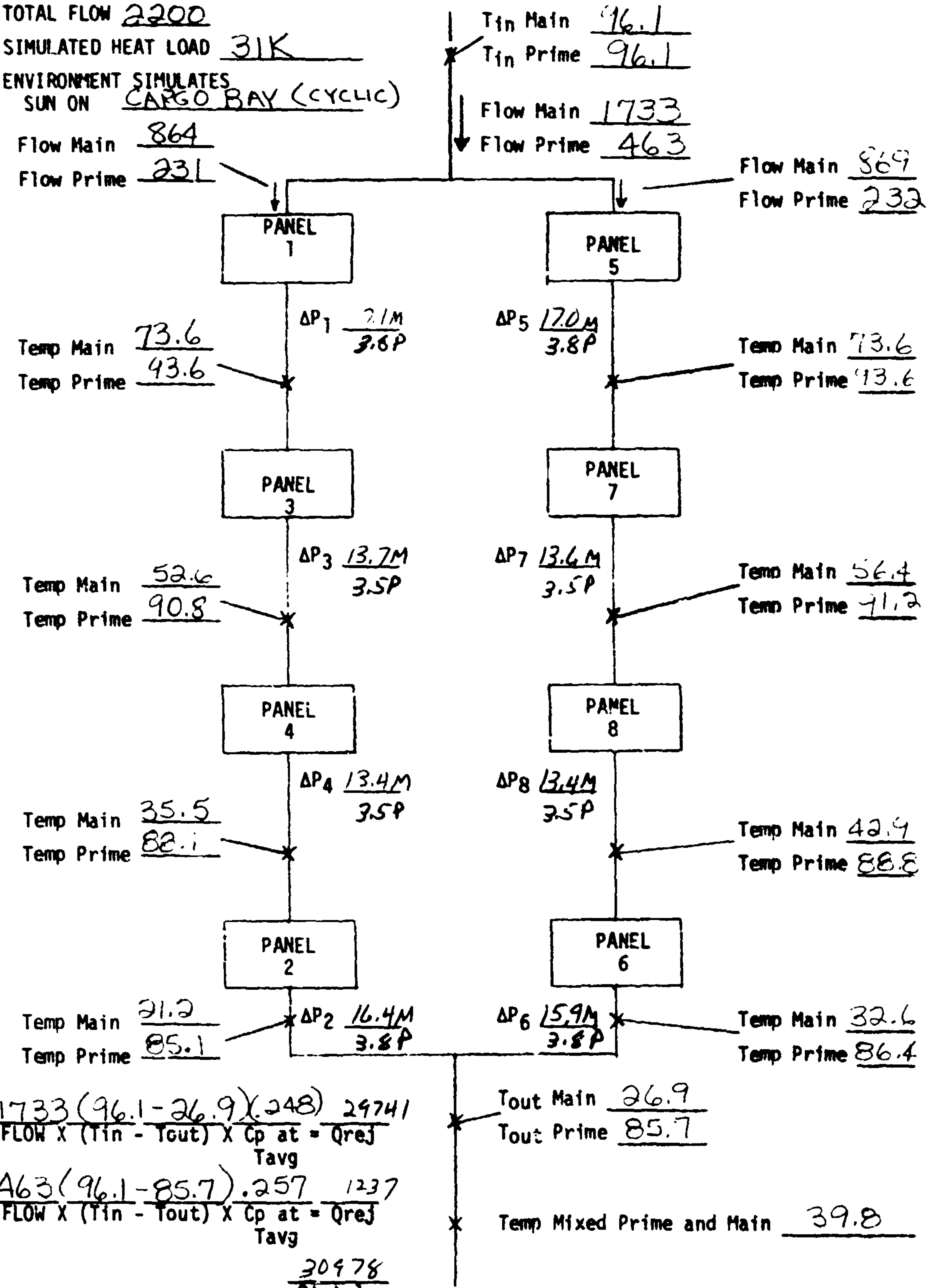
WEEK 1ST

TEST TIME 28.2

TOTAL FLOW 2200

SIMULATED HEAT LOAD 31K

ENVIRONMENT SIMULATES SUN ON CARGO BAY (CYCLIC)



MAIN 1733(96.1-26.9)(.248) 29741

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 463(96.1-85.7).257 1237

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

30978

Qtotal

CONFIGURATION α

TEST POINTS 7 HIGH MAIN OUTLET

WEEK 1ST

TEST TIME 08.1

TOTAL FLOW 2200

SIMULATED HEAT LOAD 31K

ENVIRONMENT SIMULATES
SUN ON CARGO BAY (CYCLIC)

Tin Main 96.1
Tin Prime 96.1

Flow Main 1941
Flow Prime 255

Flow Main 966
Flow Prime 127

Flow Main 974
Flow Prime 128

PANEL 1

PANEL 5

ΔP1 21.2M
1.2P

ΔP5 21.2M
1.2P

Temp Main 76.8
Temp Prime 92.

Temp Main 76.9
Temp Prime 92.

PANEL 3

PANEL 7

ΔP3 16.4M
1.1P

ΔP7 16.4M
1.1P

Temp Main 60.6
Temp Prime 88.4

Temp Main 57.4
Temp Prime 87.4

PANEL 4

PANEL 8

ΔP4 16.8M
1.1P

ΔP8 16.7M
1.1P

Temp Main 51.6
Temp Prime 85.2

Temp Main 41.1
Temp Prime 82.8

PANEL 2

PANEL 6

Temp Main 42.9
Temp Prime 82.7

ΔP2 20.3
1.2P

ΔP6 20.6M
1.2P

Temp Main 27.3
Temp Prime 79.0

Tout Main 35.1
Tout Prime 81.

MAIN 1941 (96.1 - 35.1) .25 29600
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 255 (96.1 - 81) .256 986
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 40.7

30 586
Qtotal

CONFIGURATION B

TEST POINTS 8-1

WEEK 1
TEST TIME 32.1 (low [illegible] 4+2)
TOTAL FLOW 1100
SIMULATED HEAT LOAD 57.7K
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

T_{in} Main 103
T_{in} Prime 103

Flow Main 853
Flow Prime 246

Flow Main 437
Flow Prime 124

Flow Main 416
Flow Prime 122

PANEL 1 ΔP_1 4.6

PANEL 5 ΔP_5 4.2

Temp Main 91.7
Temp Prime 101.6

Temp Main 91.4
Temp Prime 101.6

PANEL 3 ΔP_3 3.8

PANEL 7 ΔP_7 4.2

Temp Main 85.3
Temp Prime 100.2

Temp Main 84.9
Temp Prime 100.2

Temp Main 85.1
Temp Prime 99.7

PANEL 4 ΔP_4 ____

MAIN 853(103 - 25.6) .25 16505
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 246(103 - 90.7) .259 783
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

17,289
Qtotal

Temp Main 52.1
Temp Prime 55.8

ΔP_{4+2} = 3.2

PANEL 2 ΔP_2 ____

T_{out} Main 25.6
T_{out} Prime 90.7

T_{out} Mixed Main and Prime 40.3

CONFIGURATION B

TEST POINTS 8 - 2

WEEK 1
TEST TIME 32.8 (H: [illegible] on 4+2)
TOTAL FLOW 1100
SIMULATED HEAT LOAD 57.7K
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

T_{in} Main 103
T_{in} Prime 103

Flow Main 1084
Flow Prime 14.6

Flow Main 555
Flow Prime 7.5

PANEL 1 ΔP_1 ____

Flow Main 528
Flow Prime 7.1

PANEL 5 ΔP_5 ____

Temp Main 93.3
Temp Prime 98.1

Temp Main 93.0
Temp Prime 97.5

PANEL 3 ΔP_3 ____

PANEL 7 ΔP_7 ____

Temp Main 82.1
Temp Prime 94.4

Temp Main 86.6
Temp Prime 94.0

Temp Main 86.8
Temp Prime 95.8

PANEL 4 ΔP_4 ____

MAIN $\frac{1084(103-56.3).254}{\text{FLOW X (Tin - Tout) X Cp at Tavg}} \; \frac{12658}{\text{Qrej}}$

Temp Main 70.0
Temp Prime 72.4

PRIME $\frac{14.6(103-71.9).256}{\text{FLOW X (Tin - Tout) X Cp at Tavg}} \; \frac{116}{\text{Qrej}}$

$\Delta P_{4+2} = 49.3$

$\frac{12774}{\text{Qtotal}}$

PANEL 2 ΔP_2 ____

T_{out} Main 56.3
T_{out} Prime 71.9

T_{out} Mixed Main and Prime 56.6

CONFIGURATION α

TEST POINTS 9

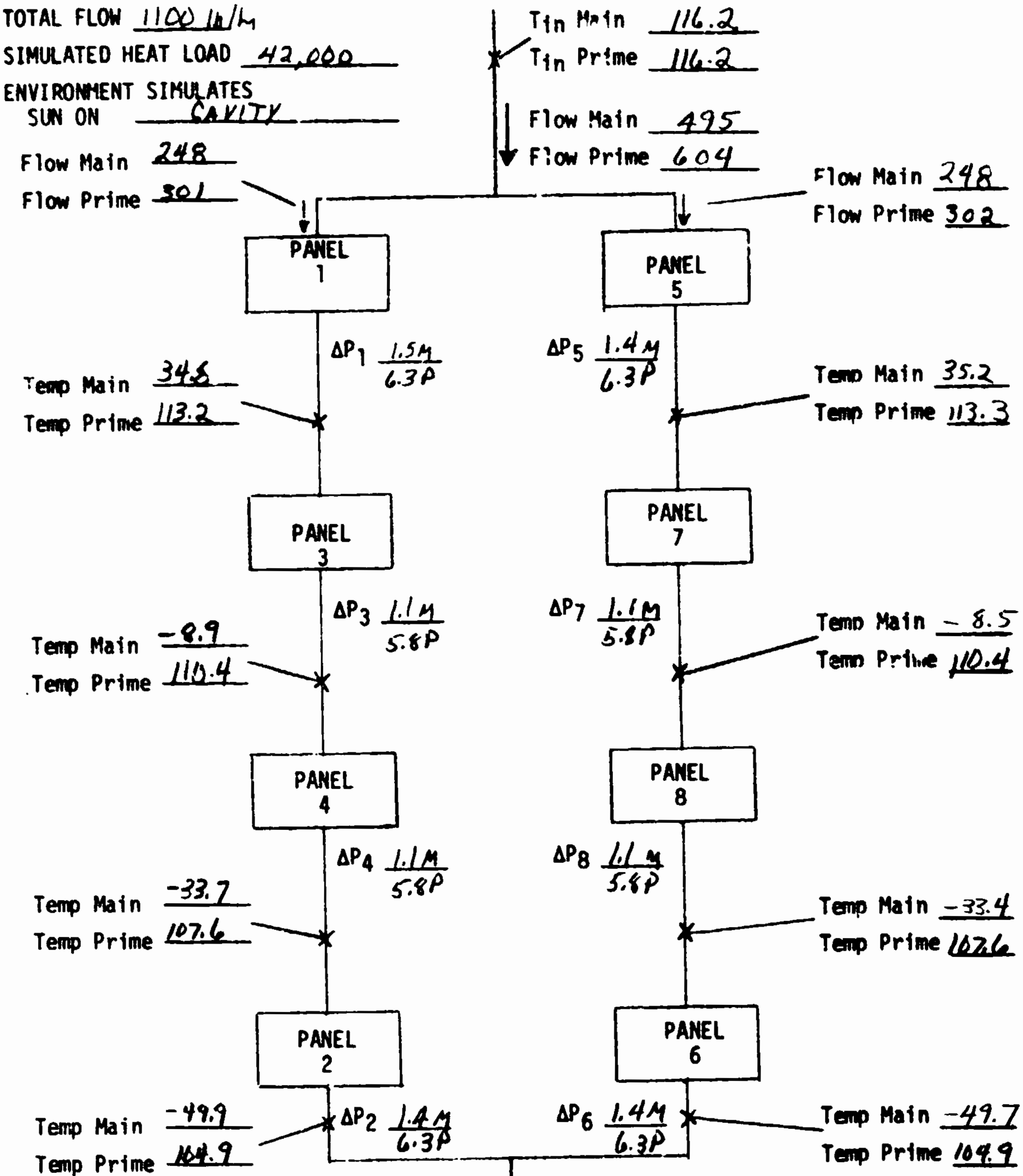
WEEK 1

TEST TIME 38 hrs

TOTAL FLOW 1100 lb/hr

SIMULATED HEAT LOAD 42,000

ENVIRONMENT SIMULATES
SUN ON CAVITY



Tout Main -49.8

Tout Prime 104.9

MAIN 495 (116.2+49.8) .247 8118
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 604(116.2-104.9) .264 1801
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 39.4

9920
Qtotal

CONFIGURATION α

TEST POINTS 10

WEEK 1

TEST TIME 42 hrs

TOTAL FLOW 1100 lb/h

SIMULATED HEAT LOAD 70,000

ENVIRONMENT SIMULATES SUN ON CAVITY

T_{in} Main 162.4

T_{in} Prime 162.4

Flow Main 698

Flow Prime 401

Flow Main 348

Flow Prime 200

Flow Main 350

Flow Prime 201

PANEL 1

PANEL 5

ΔP_1 3.1 M / 3.0 P

ΔP_5 3.1 M / 3.0 P

Temp Main 77.3

Temp Prime 156.8

Temp Main 77.7

Temp Prime 156.8

PANEL 3

PANEL 7

ΔP_3 2.5 M / 2.7 P

ΔP_7 2.4 M / 2.7 P

Temp Main 26.4

Temp Prime 151.4

Temp Main 26.8

Temp Prime 151.5

PANEL 4

PANEL 8

ΔP_4 2.2 M / 2.7 P

ΔP_8 2.2 M / 2.7 P

Temp Main -6.1

Temp Prime 146.2

Temp Main -5.6

Temp Prime 146.2

PANEL 2

PANEL 6

Temp Main -27.8

Temp Prime 141.1

ΔP_2 2.7 M / 2.9 P

ΔP_6 2.2 M / 2.9 P

Temp Main -27.4

Temp Prime 141.1

MAIN 698 (162.4+27.6) .25 = 33155

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Tout Main -27.6

Tout Prime 141.1

PRIME 401 (162.4-141.1) .278 = 2374

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 40.2

35529

Qtotal

CONFIGURATION β

TEST POINTS 11

WEEK 1
TEST TIME 48
TOTAL FLOW 1100
SIMULATED HEAT LOAD 70 K
ENVIRONMENT SIMULATES
SUN ON CAVITY

T_{in} Main 26.8
T_{in} Prime 151.4

Flow Main 1084
Flow Prime 14.5

Flow Main 556
Flow Prime 7.5

PANEL 1 — ΔP_1 2.1

Flow Main 528
Flow Prime 2.0

PANEL 5 — ΔP_5 6.4

Temp Main 3.9
Temp Prime 113.8

Temp Main 2.9
Temp Prime 111.4

PANEL 3 — ΔP_3 5.7

PANEL 7 — ΔP_7 6.4

Temp Main -13.6
Temp Prime 79.3

Temp Main -15.0
Temp Prime 74.9

Temp Main -14.5
Temp Prime 77.0

PANEL 4 — ΔP_4 ____

MAIN $1084(26.8-48.6)\,.242 = -5718$
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME $14.5(151.4-105.4)\,.269 = 179$
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

-5539
Qtotal

Temp Main 20.1
Temp Prime 52.7

$\Delta P_{4+2} = 47.4$

PANEL 2 — ΔP_2 ____

T_{out} Main 46.6
T_{out} Prime 165.4

T_{out} Mixed Main and Prime 49.4

CONFIGURATION B

TEST POINTS 12

WEEK 1
TEST TIME 54
TOTAL FLOW 1100
SIMULATED HEAT LOAD 70
ENVIRONMENT SIMULATES
SUN ON OPPOSITE CAVITY

T_{in} Main 26.8
T_{in} Prime 151.4

Flow Main 600
Flow Prime 499

Flow Main 308
Flow Prime 252

Flow Main 292
Flow Prime 247

PANEL 1 — ΔP_1 2.2 M / 4.3 P

PANEL 5 — ΔP_5 1.9 M / 4.3 P

Temp Main -8.5
Temp Prime 147.2

Temp Main -9.8
Temp Prime 147.1

PANEL 3 — ΔP_3 1.6 M / 4.3 P

PANEL 7 — ΔP_7 1.9 M / 4.3 P

Temp Main -31.3
Temp Prime 143.0

Temp Main -32.9
Temp Prime 142.9

Temp Main -32.4
Temp Prime 142.9

PANEL 4 — ΔP_4 ____

MAIN 600(26.8+56.3).237 11816
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Main -45.5
Temp Prime 140.7

ΔP_{4+2} = 15.2 M
ΔP_{4+2} = 32.8 P

PRIME 499(151.4 - 138.5).275 1770
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

13587
Qtotal

PANEL 2 — ΔP_2 ____

Tout Main -56.3
Tout Prime 138.5

Tout Mixed Main and Prime 40.2

CONFIGURATION B

TEST POINTS 13

WEEK 1
TEST TIME 58
TOTAL FLOW 1120
SIMULATED HEAT LOAD H2K
ENVIRONMENT SIMULATES
SUN ON CAVITY

T_{in} Main -8.5
T_{in} Prime 110.4

Flow Main 1029
Flow Prime 69.2

Flow Main 528
Flow Prime 35

Flow Main 501
Flow Prime 34

PANEL 1 ΔP_1 6.4

PANEL 5 ΔP_5 5.7

Temp Main -23.8
Temp Prime 92.0

Temp Main -24.5
Temp Prime 91.7

PANEL 3 ΔP_3 5.1

PANEL 7 ΔP_7 5.7

Temp Main -35.7
Temp Prime 75.7

Temp Main -36.7
Temp Prime 75.3

Temp Main -36.4
Temp Prime 75.5

PANEL 4 ΔP_4 ____

MAIN 1029 (-8.5-36.5) .239 -11066
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Main 3.5
Temp Prime 82.5

$\Delta P_{4+2} = 62.8$

PRIME 69.2 (110.4-88.9) .26 366
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

-10 680
Qtotal

PANEL 2 ΔP_2 ____

T_{out} Main 36.5
T_{out} Prime 88.9

T_{out} Mixed Main and Prime 39.9

CONFIGURATION α

TEST POINTS 14

WEEK 1

TEST TIME 62 hr

TOTAL FLOW 2200 lb/hr

SIMULATED HEAT LOAD 70,000

ENVIRONMENT SIMULATES SUN ON ONE CAVITY

T_{in} Main -6.0

T_{in} Prime 146.2

Flow Main 1677

Flow Prime 519

Flow Main 833

Flow Prime 259

Flow Main 844

Flow Prime 260

PANEL 1

PANEL 5

ΔP_1 12.8 M / 7.4 P

ΔP_5 12.9 M / 7.4 P

Temp Main -16.8

Temp Prime 142.2

Temp Main -16.7

Temp Prime 142.2

PANEL 3

PANEL 7

ΔP_3 10.8 M / 6.9 P

ΔP_7 10.4 M / 6.9 P

Temp Main -25.9

Temp Prime 138.2

Temp Main -25.7

Temp Prime 138.3

PANEL 4

PANEL 8

ΔP_4 10.2 M / 6.9 P

ΔP_8 10.4 M / 6.5 P

Temp Main 19.9

Temp Prime 138.6

Temp Main -36.3

Temp Prime 134.2

PANEL 2

PANEL 6

Temp Main 55.5

Temp Prime 138.9

ΔP_2 13.1 M / 7.4 P

ΔP_6 12.9 M / 7.4 P

Temp Main -45.5

Temp Prime 130.2

Tout Main 6.2

Tout Prime 134.6

Temp Mixed Prime and Main 39.7

MAIN 1677(-6-6.2).238 -4840

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 519(146.2-134.6).274 1649

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

-3191

Qtotal

CONFIGURATION α

TEST POINTS 15

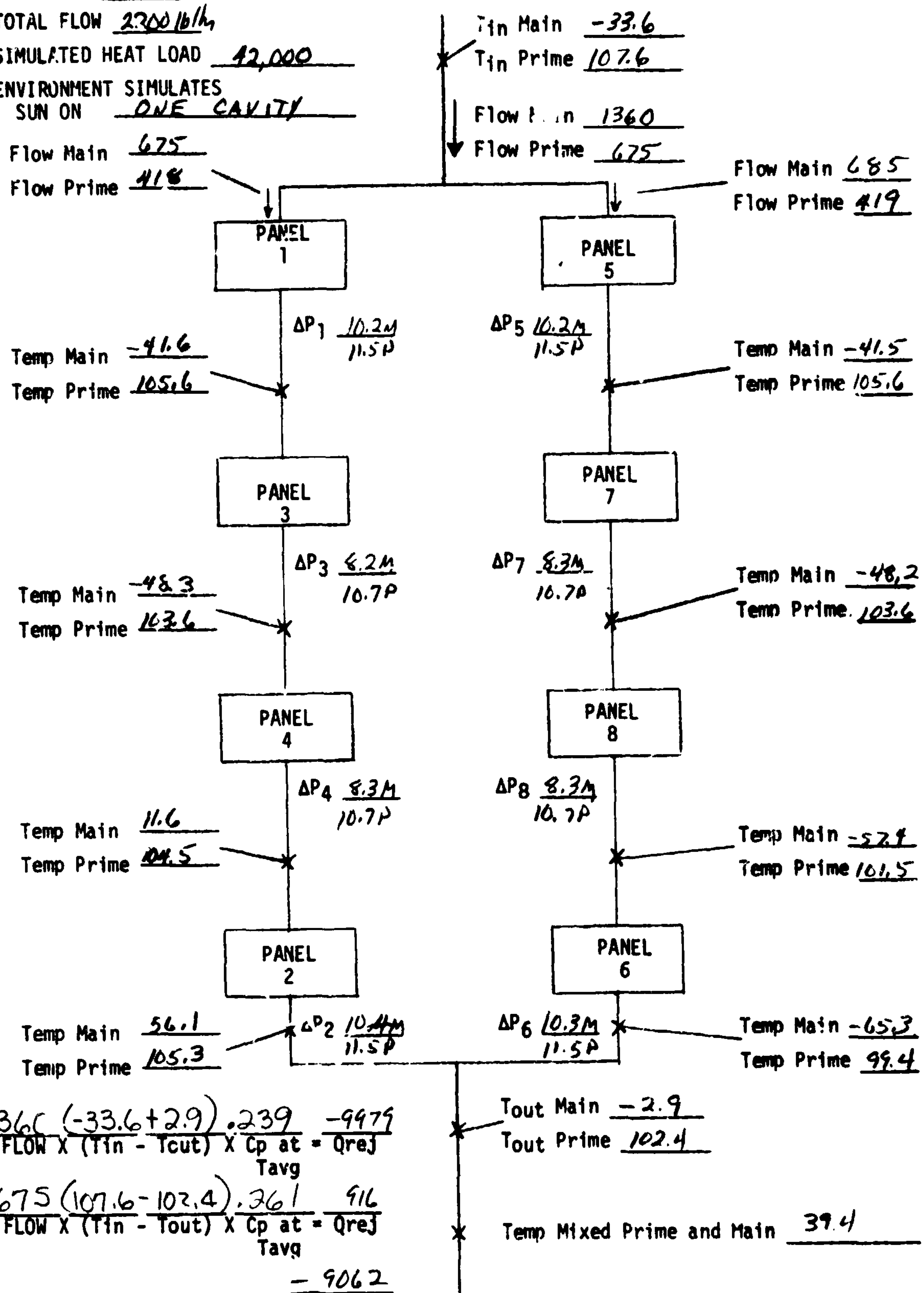
WEEK 1

TEST TIME 52m

TOTAL FLOW 2300 lb/hr

SIMULATED HEAT LOAD 42,000

ENVIRONMENT SIMULATES SUN ON ONE CAVITY



MAIN 1360 (-33.6+2.9) .239 -9979

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 675 (107.6-102.4) .261 916

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

-9062

Qtotal

CONFIGURATION α

WEEK 1st

TEST TIME 13.5

TOTAL FLOW 2200

SIMULATED HEAT LOAD —

ENVIRONMENT SIMULATES
SUN ON BELLY (CYCLIC CAVITY)

TEST POINTS 16 LOW MAIN OUTLET

T_{in} Main 53.

T_{in} Prime 53.

Flow Main 163

Flow Prime 2032

Flow Main 79.4

Flow Prime 1015

Flow Main 84.0

Flow Prime 1017

PANEL 1

ΔP_1 60.5

Temp Main -54.4

Temp Prime 52.4

PANEL 5

ΔP_5 60.4

Temp Main -48.8?

Temp Prime 52.4

PANEL 3

ΔP_3 56.2

Temp Main -93.6

Temp Prime 51.8

PANEL 7

ΔP_7 56.1

Temp Main -87.5

Temp Prime 51.8

PANEL 4

ΔP_4 56.0

Temp Main -107.1

Temp Prime 51.3

PANEL 8

ΔP_8 56.0

Temp Main -97.2?

Temp Prime 51.2

PANEL 2

ΔP_2 60.5

Temp Main -120.9

Temp Prime 50.7

PANEL 6

ΔP_6 60.3

Temp Main -81.?

Temp Prime 50.6

Tout Main -100.2

Tout Prime 50.7

MAIN 163 (53 + 100.2) .236 5893
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 2032 (53 - 50.7) .246 1150
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 40.2

7043
Qtotal

CONFIGURATION α

TEST POINTS 16 (HIGH MAIN OUTLET)

WEEK 1ST

TEST TIME 73.25

TOTAL FLOW 2200

SIMULATED HEAT LOAD —

ENVIRONMENT SIMULATES SUN ON BELLY (CYCLIC CAVITY)

Tin Main 53.

Tin Prime 53.

Flow Main 163

Flow Prime 2032

Flow Main 75.7

Flow Prime 1015

Flow Main 87.6

Flow Prime 1017

PANEL 1

PANEL 5

ΔP_1 60.5

ΔP_5 60.4

Temp Main -54.4

Temp Prime 52.4

Temp Main -48.6

Temp Prime 52.4

PANEL 3

PANEL 7

ΔP_3 56.2

ΔP_7 56.1

Temp Main -92.8

Temp Prime 51.8

Temp Main -90.3

Temp Prime 51.8

PANEL 4

PANEL 8

ΔP_4 56.0

ΔP_8 56.0

Temp Main -126.2

Temp Prime 51.2

Temp Main -71.5

Temp Prime 51.3

PANEL 2

PANEL 6

Temp Main -131.4

Temp Prime 50.6

ΔP_2 60.5

ΔP_6 60.3

Temp Main -69.6

Temp Prime 50.8

MAIN 163 (53 + 97.8) .236 = 5801

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Tout Main -97.8

Tout Prime 50.7

PRIME 2032 (53 - 50.7) .246 = 1149

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 40.4

6951

Qtotal

CONFIGURATION α

TEST POINTS 17

WEEK 1

TEST TIME 60m

TOTAL FLOW 1100

SIMULATED HEAT LOAD 7000

ENVIRONMENT SIMULATES SUN ON BELLY

T_{in} Main 53

T_{in} Prime 53

Flow Main 56

Flow Prime 1042

Flow Main 27.7

Flow Prime 521

Flow Main 28.1

Flow Prime 522

PANEL 1

ΔP_1 17.0P

Temp Main -101.0

Temp Prime 51.8

PANEL 5

ΔP_5 17.6P

Temp Main -100.4

Temp Prime 51.8

PANEL 3

ΔP_3 15.8P

Temp Main -121.0

Temp Prime 50.7

PANEL 7

ΔP_7 15.8P

Temp Main -120.6

Temp Prime 50.7

PANEL 4

ΔP_4 15.8P

Temp Main -124.2

Temp Prime 49.6

PANEL 8

ΔP_8 15.6P

Temp Main -124.1

Temp Prime 49.6

PANEL 2

ΔP_2 17.0P

Temp Main -124.7

Temp Prime 48.4

PANEL 6

ΔP_6 17.6P

Temp Main -124.7

Temp Prime 48.5

Tout Main -124.7

Tout Prime 48.4

MAIN 56 (53+124.7) .235 2338

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 1042 (53 -48.4) .246 1179

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 40.3

3517

Qtotal

CONFIGURATION α

TEST POINTS 18

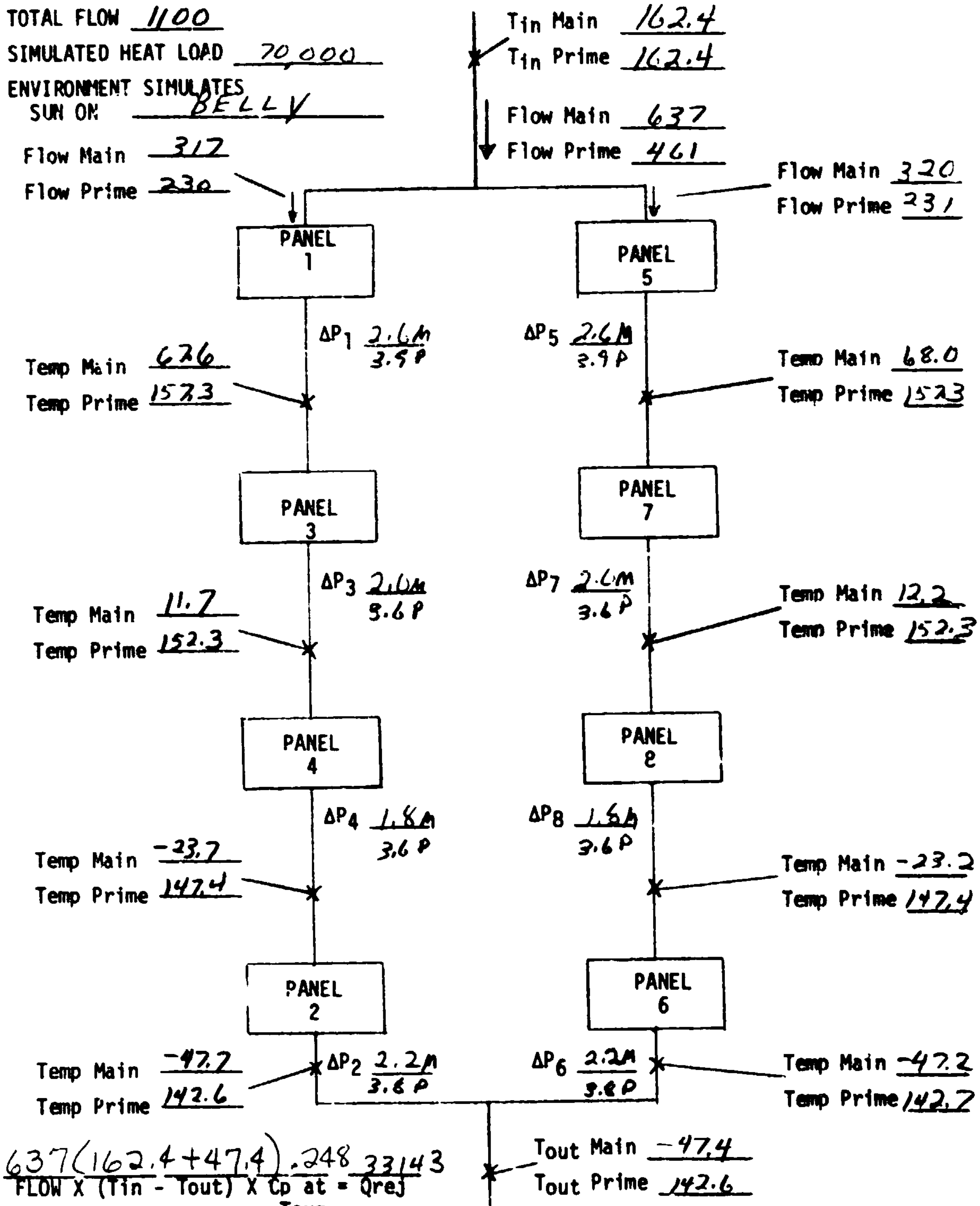
WEEK 1

TEST TIME 86

TOTAL FLOW 1100

SIMULATED HEAT LOAD 70,000

ENVIRONMENT SIMULATES SUN ON BELLY



MAIN 637(162.4+47.4).248 33143

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 461(162.4-142.6).278 2537

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

35680

Qtotal

CONFIGURATION α

TEST POINTS 19 - 1

WEEK 1

TES[illegible] 91.3 (LOW MAIN OUTLET)

TO[illegible]AL [illegible]OW 2200

S[illegible]MULA[illegible]ED HEAT LOAD 70 K

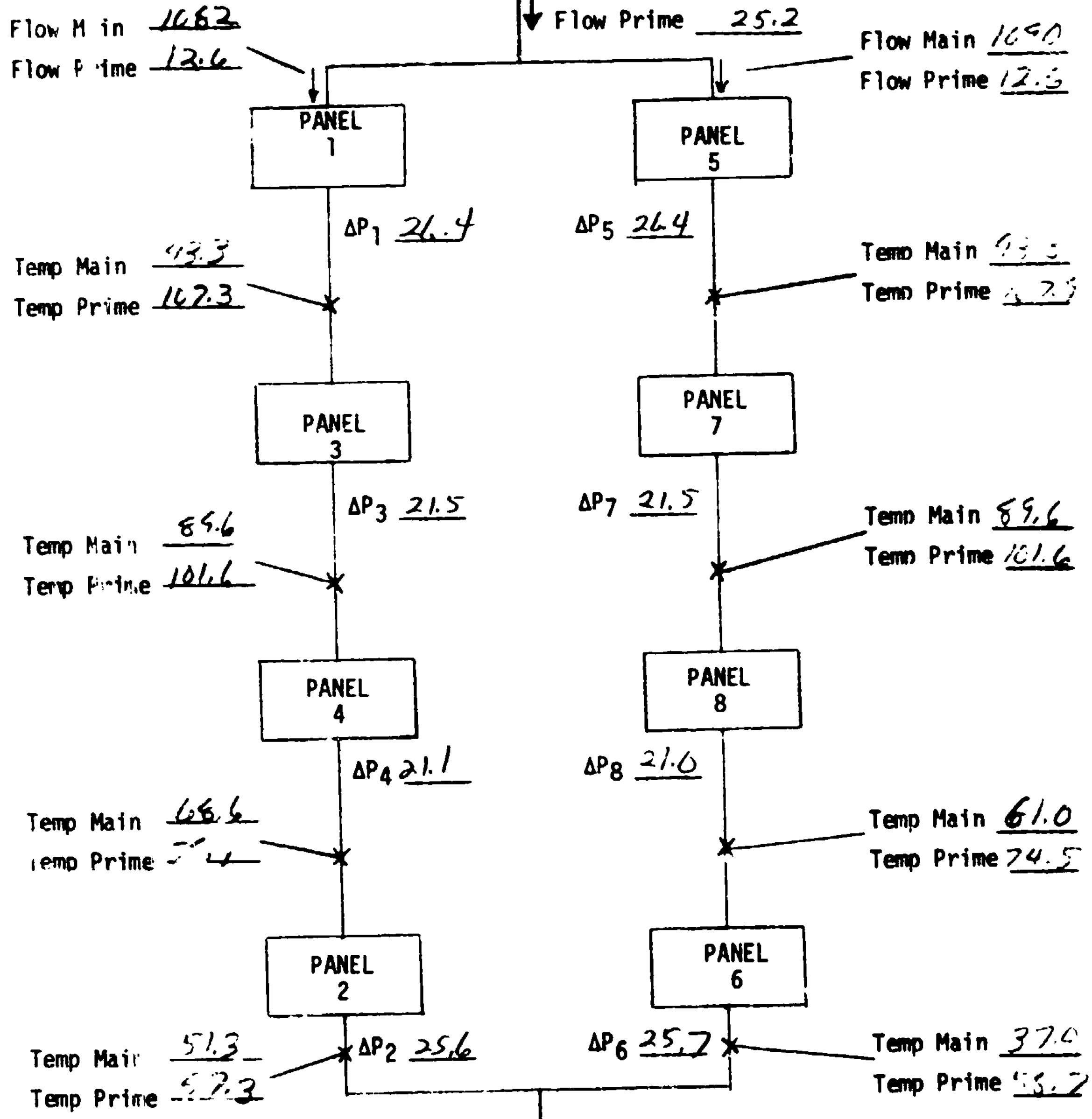
ENVIRON[illegible]ENT SIMULATES SUN ON CARGO BAY

Tin Main 98.0

Tin Prime 116.0

Flow Main 2171

Flow Prime 25.2



Tout Main 44.2

Tout Prime 58.4

MAIN 2171 (98 - 44.0) .25 29200

FLOW X (Tin - Tout) X Cp at Tavg = QreJ

PRIME 25.2 (116. - 58.4) .257 373

FLOW X (Tin - Tout) X Cp at Tavg = QreJ

Temp Mixed Prime and Main 44.3

29573

Qtotal

CONFIGURATION α

TEST POINTS 19-2

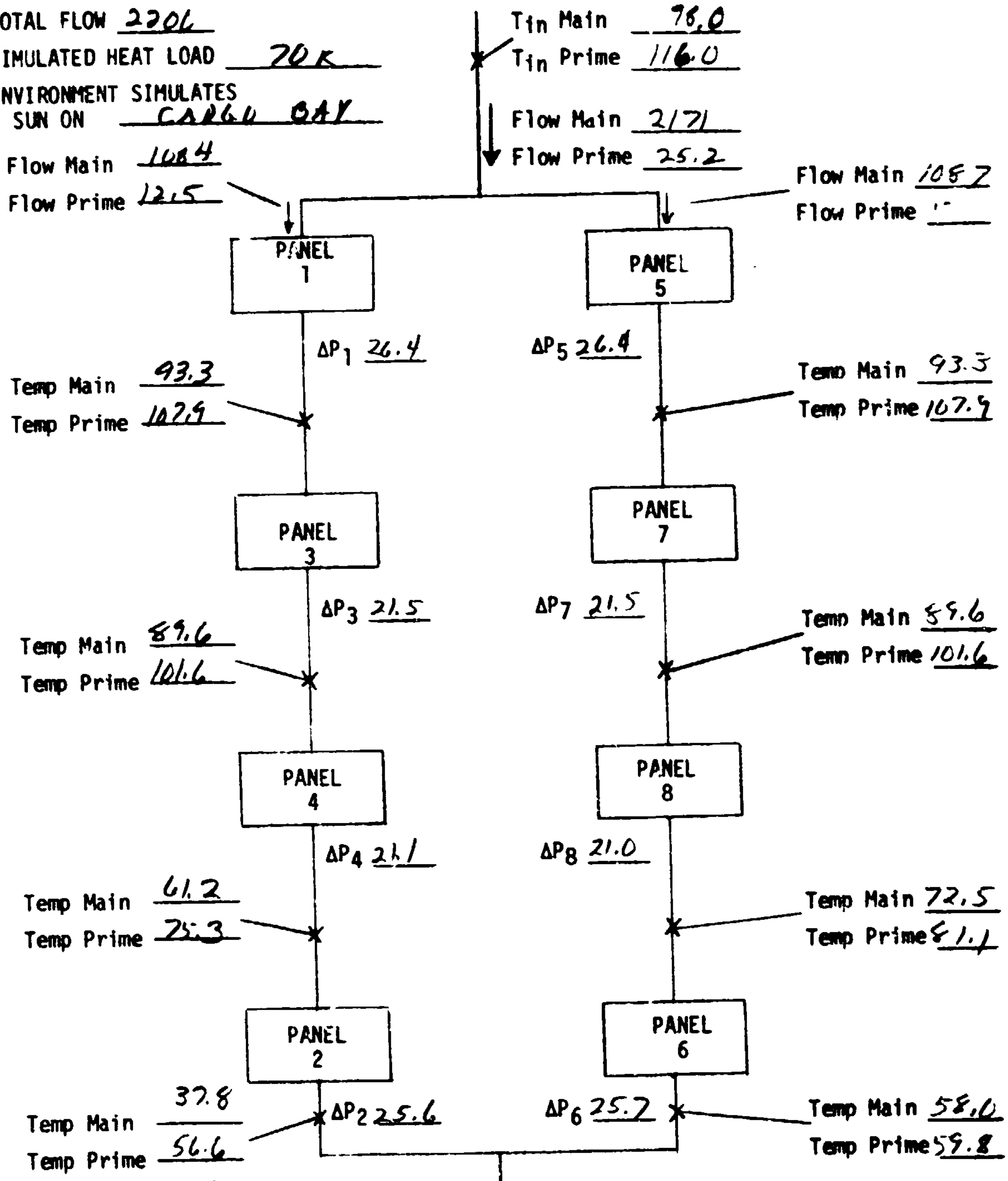
WEEK 1

TEST TIME 92.0 (High Main Test)

TOTAL FLOW 2206

SIMULATED HEAT LOAD 70K

ENVIRONMENT SIMULATES SUN ON CARGO BAY



Tout Main 48.0

Tout Prime 57.9

MAIN 2171 (98 − 48) .252 = 27355
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 25.2 (116 − 57.9) .257 = 376
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 48.1

27736
Qtotal

CONFIGURATION α

WEEK 1

TEST POINTS 2C-1

TEST TIME 58.8 hr (low main outlet)

TOTAL FLOW 2200

SIMULATED HEAT LOAD 57.7 K

ENVIRONMENT SIMULATES SUN ON CARGO BAY

T_{in} Main 93.
T_{in} Prime 106.

Flow Main 2171
Flow Prime 25.2

Flow Main 1062
Flow Prime 12.6

Flow Main 1090
Flow Prime 12.6

PANEL 1

PANEL 5

ΔP_1 26.4

ΔP_5 26.2

Temp Main 89.4
Temp Prime 100.1

Temp Main 89.4
Temp Prime 100.1

PANEL 3

PANEL 7

ΔP_3 21.5

ΔP_7 21.0

Temp Main 86.5
Temp Prime 95.5

Temp Main 86.5
Temp Prime 95.4

PANEL 4

PANEL 8

ΔP_4 21.1

ΔP_8 21.1

Temp Main 65.6
Temp Prime 73.7

Temp Main 59.1
Temp Prime 71.2

PANEL 2

PANEL 6

ΔP_2 26.5

ΔP_6 25.8

Temp Main 48.0
Temp Prime 52.2

Temp Main 36.7
Temp Prime 56.4

MAIN 2171 (93 - 42.4) .25 = 27463
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Tout Main 42.4
Tout Prime 54.5

PRIME 25.2 (106 - 54.5) .254 = 329
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 42.5

27793
Qtotal

CONFIGURATION α

TEST POINTS 20-2

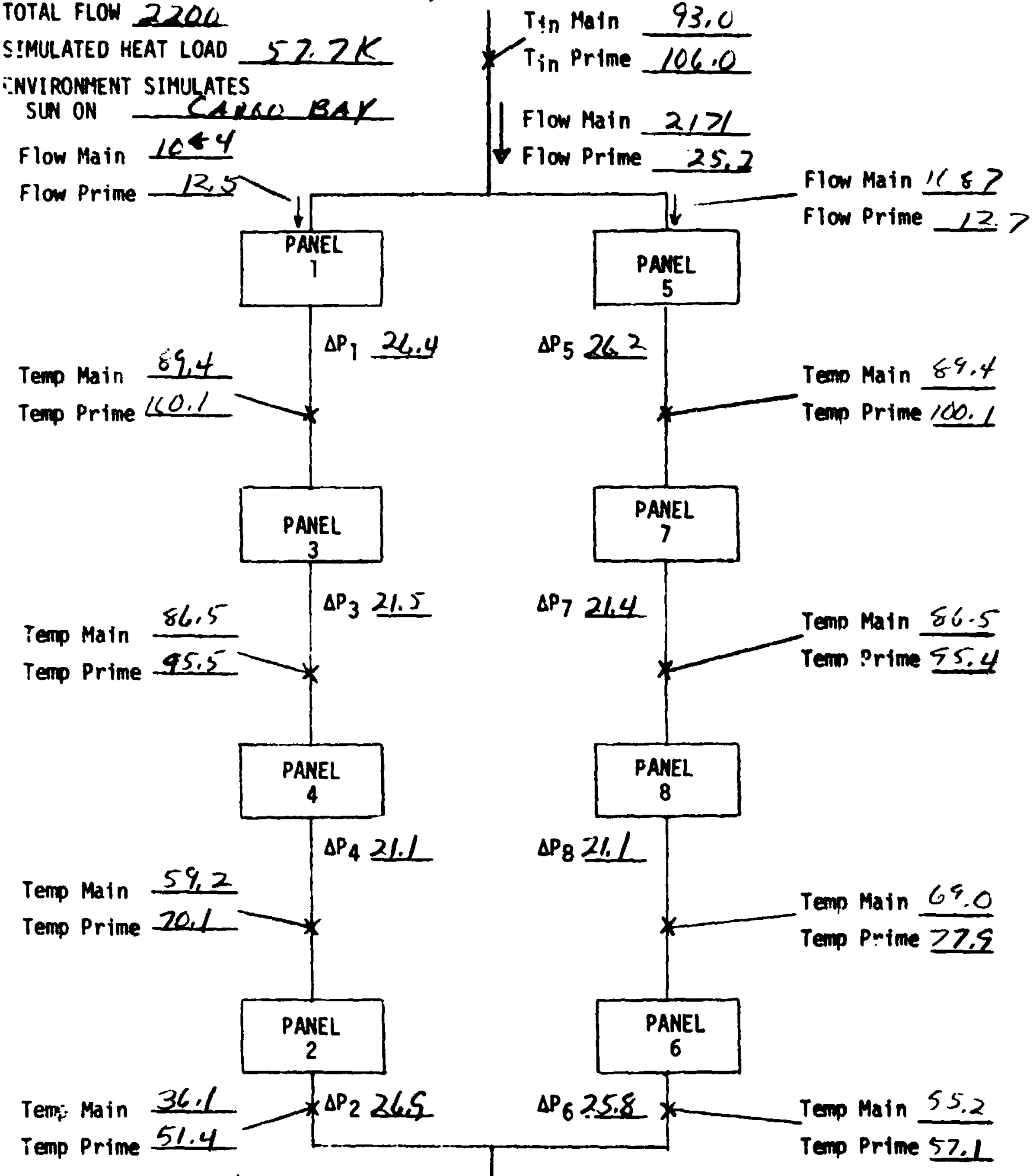
WEEK 1

TEST TIME 99.5 hr (high main outlet)

TOTAL FLOW 2200

SIMULATED HEAT LOAD 57.7K

ENVIRONMENT SIMULATES SUN ON CARGO BAY



Tout Main 45.7

Tout Prime 54.6

MAIN 2171 (93 - 45.7) .25 25672

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 25.2 (106 - 54.) .254 333

FLOW X (Tin - Tout) X Cp at Tavg = Qrej

Temp Mixed Prime and Main 45.8

26,005

Qtotal

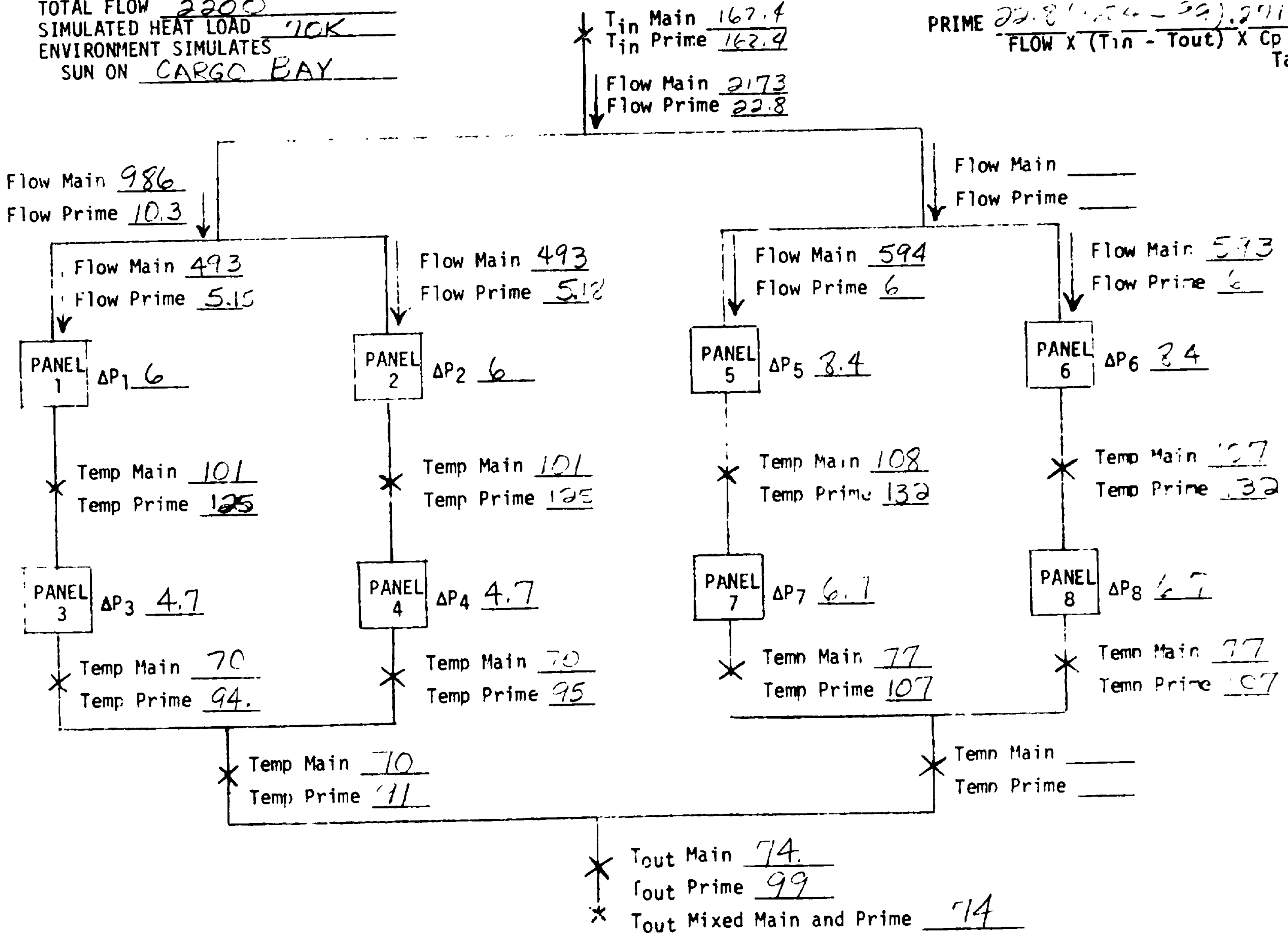
WEEK 2nd
TEST TIME 4
TOTAL FLOW 2200
SIMULATED HEAT LOAD 70K
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

CONFIGURATION Y
TEST POINTS 21

MAIN [illegible] 51,277
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME [illegible] 392.8
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

51,669.8
Qtotal



WEEK 2nd
TEST TIME 9.25
TOTAL FLOW 2200
SIMULATED HEAT LOAD 70K
ENVIRONMENT SIMULATES
SUN ON CARGO BAY (CYCLIC)

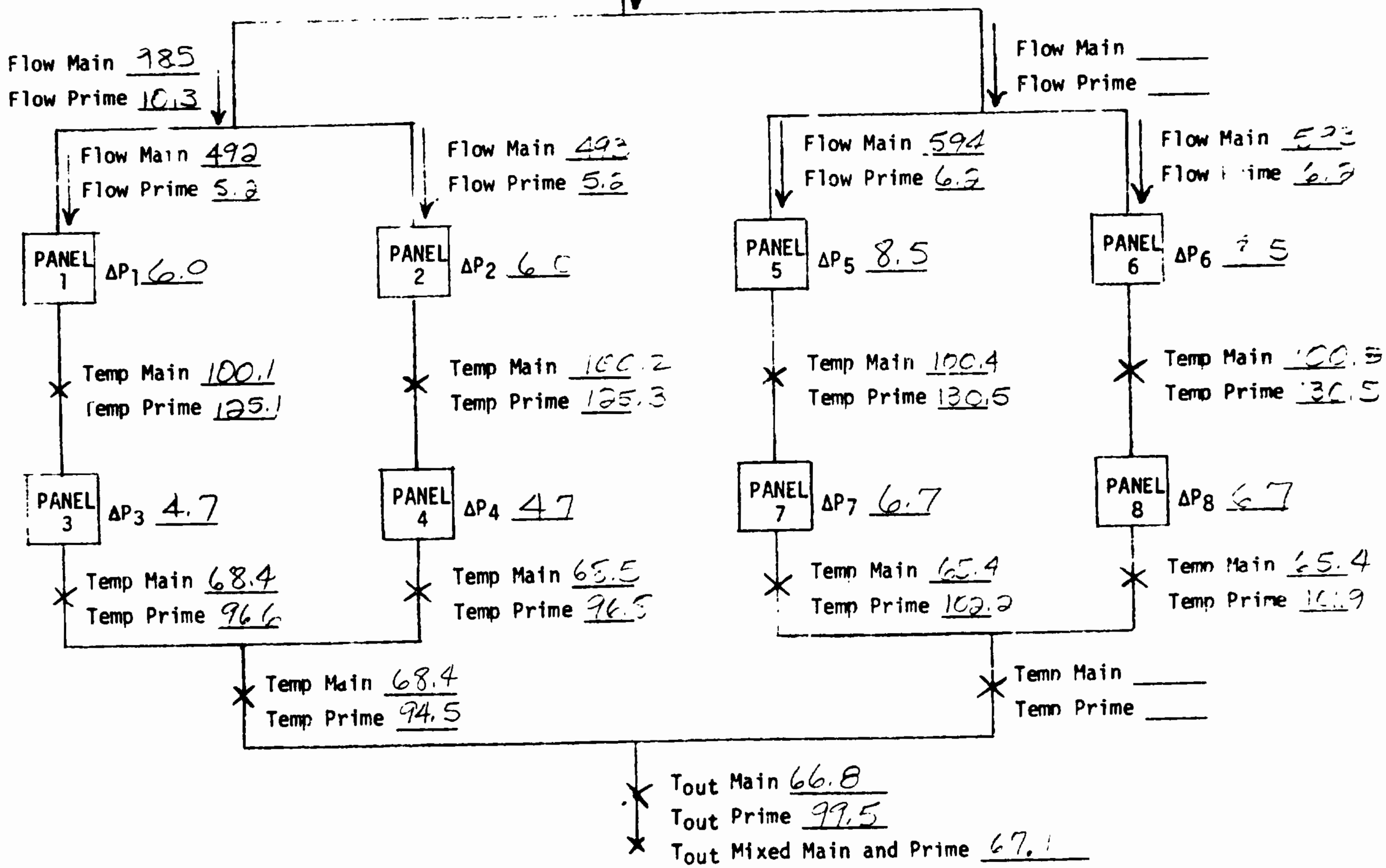
CONFIGURATION Y
TEST POINTS 22 LOW MAIN OUTLET

T_{in} Main 162.4
T_{in} Prime 162.?
Flow Main 2173
Flow Prime 22.8

MAIN 2173(162.4 − 66.8).2656 = 55,17?
FLOW X (T_{in} − Tout) X Cp at Tavg = Qrej

PRIME 22.8(162.4 − 94.5).272 = 3??
FLOW X (T_{in} − Tout) X Cp at Tavg = Qrej

55,56? Qtotal



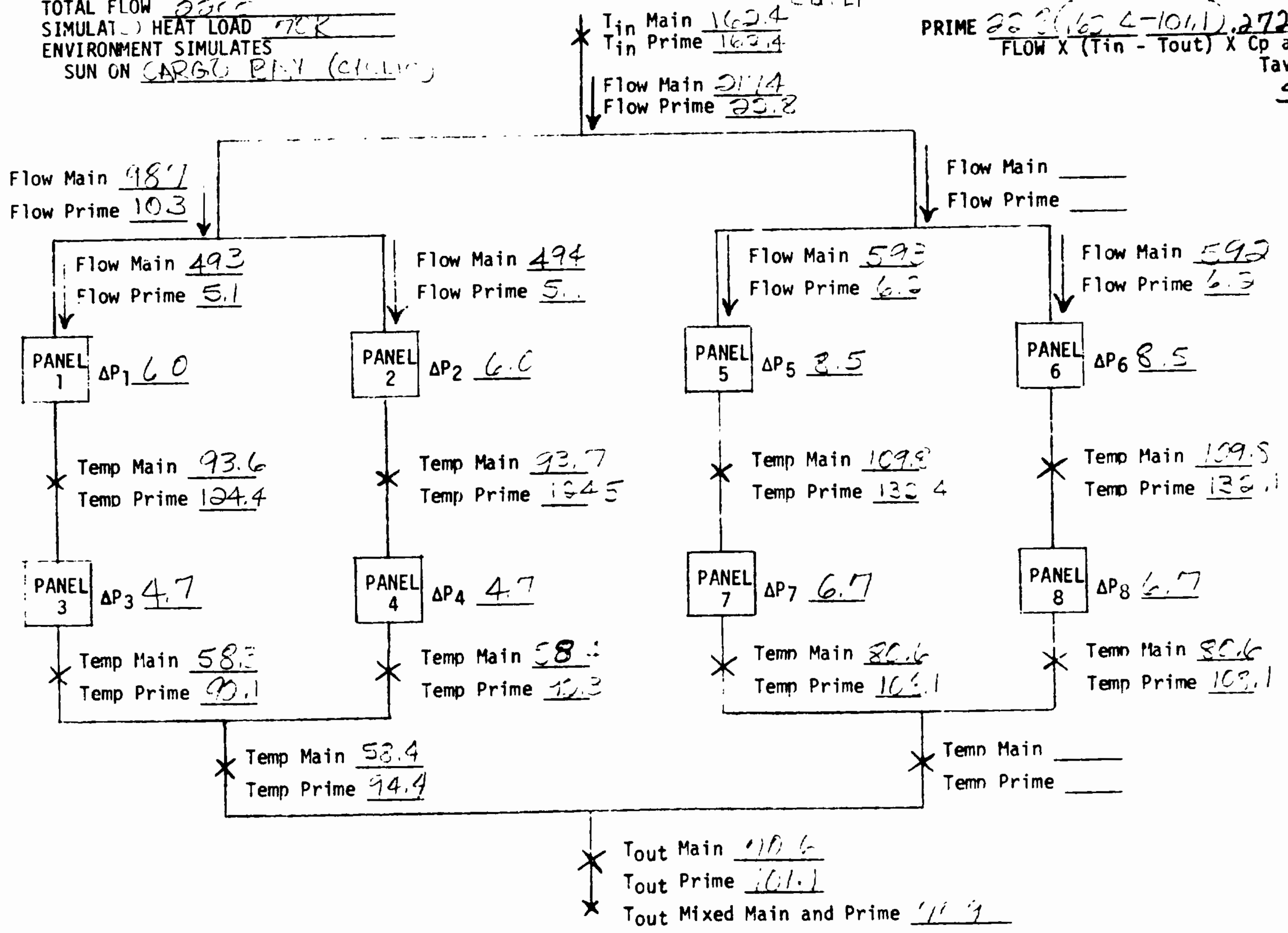
WEEK 2nd
TEST TIME 10.
TOTAL FLOW 25[illegible]
SIMULAT[illegible] HEAT LOAD 7[illegible]K
ENVIRONMENT SIMULATES
SUN ON CARGO BAY (C[illegible])

CONFIGURATION Y
TEST POINTS 22 HIGH MAIN OUTLET

MAIN $\frac{2[illegible](1[illegible]4 - 70.6)\ .2663}{\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at Tavg}} = \frac{53,149}{\text{Qrej}}$

PRIME $\frac{22.3(162.4 - 101.1)\ .272}{\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at Tavg}} = \frac{380.3}{\text{Qrej}}$

$\frac{53529.3}{Q_{total}}$



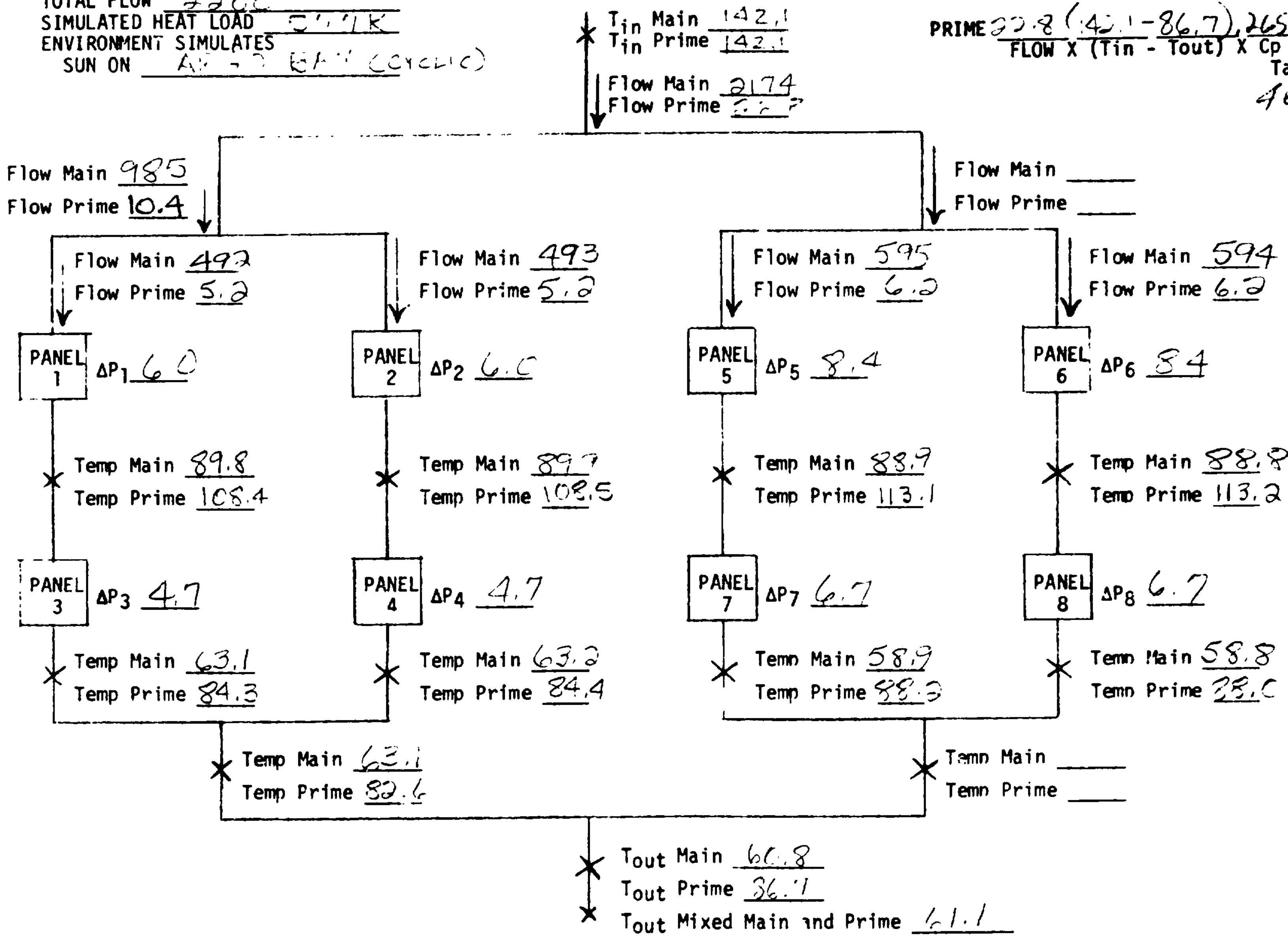
WEEK 5 ?
TEST TIME 15.35 LOW MAIN OUTLET
TOTAL FLOW 2200
SIMULATED HEAT LOAD 50.1K
ENVIRONMENT SIMULATES
SUN ON AP-? BAY (CYCLIC)

CONFIGURATION Y
TEST POINTS 53-1

MAIN $\frac{2174\,(142.1-60.8)\,.261}{\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at Tavg}} = \frac{46,13}{\text{Qrej}}$

PRIME $\frac{22.8\,(142.1-86.7)\,.2655}{\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at Tavg}} = \text{Qrej}$

$\frac{46,413.9}{\text{Qtotal}}$



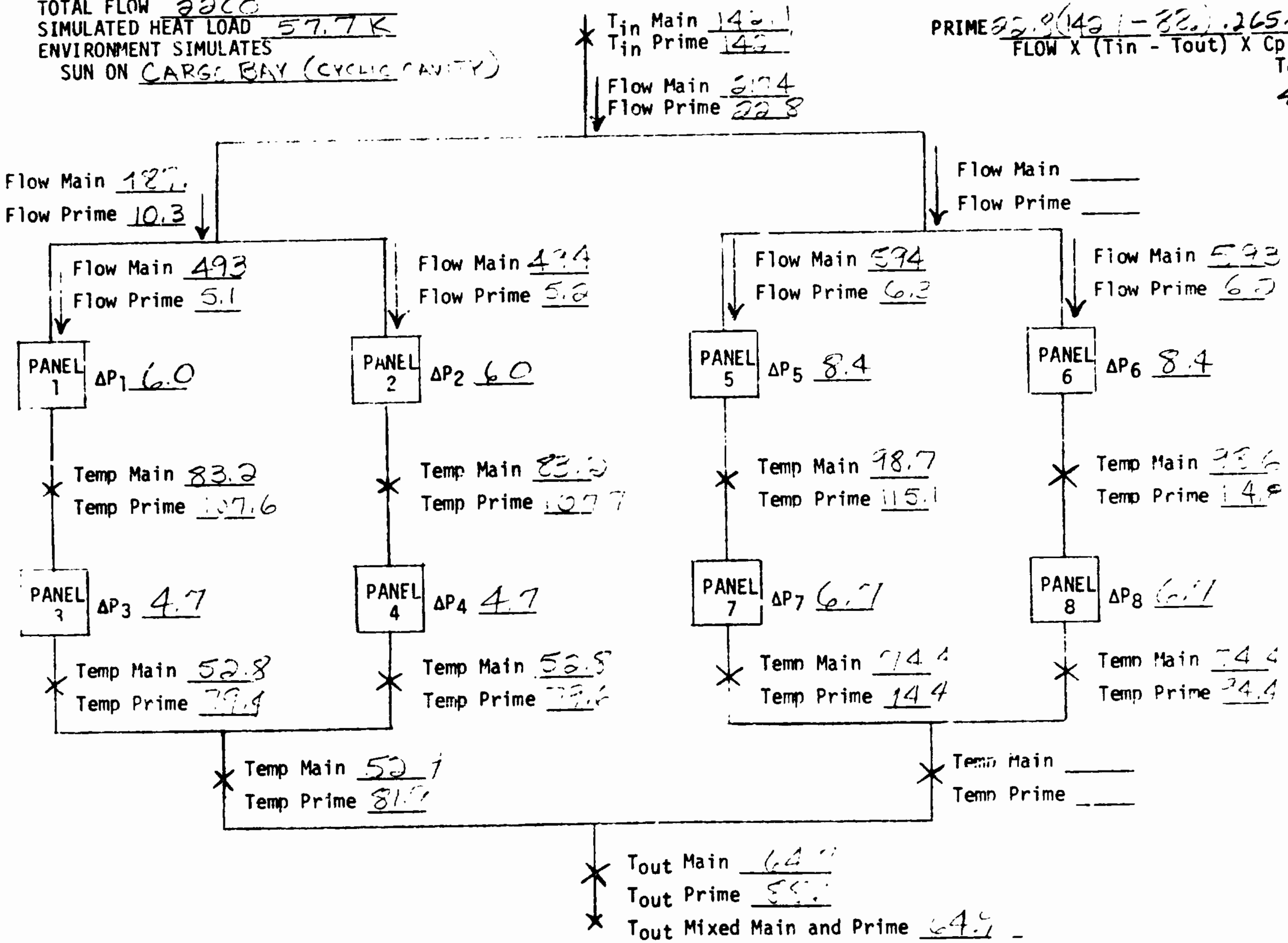
WEEK 2nd
TEST TIME 16. HIGH MAIN OUTLET
TOTAL FLOW 2200
SIMULATED HEAT LOAD 57.7 K
ENVIRONMENT SIMULATES
SUN ON CARGO BAY (CYCLIC CAVITY)

CONFIGURATION Y
TEST POINTS 23-2

MAIN $\underset{\text{FLOW X (Tin - Tout) X Cp at Tavg}}{214(142.1 - 64.7).2611} = \underset{\text{Qrej}}{44,035.4}$

PRIME $\underset{\text{FLOW X (Tin - Tout) X Cp at Tavg}}{22.8(142.1 - 88.1).2658} = \underset{\text{Qrej}}{327.8}$

$\underset{\text{Qtotal}}{44,363.2}$



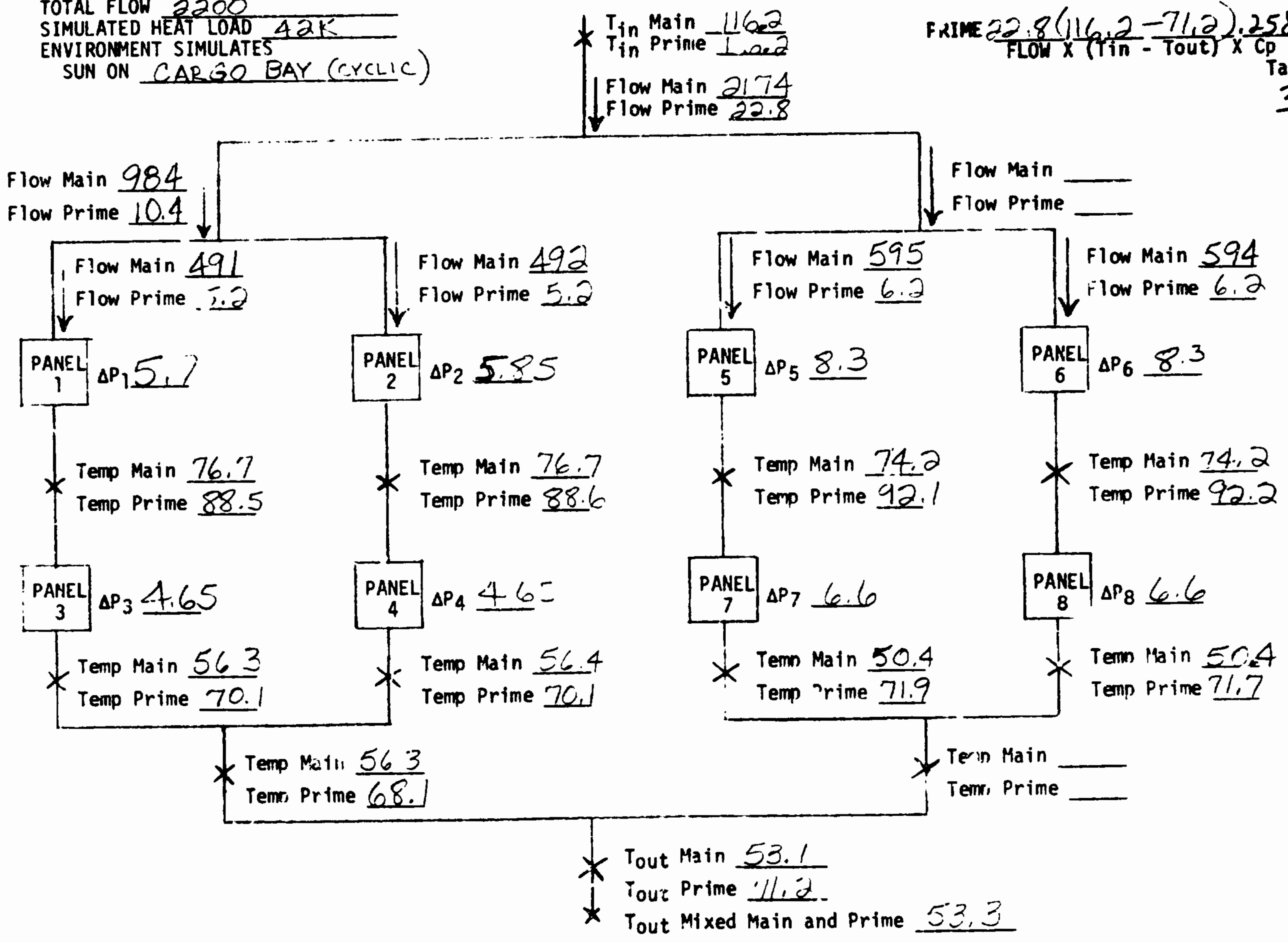
WEEK 2nd
TEST TIME 21.25 - LOW MAIN OUTLET
TOTAL FLOW 2200
SIMULATED HEAT LOAD 42K
ENVIRONMENT SIMULATES
SUN ON CARGO BAY (CYCLIC)

CONFIGURATION TEST POINTS 2A-1

MAIN $\frac{2174(116.2-53.1).2557}{\text{FLOW X (Tin - Tout) X Cp at Tavg}} = \frac{35{,}07}{\text{Qrej}}$

PRIME $\frac{22.8(116.2-71.2).2585}{\text{FLOW X (Tin - Tout) X Cp at Tavg}} = \frac{265}{\text{Qrej}}$

$\frac{35{,}344}{\text{Qtotal}}$



WEEK 2
TEST TIME 22.0
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD 32,700
ENVIRONMENT SIMULATES
SUN ON CARGO BAY (CYCLIC CAVITY)

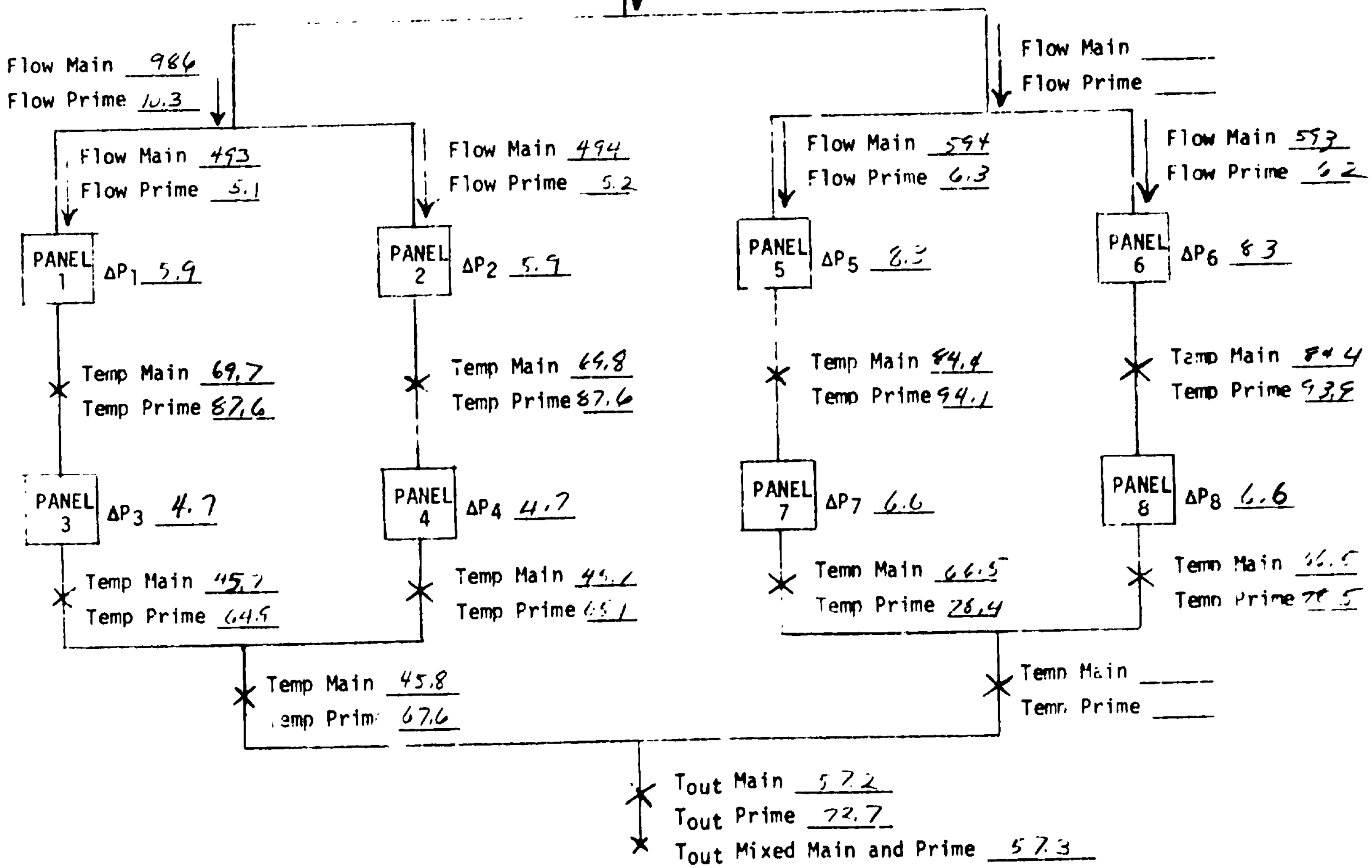
CONFIGURATION Y
TEST POINTS 24.2 (HIGH MAIN INLET)

T_{in} Main 116.2
T_{in} Prime 116.2
Flow Main 2174
Flow Prime 22.8

MAIN 2174 (116.2 − 57.3) .2563 = 32,879
FLOW X (Tin − Tout) X Cp at Tavg = Qrej

PRIME 22.8 (116.2 − 72.7) .2588 = 256.6
FLOW X (Tin − Tout) X Cp at Tavg = Qrej

33,135.6
Qtotal



WEEK 2
TEST TIME 27.25 hr
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD 34,000
ENVIRONMENT SIMULATES
SUN ON CARGO BAY (CYCLIC CAVITY)

CONFIGURATION Y
TEST POINTS 25-1 (LOW MAIN OUTLET)

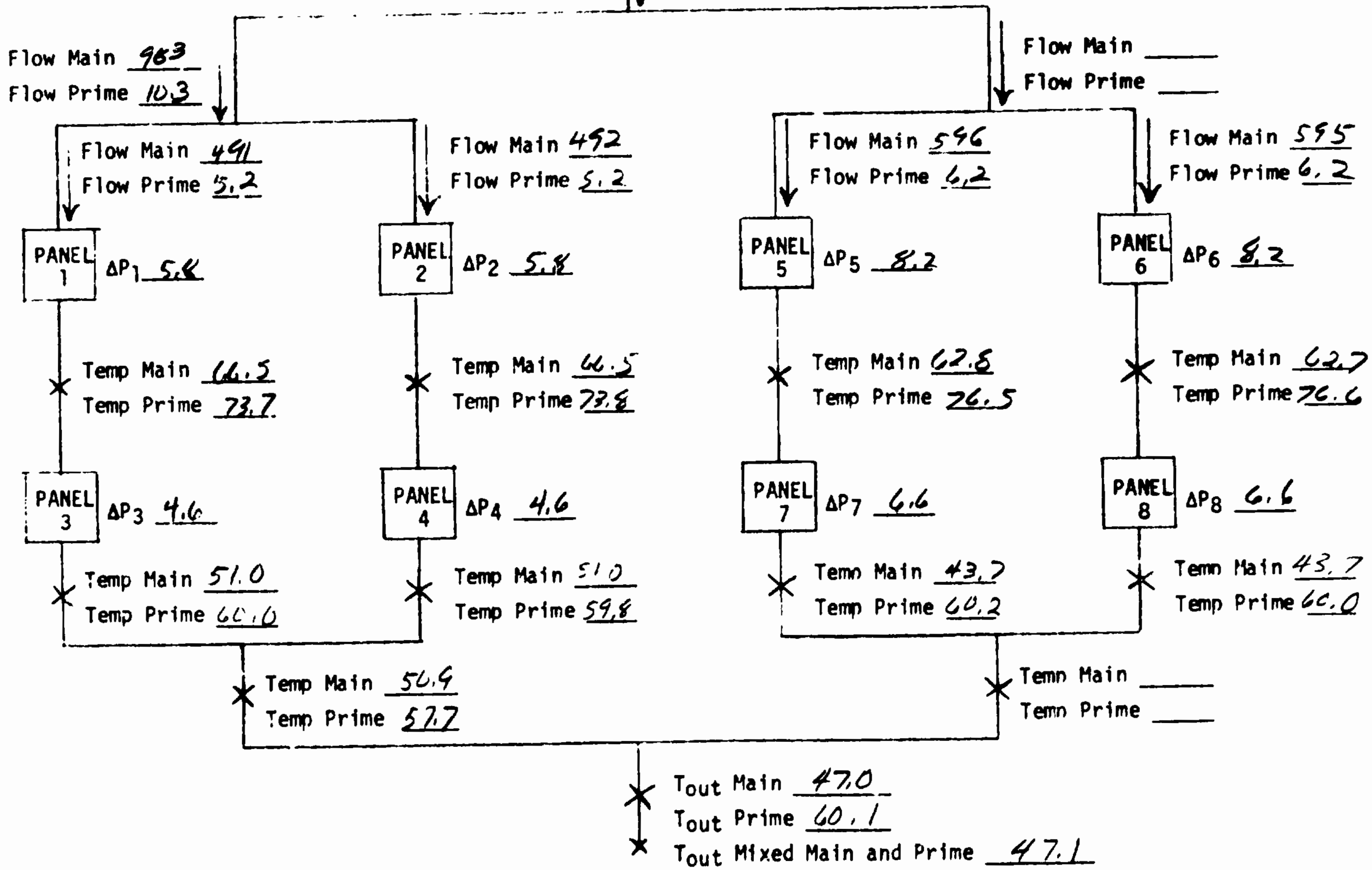
T_{in} Main 96.1
T_{in} Prime 96.1

Flow Main 2174
Flow Prime 22.8

MAIN $2174\,(96.1 - 47.1)\;.25197 = 26,8..$
$\text{FLOW} \times (T_{in} - T_{out}) \times C_p \text{ at } T_{avg} = Q_{rej}$

PRIME $22.8\,(96.1 - 60.1)\;.2532 = 208$
$\text{FLOW} \times (T_{in} - T_{out}) \times C_p \text{ at } T_{avg} = Q_{rej}$

27,104.
Q_{total}



WEEK 2
TEST TIME 28.0
TOTAL FLOW 2200 lb/h
SIMULATED HEAT LOAD 31,000
ENVIRONMENT SIMULATES
SUN ON CARGO BAY (CYCLIC CAVITY)

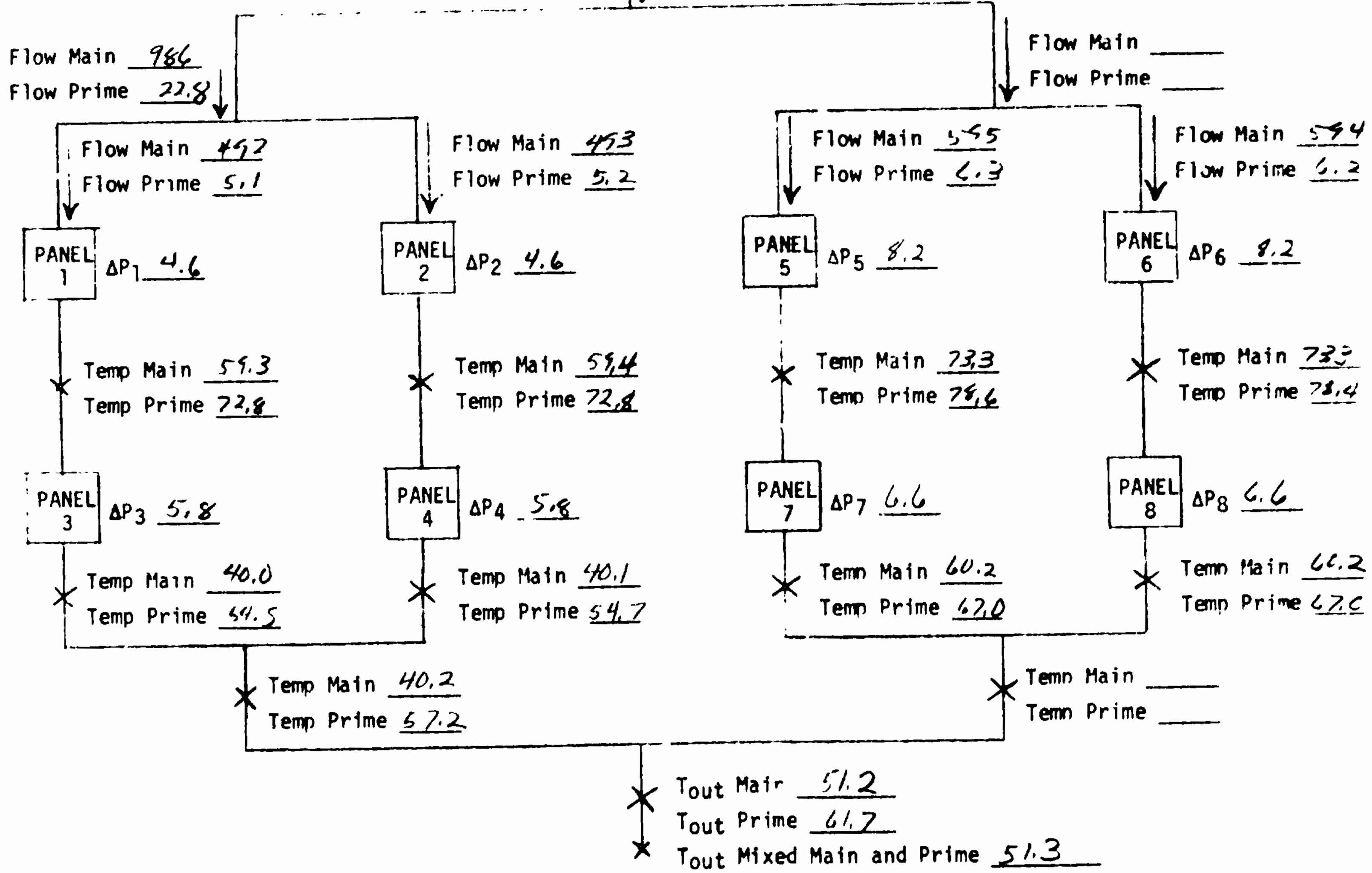
CONFIGURATION Y
TEST POINTS 25-2 (High Main Outlet)

T_{in} Main 96.1
T_{in} Prime 96.1
Flow Main 2174
Flow Prime 22.8

MAIN 2174 (96.1 − 51.2) .2526 = 24,651.7
FLOW X (Tin - Tout) X Cp at Tavg = QreJ

PRIME 22.8 (96.1 − 61.7) .254 = 199.2
FLOW X (Tin - Tout) X Cp at Tavg = QreJ

24,850.9
Qtotal



WEEK 3 ...
TEST TIME 34
TOTAL FLOW 2200
SIMULATED HEAT LOAD 42K
ENVIRONMENT SIMULATES
SUN ON CAVITY

CONFIGURATION Y
TEST POINTS 26

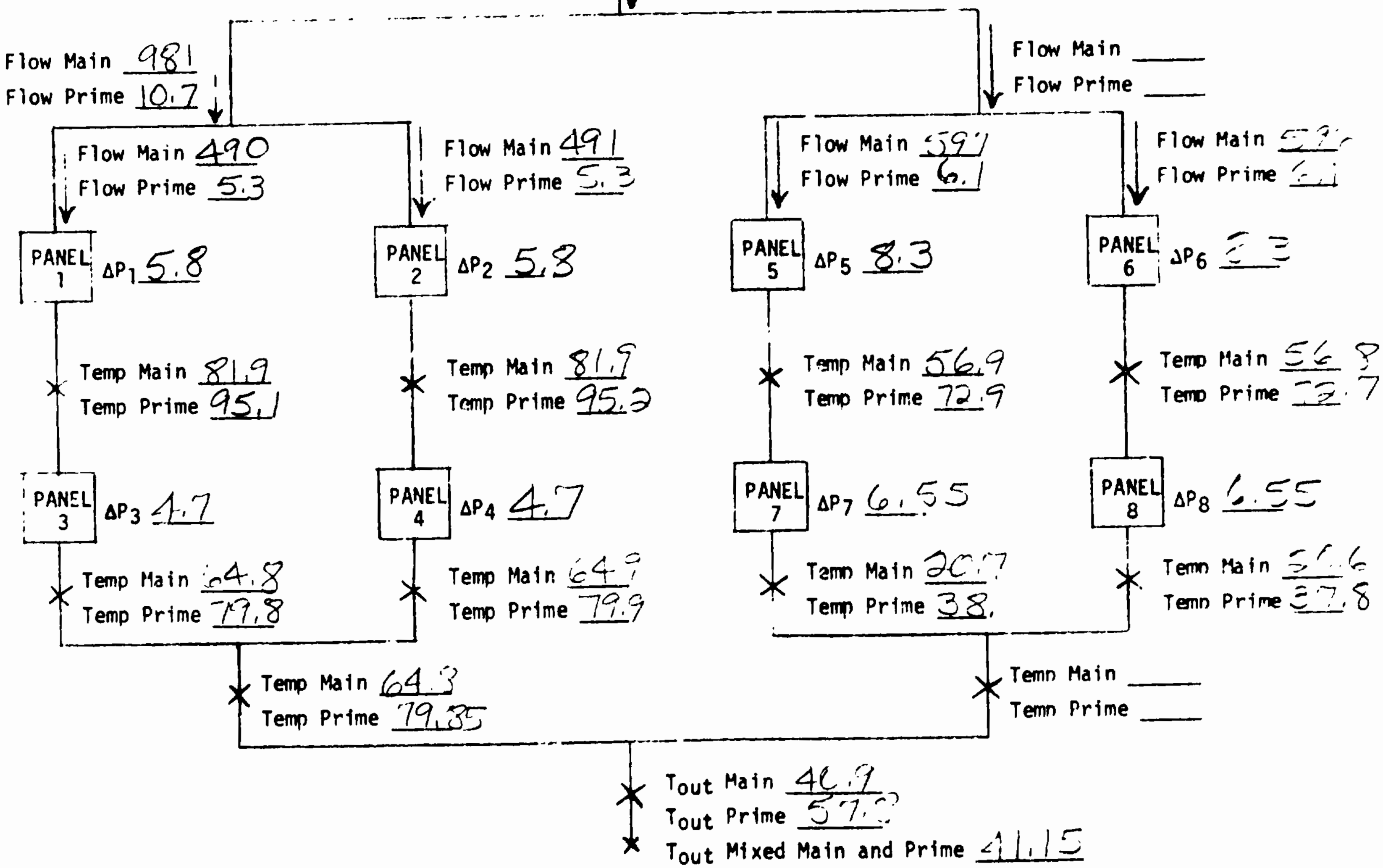
T_{in} Main 116.2
T_{in} Prime 116.2

Flow Main 2174
Flow Prime 22.8

MAIN 2174 (116.2 - 40.9) .2539 — 41,562
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 22.8 (116.2 - 57.8) .2564 — 341.
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

41,909.9
Qtotal



WEEK 2
TEST TIME 38 h
TOTAL FLOW 2200
SIMULATED HEAT LOAD 70 K
ENVIRONMENT SIMULATES
SUN ON CAVITY

CONFIGURATION Y
TEST POINTS 27

T_{in} Main 162.4
T_{in} Prime 162.4

Flow Main 2174
Flow Prime 22.8

MAIN 2174 (162.4 - 55.5) .226 = 61,263.6
FLOW X (T_{in} - Tout) X Cp at Tavg = Qrej

PRIME 22.8 (162.4 - 55.2) .269 = 413.
FLOW X (T_{in} - Tout) X Cp at Tavg = Qrej

61,736.2
Qtotal

Flow Main 983
Flow Prime 10.6

Flow Main ____
Flow Prime ____

Flow Main 491
Flow Prime 5.3
PANEL 1
ΔP_1 4947 - 4066
Temp Main 104.4
Temp Prime 130.0

Flow Main 492
Flow Prime 5.3
PANEL 2
ΔP_2 4947 - 4068
Temp Main 104.9
Temp Prime 130.4

Flow Main 556
Flow Prime 6.1
PANEL 5
ΔP_5 5664 - 3780
Temp Main 84.4
Temp Prime 113.5

Flow Main 555
Flow Prime 6.1
PANEL 6
ΔP_6 5664 - 3777
Temp Main 84.4
Temp Prime 113.7

PANEL 3
ΔP_3 4066 - 3406
Temp Main 76.4
Temp Prime 104.3

PANEL 4
ΔP_4 4068 - 3406
Temp Main 76.4
Temp Prime 104.7

PANEL 7
ΔP_7 3780 - 2624
Temp Main 37.2
Temp Prime 70.4

PANEL 8
ΔP_8 3777 - 2624
Temp Main 37.6
Temp Prime 69.9

Temp Main 76.4
Temp Prime 102.4

Temp Main ____
Temp Prime ____

Tout Main 55.5
Tout Prime 85.2
Tout Mixed Main and Prime 55.8

A-50

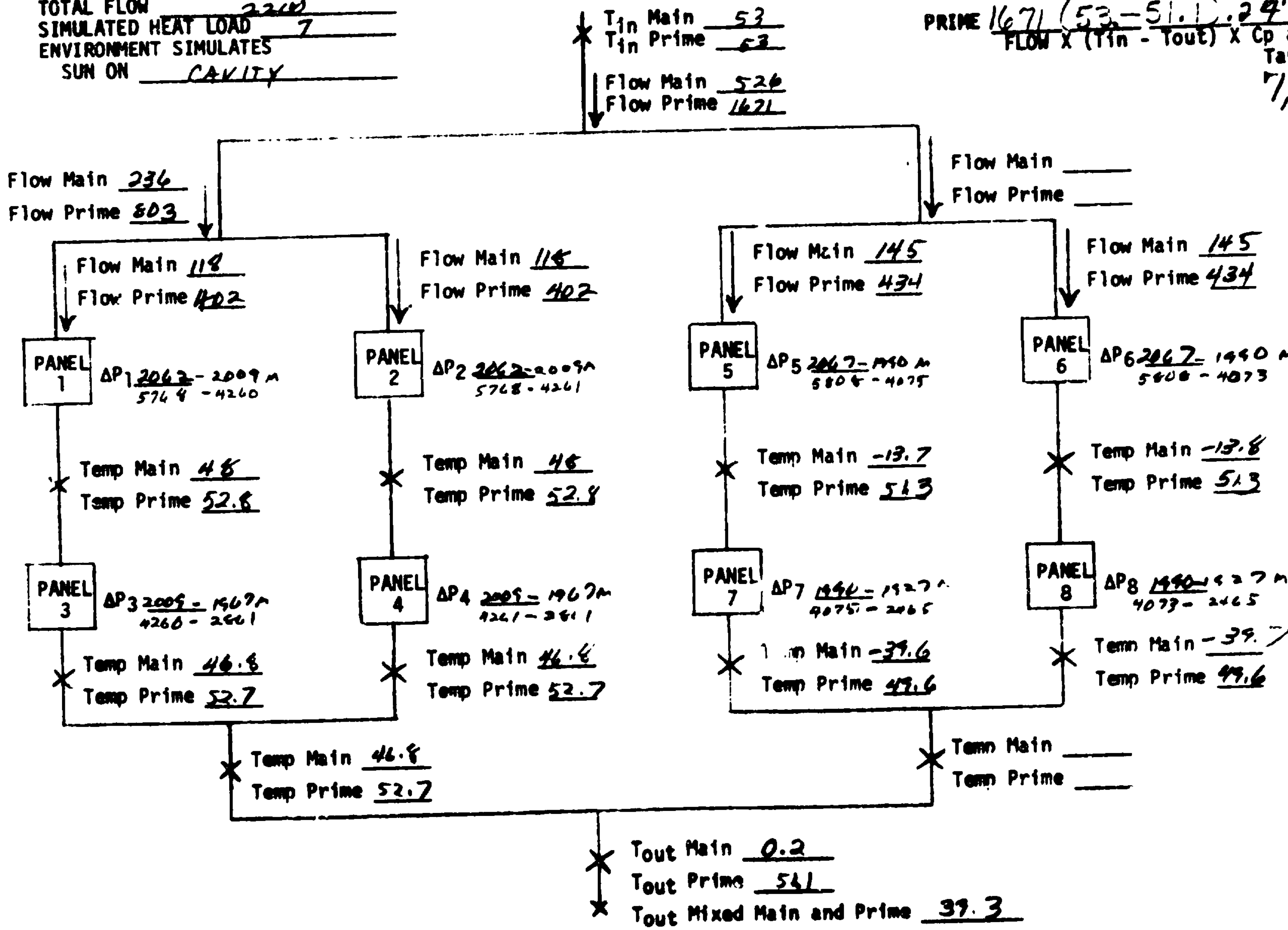
WEEK 2
TEST TIME 50
TOTAL FLOW 2210
SIMULATED HEAT LOAD 7
ENVIRONMENT SIMULATES
SUN ON CAVITY

CONFIGURATION Y
TEST POINTS 28

MAIN 526 (53. - .2) .2418 6715.
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 1671 (53 - 51.1) .247 784
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

7,560.
Qtotal



WEEK 2
TEST TIME 1175
TOTAL FLOW 2200
SIMULATED HEAT LOAD 7K
ENVIRONMENT SIMULATES
SUN ON BELLY (CYCLIC CAVITY)

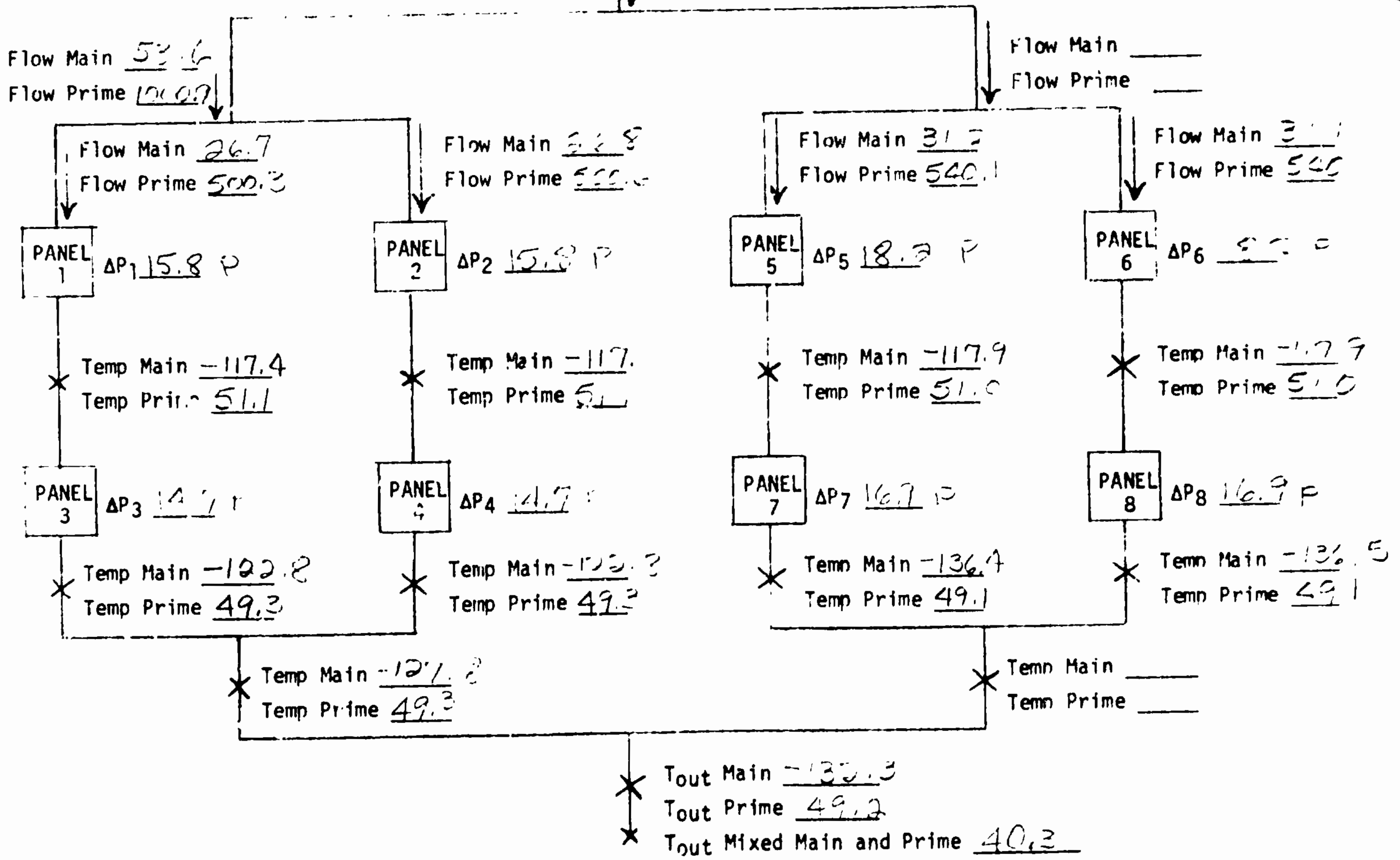
CONFIGURATION Y
TEST POINTS 27 Low, MAIN

T_{in} Main 53
T_{in} Prime 53.
Flow Main 115.9
Flow Prime 2220

MAIN 115.9 (53 − (−133.3)) .23 = 5035.9
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 2220 (53 − 49.2) .2468 1950.
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

6,986.7
Qtotal



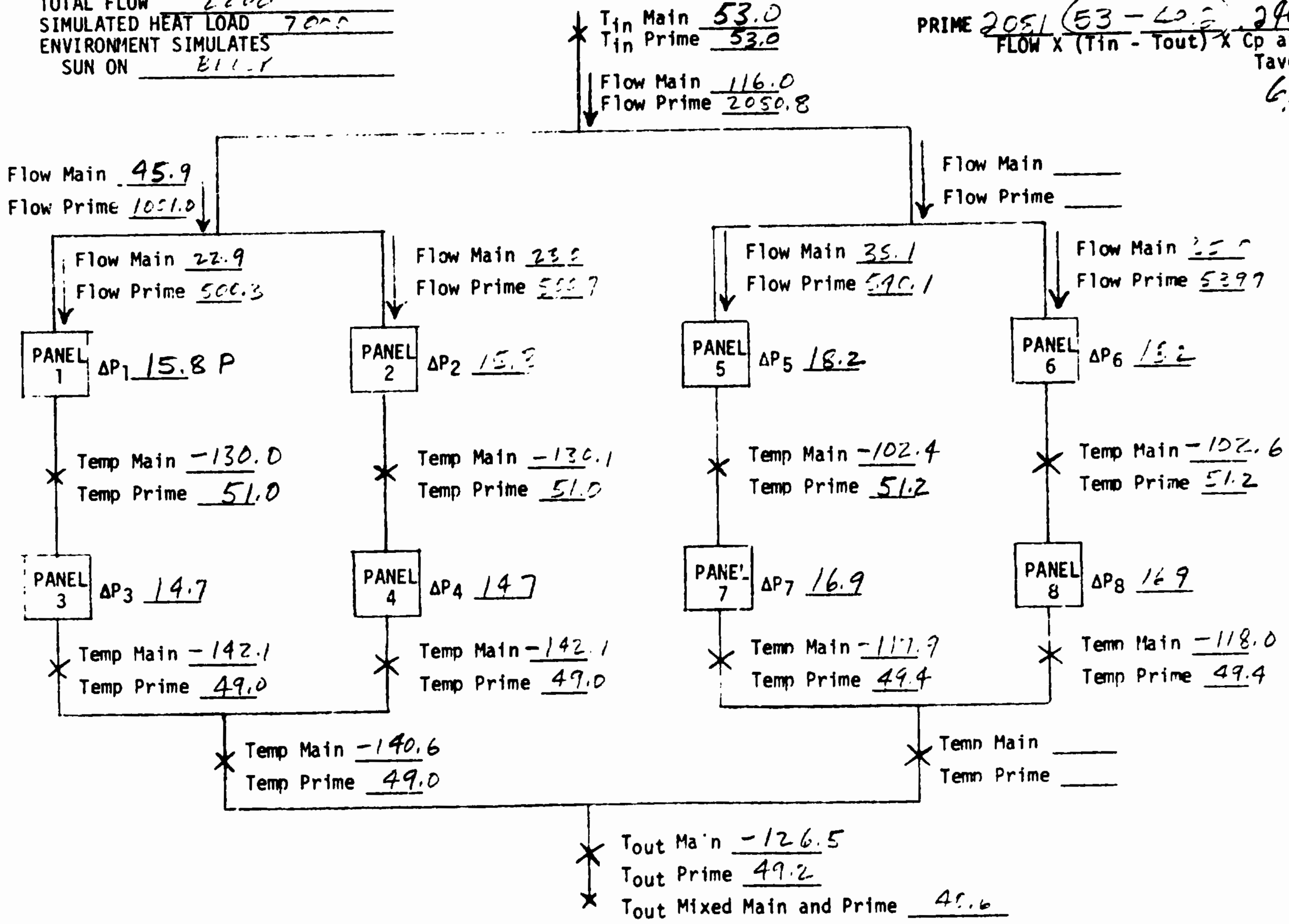
WEEK 2
TEST TIME 5975 HRS
TOTAL FLOW 2200
SIMULATED HEAT LOAD 7000
ENVIRONMENT SIMULATES
SUN ON

CONFIGURATION Y
TEST POINTS 29 MAX.

MAIN 116.0 (53.0 + 126.5) .2396
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 2051 (53 - 49.2) .2968
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

6,837.
Qtotal



WEEK 2nd
TEST TIME 67.25 LAW MAIN OUTLET
TOTAL FLOW 2200.
SIMULATED HEAT LOAD 70K
ENVIRONMENT SIMULATES
SUN ON BELLY (CYCLIC CAVITY)

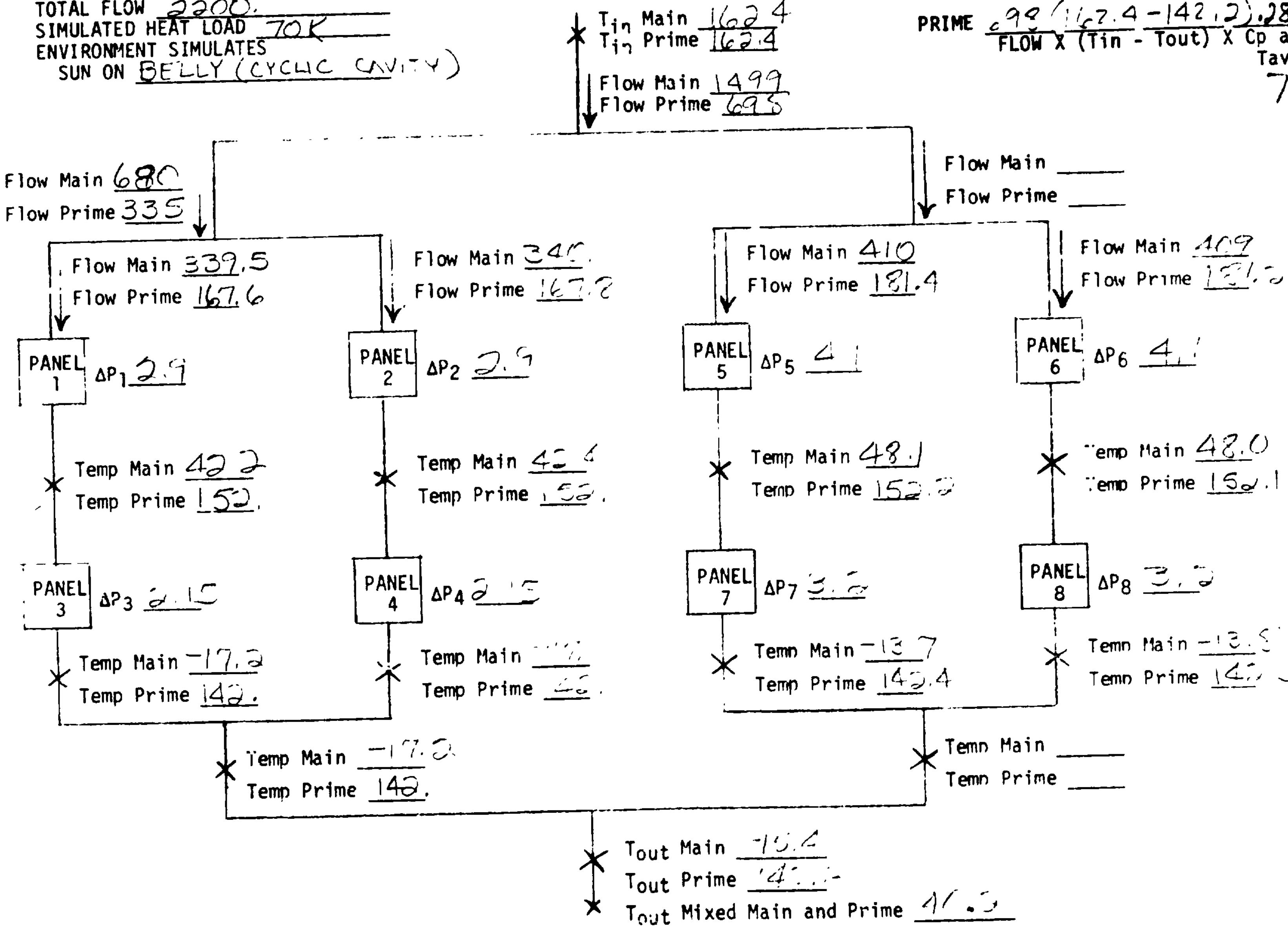
CONFIGURATION Y
TEST POINTS 30-1

67,292.1

MAIN 1499 [162.4 − (−15.4)] .2525
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

PRIME 699 (162.4 − 142.2) .2807 3958.
FLOW X (Tin - Tout) X Cp at Tavg = Qrej

71,256.
Qtotal



WEEK 2
TEST TIME 67.999 HIGH MAIN OUTLET
TOTAL FLOW 2200
SIMULATED HEAT LOAD
ENVIRONMENT SIMULATES
SUN ON BELLY (CYCLIC CAVITY)

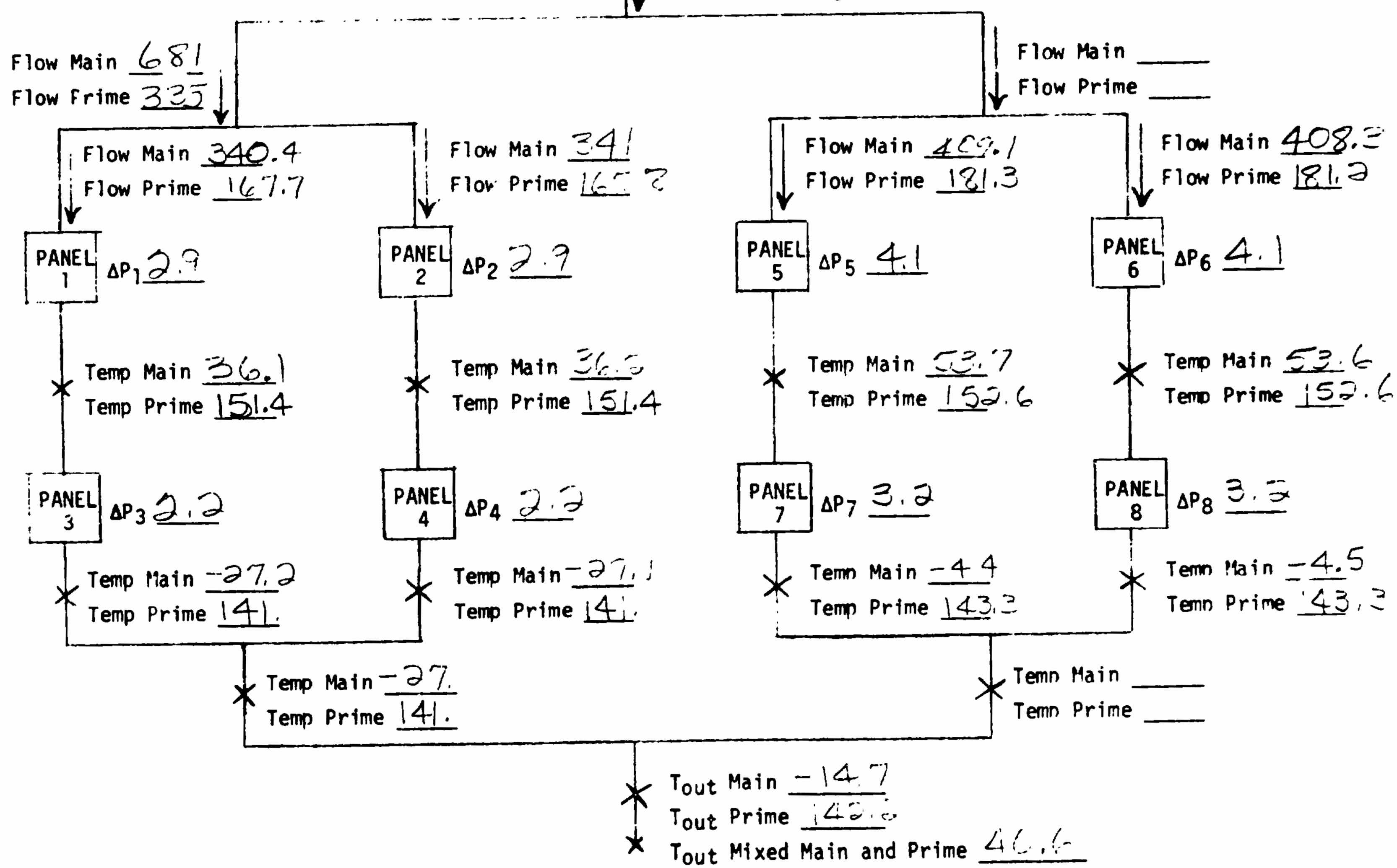
CONFIGURATION Y
TEST POINTS 30-2

MAIN 1499 [162.4 − (−14.7)] .2569
FLOW X (Tin - Tout) X Cp at Tavg = Qrej
375

PRIME 698 (162.4 − 142.2) .2807
FLOW x (Tin - Tout) X Cp at Tavg = Qrej

60,836.7
Qtotal

T_{in} Main 162.4
T_{in} Prime 162.4
Flow Main 1499
Flow Prime 698



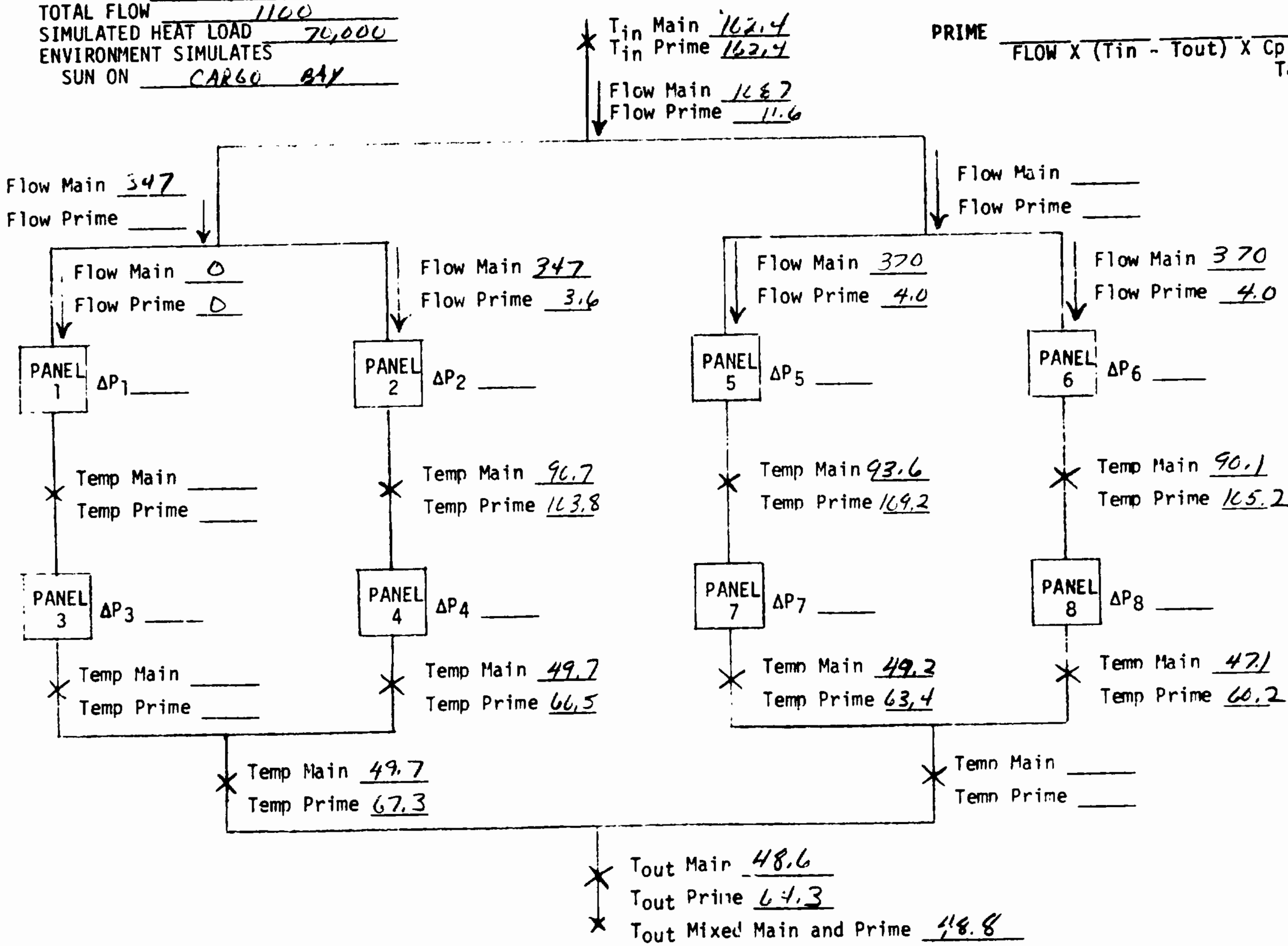
WEEK 3
TEST TIME 4 hr
TOTAL FLOW 1100
SIMULATED HEAT LOAD 70,000
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

CONFIGURATION Y - 1.3
TEST POINTS 31

MAIN FLOW X (Tin - Tout) X Cp at Tavg = Qrej 34460

PRIME FLOW X (Tin - Tout) X Cp at Tavg = Qrej 301

34761 Qtotal



WEEK 3
TEST TIME 8 hr
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD 20,000
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

CONFIGURATION Y
TEST POINTS 32

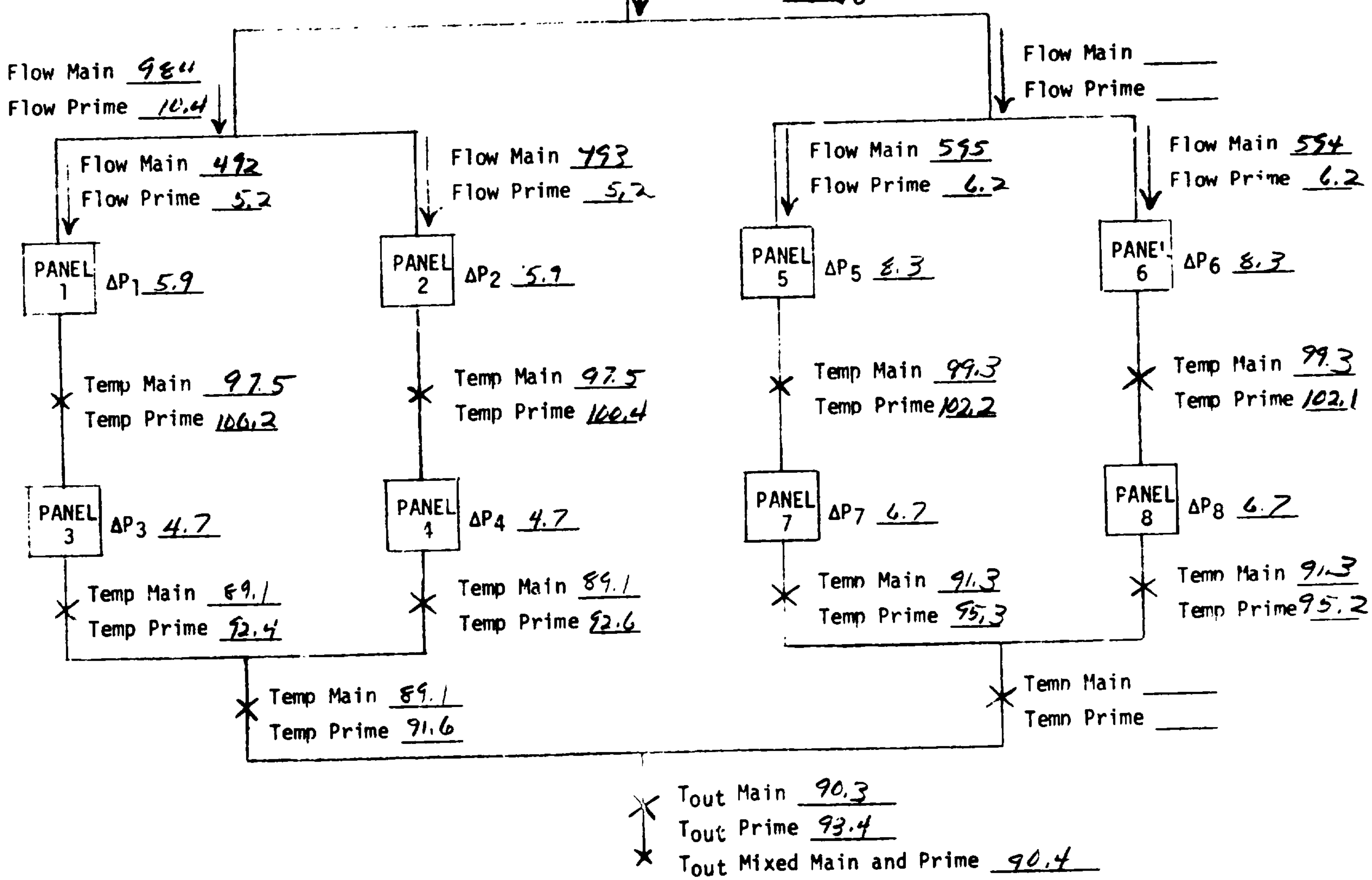
MAIN FLOW X (Tin - Tout) X Cp at Tavg = Qrej 11850

PRIME FLOW X (Tin - Tout) X Cp at Tavg = Qrej 106

Qtotal 11956

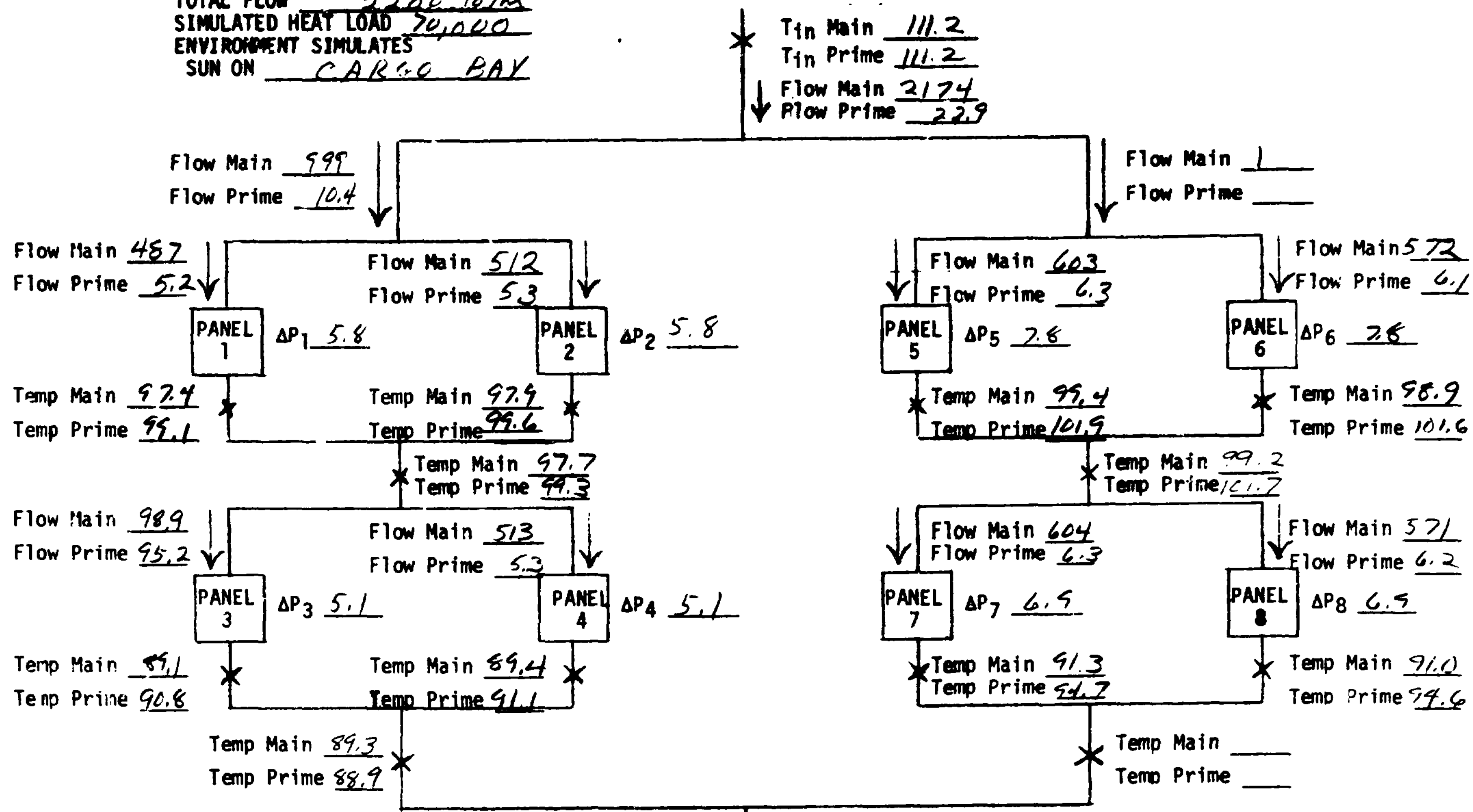
T_{in} Main 111.2
T_{in} Prime 111.2

Flow Main 2174
Flow Prime 22.8



WEEK 3
TEST TIME 12 hr
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD 70,000
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

CONFIGURATION 6
TEST POINTS 33



MAIN $\frac{\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at Tavg}}{} = \text{Qrej}$ 10337

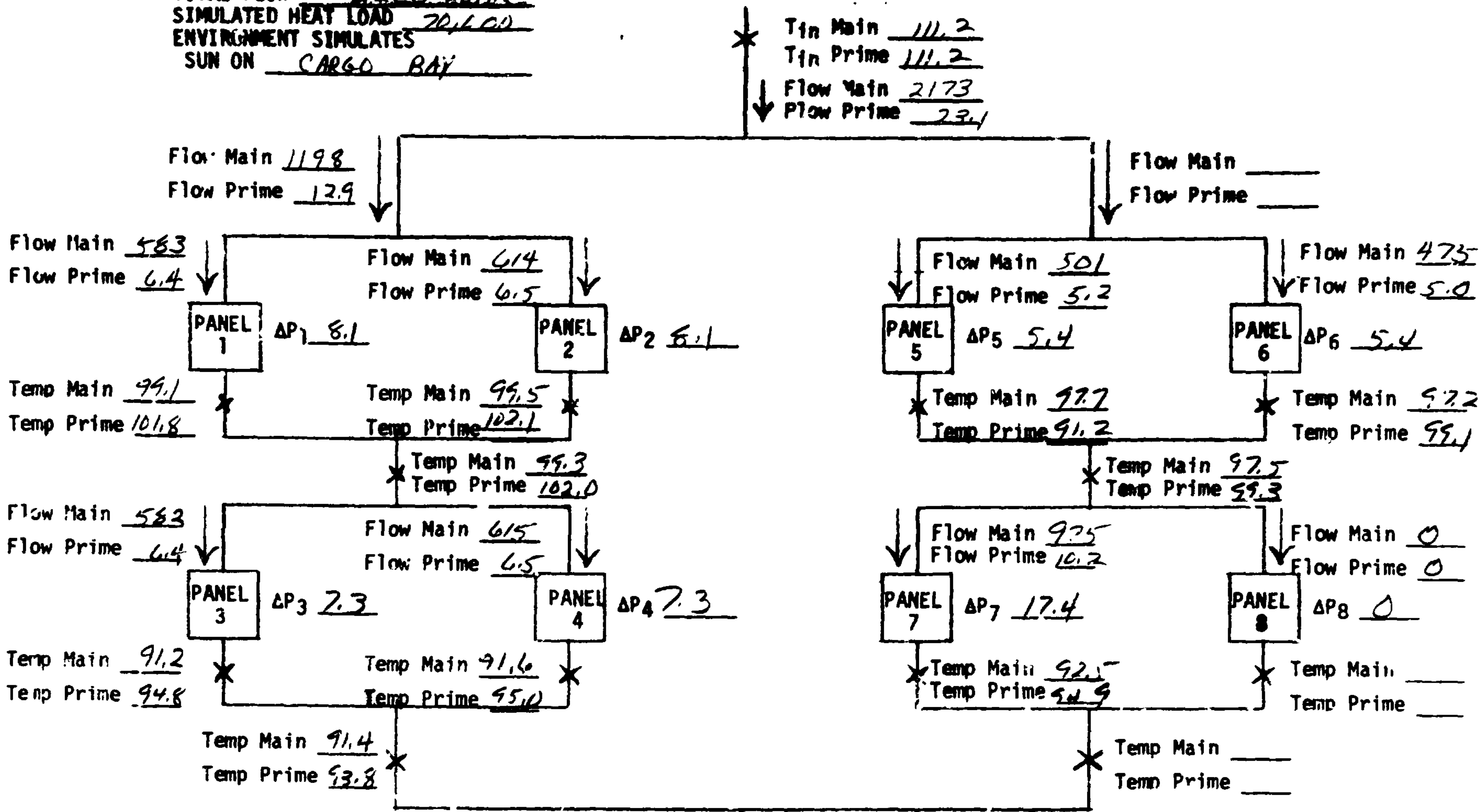
PRIME $\frac{\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at Tavg}}{} = \text{Qrej}$ 117

10454
Qtotal

Tout Main 90.3
Tout Prime 91.5
Tout Mixed Main and Prime 90.3

WEEK 3
TEST TIME 16 hrs
TOTAL FLOW 2260 LB/HR
SIMULATED HEAT LOAD 20,600
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

CONFIGURATION 8*
TEST POINTS 34



Tout Main 91.9
Tout Prime 93.8
Tout Mixed Main and Prime 91.9

MAIN $\dfrac{\text{FLOW X (Tin - Tout) X} \quad \text{at}}{\text{.avg}} = \text{Qrej}$ 10949

PRIME $\dfrac{\text{FLOW X (Tin - Tout) X Cp at}}{\text{Tavg}} = \text{Qrej}$ 106

11055 Qtotal

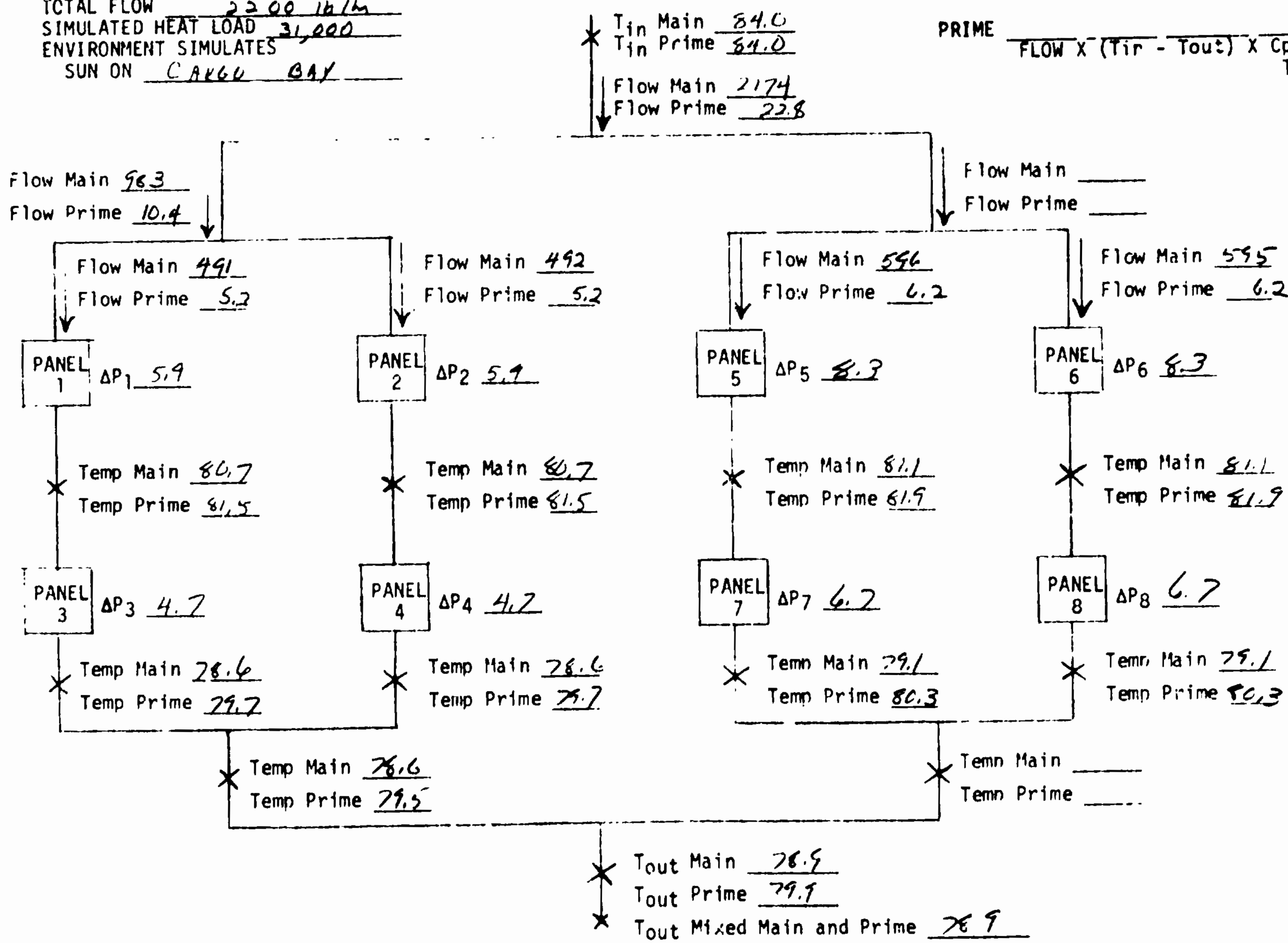
WEEK 3
TEST TIME 22 hrs
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD 31,000
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

CONFIGURATION Y
TEST POINTS 35

MAIN $\text{FLOW} \times (T_{in} - T_{out}) \times C_p \text{ at } T_{avg} = Q_{rej}$ 2874

PRIME $\text{FLOW} \times (T_{in} - T_{out}) \times C_p \text{ at } T_{avg} = Q_{rej}$ 24

2849
Q_{total}



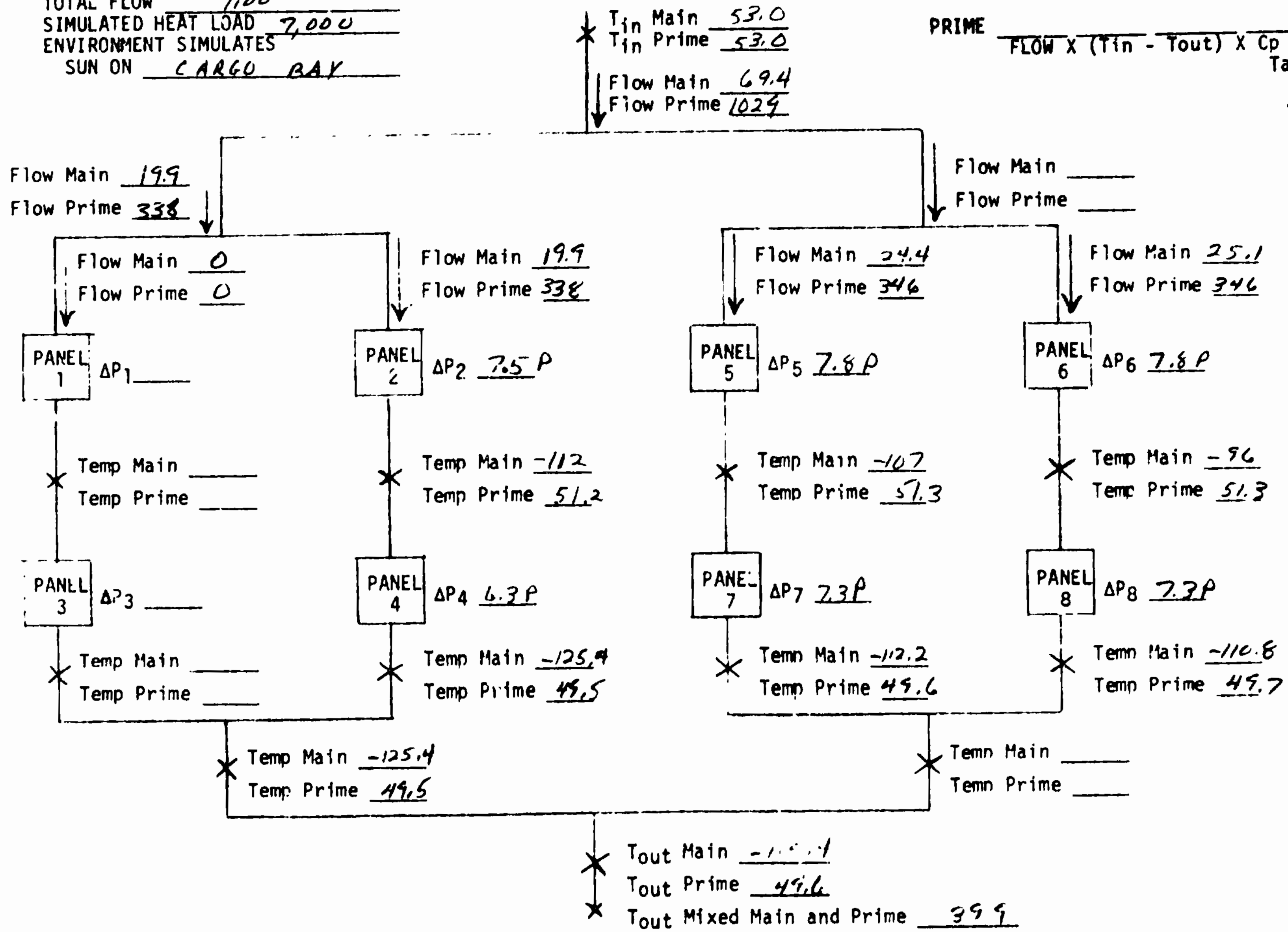
WEEK 3
TEST TIME 66 hr
TOTAL FLOW 1100
SIMULATED HEAT LOAD 7,000
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

CONFIGURATION Y - 1, 3
TEST POINTS 36

MAIN $\dfrac{2695}{\text{FLOW} \times (T_{in} - T_{out}) \times C_p \text{ at } T_{avg}} = Q_{rej}$

PRIME $\dfrac{864}{\text{FLOW} \times (T_{in} - T_{out}) \times C_p \text{ at } T_{avg}} = Q_{rej}$

$\dfrac{3558}{Q_{total}}$



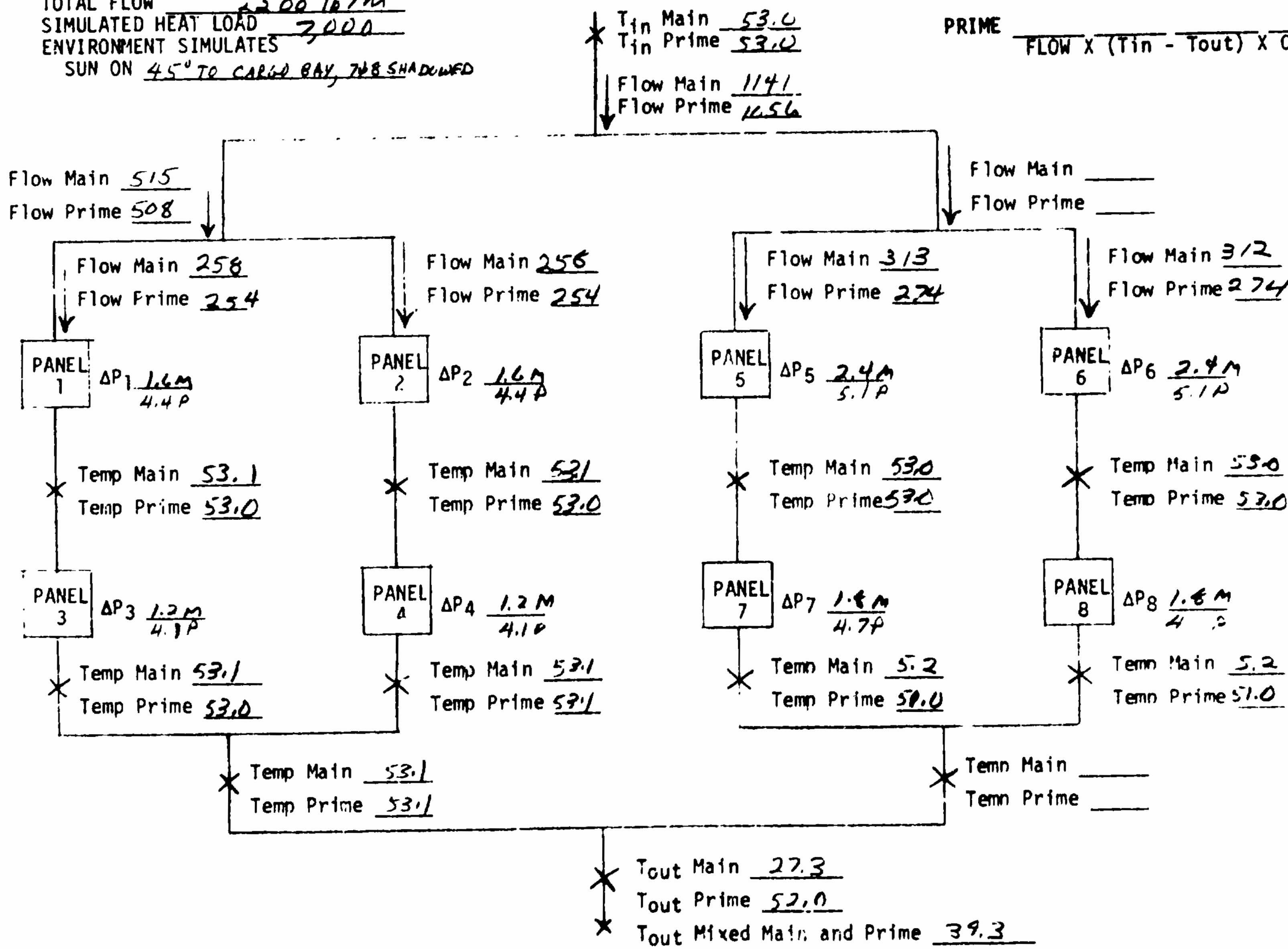
WEEK 3
TEST TIME 20 hr
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD 7000
ENVIRONMENT SIMULATES
SUN ON 45° TO CARGO BAY, 7&8 SHADOWED

CONFIGURATION Y
TEST POINTS 37

MAIN $\overline{\text{FLOW}} \times \overline{(\text{Tin} - \text{Tout})} \times \overline{\text{Cp at Tavg}} = \frac{7168}{\text{Qrej}}$

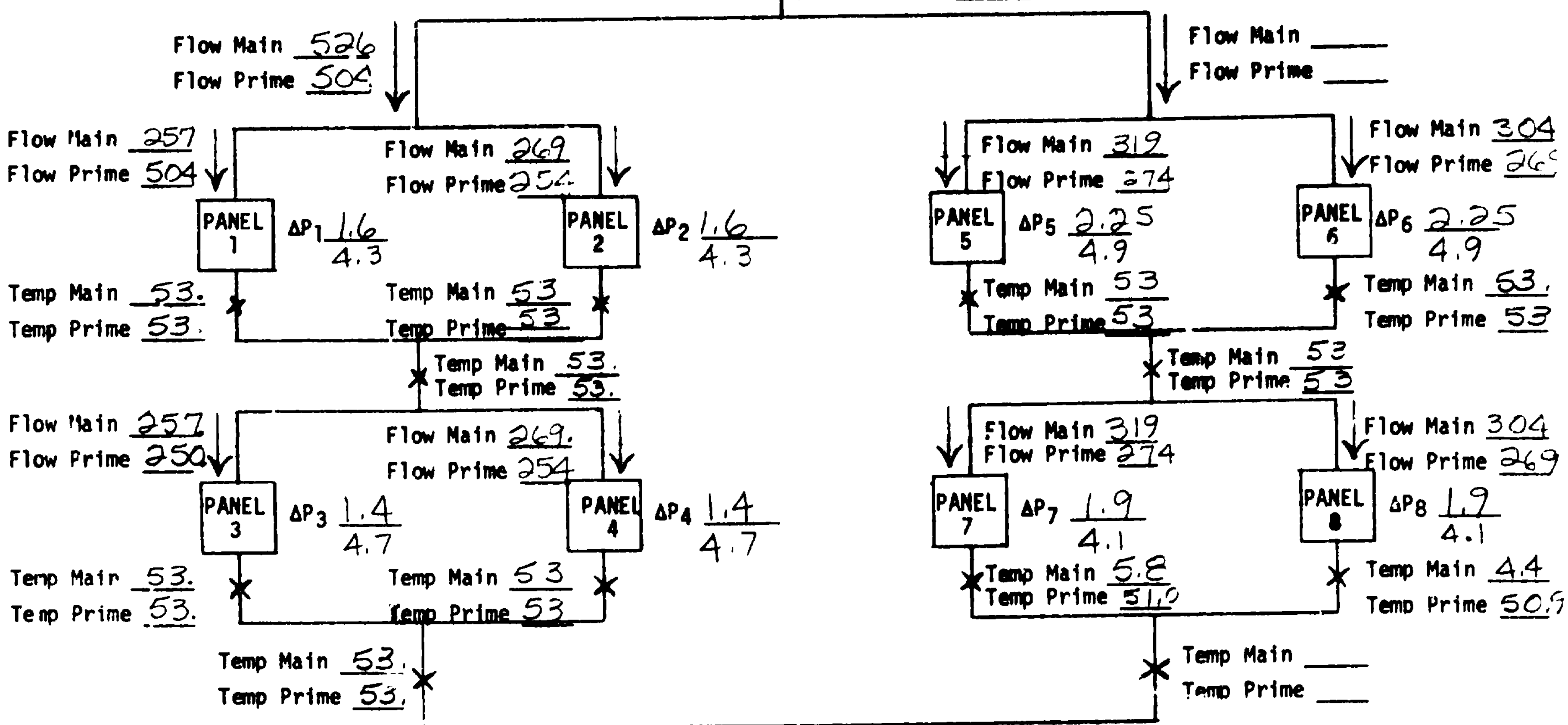
PRIME $\overline{\text{FLOW}} \times \overline{(\text{Tin} - \text{Tout})} \times \overline{\text{Cp at Tavg}} = \frac{260}{\text{Qrej}}$

$\frac{7429}{\text{Qtotal}}$



WEEK 3rd
TEST TIME 34
TOTAL FLOW 2200
SIMULATED HEAT LOAD 7K
ENVIRONMENT SIMULATES
SUN ON 45° TO CARGO BAY
WITH PANELS 7, 8 SHADOWED

CONFIGURATION 6
TEST POINTS 38



MAIN $\frac{\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at Tavg}}{}$ = Qrej 7162

PRIME $\frac{\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at Tavg}}{}$ = Qrej 285

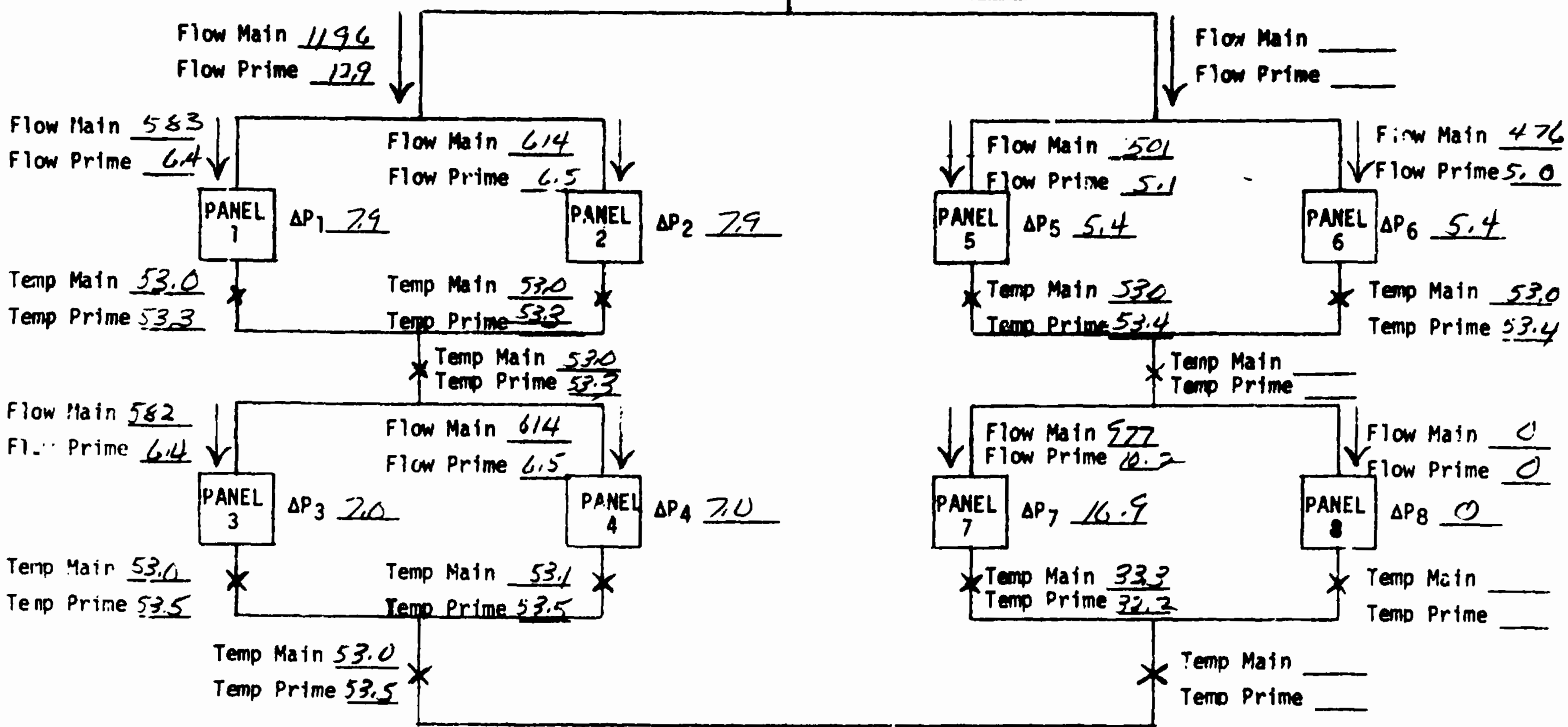
7447
Qtotal

Tout Main 27.5
Tout Prime 51.9
Tout Mixed Main and Prime 39.3

WEEK 3
TEST TIME 40
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD 7000
ENVIRONMENT SIMULATES
SUN ON 45' TO CARGO BAY WITH PANELS 7+8 SHADED

CONFIGURATION 6*
TEST POINTS 39

T_{in} Main 53
T_{in} Prime 53
Flow Main 2173
Flow Prime 23



Tout Main 44.3
Tout Prime 44.2
Tout Mixed Main and Prime 44.3

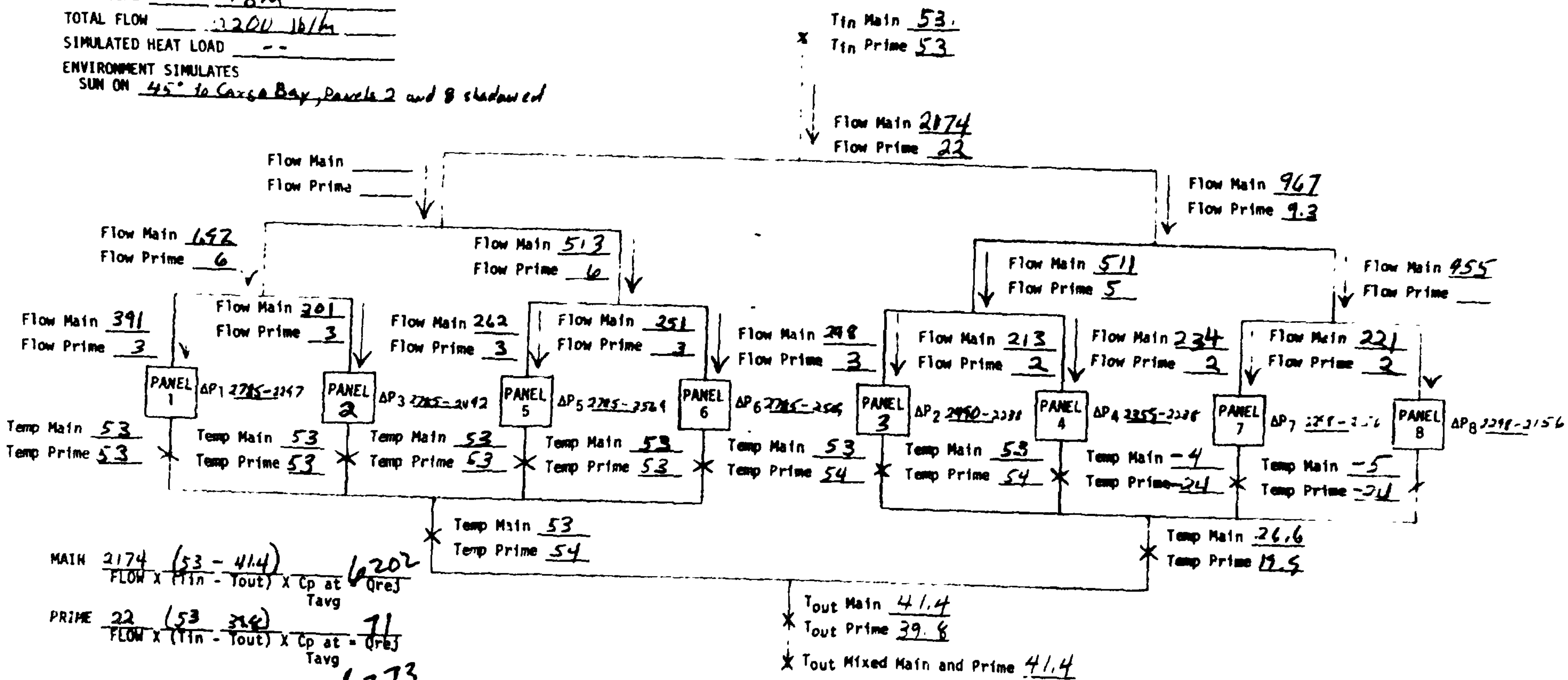
MAIN $\overline{\text{FLOW} \times (T_{in} - T_{out}) \times C_p \text{ at } T_{avg}} = \overline{Q_{rej}}$ 4656

PRIME $\overline{\text{FLOW} \times (T_{in} - T_{out}) \times C_p \text{ at } T_{avg}} = \overline{Q_{rej}}$ 50

4706
Qtotal

WEEK 3
TEST TIME 48h
TOTAL FLOW 2200 lb/h
SIMULATED HEAT LOAD --
ENVIRONMENT SIMULATES
SUN ON 45° to Cargo Bay, Panels 2 and 8 shadowed

CONFIGURATION c
TEST POINTS 40



MAIN $\underset{\text{FLOW}}{2174} \times \underset{(\text{Tin - Tout})}{(53 - 41.4)} \times \underset{\text{Tavg}}{\text{Cp at}} \quad \underset{\text{Qrej}}{6202}$

PRIME $\underset{\text{FLOW}}{22} \times \underset{(\text{Tin - Tout})}{(53 - 39.8)} \times \underset{\text{Tavg}}{\text{Cp at}} = \underset{\text{Qrej}}{71}$

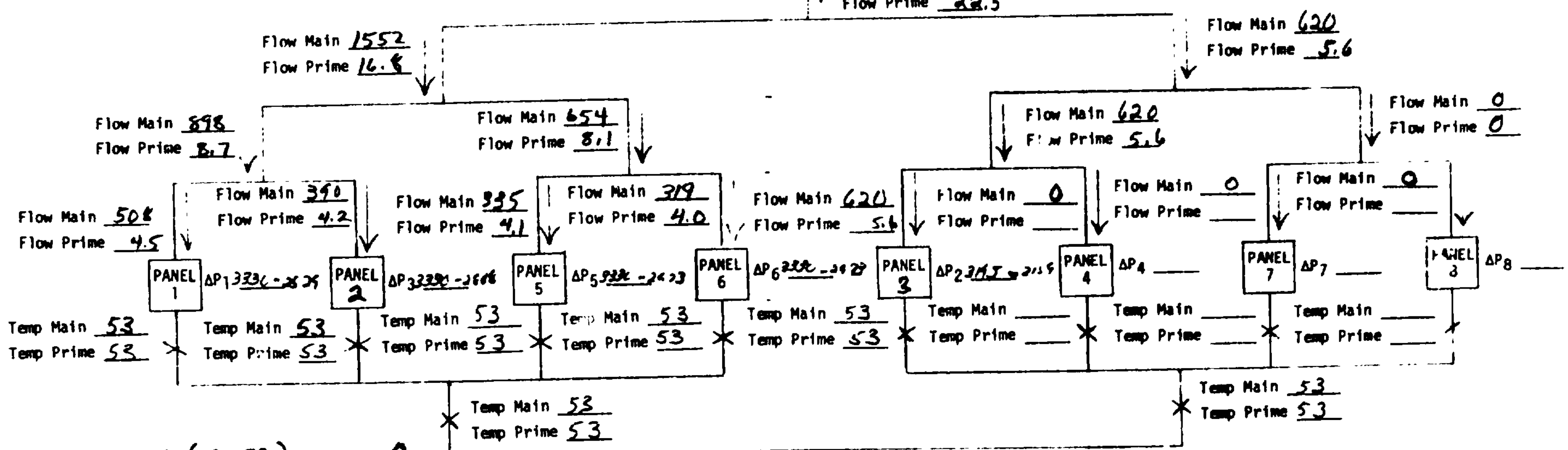
$\underset{\text{Qtotal}}{6273}$

CONFIGURATION ε**
TEST POINTS 41

WEEK 3
TEST TIME 52 hr
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD –
ENVIRONMENT SIMULAT'S
SUN ON 45° to Cargo Bay with panels 7 and 8 shadowed

Tin Main 53
Tin Prime 53

Flow Main 2174
Flow Prime 22.5



Tout Main 53
Tout Prime 53
Tout Mixed Main and Prime 53

MAIN $\frac{2174}{\text{FLOW}} \times \frac{(53\ \ 53)}{(\text{Tin - Tout})} \times \underset{\text{Tavg}}{\text{Cp at}} = \frac{0}{\text{QreJ}}$

PRIME $\frac{22.5}{\text{FLOW}} \times \frac{(53 - 53)}{(\text{Tin - Tout})} \times \underset{\text{Tavg}}{\text{Cp at}} = \frac{0}{\text{QreJ}}$

$\frac{0}{\text{Qtotal}}$

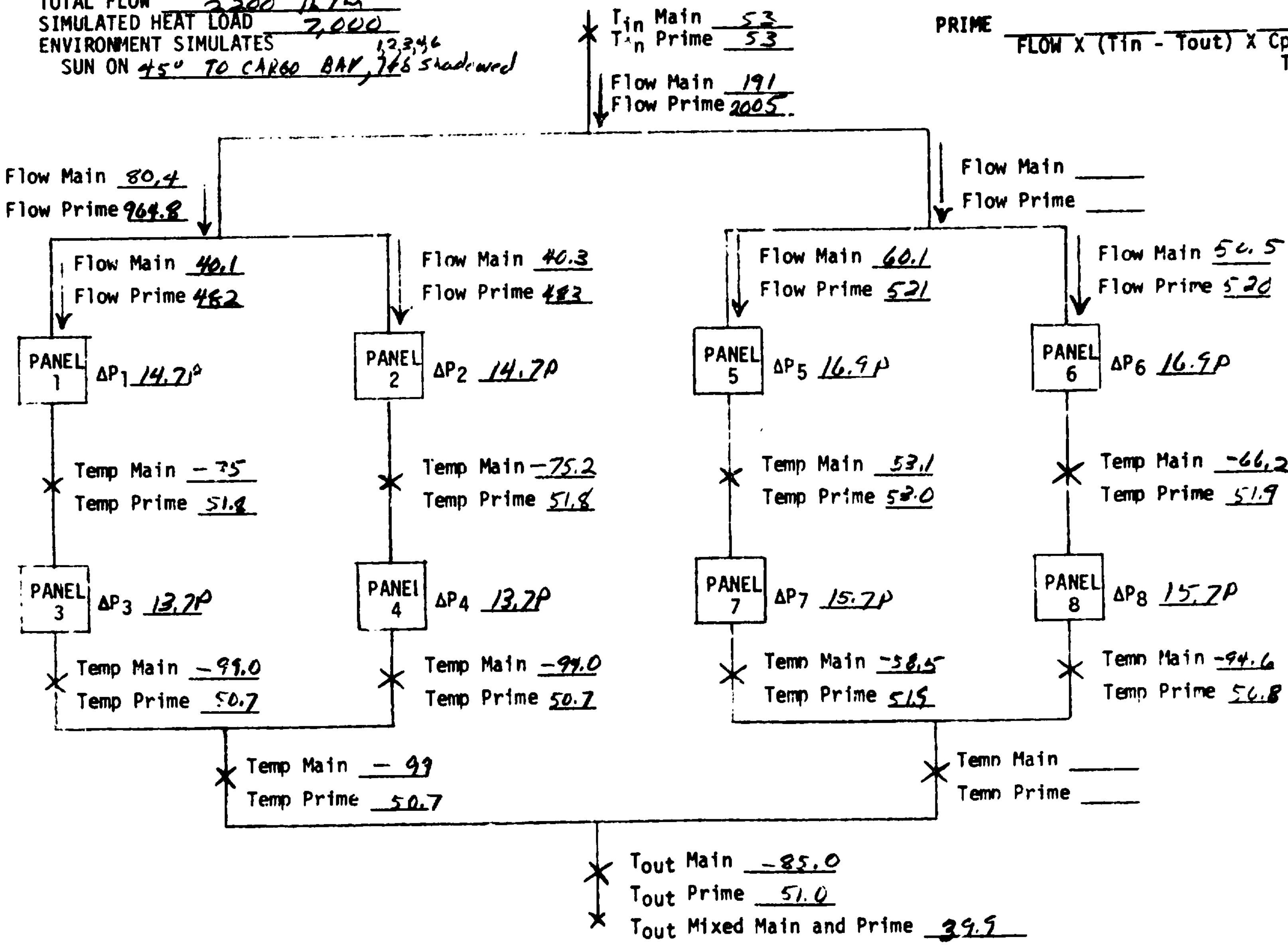
WEEK 3
TEST TIME 58hr
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD 7,000
ENVIRONMENT SIMULATES 1,2,3,4,6
SUN ON 45° TO CARGO BAY, 7&8 shadowed

CONFIGURATION Y
TEST POINTS 42

MAIN FLOW X (Tin - Tout) X Cp at Tavg = Qrej 6227

PRIME FLOW X (Tin - Tout) X Cp at Tavg = Qrej 991

Qtotal 7212



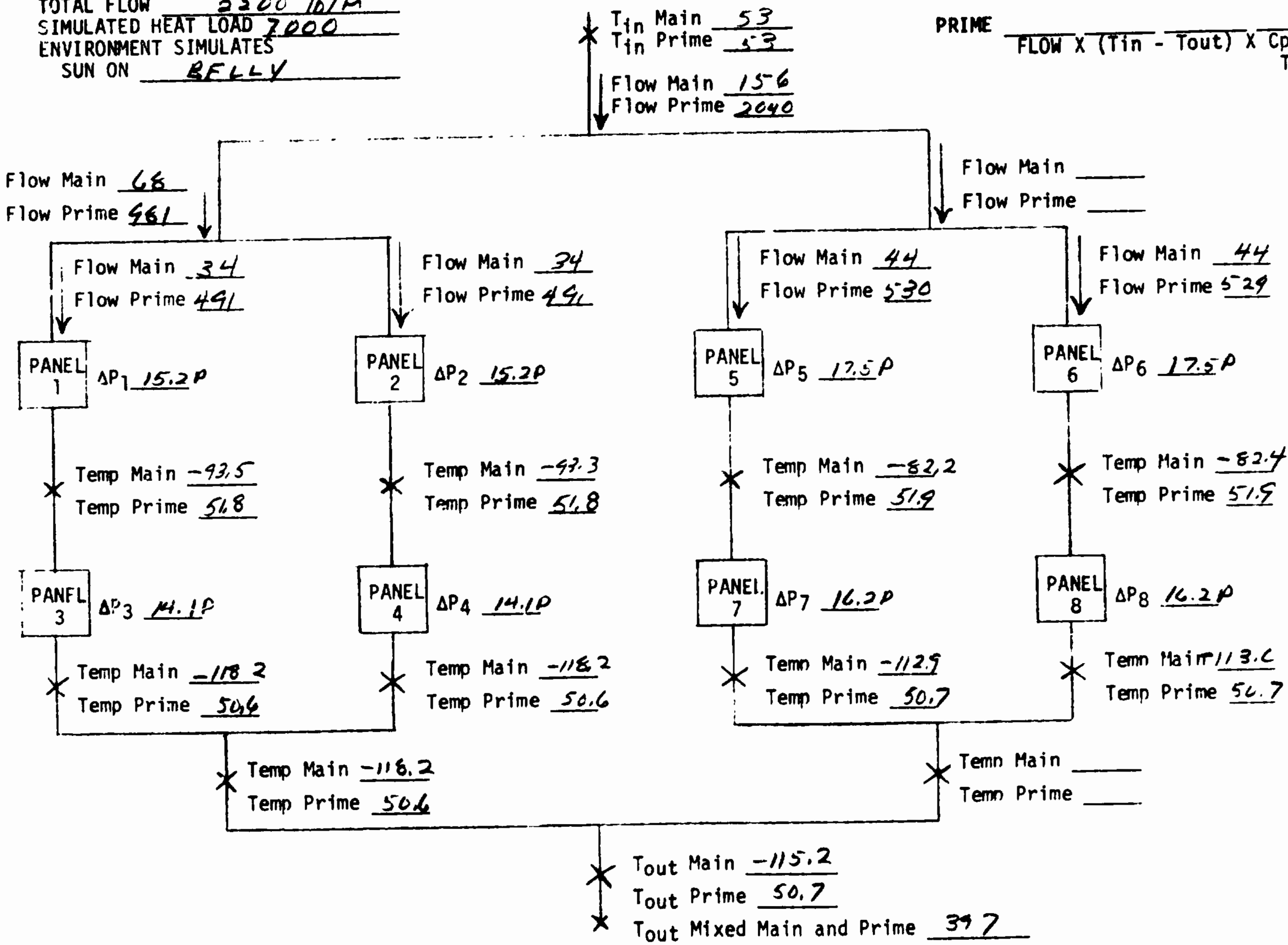
WEEK 3
TEST TIME 72
TOTAL FLOW 2200 lb/H
SIMULATED HEAT LOAD 7000
ENVIRONMENT SIMULATES
SUN ON BELLY

CONFIGURATION Y
TEST POINTS 43

MAIN $\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at}_{\text{Tavg}} = \text{Qrej}$ 6164

PRIME $\text{FLOW} \times (\text{Tin} - \text{Tout}) \times \text{Cp at}_{\text{Tavg}} = \text{Qrej}$ 89

6234 Qtotal



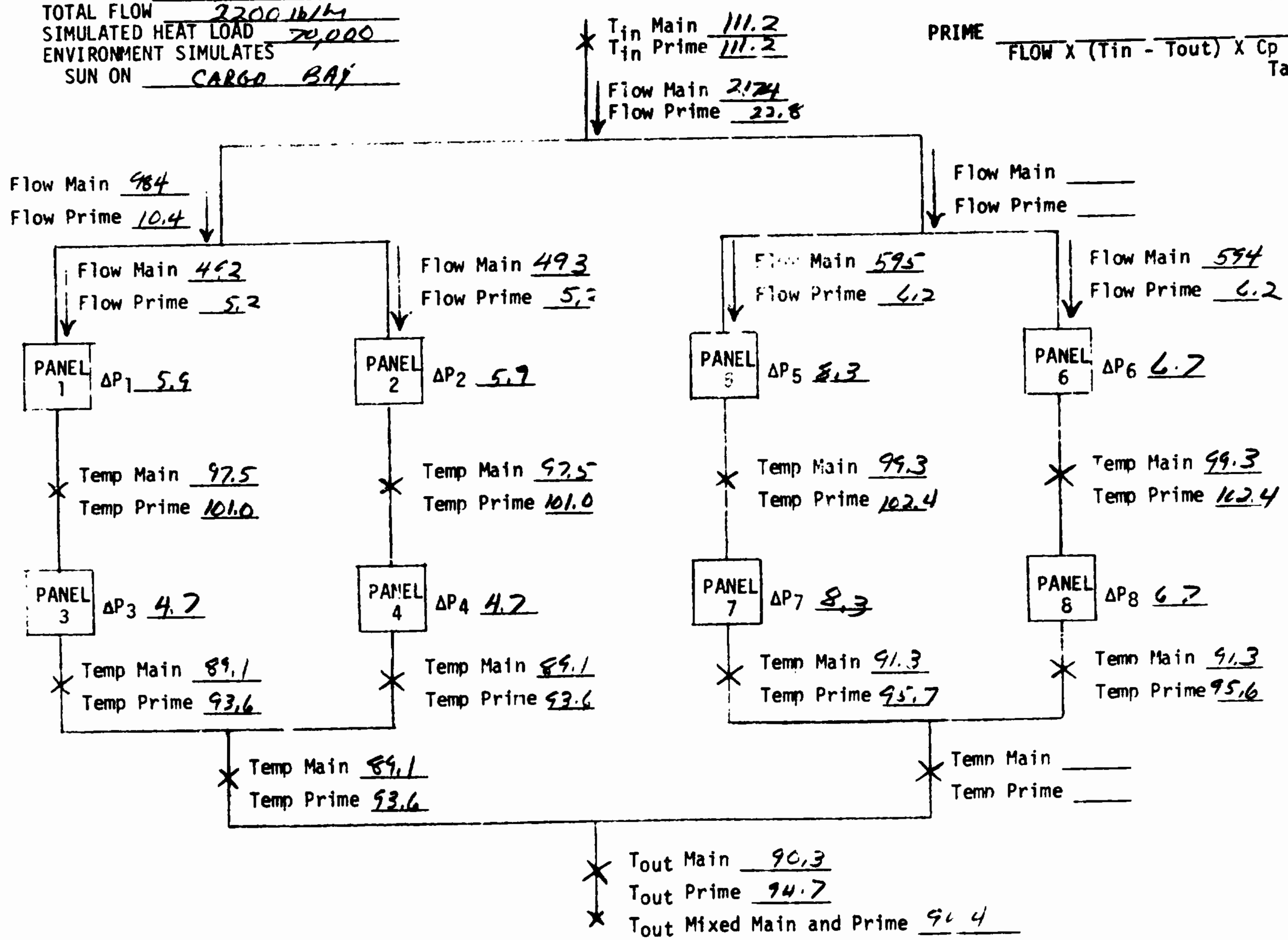
WEEK 3
TEST TIME 28
TOTAL FLOW 2200 lb/hr
SIMULATED HEAT LOAD 70,000
ENVIRONMENT SIMULATES
SUN ON CARGO BAY

CONFIGURATION Y
TEST POINTS 44

MAIN FLOW X (Tin - Tout) X Cp at Tavg = Qrej 11850

PRIME FLOW X (Tin - Tout) X Cp at Tavg = Qrej 98

11948 Qtotal



CONFIGURATION ε

TEST POINTS 45

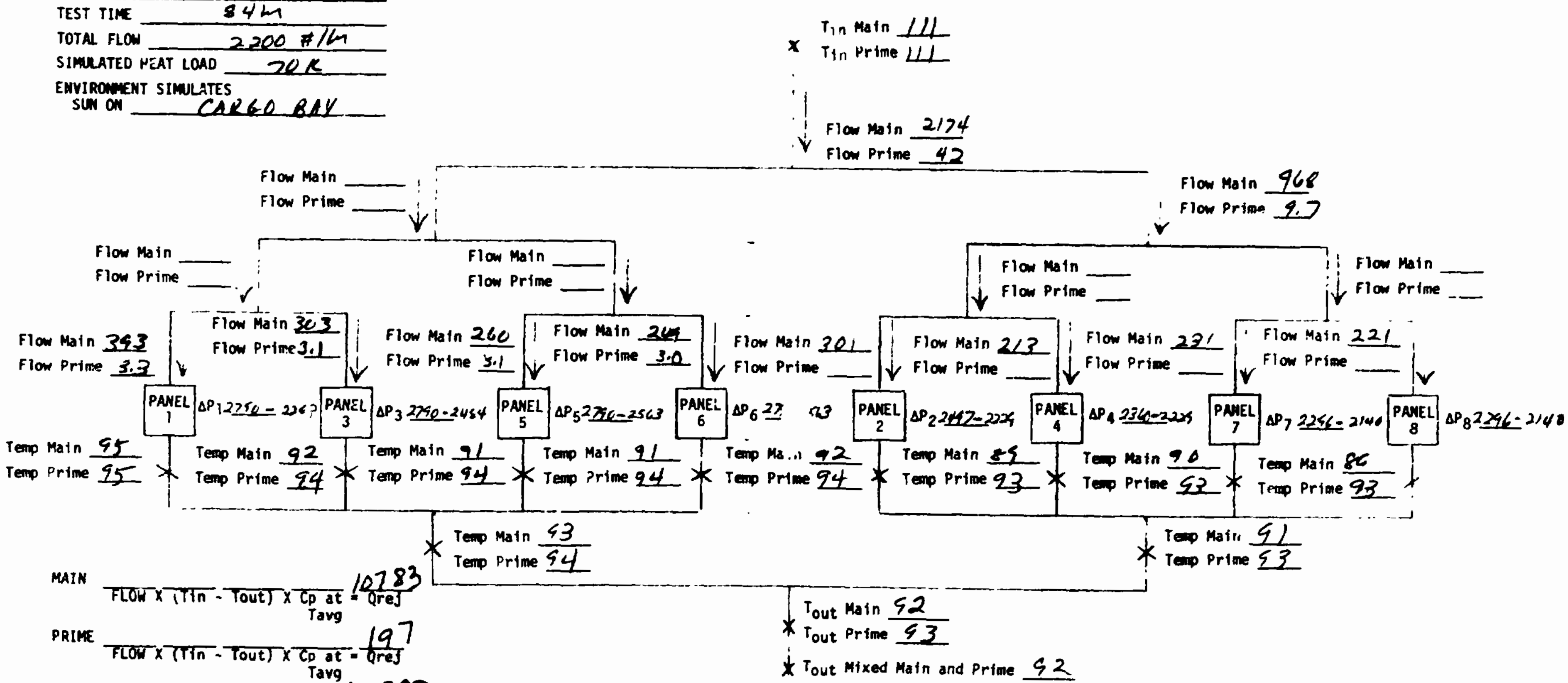
WEEK 3

TEST TIME 84 hr

TOTAL FLOW 2200 #/hr

SIMULATED HEAT LOAD 70 K

ENVIRONMENT SIMULATES SUN ON CARGO BAY



MAIN FLOW X (Tin - Tout) X Cp at Tavg = Qrej 10783

PRIME FLOW X (Tin - Tout) X Cp at Tavg = Qrej 197

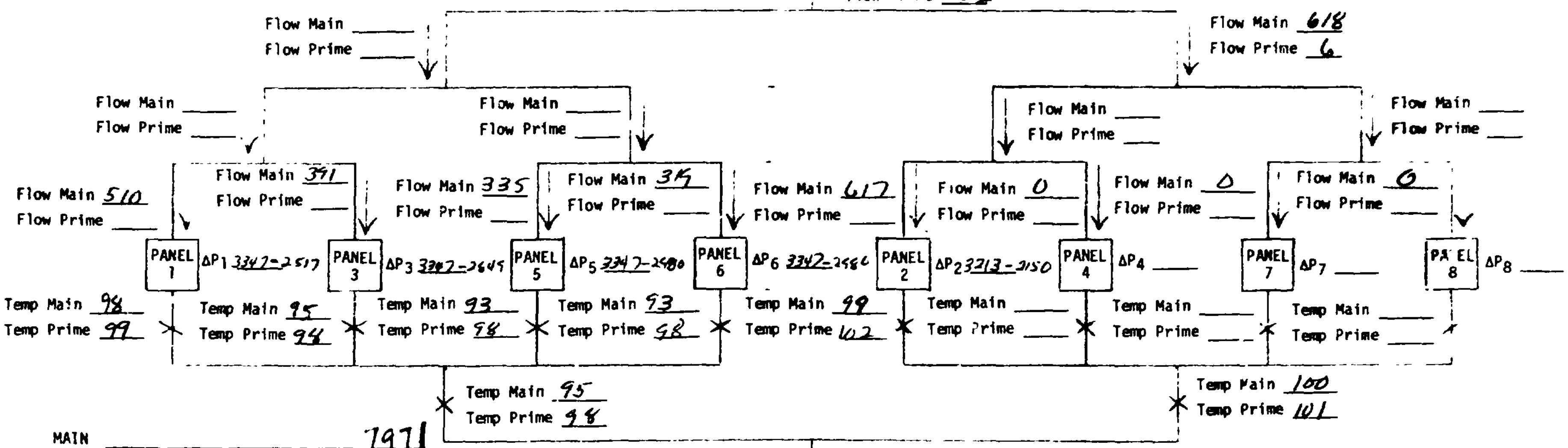
10980 Qtotal

CONFIGURATION ε
TEST POINTS 46

WEEK 3
TEST TIME 50 h
TOTAL FLOW 2200 lb/h
SIMULATED HEAT LOAD 20
ENVIRONMENT SIMULATES SUN ON CARGO BAY

T_{in} Main 111
T_{in} Prime 111

Flow Main 2174
Flow Prime 22



MAIN $\frac{\text{FLOW X (Tin - Tout) X Cp at Tavg}}{} = Q_{rej}$ 7971

PRIME $\frac{\text{FLOW X (Tin - Tout) X Cp at Tavg}}{} = Q_{rej}$ 69

8040 Q_{total}

T_{out} Main 97
T_{out} Prime 99
T_{out} Mixed Main and Prime 97