4A.3 PREDICTED PUMP PERFORMANCE

The predicted pump performance is based on the test curve of RCP head versus flow in conjunction with the curve of system head versus flow. The intersection of these curves is the best estimate system flow. When positive and negative error bands are applied to the pump capacity curve and to the system curve, the result is a nine point intersection which gives the range of possible full power flows. The errors in predicting pump performance are necessarily greater than the error in determining reactor coolant loop flow through measurement of the pump ΔP. The results of the flow prediction will, therefore, be superseded by post-core load test results.

4A.3.1 PUMP HEAD VERSUS FLOW CURVE

The curve of pump head versus flow was generated in a different manner than the curve of pump ΔP versus flow. Test data for both curves was taken simultaneously. The flow data points and their associated errors (Appendix 4A.2.2) were the same for both curves. The pump head was determined by measuring individual inlet and outlet pressure at the appropriate distance between pump inlet and outlet in accordance with the Hydraulic Institute Code. Inlet and outlet pressures were measured as shown in Figure A. The pressures were corrected in accordance with the gauge calibration curve. Pump total dynamic head was corrected for the differential velocity head between pressure gauges.

4A.3.2 PREDICTED SYSTEM CURVE

The predicted system curve was calculated from the resistance of the individual RCS elements. The system curve is based on as-built dimensions for Unit 1. Unit 1 tests will be used to predict the Unit 2 flow. Tolerances are applied to each of the resistances to account for uncertainty in friction factors and shock loss factors. A discussion of the development of the individual flow resistances follows:

Reactor Coolant System Piping. As-built pipe IDs, lengths, and radii are used. A tolerance of ± 10% is applied to the pipe friction factors and ± 20% to the shock loss factors.

Steam Generators. As-built dimensions for each original Combustion Engineering, Inc. steam generator are used. The calculation includes steam generator tubes which were plugged during the manufacturing process (total of nine). A tolerance of ± 10% is applied to friction factors and ± 20% to shock loss factors. The shock loss factors have been verified through flow model testing. Note that the replacement steam generators manufactured by Babcock & Wilcox, Canada, have equivalent primary flow pressure loss as compared to the original Combustion Engineering, Inc. steam generators.

Reactor Vessel. Reactor vessel flow resistance is calculated using as-built dimensions of the reactor vessel, inlet and outlet nozzles, fuel and internals. The best estimate, maximum and minimum flow resistances use allowances as follows:

	Flow Resistances		
	Minimum	Best Estimate	Maximum
Power	0	100%	100%
Bypass Leakage	Maximum	Maximum	Minimum
Core Friction Factor	Nominal	Nominal	+50%
Spacer Grid Loss	Nominal	Nominal	Maximum
Calculational Uncertainty	-1.5%	0	+2%
Fuel Rod OD	Minimum	Nominal	Maximum

4A.3.3 PREDICTED FLOW

The PIPEANA Code utilizes the resistances of the individual loop components, the pump head versus flow curves, and vessel inlet temperature to calculate the minimum, best estimate, and maximum pump flows. The flows are then summed to determine the total reactor vessel flow. As determined in Appendix 4A.2, the average pump flow must be 96,100 gpm at 100% power to assure that a reactor vessel flow rate of 139.5×10^6 lb/hr is present. A reanalysis of the flow rates has been performed since the submittal of CENPD-106. This reanalysis has used the individual pump characteristics rather than the worst case pump characteristic. The results are:

	Pump Flow		
Pump	Minimum	Best Estimate	Maximum
11A	95,000	97,091	106,000
11B	94,109	96,200	105,109
12A	94,579	96,670	105,579
12B	94,609	96,700	105,609
Average	94,574	96,665	105,574

The prediction methodology has been verified for the Palisades, Omaha, and Maine Yankee reactors. The Palisades best estimate prediction equaled the actual Palisades flow. For Omaha and Maine Yankee, the maximum flow prediction was closest to the actual pump flow.