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FLOW CAPABILITIES

B, C, AND D WATER PLANTS

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FLOW CAPABILITIES

B, C, AND D WATER PLANTS

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December 1, 1966

FLOW CAPABILITIES

B, C, AND D WATER PLANTS

I. INTRODUCTION

A. Purpose

The purpose of this report is to: (1) establish the existing maximum flow capabilities of B, C and D Water Plants, (2) determine the limiting factors under existing flow conditions and, (3) develop a systematic plan, including scope cost estimates, for removal of limitations which can be accomplished without major expenditures.

B. Scope

The scope of the study included increases in the primary coolant flows only for B, C and D Water Plants from the 181 River Pump Facilities through the 190 Process Pumping. Four cases were studied.

In all cases, primary consideration was directed toward gaining additional process flow capabilities at 181-BC either by exchange of smaller capacity raw water pumps on the 181-C side with pumps of larger capacity or transfer of the export pumping to 182-D.

Process water utilization, process piping and effluent system capabilities, and the adequacy of the coolant backup under increased flow conditions were not studied.

II. BASIC ASSUMPTIONS AND CONSIDERATIONS

1. The existing process pump drive motors and speed increasing gear sets in 190-B and 190-D are suitable for 5750 input horsepower¹.
2. All process pumping units in the 181, 183, and 190 Buildings will be fully utilized as required to obtain maximum reactor flows. No units will be considered as spares.
3. Since the failure of equipment in any part of the process water pumping system may reduce the maximum flow, reactor flow demands will be established within a range suitable for sustained seven-pump operation in 190-B and 190-D and nine-pump operation in 190-C without subjecting the pumps to excessive cavitation, or the drive equipment to greater than established maximum loads.
4. The potential increased flows to the B and D Reactors are based primarily on lowering the reactor flow resistance by new design process tubes and/or fuel. Although the appropriate timing for design, testing, procurement and installation of new process tubes and/or fuel is shown in the case tables, further study has not been made. The installation of the new design process tubes and/or fuel is proposed during the period when the necessary mass replacement of existing process tubes is expected².

III. SUMMARY

The tables for each case display the completed or planned modifications with approximate costs, and the proposed modifications with estimated costs, that have increased or will result in increased process flows. These modifications are shown by plants for each system or facility from FY 1966 through FY 1969.

A. Case I - Tables 1 and 2

This case includes the necessary revisions and/or additions required to provide process flows of 108,000 gpm from 190-B and 190-D to the respective reactors. The primary item is increasing the 181-BC raw water pumping capacity.

1. B Water Plant

The proposed revisions and additions include: (1) exchange of three of the smaller capacity 181-C raw water pumps for pumps of larger capacity, (Additional flow requirements for B to be provided through 183-C), (2) installation of an additional process pump in 183-B and piping modification for increased flow to the 190-B Tanks, and (3) development, testing and installation of impellers, designed for higher flow at lower discharge pressure, in the 190-B Process Pumps.

2. D Water Plant

The proposed revisions and additions include: (1) piping modifications or installation of one additional process pump for increased flow from 183-D to the 190-D Tanks and (2) development, testing and installation of impellers, designed for higher flow at lower discharge pressure, in the 190-D Process Pumps.

3. Estimated Cost and Expenditure Pattern (Proposed Modifications Only)

(Amount in thousands of dollars)

	FY 67		FY 68		FY 69		
	Exp.	Cap.	Exp.	Cap.	Exp.	Cap.	Total
B Water Plant	15.0		80.0	70.0	48.0		213.0
D Water Plant	15.0		20.0	25.0	48.0		108.0
	<u>30.0</u>		<u>100.0</u>	<u>95.0</u>	<u>96.0</u>		<u>321.0</u>

Note: The value of transferred equipment is not included in the capital costs.

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B-WATER PLANT- CASE I

TABLE I

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D-WATER PLANT - CASE I

ITEM	DESCRIPTION	EXPENDITURES \$1000
100	INSTALL CHECK VALVES - BY-PASS LINES 180 TANKS	5.0
101	INSTALL 7" PROCESS PUMP	4.0
102	183-D	15.0
103	REAR FACE HDWE 183-D	52.0
104	185-D	15.0
105	DEV. & TEST PUMP IMPELLERS	15.0
106	190-D	15.0
107	DESIGN & TEST TUBES AND/OR FEEL 105-D	22.0
108	FEEL 105-D	22.0
109	FEEL 105-D	22.0
110	FEEL 105-D	22.0
111	FEEL 105-D	22.0
112	FEEL 105-D	22.0
113	FEEL 105-D	22.0
114	FEEL 105-D	22.0
115	FEEL 105-D	22.0
116	FEEL 105-D	22.0
117	FEEL 105-D	22.0
118	FEEL 105-D	22.0
119	FEEL 105-D	22.0
120	FEEL 105-D	22.0
121	FEEL 105-D	22.0
122	FEEL 105-D	22.0
123	FEEL 105-D	22.0
124	FEEL 105-D	22.0
125	FEEL 105-D	22.0
126	FEEL 105-D	22.0
127	FEEL 105-D	22.0
128	FEEL 105-D	22.0
129	FEEL 105-D	22.0
130	FEEL 105-D	22.0
131	FEEL 105-D	22.0
132	FEEL 105-D	22.0
133	FEEL 105-D	22.0
134	FEEL 105-D	22.0
135	FEEL 105-D	22.0
136	FEEL 105-D	22.0
137	FEEL 105-D	22.0
138	FEEL 105-D	22.0
139	FEEL 105-D	22.0
140	FEEL 105-D	22.0
141	FEEL 105-D	22.0
142	FEEL 105-D	22.0
143	FEEL 105-D	22.0
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174	FEEL 105-D	22.0
175	FEEL 105-D	22.0
176	FEEL 105-D	22.0
177	FEEL 105-D	22.0
178	FEEL 105-D	22.0
179	FEEL 105-D	22.0
180	FEEL 105-D	22.0
181	FEEL 105-D	22.0
182	FEEL 105-D	22.0
183	FEEL 105-D	22.0
184	FEEL 105-D	22.0
185	FEEL 105-D	22.0
186	FEEL 105-D	22.0
187	FEEL 105-D	22.0
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211	FEEL 105-D	22.0
212	FEEL 105-D	22.0
213	FEEL 105-D	22.0
214	FEEL 105-D	22.0
215	FEEL 105-D	22.0
216	FEEL 105-D	22.0
217	FEEL 105-D	22.0
218	FEEL 105-D	22.0
219	FEEL 105-D	22.0
220	FEEL 105-D	22.0
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222	FEEL 105-D	22.0
223	FEEL 105-D	22.0
224	FEEL 105-D	22.0
225	FEEL 105-D	22.0
226	FEEL 105-D	22.0
227	FEEL 105-D	22.0
228	FEEL 105-D	22.0
229	FEEL 105-D	22.0
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231	FEEL 105-D	22.0
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233	FEEL 105-D	22.0
234	FEEL 105-D	22.0
235	FEEL 105-D	22.0
236	FEEL 105-D	22.0
237	FEEL 105-D	22.0
238	FEEL 105-D	22.0
239	FEEL 105-D	22.0
240	FEEL 105-D	22.0
241	FEEL 105-D	22.0
242	FEEL 105-D	22.0
243	FEEL 105-D	22.0
244	FEEL 105-D	22.0
245	FEEL 105-D	22.0
246	FEEL 105-D	22.0
247	FEEL 105-D	22.0
248	FEEL 105-D	22.0
249	FEEL 105-D	22.0
250	FEEL 105-D	22.0
251	FEEL 105-D	22.0
252	FEEL 105-D	22.0
253	FEEL 105-D	22.0
254	FEEL 105-D	22.0
255	FEEL 105-D	22.0
256	FEEL 105-D	22.0
257	FEEL 105-D	22.0
258	FEEL 105-D	22.0
259	FEEL 105-D	22.0
260	FEEL 105-D	22.0
261	FEEL 105-D	22.0
262	FEEL 105-D	22.0
263	FEEL 105-D	22.0
264	FEEL 105-D	22.0
265	FEEL 105-D	22.0
266	FEEL 105-D	22.0
267	FEEL 105-D	22.0
268	FEEL 105-D	22.0
269	FEEL 105-D	22.0
270	FEEL 105-D	22.0
271	FEEL 105-D	22.0
272	FEEL 105-D	22.0
273	FEEL 105-D	22.0
274	FEEL 105-D	22.0
275	FEEL 105-D	22.0
276	FEEL 105-D	22.0
277	FEEL 105-D	22.0
278	FEEL 105-D	22.0
279	FEEL 105-D	22.0
280	FEEL 105-D	22.0
281	FEEL 105-D	22.0
282	FEEL 105-D	22.0
283	FEEL 105-D	22.0
284	FEEL 105-D	22.0
285	FEEL 105-D	22.0
286	FEEL 105-D	22.0
287	FEEL 105-D	22.0
288	FEEL 105-D	22.0
289	FEEL 105-D	22.0
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293	FEEL 105-D	22.0
294	FEEL 105-D	22.0
295	FEEL 105-D	22.0
296	FEEL 105-D	22.0
297	FEEL 105-D	22.0
298	FEEL 105-D	22.0
299	FEEL 105-D	22.0
300	FEEL 105-D	22.0

TABLE 2

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III. SUMMARY - (continued)

B. Case II - Tables 3 and 4

This case includes the necessary revisions and/or additions required to provide process flows of 108,000 gpm from 190-B and 190-D to the respective reactors. The primary item is transfer of the export pumping to 100-D.

1. B Water Plant

The proposed revisions and additions include: (1) transfer of the export pumping to 100-D and modification of the piping from the existing export pumps at 181-B to provide additional flow to 183-C (additional flow requirements for B to be provided through 183-C), (2) installation of an additional process pump in 183-B and piping modifications for increased flow to the 190-B Tanks, and (3) development, testing and installation of impellers, designed for higher flow at lower discharge pressure, in the 190-B Process Pumps.

2. D Water Plant

The proposed revisions and additions include: (1) exchange of two motor-driven 3000 gpm export pumps for 6000 gpm pumps, addition of one 6000 gpm export pump and piping modification in 182-D to meet the export flow requirements, (2) piping modifications or installation of one additional process pump for increased flow from the 183-D to the 190-D Tanks, and (3) development, testing and installation of impellers, designed for higher flow at lower discharge pressure, in the 190-D Process Pumps.

3. Estimated Cost and Expenditure Pattern (Proposed Modifications Only)

(Amounts in thousands of dollars)

	FY 67		FY 68		FY 69		
	Exp.	Cap.	Exp.	Cap.	Exp.	Cap.	Total
B Water Plant	15.0		80.0	25.0	48.0		168.0
D Water Plant	<u>15.0</u>		<u>30.0</u>	<u>70.0</u>	<u>48.0</u>		<u>163.0</u>
	30.0		110.0	95.0	96.0		331.0

Note: The cost of installing additional export pumps in 182-D is included in the D Water Plant estimated cost; however, the transfer of export pumping would be made to improve the B-C Water Plant capabilities for reactor flow. The value of transferred equipment is not included in the capital costs.

B-WATER PLANT-CASE II

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TABLE 3

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D-WATER PLANT - CASE II

LEGEND

 PROCESS FLOW
 NON-PROCESS
 EXPORT
 AVAILABLE
 DESIGN TEST
 CRITICAL ITEMS

TABLE 4

III. SUMMARY - (continued)

C. Case III - Tables 5, 6 and 7

This case includes the necessary revisions and/or additions required to provide process flows of 108,000 gpm from 190-B and 190-D and 115,000 gpm from 190-C to the respective reactors. The primary items are increasing 181-BC pumping capacity and the installing of one additional process pump unit in 190-C.

1. B-C Water Plants

The proposed revisions and additions include: (1) exchange of four of the smaller capacity 181-C raw water pumps for pumps of larger capacity to increase the flow to 183-C to meet the requirements for both B and C plant, (additional flow for B to be provided through 183-C), (2) installation of an additional process pump and piping modifications in 183-B for increased flow to the 190-B Tanks, (3) development, testing and installation of impellers, designed for higher flow at lower discharge pressure, in the 190-B Process Pumps and (4), installation of one additional process pump unit in 190-C.

2. D Water Plant

The proposed revisions and additions, include: (1) piping modifications or installation of one additional process pump for increased flow from 183-D to the 190-D Tanks, and (2) development, testing and installation of impellers, designed for higher flow at lower discharge pressure, in the 190-D Process Pumps.

3. Estimated Cost and Expenditure Pattern (Proposed Modifications Only)

(Amount in thousands of dollars)

	FY 67		FY 68		FY 69		
	Exp.	Cap.	Exp.	Cap.	Exp.	Cap.	Total
B Water Plant	15.0		65.0	25.0	48.0		153.0
C Water Plant			20.0	60.0	20.0	250.0	350.0
D Water Plant	<u>15.0</u>		<u>20.0</u>	<u>25.0</u>	<u>48.0</u>		<u>108.0</u>
	30.0		105.0	110.0	116.0	250.0	611.0

Note: The cost of the exchange of raw water pumps at 181-C is included in C Water Plant although some of the increases in flow will be provided to 183-B. The value of transferred equipment is not included in the capital costs.

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B-WATER PLANT- CASE III

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LEGEND: PROCESS FLOW, NON-PROCESS, EXPORT, AVAILABLE, DESIGN & TEST, ACTION ITEMS

TABLE 5

Q-WATER PLANT - CASE III

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TABLE 6

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D-WATER PLANT - CASE III

TABLE 7

III. SUMMARY - (continued)D. Case IV - Tables 8, 9 and 10

This case includes the necessary revisions and/or additions required to provide process flows of 108,000 gpm from 190-B and 190-D and 115,000 gpm from 190-C to the respective reactors. The primary items are transfer of the export pumping to 100-D and the installation of one additional process pump unit in 190-C.

1. B-C Water Plant

The proposed revisions or additions include: (1) transfer of the export pumping to 100-D and modification of the piping from the existing export pumps at 181-B to provide additional flow to 183-C (additional flow requirements for B to be provided through 183-C), (2) installation of an additional process pump in 183-B and piping modifications for increased flow to the 190-B Tanks, (3) development, testing and installation of impellers, designed for higher flow at lower discharge pressure, in the 190-B Process Pumps, and (4) installation of one additional process pump unit in 190-C.

2. D Water Plant

The proposed revisions and additions include: (1) exchange of two motor-driven 3000 gpm export pumps for 6000 gpm pumps, installation of one additional 6000 gpm export pump and piping modifications in 182 D to meet the export flow requirements, (2) piping modifications or installation of one additional process pump for increased flow from 183-D to the 190-D Tanks and (3) development, testing and installation of impellers, designed for higher flow at lower discharge pressure, in the 190-D Process Pumps.

3. Estimated Cost and Expenditure Pattern (Proposed Modifications Only)

(Amount in thousands of dollars)

	FY 67		FY 68		FY 69		
	Exp.	Cap.	Exp.	Cap.	Exp.	Cap.	Total
B Water Plant	15.0		65.0	25.0	48.0		153.0
C Water Plant			15.0		20.0	250.0	285.0
D Water Plant	15.0		30.0	70.0	48.0		163.0
	<u>30.0</u>		<u>110.0</u>	<u>95.0</u>	<u>116.0</u>	<u>250.0</u>	<u>601.0</u>

Note: The cost of installing additional export pumps in 182-D is included in the D Water Plant costs; however, the transfer of export pumping would be made to improve the B-C Water Plant capabilities for increased reactor flow. The value of transferred equipment is not included in the capital costs.

Increased flow through C Water Plant only was not considered as an individual case. A target flow of 115,000 gpm through C Water Plant only could be accomplished by exchanging two smaller capacity pumps on 181-C side with pumps of larger capacity and installing one additional process pump unit in 190-C. Estimated cost is \$310,000.00.

B-WATER PLANT-CASE IV

TABLE 8

C-WATER PLANT - CASE IV

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The diagram illustrates the hydraulic layout of the C-Water Plant for Case IV. It features a grid with flow rate (GPM x 10) on the vertical axis (0 to 160) and stationing on the horizontal axis (181 to 195). Key components include:

- Equipment:** EX-66 Filter Pump, EX-67 Filter Pump, EX-68 Filter Pump, EX-69 Filter Pump, EX-70 Filter Pump, EX-71 Filter Pump, EX-72 Filter Pump, EX-73 Filter Pump, EX-74 Filter Pump, EX-75 Filter Pump, EX-76 Filter Pump, EX-77 Filter Pump, EX-78 Filter Pump, EX-79 Filter Pump, EX-80 Filter Pump, EX-81 Filter Pump, EX-82 Filter Pump, EX-83 Filter Pump, EX-84 Filter Pump, EX-85 Filter Pump, EX-86 Filter Pump, EX-87 Filter Pump, EX-88 Filter Pump, EX-89 Filter Pump, EX-90 Filter Pump, EX-91 Filter Pump, EX-92 Filter Pump, EX-93 Filter Pump, EX-94 Filter Pump, EX-95 Filter Pump, EX-96 Filter Pump, EX-97 Filter Pump, EX-98 Filter Pump, EX-99 Filter Pump, EX-100 Filter Pump.
- Flow Paths:** Indicated by arrows and shaded regions, showing the distribution of water from the pumps to various points in the system.
- Legend:**
 - PROCESS FLOW:** Represented by a solid line.
 - NON-PROCESS:** Represented by a dashed line.
 - AVAILABLE:** Represented by a dotted line.
 - DESIGN START:** Represented by a cross-hatched pattern.
 - FLOW TO 183-13:** Represented by a diagonal line.
 - ACTION ITEMS:** Represented by a wavy line.
- Summary Table:**

ITEM	DESCRIPTION	FLOW RATE (GPM x 10)	STATIONING
1	INLET MAIN	150	181
2	105-C	150	181
3	105-C	150	181
4	105-C	150	181
5	105-C	150	181
6	105-C	150	181
7	105-C	150	181
8	105-C	150	181
9	105-C	150	181
10	105-C	150	181
11	105-C	150	181
12	105-C	150	181
13	105-C	150	181
14	105-C	150	181
15	105-C	150	181
16	105-C	150	181
17	105-C	150	181
18	105-C	150	181
19	105-C	150	181
20	105-C	150	181
21	105-C	150	181
22	105-C	150	181
23	105-C	150	181
24	105-C	150	181
25	105-C	150	181
26	105-C	150	181
27	105-C	150	181
28	105-C	150	181
29	105-C	150	181
30	105-C	150	181
31	105-C	150	181
32	105-C	150	181
33	105-C	150	181
34	105-C	150	181
35	105-C	150	181
36	105-C	150	181
37	105-C	150	181
38	105-C	150	181
39	105-C	150	181
40	105-C	150	181
41	105-C	150	181
42	105-C	150	181
43	105-C	150	181
44	105-C	150	181
45	105-C	150	181
46	105-C	150	181
47	105-C	150	181
48	105-C	150	181
49	105-C	150	181
50	105-C	150	181
51	105-C	150	181
52	105-C	150	181
53	105-C	150	181
54	105-C	150	181
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57	105-C	150	181
58	105-C	150	181
59	105-C	150	181
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61	105-C	150	181
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64	105-C	150	181
65	105-C	150	181
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67	105-C	150	181
68	105-C	150	181
69	105-C	150	181
70	105-C	150	181
71	105-C	150	181
72	105-C	150	181
73	105-C	150	181
74	105-C	150	181
75	105-C	150	181
76	105-C	150	181
77	105-C	150	181
78	105-C	150	181

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SUB-TOTAL	EXP	630	30
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	630	3.0
SUB-TOTAL	630	3.0

SUB-TOTAL	20
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TOTAL	630	12.0
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PROPOSED

[illegible]

SUB-TOTAL 20

		TOTAL
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[illegible][illegible][illegible]

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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TABLE 9

FLOW TO 183-13
ACTION ITEMS-

DESIGN TEST

Available	
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NON-PROCESS

PROCESS FLOW

LEGEND

10

D-WATER PLANT—CASE IV

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LEGEND
 PROCESS FLOW
 NON-PROCESS
 AVAILABLE
 EXPERT
 DESIGN & TEST
 ACTION ITEMS

TABLE 10

ITEM	DESCRIPTION	EXPENDITURES, 1966
1	WATER CHECK VALVES, 1500 TUNES	50
2	WATER PUMP	40
3	WATER PUMP	150
4	WATER PUMP	520
5	WATER PUMP	150
6	WATER PUMP	150
7	WATER PUMP	220
8	WATER PUMP	100
9	WATER PUMP	450
10	WATER PUMP	50
11	WATER PUMP	250
12	WATER PUMP	40
13	WATER PUMP	150
14	WATER PUMP	150
15	WATER PUMP	150
16	WATER PUMP	150
17	WATER PUMP	150
18	WATER PUMP	150
19	WATER PUMP	150
20	WATER PUMP	150
21	WATER PUMP	150
22	WATER PUMP	150
23	WATER PUMP	150
24	WATER PUMP	150
25	WATER PUMP	150
26	WATER PUMP	150
27	WATER PUMP	150
28	WATER PUMP	150
29	WATER PUMP	150
30	WATER PUMP	150
31	WATER PUMP	150
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42	WATER PUMP	150
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44	WATER PUMP	150
45	WATER PUMP	150
46	WATER PUMP	150
47	WATER PUMP	150
48	WATER PUMP	150
49	WATER PUMP	150
50	WATER PUMP	150
51	WATER PUMP	150
52	WATER PUMP	150
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54	WATER PUMP	150
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66	WATER PUMP	150
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87	WATER PUMP	150
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89	WATER PUMP	150
90	WATER PUMP	150
91	WATER PUMP	150
92	WATER PUMP	150
93	WATER PUMP	150
94	WATER PUMP	150
95	WATER PUMP	150
96	WATER PUMP	150
97	WATER PUMP	150
98	WATER PUMP	150
99	WATER PUMP	150
100	WATER PUMP	150

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IV. CONCLUSIONS

Case I or Case II outlines the modification necessary to obtain target flows of 108,000 gpm to B and D Reactors only. Case III and Case IV outline the modifications necessary to obtain target flows of 108,000 gpm to B and D Reactors and 115,000 gpm to C Reactor. The primary difference between Case I and Case II, or Case III and Case IV, is the means for providing the necessary increase in the 181-BC pumping capabilities. Case I and Case III consider increasing the 181-BC pumping capacity by exchange of 450 HP pumps for 900 HP pumps. Case II and Case IV consider the transfer of the export pumping to D Water Plant.

The only pumps suitable for replacement of the smaller capacity pumps at 181-BC, that are not in use, are the 181-DR pumps. The DR pumps could be installed in 183-C with a minimum of equipment or building modification although it would be necessary to move the switchgear with the pumps. The DR Reactor Plant was deactivated but is maintained on a "standby" status.

If the 181-DR pumps can be made available, it is proposed that modifications as outlined in Case I (flow increases in B and D Water Plants) or Case III (flow increases in B, C, and D Water Plants) be planned. Both cases include increasing the 181-BC pumping capability by exchanging the 450 HP pumps for 900 HP pumps from 181-DR. This action is more in line with past planning and modifications and can be accomplished at about the same costs as transferring the export pumping to 182-D. It would be necessary to replace three or four pumps in 181-BC, dependent upon planned flow increases in B Water Plant only or both B and C Water Plants. If the DR Reactor Plant was reactivated, it would be necessary to procure new pumps for 181-DR. If the export pumping was transferred to 182-D and DR Reactor Plant was reactivated it would be necessary to install additional pumps in 181-D to meet the export flow requirements.

Dependent upon management decisions concerning increased flows to the reactors, further study and initiation of budget action for FY 1968 and FY 1969, will be necessary.

V. DISCUSSION

A. B-C Water Plant

1. 181-BC River Pump Facilities

During the low river elevations or low river flow periods, normally experienced from October through March, the full capacity of the raw water pumps on both the 181-B and 181-C sides have been required to maintain a total flow of about 229,000 gpm. This included 91,000 gpm to B Reactor, 108,000 gpm to C Reactor, 15,000 gpm for export flow and 15,000 gpm for nor-process use.

Project DOP 500, "Increased Raw Water Pumping Capacity, 181-BC River Pump House", recently completed, provided for the installation of two additional pumps (10,500 gpm, 180 ft. hd, 600 HP) removed from 181-H. These two additional pumps will provide only the necessary raw water flow for the increase of about 6000 gpm to the B Reactor, resulting from the process tube outlet hardware modification recently completed,

and for the committed increase in export flow to 23,000 gpm³. Any further significant planned increase in B and/or C Reactor flow must provide additional raw water capacity at the 181-BC River Pump Facility, or transfer of the export pumping. It is proposed that three 450 HP pump units located on the 181-C side be exchanged with 900 HP pumps from 181-DR to provide the additional flow of 12,000 gpm required to attain 108,000 gpm target flow at B Reactor as outlined in Case I. Any significant increase in flow to B Reactor should be provided through 183-C because of line sizes from 181-B to 183-B and 183-B filter limitations. To attain the target flows of 108,000 gpm for B Reactor and 115,000 gpm for C Reactor as outlined in Case III, it would be necessary to exchange four 450 HP pump units with 900 HP pump units.

The 181-DR raw water pumps have a higher discharge head than the existing 181-C pumps; however, due to the large pipe line capacities to 183-C these pumps probably would not unbalanced the system. The higher head pumps, however, should be located so that their flow could be isolated to one raw water line to 183-C if it proved advantageous.

2. 183-B and 183-C Filter Capacities

The capacity of 183-B filters is approximately 92,000 gpm and the capacity of the 183-C filters is greater than 150,000 gpm. Raw water can be filtered in 183-C and directed to 183-B by the 30" crosstie line. Under existing flow conditions with both reactors operating, about 11,000 gpm is provided by 183-C to 183-B. The increased B Reactor flow expected from the reactor rear face hardware modification will require the maximum flow through the 183-B filters plus about 11,000 gpm from 183-C. Since there remains some flexibility in operation at this point, it may be desirable to filter less through 183-B and provide more from 183-C. At the target flow of 108,000 gpm to B Reactor, the 183-B filters will be required to operate at the maximum capacity plus 23,000 gpm through the 183-C to 183-B intertie line. This approaches the maximum calculated flow for the intertie line at 517.0 elevation for 183-C clearwell water surface.

The 183-C filters have the capacity to provide the necessary filtered water for any expected flows to 183-B and 190-C.

3. 183-B Process Pumping

An additional process pump (15,000 gpm - 150 ft. hd., 700 HP) was installed in 183-B during FY 1966. This installation was necessary to provide the increased flow resulting from the planned reactor outlet hardware modifications. The process pumping capacity with seven pumps is about 97,000 gpm. To meet the target flow of 108,000 gpm, it would be necessary to (1) install an additional process pump and, (2) perform some piping modifications. The piping modifications would probably include increasing the size of the process pump discharge lines. Further testing and study, however, is required to determine optimum modifications.

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4. 183-C Process Pumping

The installation of an additional process pump, recently completed, increased the process pumping capacity to about 124,000 gpm. This is adequate for any planned increases in flow to 190-C and provides some maintenance flexibility.

5. 190-B Process Pumping

Increased process flow to the reactor with existing pumping equipment is limited by probable damaging pump cavitation during sustained seven pump operations. Based on cavitation tests run on nine process pumps (two at 190-F⁴ and seven at 190-D⁵), the average approach to cavitation cut-off for all pumps was 14,700 gpm with one pump approaching the lowest cavitation cut-off at 13,700 gpm and another pump approaching cavitation cut-off at 13,900 gpm. The approach to cavitation cut-off flows on the other seven pumps was greater than 14,500 gpm. (See Figure I.)

A maximum flow of 98,000 gpm can be established with the existing pumps on the basis that: (1) further testing of individual pump performance will be continued and corrective action will be taken on pumps with low efficiency at the higher flows (it is believed that impeller replacement will correct the low cavitation cut-off on most pumps) and, (2) sustained seven pump operation would only be considered when required because of equipment failure on any part of the system which would limit maximum flow. At a reactor demand flow of 98,000 gpm for eight pump operation, each pump during seven pump operation would provide about 13,500 gpm. This flow is considered safe from cavitation cut-off but is in the range of increased impeller erosion and possible cavitation damage.

Installation of new impellers in the process pumps, designed for greater flow at lower discharge pressure, has been considered previously for increased reactor flow¹. Based on lowering the reactor flow resistance by new process tubes and/or fuel design, installation of new impellers is necessary to gain significant flow increases.

If new design impellers can provide the desired pump characteristics at higher flow with the lower discharge pressure, motor input horsepower during sustained seven-pump operation could become the limiting factor. Based on a target flow of 108,000 gpm for eight-pump operation, the input horsepower to the motors would be about 5400. Sustained seven-pump operation would require about 5650 input horsepower. This is less than the maximum of 5750 input established for the drive motors¹, but it is believed (because of age and maintenance problems experienced with the motors) that further increases in motor load should not be made until operating experience has been gained.

The main concern in increasing the input horsepower to the motors is the motor winding temperatures. The rotor bar cracking recently experienced in the motors resulted from the starting duty requirement and should not be aggravated by increased input horsepower to the motors⁶. When the

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planned exchanges are completed, 190-B will have seven motors with Class "B" insulation and one motor with Class "A" insulation. The probable motor winding temperature at increased input horsepower should be better established.

6. 190-C Process Pumping

Ten-pump operation in 190-C is producing about 108,000 gpm through reactor flow. The load on No. 8 pump drive motor (Class "A" insulation) is being limited because of motor winding temperature. Insulation in all other motors is rated as Class "B" or better, and the motors are operating within the limitations without load restrictions. The drive motors with the exception of No. 8 are operating at about 4100 input horsepower. This load would increase to about 4300 input horsepower during sustained nine-pump operation. The motors are operating at about 20% overload. This is possible because of the upgraded insulation. The maximum safe input horsepower has not been determined.

The gear units within the pump units are considered by the manufacturer to be suitable for 4100 input horsepower demand at a service factor of 1.4⁷.

Reactor flow is controlled by pump speed obtained through the fluid drive located between the speed increaser and flywheel in the pump unit. At the present reactor flow during ten-pump operation, approximately 50% of the fluid drives are operating in the fully-clutched position; however, fluid drive oil is being maintained at the desired temperature with low cooling water flow.

It appears that the fluid drives may be the first limiting factor in flow increases. It is the opinion that no gain can be accomplished in fluid drive output by clutch adjustment⁸. The fluid drives are operating at about 7% over maximum duty input horsepower as per the manufacturer's specification at the time of purchase. New design rotors, however, were installed in the drives because of failure of the original rotors. Maintenance experience with the drives has been good since the installation of the new design rotors.

Plans have been made for tests to determine the reactor hot flow that can be sustained during nine pump operation. This test should better determine the capability of the fluid drives as well as other equipment within the pump unit. It appears that some flow increase may be obtainable with existing equipment without modification if the reactor flow resistance is lowered.

If the target flow of 115,000 gpm, however, is obtained, it appears necessary from information to date to make some equipment modification or replacement. If extensive modification or replacement of existing equipment is required, a more economical and better functional system can be obtained by installation of one additional process pump unit. Installation of additional pumps for increased reactor flow was previously considered¹. There are two spare pump foundations in the 190-C pump room.

Utilization of a process pump unit from 190-F or 190-H should be considered. These pumps have too high a discharge head for the 190-C system, and would require (1) installation of a new impeller designed for lower discharge pressure, (2) operating with a throttled discharge valve or (3) procurement of a new pump. Procurement of a new pump, compatible with existing flow conditions, would provide more efficient and satisfactory operation. A new pump would cost about \$30,000. An additional transformer at 190-C would be required for the pump. Modification to the spare pump foundation would be required because of the different dimensional size of the pump unit and the larger O.D. flywheel.

Installation of an additional pump with corresponding lowering of reactor flow resistance by new process tube and/or fuel design would provide about 115,000 gpm through-reactor flow.

B. D Water Plant

1. 181-D River Pump Facilities

Maximum pumping capabilities are based on flow at low river elevation or low river flow periods normally experienced from October through March. The capacity of the pumps in 181-D system, including any export requirements, is about 119,000 gpm which is adequate for any flows considered for D Water Plant. Also the 181-DR pumps which are not being utilized at the present time have a capacity of about 80,000 gpm.

2. 183-D Filter Capacity

183-D has 16 filters with a total capacity of about 120,000 gpm, which is adequate for any flows considered for D Water Plant.

3. 183-D Process Pumping

The seventh process pump (15,000 gpm - 150 ft. hd., 700 HP) was installed during FY 1966. Flows as high as 101,000 gpm have been obtained with seven pump operations⁹. Also, check valves were installed in the two 190 Storage Tank bypass lines to allow usage of these lines to supply flow to 190 Process Pumps. Operating conditions have prevented sufficient tests to determine the gain in flow from 183-D to 190-D that can be expected from the use of the 190 Tank bypass lines. For purposes of this report this gain is estimated at 3,000 gpm. It may be substantially greater.

To meet the target flow requirements, some piping modification or the installation of an 8th process pump would be required. Depending upon further testing and study, the primary piping modification would be replacement of the 20" check valves in the four storage tank inlet lines with 24" check valves or increasing the size of process pump discharge lines. It might be more desirable for maintenance flexibility to install the 8th process pump.

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4. 190-D Process Pumping

Flow conditions and equipment modification are essentially the same as for the 190-B Process Pumping discussed previously. When the planned exchange of pump drive motors is completed, 190-D will have seven motors with Class "A" insulation and one motor with Class "B" insulation.

5. 182-D Export Pumping

At present, two motor driven, 6000 gpm pumps and two motor driven, 3000 gpm pumps are installed in 182-D for export pumping. If the export pumping was transferred to 182-D, it would be necessary to exchange the two 3000 gpm pumps for 6000 gpm pumps and install one additional motor-driven 6000 gpm pump. This is based on an export requirement of 23,000 gpm. The 181-DR pumps could provide raw water flow to the 182-D Reservoir for export purposes with minor modifications. Piping modifications at 181-B would be required to reduce head loss in directing the existing export flow to 183-C.

VI. ACKNOWLEDGMENTS

The assistance of C. E. Harkins and R. B. Crum, B-C Power Operation, G. D. Geise and R. J. King, D Power Operation, and J. W. Hedges and C. R. Oak, Plant Engineering-Mechanical, in establishing flow and equipment data is gratefully acknowledged.

RMS:jmf

VII. REFERENCES

1. HW-64458 (Secret) "Water Plant Modifications for Increased Production at B, C, D, DR, F, and H Reactors" by L. B. Brinkman and J. P. Corley, April 15, 1960.
2. Letter, "Fuel Element and Tube Dimensions, Increased Flow at B and D Reactors", S. M. Graves to R. W. Reid, November 21; 1966.
3. Personal communication - C. E. Harkins and R. B. Crum.
4. RL-REA-2383, "Cavitation Tests - 190 F Annex Pumps" by C. R. Oak, July 22, 1965.
5. Pump Cavitation Data - 190 D, by C. R. Oak, November 4, 1965.
6. Personal communication - P. E. Lindstrom.
7. Letter, "Pump Drive, Model 160HS230, AEC Order DC 61231, 1952", from Western Gear Corporation to C. R. Oak, August 18, 1966.
8. Personal communication - E. P. Skow.
9. Personal communication - R. J. King

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B-C WATER PLANT
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FROM 185-B

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BASINS - 183C
C-WATER PLANT
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TO 183-D

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