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MAXIMUM CAPACITIES OF THE 100-B WATER PLANT

INTRODUCTION

Increases in process water flows will be needed as the current program of increasing pile power levels continues. The future process water flows that will be required are known to be beyond the present maximum capacities of component parts of the water system. It is desirable to determine the present maximum capacities of each major component part so that plans can be made for modifications and/or additions to the present equipment to meet future required flows.

The apparent hydraulic limit of the present piles is about 68,000 gpm. This figure is based on a tube inlet pressure of 400 psi, a tube flow of 34 gpm, (1) and 2,000 effective tubes.

In this document the results of tests and calculations to determine the present maximum capacities of each major component part of the 100-B water system will be presented. Emergency steam operated pumps will not be considered as it is doubtful if year around operation of a steam driven pump could be economically justified.

Some possible ways to increase the process water flows of each component part of the water system to the ultimate of 68,000 gpm will be given.

SUMMARY

The present capacity of each major component of the 100-B water plant has been obtained by test or calculation. The results are tabulated in Table I.

From Table I it is seen that the 183 filter plant is limiting at about 38,000 gpm, based on present knowledge of filtering rates. By using the alum activated silica process rather than the present ferric sulfate process, and by constructing three additional units, each consisting of flocculators, sedimentation basin, filter, and complementary equipment, the process flow could be brought up to 68,000 gpm guaranteed year around. The next limiting flow is 48,000 gpm from the 183 process pumps. To raise the capacity of the 183 pumps to 68,000 gpm, an additional process pump plus a separate pump to supply the 187 high tanks should be added. The 182 process pumps are next limiting at 49,000 gpm. The addition of three process pumps would bring the flow up to 68,000 gpm. To bring the capacity of the 181 pumps to 68,000 gpm process flow, three more process pumps would be needed. The 190 pumps as calculated from available characteristic curves are limiting at 51,000 gpm. It would require at least four additional units to increase the capacity of the 190 pumps to 68,000 gpm at a primary pump speed of 2,560 rpm.

(1) Roy, G. M., Locke, G. L., "Increase of Pile Operating Level Through Use of Enlarged Pigtails", HDC-2051, March 2, 1951.

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TABLE I

A SUMMARY OF THE PRESENT AND POSSIBLE MAXIMUM FLOWS
OF THE MAJOR COMPONENTS OF THE 100-B WATER PLANT

Component	Change	Present Maximum, gpm	Maximum with Change, gpm	Non Process Use, gpm	Process Flow, gpm
181 Pumps (Under worst conditions of extreme low river level)	Add 1 process pump	55,000	63,000	5,000	50,000
	Add 2 process pumps		71,000	5,720	57,200
	Add 3 process pumps		78,000	6,450	64,500
				7,100	71,000
182 Pumps	Add 1 process pump	54,000	61,000	4,900	49,000
	Add 2 process pumps		68,000	5,500	55,000
	Add 3 process pumps		75,000	6,200	62,000
				6,800	68,000
183 Filters (Period of high turbidity)	Add Alum Activated Silica	42,000	60,000	3,800	38,000
	Plus 1 additional unit		65,000	5,450	54,500
	Plus 2 additional units		70,000	5,900	59,000
	Plus 3 additional units		75,000	6,350	63,500
				6,800	68,000
183 Pumps	Add 1 process pump	48,000	58,000		48,000
	Add separate pump to supply 187 high tanks		58,000		58,000
	Add 1 process pump plus separate pump to supply 187 high tanks		70,000		70,000
190 Pumps	Add 1 process unit	51,000	55,200		51,000
	Add 2 process units		59,500		55,200
	Add 3 process units		63,700		59,500
	Add 4 process units		68,000		63,700
					68,000

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DISCUSSION

To determine the maximum pumping capacity of each major component part of the 100-B water system, actual operating tests were performed wherever possible. The maximum flows were determined at 181, 182, and 183 by actual test. The 190 pump flow was determined by means of a graphical solution using available characteristic curves. Filter capacity was estimated from past experience throughout the 100 areas. Below are discussions of the determinations of maximum flows of each major component part of the 100-B water system.

181-B*

There are six 181-B electric process pumps, each rated 10,000 gpm at 150 foot total dynamic head.

The maximum capacity of the 181-B process pumps was determined by measuring the rate of fill-up of the 15 million gallon side of the 182-B reservoir while all pumps were operating and the inlet houses' valves were wide open. The rate of fill-up was measured by the use of a float in the 182-B reservoir flume. The float was placed in a vertically suspended five inch aluminum tube four feet long. Two stop watches were used, one to time the 1/4 inch rises and the other to time the 4, 5, 6, and 7 inch rises.

It was found that the maximum 181-B electric process pump capacity was about 58,400 gpm with a river elevation of approximately 388 feet. By use of the vendor's pump characteristic curve it is estimated that the maximum capacity will vary from 55,000 gpm to 66,000 gpm as the river elevation varies from extreme low to extreme high.

To reach the ultimate flow of 68,000 gpm plus 10 per cent for non process use or a total of 74,800 gpm it is estimated that three additional 181 process pumps would be needed.

182-B*

Seven 182-B electric process pumps are located in the 182-B pump room. Each pump is rated 6,000 gpm at 100 foot total dynamic head.

The seven 182-B pumps were operated simultaneously at the lowest required head to supply water to the filter plant. The maximum total flow was found to be about 54,000 gpm.

To reach the ultimate flow of 68,000 gpm plus 10 per cent for non process use, or a total of 74,800 gpm, it is estimated that three additional pumps will be required.

183-B Filters

The 183-B filter plant consists of 12 filter units each of 1,152 sq.ft. of filter area or a total of 13,824 sq.ft.

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* Test was conducted by 100-B Power.

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Due to the variation of raw water quality a maximum capacity test of the filters would give data applicable only to the test period. The period of approximately February through June is usually a period of high raw water turbidity. The filter runs during this time are relatively short, with a consequent increased backwash demand and non process use up to about 10 per cent.

With the ferric sulfate treatment now used at 100-B Area, tests have shown that during the period of high turbidity the average filter flow can be maintained at about 3,500 gpm per filter or a total of 42,000 gpm. Subtracting 10 per cent for non process use this gives an approximate figure of 38,000 gpm which could be considered a guaranteed year around flow. Tests now being performed by the Process Sub-Section will provide more accurate data concerning filter rate limits.

To increase the 100-B filter capacity the alum activated silica process could be used. With this process the maximum flow per filter during the period of high turbidity would be about 5,000 gpm or a total flow of about 54,500 gpm with 10 per cent for non-process use subtracted.

It seems that to increase the filter capacity to the ultimate of 66,000 gpm process flow during difficult treatment periods, three additional treatment units would be needed. Each treatment unit would consist of flocculators, basin, and filter.

It is possible that a flow of 6,000 gpm per filter may be attained during difficult treatment periods. This would give a total flow of about 65,500 gpm with 10 per cent subtracted for non process use. Only one additional treatment unit would be needed in this case.

183-B

There are four 183-B electric process pumps each rated 10,000 gpm at 230 foot total dynamic head.

The maximum capacity of these pumps was found by determining the rate of fill-up of the previously lowered 190 tanks. Preparations for the test consisted of lowering the level of the four 190 tanks approximately 11 feet, attaching a 50 foot steel tape to each of the tanks' level indicators to be read from a reference mark, opening wide all valves in the system, and using a separate steam powered pump to supply the 187 high tanks. After preparations were completed, all four 183-B electric process pumps were operated and the rate of rise of the 190 tanks' water level was recorded. Simultaneously, the rate of flow leaving the tanks was recorded and this rate added to the rate of fill-up gave a total maximum flow of about 58,000 gpm.

It is estimated that the maximum flow obtainable while operating the four 183 pumps at a head sufficient to supply the 187 high tanks would be about 48,000 gpm.

With the addition of one more 183 pump it is estimated that the total maximum flow would be at least 68,000 gpm in the case where a separate pump feeds the 187 high tanks. With the process pumps supplying the 187 high tanks, the addition of one more pump would increase the maximum total flow to an estimated value of about 58,000 gpm.

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190-B

There are twelve 190 process pump units. Each unit consists of a steam turbine driven primary pump rated 3,000 gpm at 352 foot total dynamic head at 2,100 rpm and an electrically driven secondary pump rated 3,000 gpm at 560 foot total dynamic head.

The maximum permissible secondary pump discharge pressure is about 425 psig. At a secondary pump discharge pressure of 425 psig the orifice pattern dictates the flow and would have to be enlarged in order to accommodate greater flows at a pump discharge pressure of 425 psi.

An approximate method of testing the maximum capacity of the 190 pumps is to cut pumps off the line while the remaining pumps increase in speed to maintain the required discharge pressure. The flow per pump unit is then obtained when the remaining turbines reach governed speed. This test has not been run as yet.

Based on available characteristic curves, a plot of secondary pump rpm versus total flow at a constant discharge pressure of 425 psig is shown on Figure 1. This plot assumes an appropriate orifice pattern for each condition.

At the primary pump governed speed of 2,560 rpm the total maximum 190 pump flow is in the neighborhood of 51,000 gpm. To reach a capacity of 68,000 gpm, four additional units would be needed.

CONCLUSIONS

From the results of these tests and calculations it can be concluded that:

1. The present capacity of the 100-B Area's water system is 38,000 gpm process flow limited by the filter plant during difficult treatment periods.
2. To reach the ultimate flow of 68,000 gpm would require the addition of three pumps at 181, three pumps at 182, the addition of three more water treatment units plus a conversion to the alum activated silica process at the 183 filter plant, one additional 183 process pump plus a separate pump to supply the 187 high tanks, and four 190 process pump units.

RECOMMENDATION

On the basis of these tests and calculations it is recommended that economic studies be made to determine the optimum extent of expansion of the 100-B water plant with regard to future feasible increases of pile productivity.

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PRIMARY PUMP SPEED VS TOTAL 190-B PROCESS
FLOW AT 425 PSIG SECONDARY DISCHARGE PRESSURE
FIGURE 1

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