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DATE July 3, 1951

SUBJECT Memo on Process Water Refrigeration
A Current Evaluation, 100 F. D. & DR Areas

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FROM SL Nelson

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July 3, 1951

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MEMO ON PROCESS WATER REFRIGERATION
A CURRENT EVALUATION - 100-F, 100-D AND 100-DR AREAS

INTRODUCTION

The policy of operating the Hanford Piles at the highest level attainable under existing standards has resulted in pile levels being occasionally limited by maximum permissible exit water temperatures. The practicability of using refrigeration to reduce the inlet water temperature during peak periods and so increase pile levels has been reviewed and is discussed in this document.

For the purpose of estimating the maximum usefulness of refrigeration an outlet water temperature limitation of 80° C has been assumed. It has also been assumed that full operating advantage could be taken of lowered inlet water temperatures.

SUMMARY AND CONCLUSIONS

Only the 100-D and 100-F Areas were originally equipped with refrigeration facilities, part of which are still in place. These two areas are therefore assumed to represent the most favorable economic conditions for the start-up and use of refrigeration. Evaluations are presented here for the F, D and DR Piles. Since the figures are estimates, they have been rounded off for convenience. Cost estimates are conservative rather than liberal. A summary tabulation follows.

File	Cost of Renovation	Annual Cost Of Operation	Maximum Possible MWd Gain	Gross Value of Gain @ \$22/MWd
100-F (2 units)	\$ 10,000	\$ 50,000	1500	\$33,000
100-D (6 units)	200,000	150,000	3200	70,000
100-DR (6 units)	275,000	150,000	4200	92,000

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In addition to the economic aspects of refrigeration the following must also be considered.

1. Four 10,000 GPM pumps required for operation of the 100-F Area refrigeration, are allocated to construction of the C Pile water area. Their retention at the 100-F Area would seriously delay completion of the C Pile.
2. At the 100-D and DR Areas, five 10,000 GPM pumps and considerable electrical equipment (originally part of the 100-D refrigeration system) are now incorporated into the DR Pile water supply system.
3. Temperature limitations currently affecting pile levels are under intensive study and may well be revised. This is particularly true of maximum outlet water temperature limits.
4. Essentially, any gains which might be achieved through refrigeration could also be achieved by additional cooling water at a lower or comparable cost; e.g., a gain of 5000 or more MMD during the summer months, can be obtained at the DR Pile by orifice changes costing approximately \$7500.

A comparison of costs with the value of the MMD to be gained indicates that refrigeration is economically unsound. Other considerations make it apparent that under any presently foreseeable conditions refrigeration is also infeasible, particularly since equivalent power level gains could be achieved by additional cooling water and larger orifices at a lower cost.

DISCUSSION

Pile exit water temperatures may be limiting to pile levels during the summer months when river temperatures are highest. One method of overcoming this limitation is to refrigerate the inlet water. Equipment to do this was originally installed at the 100-D and 100-F Areas, but laid away when its use was found to be unnecessary at levels then in effect.

This document assumes an outlet water temperature limitation of 80° C. Under an 85° maximum outlet temperature limitation refrigeration would be even less attractive than is here indicated.

In examining the economic feasibility of reactivating refrigeration equipment, document HW-14369, "Economics of Process Water Refrigeration", dated September 12, 1949 was used as the main source of basic data. Where factors affecting estimates are known to have changed, the figures have been adjusted to conform more closely to known conditions. Reactivation and construction cost estimates are consistently low and any refinements to cost figures would be upward rather than downward. There has been a general rounding-off of all figures used in calculations. A more detailed evaluation would require extensive studies and construction estimates which are not readily obtainable. Following are details of the economic aspects of refrigerating process water in 100-B, D and DR Piles developed on the above basis.

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Part I - 100-F Area

Two units of the 100-F refrigeration system are essentially intact. The other two units have been excessed and sold. The remaining equipment is in a "laid away" condition and would probably require a Class A overhaul in addition to being returned to service. The four pumps (10,000 GPM capacity each) required to furnish cooling water to the unit condensers have been allocated to construction of the C Pile water area. While they are not yet removed, their withdrawal from C Pile use would seriously delay essential construction. Their replacement cost is not included in these estimates.

Cost of reactivating (2 units)	\$10,000
Annual operating costs (4 months per year)	\$50,000
Water temperature reduction	2° C
Increased level	14 MW
M&D/four month period	1500 M&D
Value @ \$22/M&D	\$33,000

Part II - 100-D Area

The 100-D Area was originally equipped with six refrigeration units. Three of these are laid away in place and three are removed and in storage. Of the three units in storage, one has been partially dismantled. The five condenser water supply pumps (10,000 GPM capacity each) are being used to supply raw water to the DR filter system. New pumps would require additional building space and probably considerable excavation. Additional pipe line would also be required. A considerable amount of the original electrical switching and connecting equipment has been removed and is being used in the 100-DR Area. Replacement equipment would have to be procured and installed before these units could be returned to service.

Cost of reactivating (6 units)	\$200,000
(including condenser pumps)	
Annual operating costs (4 months per year)	\$150,000
Water temperature reduction	5° C
Increased level	30 MW
M&D/four month period	3200 M&D
Value @ \$22/M&D	\$70,000

Part III - 100-DR Pile

As an alternate possibility, use of the six available 100-D units for refrigerating DR Pile cooling water is considered. Reactivation and operating costs would be essentially the same as for the 100-D Pile except that a new feeder line would be required to transport the refrigerated water from the 189-D Building to some point in the DR water supply system. The cost of this line would be at least \$75,000. A detailed estimate might well prove to be considerably higher.

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Cost of activating equipment to supply DR Pile with refrigerated water	\$275,000
Annual operating costs (4 months per year)	\$150,000
Water temperature reduction	5°
Possible gain in production over a 4 month period (June, July, Aug. and September)	\$4200
Value @ \$22/MWD	\$92,000

*Abstracted from figures given in document HW-20889, "Outlet Water Temperature Limitation on the DR Pile Power Level", page 2.

Part IV - Other Considerations

It is obvious that if the value placed on an MWD were increased to several times the amount of the figure used here (\$22.00) any conclusions regarding the economic feasibility of refrigeration would be drastically affected. The ultimate decision as to the practicability of using refrigeration for process water need not, however, be determined by this value.

Recent data point to the possibility that corrosion may be more affected by slug heat generation than outlet water temperature. For this reason, some revision to the outlet water temperature limit appears likely.

As discussed in document HW-20889, "Outlet Water Temperature Limitations on the DR Pile Power Level", page 3, an equivalent production gain greater than that obtainable by refrigeration may be realized simply by supplying another 3000 GPM of process water to the DR Pile and changing approximately 1100 orifices. The extra water is available and the estimated cost of \$7500 for orifice changing is considerably less than the cost of providing refrigeration. There would be no added cost of operation. In general, this same comparison could be applied to other 100 Areas. Where refrigeration would result in a gain, additional cooling water and larger orifices would accomplish the same MWD gain at smaller overall cost.

The net result of this study is to indicate that the use of refrigeration is completely unattractive under present or foreseeable conditions.

S. L. Nelson
Process Control
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