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EVALUATION OF THE HAULING OF ACTIVATED SILICA

Prepared by: W. L. Pearl

October 5, 1953

PROCESS ENGINEERING SUB-SECTION
DESIGN SECTION - ENGINEERING DEPARTMENT
GENERAL ELECTRIC COMPANY
HANFORD ATOMIC POWER OPERATION

This document has been reviewed and approved by the appropriate members of the Process Engineering Sub-Section as a portion of the engineering basis to be used in the preparation of a project proposal for requesting funds for conversion of existing water treatment processes to the alum-activated silica process.

Design Analysis

Design Analysis

Head, Reactor Design and Development

Manager, Process Engineering Sub-Section

EVALUATION OF THE HAULING OF ACTIVATED SILICA

- References: (1) Wolcott, J. R. and Roy, G. M.
"An Engineering and Economic Evaluation of Proposed
Modifications To Existing Reactor Plants - RDS-10
and RDS-11" HW-29238
Dated September 4, 1953
(2) Nixon, V. D. to Beaton, R. H.
"100-D Activated Silica Water Treatment Facility"
Dated November 3, 1952

I. INTRODUCTION

A project proposal is now under preparation for converting all areas to the alum and activated silica coagulation process, and modifying the present test installations to permanent facilities. The conversions will be designed to service increased water flows resulting from the reactor plant expansion program now under study. As an alternate to the installation of permanent facilities at the various areas, the possibility of hauling already prepared activated silica from those areas having excess capacity to those areas requiring large capital expenditures was suggested.

II. PURPOSE

The purpose of this study is to make an economic evaluation of the operating costs of hauling activated silica compared to the increased capital investment necessary to manufacture activated silica at various areas.

III. SUMMARY AND CONCLUSIONS

Activated silica was successfully hauled from C Area to D Area in January and February of this year by means of a 5000 gallon tank trailer. Sufficient activated silica for hauling to Areas B, D-DR, F, and H will be available when the K Area installations are completed. No difficulty is anticipated in hauling 1.5 per cent by weight SiO_2 compared to the 1.0 per cent material.

Based on several assumptions detailed herein, the hauling of 1.5 per cent activated silica compared to building permanent manufacturing facilities for planned 1954 flow rates is economically attractive for B and H Areas but not attractive for D-DR and F Areas. The amortization periods were 3.9 years for H Area, 6.9 years for B Area, and less than 2.5 years for D-DR and F Areas. The permanent type facility appears justified (see page 10) at flows being considered in the reactor plant modification program (reference (1)) based on amortization periods of less than 2.5 years for B, D-DR, and F Areas, and 3.2 years for H Area.

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IV. RECOMMENDATIONS

Based on the amortization periods established herein and summarized in Table VI, it is recommended that:

- A. The construction of activated silica facilities at B and H Areas be accomplished in two parts:
 1. Hauling facilities be installed at B and H Areas for immediate hauling from C Area and later from K Area manufacturing facilities.
 2. If the proposed flows for the reactor plant modification program become firm at the flows recommended in reference (1) (Case 7), the hauling facility at H be converted to a permanent manufacturing facility and the hauling facility at B be converted to a permanent installation to receive activated silica through a pipe line from C. If the flows become firm at a rate closer to Case 4 of reference (1), it is recommended that hauling to B and H Areas be put on a permanent basis.
- B. No hauling be considered further at D-DR or F Areas.

V. GENERAL

In reference (2) a plan for D Area storage and distribution of activated silica hauled from C Area was outlined. Though the hauling alternate was not accepted because of lack of construction time, activated silica was hauled from C Area to D Area from January 13 to February 22, 1953, in sufficient quantity to feed D and DR Areas. A 5000 gallon tank truck was available for the operations. About three hours were required for a round trip including loading and unloading the batch. The actual costs for hauling activated silica for D and DR Areas were well below those estimated in reference (2) for only D Area.

VI. AVAILABILITY OF ACTIVATED SILICA

A sufficient supply of activated silica should be available from manufacturing facilities existing or under construction if hauling should be desirable. The C Area facility is capable of manufacturing sufficient activated silica for treating 160,000 gpm of raw water with 5 ppm activated silica (as SiO_2). This capacity should be sufficient to supply C Area and H Area through the winter of 1954 when their combined flows to be treated are scheduled to be about 150,000 gpm. B Area is scheduled to be converted to alum and activated silica in April 1954. The existing C Area facility would not be capable of supplying

B Area in addition to C and H Areas. The three areas would be treating a total of about 200,000 gpm. C Area could be made to handle this amount by (1) feeding activated silica at a maximum rate of 4 ppm, (2) increasing the size of the aging tank by about 25 per cent, or (3) increasing the aging concentration from 1.5 per cent to 1.9 per cent. The last method is presently under investigation by the Pile Technology Sub-Section.

It will be assumed for the present calculations that C Area will be capable of supplying activated silica to C, B, and H Areas through 1954. If some difficulty should arise during peak usage, the present installation at F Area could supply a portion of the load at H Area. It would be necessary to hire an additional operator for the activated silica system at F Area during this time (see reference (2)).

By the end of 1954, the K Area activated silica facilities would be available for manufacturing activated silica. Each K plant will be capable of manufacturing sufficient activated silica for treating about 300,000 gpm of raw water with 5 ppm activated silica. If C Area will supply C and B Area needs, the two K Area plants will have sufficient capacity to supply the requirements of the remaining areas even at the proposed flows given in reference (1).

VII. ASSUMPTIONS

The economic evaluation of the hauling proposal will be based on the following assumptions.

- A. The water flow to each reactor will remain as presently scheduled (schedule supplied by Process Sub-Section of Reactor Section) until the expansion program outlined in reference (1) becomes a fact. These flows are summarized in Table I. A January 1, 1954, date of project fund authorization has been assumed. A test period of about six months between completion of the first area and completion of the second area has been used in the calculations. The expanded flow rates are based on ultimate debottlenecked capacities anticipating the use of smaller slugs.

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TABLE I
Predicted Flows to Reactors

<u>Area</u>	<u>Flow gpm</u>	<u>Effective Date</u>	<u>After Expansion</u>	
			<u>Flow gpm</u>	<u>Probable Effec- tive Date</u>
B	46,000	Feb. 1954 (Alum April '54)	70,000	March 1955
C	83,000	Nov. 1953	105,000	March 1955
D	47,000	Unchanged	70,000	Nov. 1955
DR	48,000	May 1954	70,000	Feb. 1956
F	46,000	Jan. 1954	70,000	Aug. 1956
E	57,000	Jan. 1954	72,000	May 1956

For the purpose of the present calculations, a flat 10 per cent is added to the reactor flows to arrive at the total flow through the filter plants that must be chemically treated.

- B. Sufficient activated silica will be available for hauling as outlined above.
- C. Five Thousand gallon tank trucks will at all times be available for the hauling of the silica solution. Thus, tractor and trailer may be purchased especially for this job or may be obtained from the present motor stock. The rental on said units will be:

Truck-tractor \$113/month
Trailer \$95/month

The Transportation Department controls various size tank trucks. Two 5000 gallon trucks have been assigned to the 300 Area as part of Project C-394 but have not been put to full use as yet. One of these was used for hauling activated silica in January and might be available through another winter. Several water and brush fire fighting trucks of 1500 to 4000 gallon capacity might be available especially during the months of December through May when they would be most needed for activated silica.

Any of the above tank trucks would be used on a temporary basis. To be assured of proper hauling facilities at least a portion of the required tank capacity should be budgeted for in the project proposal. The cost of a 5000 gallon tank trailer is \$10,000. The tractor for pulling the trailer would be \$13,000 for a total of \$23,000 for the combination.

- D. The time for loading, delivering, and unloading a 5000 gallon batch and returning to the source of supply will be three hours.
- E. The truck operator's time will be charged for at \$5.50/hour. (\$15.90 per 5000 gallon batch.) Since the areas under consideration for handling will have 35,000 gallons activated silica storage tanks, it is anticipated that the truck operator's time can be properly scheduled to keep this rate valid. The operator is furnished only when requested but will probably have to be paid for a full eight hours on night shifts since little other work is available for drivers on night shift. Occasional overtime is included as part of the hourly charge rate and requires no special allowance.
- F. No additional Power Sub-Section personnel will be required for the loading or unloading of the trucks. This may be an excessive burden at C Area during the winter of 1954, but will probably be required because of construction schedules regardless of the type of activated silica facility built at H. The labor should not be too much problem at the K Areas where the predicted load on the headhouse operator is not expected to be normally as great as at the present areas.
- G. Filter plant operation will be based on 28 days per month at rated flow.
- H. The flow during downtime for the expansion program will be 15 per cent of normal.

VIII. CAPITAL COSTS

An estimate has been made of the cost of permanent activated silica manufacturing facilities at D, F, and H Areas and piping activated silica from the C installation to B Area. In Table II the costs of these facilities are compared to the capital costs of storage and feeding facilities at the same areas to utilize the manufacturing capacities of the C and K Areas.

TABLE II

Estimated Costs Of Manufacturing And Hauling Installation

Area	Manufacturing	Hauling
B	\$82,000*	\$26,000
D	69,000	4,000
F	60,000	26,000
H	95,000	26,000

*Will be manufactured at C Area and piped to B Area.

The complete descriptions of the permanent facilities are available in individual criteria with accompanying drawings issued for each area concerned. The facilities in connection with hauling will consist of a large activated silica storage (surge) tank (35,000 gal), a pump for unloading a tank truck into the storage tank, some means of dilution of the solution being unloaded from 1.5 per cent to 1.0 per cent, two pumps (one spare) for feeding the activated silica through rotameters into the raw water lines, and all required piping and accessories.

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IX. OPERATING COSTS

Table III shows how the hauling charges would accumulate at H Area based on the flows and assumptions set forth earlier. The table is developed for hauling both 1 per cent solution and 1.5 per cent solution. The latter would be the more economical of the two and should offer no difficulties.

The cost of hauling to other areas was developed in a similar manner. It was assumed in the calculations that hauling to H Area would be the most attractive economically, and hauling to any other area would be in addition to hauling to H Area.

Table IV gives a summary of the hauling costs at all areas concerned. The costs give proper weight to the expected downtime in each area resulting from the expansion program.

TABLE IV

Operating Costs For Hauling
Activated Silica

Year	1% Solution				1.5% Solution			
	H	B	F	A-DR	H	B	F	A-DR
1954	\$17,000	\$ 8,000	\$13,000	\$26,500	\$12,000	\$ 5,000	\$ 8,000	\$18,000
1955	17,000	16,000	13,000	27,000	12,000	10,500	8,000	18,500
1956	14,000	19,500	10,500	39,500	10,000	14,000	7,500	27,000
1957	21,500	19,500	19,500	40,000	14,500	14,000	14,000	27,500

X. PAY-OFF PERIODS

From Table II and Table IV, the number of years that the capital investment and operating costs of the hauling system would take to equal the capital investment in the manufacturing facility can be developed. Rather than treat each area individually, the over-all hauling picture must be considered as a unit. Because of the large initial capital investment for a manufacturing facility, H Area appears the most attractive economically for consideration of a hauling facility. Hauling to B Area appears next most attractive with F, and D-DR Areas the least. In developing amortization times, it is assumed that if any hauling is to be done, B Area would only be in addition to H Area and F Area and/or D-DR Areas in addition to B and H Areas. The number of 5000 gallon tank trailers required to adequately haul the activated silica are tabulated in Table V.

TABLE III

COST FOR HAULING ACTIVATED SILICA TO H-AREA

Month	Expected Average Feed Rate ppm	1% SiO ₂ Solution				1.5% SiO ₂ Solution			
		Truck and Trailer Rent \$	No. 5000 Gal Batches	Cost \$	Total Accumulated Cost \$	Truck and Trailer Rent \$	No. 5000 Gal Batches	Cost \$	Total Accumulated Cost \$
Jan. 54	1	208	51	\$ 811	\$ 1,019	208	34	\$ 541	\$ 749
Feb.	3	208	152	2417	3,644	208	101	1606	2,563
Mar.	3	208	152	2417	6,269	208	101	1606	4,377
Apr.	4	208	203	3228	9,705	208	135	2147	6,732
May	4	208	203	3228	13,141	208	135	2147	9,087
June	3	208	152	2417	15,766	208	101	1606	10,901
July	0.5	208	25	398	16,372	208	17	270	11,379
Aug-Nov	0	0	0	0	16,372	0	0	0	11,379
Dec.	0.5	208	25	398	16,978	208	17	270	11,857
Jan. 55	1	208	51	811	17,997	208	34	541	12,606
Feb.	3	208	152	2417	20,622	208	101	1606	14,420
Mar.	3	208	152	2417	23,247	208	101	1606	16,234
Apr.	4	208	203	3228	26,683	208	135	2147	18,589
May	4	208	203	3228	30,119	208	135	2147	20,944
June	3	208	152	2417	32,744	208	101	1606	22,758
July	0.5	208	25	398	33,350	208	17	270	23,236
Aug-Nov	0	0	0	0	33,350	0	0	0	23,236
Dec.	0.5	208	25	398	33,956	208	17	270	23,714
Jan. 56	1	208	51	811	34,975	208	34	541	24,153
Feb.	3	208	152	2417	37,600	208	101	1606	26,277
Mar.*	3	208	23	366	38,174	208	15	239	26,724
Apr.*	4	208	30	477	38,859	208	20	318	27,250
May	4	416	255	4055	43,330	208	170	2703	30,161
June	3	208	191	3037	46,575	208	127	2019	32,388
July	0.5	208	32	509	47,292	208	21	334	32,930
Aug-Nov	0	0	0	0	47,292	0	0	0	32,930
Dec.	0.5	208	32	509	48,009	208	21	334	33,472
Jan. 57	1	208	64	1018	49,235	208	43	684	34,364
Feb.	3	208	191	3037	52,480	208	127	2019	36,591
Mar.	3	208	191	3037	55,725	208	127	2019	38,818
Apr.	4	416	255	4055	60,196	208	170	2703	41,724
May	4	416	255	4055	64,667	208	170	2703	44,640
June	3	208	191	3037	67,912	208	127	2019	46,867
July	0.5	208	32	509	68,629	208	21	334	47,400
Aug-Nov	0	0	0	0	68,629	0	0	0	47,400
Dec.	0.5	208	32	509	69,346	208	21	334	47,951

shown for Expansion Program

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TABLE V

No. Tank Trucks Required For Hauling Activated Silica

Area	1% Solution		1.5% Solution	
	1954 Planned Flows	Reactor Mod Flows	1954 Planned Flows	Reactor Mod Flows
H	1	2	1	1
H / B	2	3	1	2
H / B / F	3	4	2	3
H / B / D & DR	3	5	2	3
H / B / D & DR / F	4	6	3	4

A cost of \$23,000 has been added into the capital costs shown in Table II for the hauling alternate for each tank trailer and tractor combination required. The resulting periods of amortization are summarized in Table VI.

TABLE VI

Time Of Amortization of Permanent Facility
Compared To Hauling Facility

Area	Years			
	1% Solution		1.5% Solution	
	1954 Planned Flows	Reactor Mod Flows	1954 Planned Flows	Reactor Mod Flows
H	2.7	1.1	3.9	3.2
B Only (After H is in)	2.5	1.7	6.9	2.4
F Only (After B&H are in)	0.8	0.6	1.4	0.8
D&DR Only (After B&H are in)	1.6	0.5	2.3	1.5

Management is now studying the three to four year amortization periods of the reactor plant modifications recommended in reference (1). If these lengths of time are accepted for the reactor plant modifications it will be safe to assume a similar amortization period for the permanent activated silica facilities, since the water treatment method will become a part of the modified installation. From the amortization times listed in Table VI, permanent activated silica manufacturing facilities (pumping from C Area to B Area) would be justified at all areas.

If the three to four year amortization period for the reactor plant modification is rejected and hauling a 1.5 per cent activated silica solution is practical, a hauling facility only at B and H Areas is justified economically especially if the increased flows from the reactor plant modifications are discounted.

The process standards for reactor cooling water state that 1.5 per cent SiO_2 by weight solution may be kept up to six days before dilution to 100 per cent SiO_2 solution, so hauling 1.5 per cent solution should present no problems compared to hauling 1.0 per cent solution.

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