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A PROPOSAL FOR LIQUID SODIUM DICHROMATE FACILITIES FOR THE 100-C AND 100-D AREAS

Design Section
Process Engineering Unit
by J. C. Whipple JCW

This document has been reviewed and approved by the appropriate members of the Process Engineering Unit. It is the purpose of this document to record a proposal for application to existing areas in the event the conditions specified in "Recommendations" are fulfilled. It was prepared to record certain schemes which appeared advantageous for existing areas. These advantages became apparent from studies conducted initially to determine a design plan for later installation, if required, of dichromate facilities in 100-K Area.

This work was performed under research and development authorization RDS-11. No further design-development work will be performed on this proposal by the Process Engineering Unit until such time as is determined that dichromate facilities are required as a portion of the normal treatment process of existing plants or are required over an extended period for experimental purposes.

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A PROPOSAL FOR LIQUID SODIUM DICHROMATE FACILITIES FOR THE 100-C AND 100-D AREAS

PURPOSE

It is the purpose of this report to evaluate the potential cost savings (per HW-26913) to be realized by converting the sodium dichromate facilities in 100-C and 100-D areas into continuous liquid handling facilities as proposed for the 100-K areas. It is also the intent of this report to present the existing conditions and preliminary scope of the proposed conversion.

RECOMMENDATIONS

It is recommended that continuous liquid handling dichromate facilities be installed in all of the existing areas if it is determined that sodium dichromate is definitely required as a corrosion inhibitor. (This assumes that present feed rates in the magnitude of 2 ppm will be maintained. See Page 13 for discussion of effect of feed rates on economics.)

It is further recommended that liquid handling dichromate facilities be installed in the 100-C and 100-D areas if it is determined that the formal program for testing effects of sodium dichromate will extend over a period in excess of approximately one and one-half years. The maximum period of operation required to pay off the capital cost for conversion in each area is approximately one and one-third years.

JUSTIFICATION

A. Annual savings in operating cost of about $11,000 per year for the 100-C area and $14,000 for the 100-D area would be realized due to this conversion. These savings are typical of those which may be realized in the other areas. (Additional savings in operating costs of $16,000 per year would be realized at 100-D after completion of the 100-D activated silica testing program. This is further amplified on Page 10.)

B. The total conversion costs will be amortized in a short period. For example, the capital costs would be amortized at the 100-C area in 1.3 years and at the 100-D area in 1.2 years. Other areas would have similar pay-off periods.

C. The substitution of the liquid dichromate for the crystalline dichromate will eliminate dust and area maintenance problems associated with handling of this material. In addition, the risk of introducing pieces of bags or other impurities into the process water through the dichromate system would be practically eliminated.

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BACKGROUND OF STUDY

In document HW-26913 entitled "Design Planning of Sodium Dichromate Facilities for the 100-K Areas", a recommendation was made that the 100-K areas be equipped with a new type of dichromate handling facility to be designed for receiving, storing, and automatically feeding a 70% dichromate solution. Comparable material costs plus appreciable financial savings in material handling labor costs justified the selection of the 70% solution as the raw material.

In addition, operating labor savings would be appreciable since receiving dichromate in solution form inherently lends itself to a continuous type process and thus eliminates the batch method of dissolving the solid dichromate in water before injection into the process water. Continuous feeding of solid dichromate by means of conventional gravimetric feeders was considered to be inaccurate because of the deliquescent nature of the crystalline dichromate to absorb moisture and deposit cakes thus interferring with feeder operation.

Since the proposed 100-K dichromate facilities presented the desirable features of automatic operation as well as economic gains, HW-26913 recommended that the older areas employing dichromate in conjunction with Alum-treated water be investigated for conversion to a K type facility. This report will present the follow-up evaluation on the conversion of the present two dichromate make-up facilities; one at 100-C and one at 100-D.

The batch method (existing in 100-C and 100-D areas) employs dichromate in crystalline form as the raw material received and stored. This crystalline material is dissolved in water, sufficiently diluted to about 15% dichromate strength, thoroughly mixed, and transferred to solution feed tanks. The feeding of this 15% solution into process water lines from solution feed tanks is continuous.

The proposed continuous liquid handling facility would receive, store, and automatically feed from storage, sodium dichromate as a 70% solution. The 70% solution would be diluted in the dichromate feed lines downstream from the proportioning pumps and fed into the process water lines.

PRESENT CONDITIONS

1. 100-C Area

The 100-C area has all dichromate equipment located in the 183-filter pumphouse. The primary storage of raw material is at the 185-B building where it is received and stored from off-site shipment.

Limited secondary storage is provided in the filter pumphouse where the 100-pound bags are stored on pallets. Because of the storage limitations in 183-C approximately three deliveries a month from 185-B are required. The normal operation of delivering this material requires several riggers, a truck driver, and crane-truck. In addition to this tri-monthly delivery from 185-B to 183-C,

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approximately two deliveries per month to 185-B from off-site sources of material are required at the present demand for dichromate. Again the same size crew are employed approximately four hours to unload from the truck and palletize 20,000 to 30,000 pounds of dichromate in 100-pound sacks.

The dichromate operation from unloading and dumping the bagged dichromate into a solution make-up tank to transferring the dilute dichromate solution to solution feed tanks is done on a batch schedule. Two or three times a week a 15% dichromate solution of about 3600 gallons is prepared. For each batch solution three man-hours are consumed of which approximately 30-45 minutes are required for unloading the solid material into the tank.

The dissolved dichromate is then agitated for two hours in the mixing tank to insure thorough mixing and dissolution of dichromate. Following this agitation the solution is transferred to the two feed tanks. During this two hour agitation period the operator periodically inspects the agitation and cleans the unloading area. One man on a 40-hour week is required. Following the agitation the operator samples the batch for specific gravity.

The dichromate process upon reaching the two feed tanks is continuous. Four proportioning pumps, paced by flow meters in the process water lines, meter the dichromate solution from the feed tanks and inject the solution into the process water lines at feed rates in proportion to the process water flow. Normal operating procedure is to sample the dichromate treated water and perform colorimetric determinations every two hours. This serves as a back-up operation to the pacing operation of the process water summators.

2. 100-D Area

The 100-D dichromate facility located in 185-D building supplies dichromate as a 15% aqueous solution to both 100-D and 100-DR areas. As in C area, the raw material is solid dichromate which is unloaded from the shipper's truck by the three or four man rigger crew at the 185-D building and stored on pallets. At the present water flows through D and DR, approximately 14 batches of 15% dichromate solution are made up each week. The batch preparation of the 15% solution again entails dumping the dichromate into the mixing tank, adding the correct amount of water for dilution, and agitating for approximately two hours. Following this agitation, sampling is done by the operator. The solution is then transferred either to the export line to DR or to the two feed tanks from which the dichromate is fed to process water lines (the inlet process water lines to the large water reservoirs in the 190-D building).

Since the 183-DR headhouse has its own dichromate storage facility, the pumping to DR is an intermittent operation dependent on the demand of DR for a suitable dichromate backlog. From the DR storage the 15% solution is pumped and injected into the process water lines after the filters by proportioning pumps in the 183-DR headhouse. The flow from storage at DR is continuous and automatic; the proportioning pumps being paced by summaters on the filtered water lines and automatically resetting with any variation in process water flow.

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The flow from the two storage tanks in 185-D is continuous, but not automatic in varying the rate of dichromate injection with variation in process water flow. Periodic sampling of the dichromate added water is necessary, and colorimetric determinations of these samples determine the necessity of changing the rate of dichromate injection by manual adjustment of the strokes on the pumps.

The present dichromate installation employs an operator around the clock seven days - week. The day shift operator prepares two or three 800 gallon batches of the 15% dichromate solution every day in addition to making colorimetric determinations every two hours, and intermittently transferring dichromate solution to DR headhouse.

The main functions of the operators on the swing and graveyard shifts are to run the samples through the colorimetric determinations every two hours (each determination involves samples from 10 sampling points and requires approximately 30-40 minutes of the operators time) and to export a supply to DR when the supply at DR becomes acute. This exporting of dichromate to DR need not be a frequent occurance since the two storage tanks at DR together have a total capacity of about 4,000 gallons and therefore can supply approximately a maximum four days supply of 15% dichromate solution to DR process water.

CONVERSION OF 100-C AND 100-D DICHROMATE FACILITIES

1. Proposed New Installations

A. 100-C Area

The proposed conversion of the dichromate facility will completely eliminate the need for the dichromate operator's part time services as well as the labor associated with unloading the dichromate at 185-B and transporting to 183-C filter pumphouse. This new facility would be continuously operating with the elimination of the batch preparation. Basically the important changes necessary are: (1) locating the unloading site at the headhouse and (2) making a few additions to the existing facility at the 183-C filter pumphouse.

In relocating the unloading site, the present dichromate transfer pump would be relocated to the headhouse where it would serve the function of unloading the 70% solution from tank cars and transferring the solution through a new three-inch line across the flocculation and sedimentation basins (paralleling the present lime lines) through the filter building to the storage tanks in the filter pumphouse. About 800 feet of three-inch line is required for this function. An automatic shut-off valve would be provided on the discharge side of the unloading pump. This valve would be actuated by no flow in the line.

The three dichromate tanks presently in use would serve as solution storage and feed tanks. The present make-up tank would be modified by welding a

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two-foot high cylindrical section to the top of the tank to equalize its height with the other two tanks. These three tanks would supply about a 60-day storage of 70% dichromate solution. An additional source of about a 40-day supply could be obtained by spotting a tank car on a spur track. Some means of heating the car would be provided. The three inch lines from the unloading pump would branch in the filter pump house and feed all three tanks. All three tanks would be equipped with high level float control valves which would automatically open and close their respective lines depending on the height of liquid. A new line will connect the former make-up tank to the header feeding the proportioning pumps.

The five proportioning pumps (one acting as a spare) will be left in place. After the proportioning pumps new dilution water lines will tap into the four dichromate feed lines before the injection points in the 36" process water headers. The purpose of diluting the 70% solution streams will be to enhance the mixing of dichromate in the process water lines and reduce the possibility of dichromate channeling in the process water headers. Further blending is achieved in the clearwells.

The sampling lines in 183-C would remain in their present location. The colorimetric determinations would be run periodically with the pH analyses by the headhouse operator in the filter room analytical station.

B. <u>100-D and DR Facilities</u>

The proposed changes involved in this conversion will eliminate the unloading and material handling labor involved in the batch preparation. The basic change in this conversion is to relocate the facility at the 183-D headhouse, from which D and DR areas would be supplied. This would entail relocating two proportioning pumps from 185-D plus associated piping on the chemical floor of the headhouse and relocating a large horizontal 19,000 gallon storage tank (presently not in service) and one unloading pump (an outdoor acid unloading pump not in use) to south of the 183-D headhouse near the activated silica storage tank. All equipment would be cleaned and reconditioned as required.

The 70% dichromate solution would be brought into the 183-D headhouse storage area in railroad tank cars. The unloading pump would be manifolded in such a way to unload the 70% solution into the storage tank and at the same time to feed both DR storage and the two proportioning pumps to be located on the chemical floor. (The present activated silica pump at 183-D is manifolded in a similar manner.) When the tank car is not being unloaded, the pump would export 70% solution to DR and feed the D area proportioning pumps. During the time of no unloading or no exporting to DR the unloading pump would supply to the D pumps enough solution for priming the pumps and would recirculate the remainder back to the storage tank.

This storage tank is of sufficient capacity to supply dichromate to D and DR areas for 85 days.

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Seventy-percent dichromate solution would be supplied to the D feeding facilities by running a single line (1/4" or 1/2" schedule 40 pipe) from the unloading pump to the second floor of the D headhouse. There it would branch and feed the two proportioning pumps. Dilution water lines would be joined to the two D area dichromate streams after the two proportioning pumps for purposes of diluting the dichromate solution. The diluted dichromate streams then would run to the center of the headhouse, turn and cross the flocculations and sedimentation basins, and run overhead over the filters and pipe gallery and connect with two 36" process water headers in the 183-D filter pump house. These two process water lines would be tapped into for connection with the dichromate feed lines. Two ratio flow controllers would be connected with leads to existing flow meters on the process water lines and would also be connected to the proportioning pumps. In this manner the rate of dichromate feeding would always be proportional to the process water flow at the desired ppm.

Sampling lines constructed of saran tubing would be installed to run from the process water headers to the headhouse analytical station.

The DR facility would require little modification in handling the 70% solution. The tanks are equipped to receive the 70% solution and provide dilution to 15% dichromate by weight with present dilution lines before feeding to the plant. The 70% dichromate solution would be supplied to 183-DR from 183-D by means of a 2" export line which would connect to the present line running from 185-D to 183-DR. The unused line from this connecting point to 185-D would be blanked off from service.

2. Estimate Conversion Cost

Preliminary piping and equipment layout sketches have been furnished to the Estimating Services Group, Project Section, as well as other pertinent estimating information required such as sizing, lengths and type of piping required; the amount of piping to be steam traced and/or buried; and the extent of reconditioning existing equipment for use in the dichromate facilities.

With the above information, the conversion of the 100-C area has been estimated at a total project cost of $14,000. The 100-D conversion has been estimated at a total project cost of $16,300

ECONOMIC EVALUATION OF CONVERTING 100-C AND 100-D AREAS

1. Economic gains at 100-C Area

A. Operating Labor

The proposed continuous process would eliminate the need for a dichromate operator in the filter pump house at a cost savings of $8,000 per year.

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B. Materials Handling Labor

The unloading operation in 185-B would no longer be required. Based on the annual consumption of dichromate at the present water flow rates and at a unit handling cost of $10.50/ton (HW-26913), an annual savings of $3,220 would result. In addition, the unloading from 185-B and delivery to 183-C would be eliminated at an estimated savings of $4,590 per year. A higher material handling unit cost of $15.00 per ton was arbitrarily assigned to this later operation because of more handling steps involved.

C. Material costs

The following cost information received from Document HW-26913 and from the Purchasing Department was used as the basis for comparing the material cost of 70% solution with the material cost of the solid dichromate. Two means of shipment are available; (1) by rail from the East directly to Hanford Works and (2) by ship through the Panama Canal to Seattle and by truck from Seattle to Hanford. The solid material costs $14.90 per 100 pounds against $13.46 per 100 pounds of dichromate for the 70% solution, both prices on a "shipping by water to Seattle" basis. Shipping by rail raises the unit cost of both materials to $13.51 per 100 pounds for the solid material and $14.34 per 100 pounds for the 70% solution. All unit prices include FOB price plus freight rates. All total costs are based on the present dichromate demand of 2 ppm.

Consequently the annual material costs of the solid material would be $79,000 if shipped by water and $82,700 if shipped by rail compared to annual costs of 70% solution of $82,430 if shipped by water and $87,790 if shipped by rail.

D. Summary of Operating Costs

The operating costs for both types of installations are summarized in the table below:

TABLE I - ANNUAL OPERATING COSTS FOR CONTINUOUS SYSTEM AND BATCH SYSTEM (100-C AREA)

	Continuous System Receiving 70% Solution	Batch System Receiving Dichromate in Bags
Annual Labor Costs		
1. Operating Cost	No cost chargeable	$ 8,000
2. Unloading at 185-B	Eliminated	3,220
3. Delivery to 183-C	Eliminated	4,590
Annual Material Costs if Shipped by Rail	$87,790	82,700
Annual Material Costs if Shipped by Water	82,430	79,000
Total Operating Cost (Shipments by Rail)	87,790	98,510
Total Operating Cost (Shipments by Water)	82,430	94,610

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2. Economic Gains at 100-D Area

A. Operating Labor Considerations

During the middle of February, 1953 production of activated silica in the 185-D building was started. This operation coupled with the batch make-up preparation will increase the work load of the present operators now operating the dichromate system only. Transferring the dichromate facility to the 183-D headhouse would eliminate the make-up of 13 to 14 batches of dichromate solution a week in addition to eliminating the sampling duties of the operator in 185-D. This transfer of dichromate facility would leave the operator to handle the activated silica installation only. Since this activated silica facility is only a temporary test facility, on completion of the activated silica test no operator would be required.

Investigation into the 185-D activated silica test installation has shown that this operation need operate on a two shift basis only, employing only two operators instead of the present four, which will be used if the batch method of dichromate is continued. The facility is capable of producing one 3,020 gallon batch every hour or conservatively seven batches a shift. Two shifts on a seven day basis could produce enough silica to feed at the maximum rate of 5 ppm. The average rate will be much lower than 5 ppm, hence two men on a five day week would be normal operation with overtime required only under maximum treatment conditions. Figure I shows the manpower needed in the batch preparation of chemicals in 185-D before and after the proposed conversion. The probable manpower required for the proposed operation would fluctuate between one-half shift, five day operation to two shifts, five day operation over the year. Two men can be claimed as savings in operating labor on this bases and a total of four men can be claimed when the test of the activated silica is completed.

B. Materials Handling Labor

Elimination of the unloading operation at 185-D would result from the conversion. At a unit materials handling cost of $10.50 per ton, a savings of about $4,140 per year would be affected.

C. Material Costs

As discussed for the C area conversion employing the same unit costs of materials, the cost of the solid material would be $101,570 if shipped by water and $106,370 if shipped by rail. Slightly higher costs result in buying liquid dichromate as the 70% solution. These are $105,980 if shipped by water and $112,870 if shipped by rail. All costs are based on the present dichromate demand of 2 ppm.

D. Comparison of Operating Costs

The operating costs for both types of dichromate installations are summarized in the table below:

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FIGURE I

OPERATING MANPOWER REQUIRED IN 185-D BUILDING
FOR PREPARATION OF WATER TREATMENT CHEMICALS
(BASIS: SEVEN - 3000-GALLON BATCHES OF
2.5% SiO_2 PRODUCED PER SHIFT)

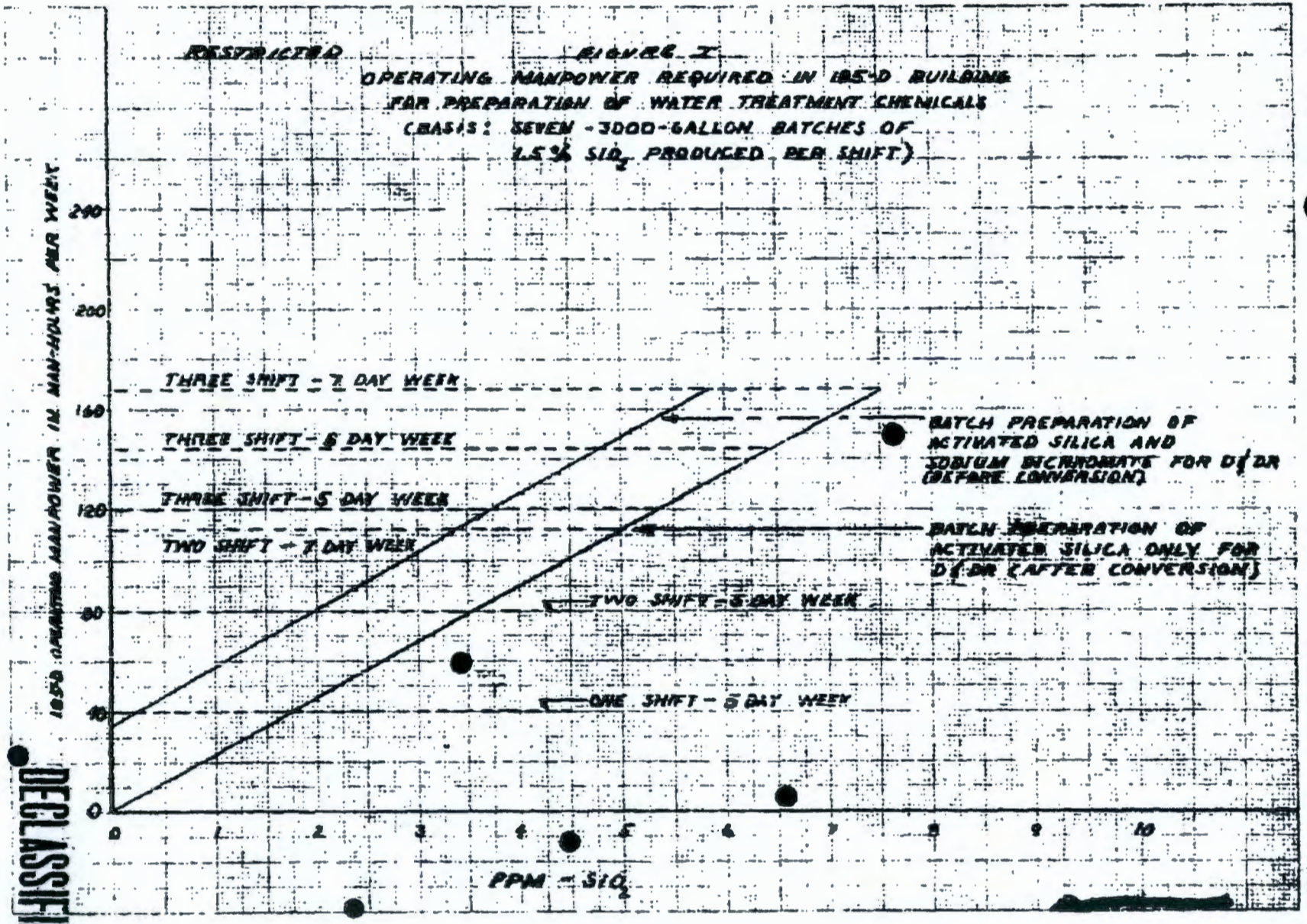

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TABLE II - ANNUAL OPERATING COSTS
FOR CONTINUOUS SYSTEM AND BATCH SYSTEM (100-D AREA)

	Continuous System Receiving 70% Solution	Batch System Receiving Dichromate in Bags
Annual Labor Costs		
1. Operating Costs	$ 16,000*	$ 32,000
2. Unloading at 185-D	Eliminated	4,140
Annual Material Costs (Shipping by Rail)	$112,870	106,370
Annual Material Costs (Shipping by Water)	105,980	101,570
Total Operating Cost (Shipments by Rail)	128,870	142,510
Total Operating Costs (Shipment by Water)	121,980	137,710

* This cost will be eliminated when the activated silica test facility is completed.

3. Additional Advantages to be Gained by the Proposed Conversions

Elimination of dust and necessary clean-up after batch preparations would result if the 70% dichromate solution is handled as the raw material. In addition, the chance of introducing pieces of bags or other impurities into the process water would be eliminated.

4. Amortization of Capital Expenditures

Since two modes of transportation are available for shipment of solid dichromate and have been employed in the past for shipping the material to Hanford works, it was assumed (for the solution form to be on an equitable basis with the crystalline dichromate) that 70% solution could also be shipped to Seattle and trucked to Hanford Works as well as transferred overland by freight. Shipping the solution by water might be impractical. However, the commodity rates on liquid shipments to some points of heavy consumption have been reduced in the past to about 90% of those which apply to granular dichromate.

For 100-C area the conversion cost of $14,000 could be paid off by operating savings ranging from $12,380 to $10,820 per year in about 1.2 to 1.3 years. The maximum and minimum savings result depending on the method of shipping the raw material.

The conversion cost of $16,300 for D area could be paid off by operating savings ranging from $15,730 to $13,640 per year in about 1.1 to 1.2 years. These operating savings would be increased by $16,000 per year upon completion of the activated silica test facility. The exact operating savings would depend again on the method of shipping the raw material.

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5. Future Changes in Dichromate Feed Rates

All operating cost figures and resulting amortization periods presented in this report are based on the present rate of 2 ppm of dichromate addition and do not reflect conditions which may exist if the rate of dichromate is materially decreased in the future. The justification of conversion would probably decrease in the case of the 100-C area by virtue of lower material handling costs and possible elimination of the operating labor cost at low dichromate feed rates. However, the 100-D conversion would show an even smaller amortization period by virtue of greater operating savings resulting from a smaller difference in material costs. At the lower feed rates the operator would still be required for the batch, solid handling system on a 24-hour basis at 100-D.

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