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Historical Document
Released for Public Availability**

Released 1994

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**

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DESIGN REPORT

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GENERAL ELECTRIC COMPANY
HANFORD WORKS - PROJECT C-431-A
PRODUCTION FACILITY - SECTION "A"

This document consists of

64 pages

DESIGN REPORT

I GENERAL DESCRIPTION OF PROJECT

a. Plant Location - The 100-C project is to be located adjacent to the present 100-B Area. It is planned to build an addition to the present 181-B river pump house using the same elevations for pump settings, intakes, and floors as for the present pump house, thus maintaining the same suction conditions and flood protection as B Area. The 105 Building will be located on higher ground than B Area and therefore, protection against possible flood damage is assured.

Four locations adjacent to B Area have been considered. Two of these have been eliminated for physical reasons which make them unworkable. The other two have been studied in detail and cost differences, layout, construction problems, and operating advantages have been compared. These two sites are shown on Drawing No. SP-5001 "Proposed Site Plan".

Site No. 1 South of B Area
Site No. 2 Northeast of B Area

The advantages and disadvantages of the two sites are summarized as follows:

1. Considering the items in the water plant only, Site No. 2 shows a saving in cost of approximately \$300,000. This figure was arrived at by estimating the variable items on each site such as sewer lines, raw water lines, electric lines, steam lines, export water line, emergency connection to 182-B, railroad relocation, road relocation, temporary construction facilities, and other miscellaneous items.
2. Site No. 2 has the disadvantage that railroads, roads, fences and gate house must be moved and relocated before work can begin, thus delaying the start of the

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main work. A delay in design of the main project will also occur while preliminary design work is being done.

3. Site No. 2 has the disadvantage of being in direct line of the prevailing winds from the 105-B and P10 Building exhaust stacks.
4. Site No. 1 has the advantage that the 115-B Building can be used for both B and C Areas by constructing a tunnel between them. This is not possible at Site No. 2. We have been advised this item alone amounts to a saving which will more than offset the \$300,000 mentioned in Number 1 above.
5. Site No. 1 has the advantage that the sewers to the retention basins and the retention basins themselves can be cross connected with those of B Area which gives added security to both areas. This is not possible on Site No. 2.

It is recommended that Site No. 1 south of B Area be adopted because of lowest overall cost, earliest time for starting construction, elimination of exhaust stack gas hazard, increased security by cross connecting retention basins and sewers, and the possibility of using a common 115 Building for both B and C Areas.

b. Description - See Drawing No. SP-5003. The proposed water plant will be comprised of units similar in layout to that described in INDC-3917 for DR Area, but with certain modifications. It conforms in general with existing filtration plants now in successful operation in the Hanford Works. The plant will consist of the following units:

- ✓ 1. Addition to present river pump house 181-B.
2. Pipe lines from 181-B to the chemical head house.
3. Head house.
4. Four Flash mixers.
- ✓ 5. Eight flocculation and eight sedimentation basins.
6. Filter house containing twelve filters.
- ✓ 7. Four clearwell tanks.
- ✓ 8. Process pump house.
9. Process delivery lines.

- ✓ 10. Emergency generators in 194-B Steam Plant.
- ✓ 11. Two high tanks.
- ✓ 12. Two retention basins.
- 13. Sewers, drains, steam and electric lines.

c. Capacity - The principal hydraulic data for the plant design is as follows:

<u>Continuous Quantity of Water to be Handled</u>	<u>Present</u>	<u>Future</u>
Pump house and clearwells	62,000	80,000 ✓
Filter Plant (For breakdown see Filter Plant Section)	72,000	90,000
Addition to river pump house (For breakdown see Filter Plant Section)	72,000	90,000

Provision for future extension will be made as follows:

River Pump House	Provide Stalls for two additional pumps. ✓
Water lines from river pump house to head house	Pipes to be designed for full future flow. ✓
Head House	All chemical systems and storage will be designed for full future flow. ✓
Basins	Provide dowels and keys for an additional basin on each side. Design flumes for both present and future conditions - Provide two additional flash mixer basins for two future flash mixers.
Filter Building	Provide dowels and keys for an additional row of filters on each end. Design inlet and outlet flumes for future flow. In this way three additional filters can be added on either end of the building or divided between the two ends as desired. ✓
Clearwells	No change in size for future. Design inlets and outlets for future flow. ✓

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Pump House

Provide space in pump house and dowels
and keys for two additional pumps. ✓
Pipes to 105-C to be designed for
future flow.

Sewers and other under-
ground piping.

To be designed for full future flow. ✓

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II ADDITION TO EXISTING RIVER PUMP HOUSE 181-B

a. Use of available pumps vs. new pumps - Analysis of cost has been made for using nine existing pumps which we understand are available from other areas, vs. buying new pumps. In this analysis consideration was given to the size of the building, cost of pumps and cost of piping and valves. A saving of approximately \$80,000 can be made by using the existing pumps. If, however, none were available, it would be more economical to buy larger pumps. By using existing pumps there are other advantages. Design of building and layout of pumps and piping will be approximately the same as in the existing pump house. All manufacturer's prints of existing pumps are available and no delay will be necessary as would be the case if new pumps were purchased. This is important because construction must start next August in order that the work be done during the ensuing low water period.

It is recommended that the existing pumps be used and duplicates bought as needed based on lowest cost and need for early start of construction.

b. Location and description - The addition to the river pump house will be located adjacent to and east of the existing pump house and be of the same general design. Keys and dowels were built in the existing pump house for a later addition at this location. Two new trash racks and moving screens will admit water to the pump well which will be divided by a division wall between the two screens. A sluice gate will be provided in this wall to allow connection between the two halves of the pump well. The general arrangement of pumps and electrical equipment will be the same as in existing building.

c. Number and capacity of pumps - For the initial flow of 72,000 GPM there will be installed ten (10) motor driven pumps (2 spares included) each having a capacity of approximately 10,000 GPM at 150' total head. For the future capacity of 90,000 GPM space will be provided for two (2) additional motor driven pumps of the same capacity.

d. Intake - Water will be admitted from the river by enlarging the present forebay from the river to the pump house. Trash racks and moving screens will admit water to the pump well.

e. General piping arrangement - The general piping arrangement will be the same as in the existing building except that one header will receive the water from all pumps. (See Drawing SP-5004.) A cross connection will be made from the existing steam header discharge pipe in 181-B to the main header in 181-B Addition.

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All electric pumps will connect into the main header, and the three discharge lines to the head house will connect to it. No sectionalizing valves will be used.

f. Controls - All pumps will be controlled manually. Water level indicators will be installed on each side of each screen. Pressure gauges will be connected to each pump discharge and each section of the distribution header. A pressure switch will be connected to each section of the distribution header and at low pressure sound an alarm in the operating room.

g. Building service - The building will be heated by overhead unit heaters, and ventilated by roof ventilators of the same type as the present building.

No additional office space or toilet facilities will be installed.

The same gantry crane as is now used on the present building for handling the pumps will be used for the addition. The tracks will be extended on the roof of the addition and hatches provided in the roof over each pump.

h. Electrical - The substation adjacent to the present pump house will be enlarged by General Electric Company to take care of the additional load.

Additional 2300 Volt underground feeder capacity will be installed from this substation to the switchgear in the new addition.

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III RAW WATER LINES FROM 181-B ADDITION TO 183-C HEAD HOUSE

a. Analysis of Pipe Sizes - An analysis has been made of the size of line to carry the raw water from 181-B river pump house to 183-C head house.

Consideration was given to the cost, line losses, velocities and internal stresses expected because of ground conditions.

It was found that with the available head on the existing pumps and reasonable velocities within the lines, two 72", three 54" or three 48" lines could be used.

The three 48" lines are the least costly although the friction head for these lines, when one line is out of use and total flow is carried by two 48" lines, is slightly over the head of the pumps and until final design is completed exact head needed cannot be determined.

It is recommended that the three 48" lines be used and when one line is out of service if necessary an additional pump be started in the river pump house or water be taken through the emergency line to the head house from 182-B to give the necessary flow through these two 48" lines.

b. Location of Raw Water Lines - The three (3) raw water lines will leave the river pump house extension 181-B and as soon as possible fan out to be 100 feet apart and pass to the west of the patrol road along the west side of 182-B raw water reservoir and converge and connect to the raw water header in the valve pit of 183-C head house.

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IV THE 183-C FILTER PLANT (Refe to Drawing SP-5002)

a. General - The filter plant will be of the rapid sand type with an effective capacity of 72,000 gallons per minute with provisions made for adding two (2) additional basins and three (3) filter units to increase the capacity to 90,000 gallons per minute. The breakdown of this capacity is as follows:

	<u>Present</u>	<u>Future</u>
Process Water	62,000GPM	80,000GPM
Backwash	3,000 "	3,500 "
Filtered Water to 105	3,000 "	3,000 "
Miscellaneous	1,500 "	1,500 "
Total	69,500GPM	88,000GPM
 Basis for Design	 12 filters @ 6,000 GPM = 72,000 GPM	 15 filters @ 6,000 GPM = 90,000 GPM

Backwash and all filtered water requirements are to be supplied from pumps located in the filter building pump room.

The filter plant will consist of:

1. Chemical storage area and head house.
2. Flocculation and sedimentation basins.
3. Filters.
4. Filter Building pump room.
5. Clearwells

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The plant is to treat Columbia River water to a final effluent specification as shown below:

<u>Chemical or</u> <u>Concitions</u>	<u>Raw Water Conditions</u>		<u>Process Water</u> <u>Requirements</u>
	<u>Maximum</u>	<u>Minimum</u>	
Turbidity	200	2.0 ppm	0 Coleman Spec.
Iron	1.0	.03 ppm	0.03 Max.
Sulphates	12.0	10.0 ppm	
Chlorides	0.5	.2 ppm	2.0 ppm Max.
Hardness	75.0	55 ppm	
Calcium	18.0	18 ppm	
Magnesium	5.0	4 ppm	
Methyl Orange			

Chemical or Conditions	Raw Water Conditions		Process Water
	Maximum	Minimum	Requirements
Alpality	60.0	55 ppm	---
pH	8.2	8.0 ppm	7.5 - 7.8
P. Alpality	0.0	0	---
Free CO ₂	1.0	0	---
Free Chlorine	0.0	0	0.2 ppm Max.

* Hardness not to be appreciably increased by treatment in filter plant. The manufacturer of the filters is to guarantee that the filtered water effluent is equal or better than the filtered water requirements set forth above.

Treatment of the raw water to meet the above specifications will consist of coagulation with ferric sulphate and lime, chlorination, sedimentation, and filtration. Immediately after filtration, and ahead of the clearwells, addition of sodium dichromate will be made for corrosion inhibition.

The rate of feed for the chemicals to meet the above specifications has been established on the basis of experience with the existing filter plant as follows:

	Minimum	Average	Maximum	Remarks
Chlorine		1 - 2 ppm		
Lime	0 ppm	5 ppm	20 ppm	40#/cf Bulk Density
Ferric Sulphate	4 ppm	17 ppm	60 ppm	75#/cf Bulk Density
Sodium Dichromate	1.2 ppm		2.2 ppm	15% solution

b. Head house - Storage and Feeding of Chemicals - The chemical storage area and head house will house the following facilities: inlet sectionalizing valves, rate-of-flow control valves, chlorinators, ferric sulphate and lime storage and feeding equipment, dichromate solution storage and emergency mixing facilities, control and feeding equipment.

Ferric sulphate and lime will be received by rail siding adjacent to the head house. They will be delivered by horizontal screw conveyors and bucket elevators to their respective silos. The capacity of the lime storage will be 50 days at maximum rate of feed which is 27,000 cubic feet (540 Ton) and for ferric sulphate 33 days which is 28,800 cubic feet (1,080 Ton). Reclaiming will be from the conical bottom of the silos by the same mechanical equipment, delivering to steel day storage bins by means of screw conveyors. These bins will have a capacity of 1,500 cubic feet.

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with a minimum bottom slope of 60° from the horizontal. This is equivalent to $2\frac{1}{2}$ days for lime and $1\frac{1}{2}$ days for ferric sulphate. Provisions will be made for hoisting bags to top of the day bins for emergency hand loading. Provisions also will be made for unloading bags into the screw conveyor from the track to the bucket elevator for storage of bagged material in the silos. The day bins will discharge into the day chemical feeders. Vibrators will be used on both the silos and day bins for lime only.

Three (3) automatic dry, gravimetric type feeders stainless steel or lead lined will be used for feeding each chemical. One feeder will be used to supply its respective chemical to the north raw water line and the other to the south raw water line. The third feeder will be used as a spare to either the north or the south raw water lines. Provisions will be made whereby the chemical can be injected at a point, downstream of raw water venturi tube. The automatic capacity of the lime feeder will be 450 lbs. per hour, the ferric sulphate feeder 1,350 lbs. per hour. Feeders will be capable of 20% additional capacity operating manually. The dry chemical will be fed to a solution tank, then by gravity to the point of application. The rate of chemical feed will be automatically controlled by varying the rate of feed in proportion to the rate of flow through the raw water venturi meter. The piping will be run with maximum slope and by the most direct route, with access for cleanouts at all changes in direction and be readily accessible.

Chlorine cylinders of 1-ton capacity will be received by rail and unloaded by means of an electric monorail hoist and stored in a rack on a concrete platform which will have a capacity of 26 - 1-ton cylinders. Provisions will be made to steam heat three of the cylinders under thermostatic control. Two (2) chlorinators will be installed. One will feed the north and south raw water lines through rotometers and manifolds, and one will be a spare. Space will be provided for one future chlorinator. The chlorinator solution lines will be connected to the raw water lines at points just beyond the raw water venturi tubes. Provisions will be made so that the chlorinators may eventually (at 90,000 GPM plant flow) be automatically controlled by the flow through the raw water venturi tube.

Sodium dichromate solution storage, emergency mixing and feeding facilities consisting of one mixing storage and one head tank having a total combined capacity of one week at maximum feed will be located in the head house and provide positive suction to the dichromate solution pumps. Additional mixing and storage tanks and transfer pumps will be located in 185-B and be of similar size and arrangement as those in 185-D.

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The dichromate solution pumps are to be controlled by a flow impulse transmitted by the flow meters in the separate lines to the clearwell tanks fed by respective solution pump. Chemical solution pumps are to be motor driven with automatic variable speed and manual stroke adjustment. There are to be five (5) feeders, one to each of the four (4) lines to clearwells and one (1) spare. Discharge lines are to be extended from the head house to the filter building pump room by means of a pipe trench in a basin wall. These lines are to be protected from freezing by means of a steam tracer line.

c. Flash Mixers - After addition of the chlorine and coagulation reagents, dispersion of these chemicals throughout the raw water stream will be accomplished in four (4) flash mixing chambers 7' - 6" square with 6' - 6" water depth. Each chamber will contain a vertical shaft, motor driven agitator of the paddle wheel type. The normal flow through each chamber will be 18,000 GPM but will be capable of handling a maximum of 25,000 GPM under emergency conditions. The mixer will create violent turbulence at a tip speed not less than 11½ ft. per second with normal detention time in the chamber of 9.15 seconds. Provisions will be made for two (2) additional flash mixing chambers of same size and equipment when the flow is increased 25% which will increase the detention time to 11 seconds at the increased flow.

The mixers will be located in groups of two (2) (future three (3)) at approximately the quarter points of the flocculator basin distribution flume.

d. Flocculation and Sedimentation Basins - There will be eight (8) parallel coagulation and sedimentation basins supplied from a common influent flume which receives water from the flash mixers. Provision will be made for the future addition of one basin at each side of the plant.

Each coagulation basin will be 52' - 0" wide by 49' - 0" long with 15' - 0" water depth, having a detention time of 31.9 minutes. With one (1) basin out of service the detention time will reduce to 27.3 minutes. With future basins added one (1) basin out of service the retention time will be 28.6 minutes.

Each basin will contain one (1), out of three (3), Dorr or equal paddle wheels in series powered by electric motor drive. The driving mechanism will be located in a dry well between the basin.

Each sedimentation basin will be 60' - 0" wide 210' - 0" long with 15' - 6" water depth having a detention period of approximately 4 hours, at rated flow and a velocity of 1.3 ft. per minute. With one basin out of service the detention time will be reduced to 3 hours, 30 minutes and the velocity will be 1.5 ft. per minute.

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Each basin will be provided with sludge removal facilities of the Dorrco Monorake type or equal. Sludge pumps will be installed in the flocculator basin dry wells and will deliver the sludge to the sewer. The sewer will be located parallel to and outside the basins and extended to a manhole at the end of the main sewer located near the northeast corner of the sedimentation basins. A 24" drain valve will be provided in each basin. Fire hose connections will be provided for cleaning basins. Overflows will be provided in each basin to take the rated flow with one basin out of service.

e. Filters - The filters are to be of the rapid sand, gravity type. The plant will have a total of twelve filters and be capable of producing 72,000 GPM continuous flow of filtered water at 2.6 GPM per sq. ft. filter area in accordance with the filtered water specifications.

Provisions are to be made for the addition of three (3) filters to raise the plant capacity to 90,000 GPM. Each filter will consist of two (2) filter halves with each half having a 24'-0" x 48'-0" filtering surface area. Each half will consist of a Wheeler type false bottom supporting the filter media of 10" of graded gravel, 20" of filter sand, and 10" of Anthrafilt.

The two filter halves will be served by a common influent and waste gullet, but will have separate effluent rewash and backwash connections. Each filter will be equipped with one (1) influent sluice gate, one (1) rate-of-flow controller, two (2) rewash valves, two (2) backwash valves, two (2) effluent valves and one (1) waste valve, all hydraulically operated.

The filters will be equipped with Palmer type surface agitators which will be controlled by hydraulically operated valves operated from the valve control panel.

There will be a total of twelve filter units arranged on three (3) operating galleries arranged as shown on Drawing SP-5002. Effluent from the filters will be discharged from the rate-of-flow controllers into effluent flumes located under the pipe gallery. The wash water waste will discharge into waste flumes located under the influent flume which in turn will be discharged into the common waste flume between the sedimentation basins and the filter building. For control purposes, the effluent side of the filters will be hydraulically divided into two (2) halves, with 6 filters on each side of center line of the plant.

All hydraulic valves for each filter will be operated from a central valve operating panel located at each filter. It will contain valve operating handles and indicating loss-of-head and rate-of-flow gauge.

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All hydraulic valve tail rods will be extended through the operating floor with valve position indicators, so that the operator may know the position of the valves while at the operating panel.

Sampling lines will be provided to a common point from each half of each filter, from each line to the clearwells and from the filtered water basin.

Backwash facilities will be supplied by means of backwash pumps located in a filtered water pump well. Backwash will be at the rate of approximately 17,000 GPM to one half filter unit at one time. A rate-of-flow controller will be installed to control quantity of water supplied for backwash. Backwash piping will be located in the pipe gallery.

f. Control and Instrumentation - The control and instrumentation system for the control of flow and water elevations through the filter plant and the control of chemical feed will be of the pneumatic impulse type and similar to that used in 183-DR Filter Plant and be as follows:

The elevation of the water in the clearwells will control the flow through the plant and the system will be designed to maintain full storage reserve of 21,000,000 gallons in the clearwells.

Because of the filtered water being pumped to the clearwells, the elevation of the water in each clearwell will control the flow, by means of a control valve, through the line to respective clearwell.

The flow through the filters will be controlled by the elevation of the water in the filtered water reservoir.

Two (2) master rate control units will be installed in the filter building and will be used to increase or decrease the flow through the individual rate-of-flow control valve on each filter effluent as the level in the respective halves of the filtered water reservoir decreases or increases.

The filter controllers will be set for a maximum capacity of the filter and will not exceed this rate unless manually increased.

A master rate control unit will be installed in the head house to increase or decrease the flow through each raw water rate-of-flow control valve to the flash mixing basins as the level in the sedimentation basins decrease or increase respectively.

The clearwells and each half of the filtered water reservoir will have water level indicators in the filter building. All instruments will have a triple alarm system (red, green, and amber lights).

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The sedimentation basins will have two (2) water level indicators installed in the head house to actuate the rate setter controlling the flow to the flash mixers. High and low alarms will be located in the head house control room.

The flow through each raw water line will be measured, indicated and recorded in the control room of the head house. The control of the dry chemical feeders will be obtained from these recorders. Mercury manometers will be provided to parallel the meters and to extend the range of measurement.

The filter effluent flumes will be divided so that the flow from the filters will be evenly divided. Two sub-totalizing meters will be used to total the flow through each group of rate-of-flow control valves on the filter effluent flumes.

Flow through each line to the clearwells will be measured and indicated, totaled and indicated and recorded in the filter building control panel. The indication of flow to each clearwell will also control the rate of feed of dichromates to each line to clearwell.

A totalizing meter for the total flow will be used to total the two sub-totalizing meters and indicate the flow in the filter building and record it in the head house. A backwash recording and integrating meter will be located on the filter building control panel and a large indicator will be located in the filter operating gallery.

All controls will be operated by compressed air and will be supplemented by manual control. Rate-of-flow controllers will be operated by hydraulic cylinders from air actuated pilot valves.

Compressed air will be supplied by a motor driven air compressor with spare steam unit located in head house with one air receiver located in both the head house and filter building.

The pH of the water will be measured at two points in the influent flume to the basins and at each clearwell inlet line. These six measurements will be recorded on one six-point strip chart recorder located on the control panel in the head house. Provisions will be made in the raw water piping to permit measurement of pH of raw water, at selected time intervals.

A turbidimeter is to be installed on the head house control panel to measure and record the turbidity of the water in either of the raw water lines.

g. Analysis of Gravity Flow to Clearwells vs. Pumped Flow - Two possible flow arrangements for the 100-C Area have been studied

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and results compared construction and cost-wise. Gravity flow from the sedimentation basins to the 190-C pump house forms the simplest mechanical system but imposes some construction problems. Pumped flow from the filter effluent basin to the clearwells and then by gravity flow to the 190-C pump house permits greater flexibility with regard to elevation and eliminates considerable quantities of excavation. An examination of the contours in the area selected will show the grade adverse to the gravity system.

The following data forms the basis for construction and cost comparisons:

	<u>Gravity Flow</u>	<u>Pump Flow</u>
Elev. of Sewer at 190-C	440.25	464.0
Depth of Sewer below original Ground at 190-C	50'	26.25'
Elev. of Clearwells	458.25	482
Depth of Clearwells below Original Ground	30' $\pm$	6' $\pm$
Probable Size of Sewer	84"	72"
Slope on Sewer	.0037	.0078
Elev. Pump House Excavation	434.	457.5
Depth of Pump House Excavation below Original Ground	56' $\pm$	32.5
Excavation - Cu. Yds. (items common to both arrangements not included)	1,330,000 cu. yds.	358,000 cu. yds.
Backfill	700,000 cu. yds.	210,000 cu. yds.

Cost estimates have been made covering the variable items such as excavation, backfill, increased pump well costs, pumps, piping, etc. The increase in first cost of the gravity flow over pumped flow is approximately \$300,000. The annual cost of power for the pumps in the pumped flow scheme is approximately \$10,000 and for an operator \$25,000. No attempt has been made to evaluate the added construction cost due to increased length of temporary trestles at railroad and pipe crossings and increased construction time for the gravity flow scheme.

A depth of excavation of the sewer of 50 ft., and basement of the pump house of 56 ft. for the gravity flow scheme is so deep that it imposes construction problems which make it highly undesirable from a practical point of view.

It is therefore recommended that the pumped flow arrangement be adopted.

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h. Filter Building Pump Room -

1. General Description - The filter building pump room will house the pumps for backwashing the filters, filtered water service and process water to clearwells. This room will also house a sample room and toilet. Below this room will be a filtered water reservoir connected to the filter effluent flumes from the filter area and have a capacity of approximately 1,000,000 gallons. A pump well will be incorporated in the reservoir. An overflow flume from the reservoir will be provided. A discharge header from the process pumps will be located adjacent to pumps in a valve and header chamber. A sample room will be located adjacent to the filters and set in the filtered water reservoir.

2. Storage Reservoir - The filtered water flumes under the pipe galleries in the filter building will be connected to the filtered water reservoir. The reservoir will have a capacity of approximately 1,000,000 gallons and provide a storage of filtered water for the pumps whose pump wells are part of this reservoir. The capacity of this reservoir will supply the process pumps for a period of ten minutes with no water coming from the filters.

3. Overflow facilities - Overflow from the filtered water reservoir will be by means of two weirs which will be located approximately six inches above the normal water elevation. When water raises above these weirs it will overflow into flumes connected to the sewer.

4. Sample Room - The sample room will be located adjacent to the filters and the floor will be at same elevation as floor of filtered water reservoir. Sample lines from each filter half will be extended to a sink in this room similar to 183-DR.

5. Pumps - Filter Backwash Pumps - There will be two (2) motor driven filter backwash pumps each having a capacity of 17,000 GPM which is the capacity necessary for backwashing one half filter unit at one time. The pumps will be of the vertical turbine type and be hung from the pump room floor into the pump well of the filtered water reservoir.

Filtered Water Pumps - There will be two (2) steam turbine driven and one (1) motor driven and space for one (1) future steam turbine driven pump located in the filter building pump room. Each pump will have a capacity of 4,000 GPM at a total head of 250'. Each pump will be of the vertical turbine type and hung from the pump room floor into the pump well of the filtered water reservoir. Steam turbines will drive the pump through right angle gear units. Surface condensers will be provided for the steam turbines.

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Process Water Pumps - For the initial flow of 62,000 GPM. Four (4) motor driven pumps (including one spare) will be installed with provisions made for one (1) additional motor driven pump when the flow goes to 80,000 GPM. All pumps will have a capacity of 21,000 GPM; be hung from the pump room floor into the pump well of the filtered water reservoir.

6. Piping - Backwash Piping - The piping from the backwash pumps will include check and stop valves from each pump to a main extended to the pipe gallery of the filters in which a rate-of flow controllers will be installed. All piping will be located in a pipe trench over the filtered water reservoir area and on the floor in the filter pipe galleries.

Filtered Water Piping - The filtered water piping will include check and stop valves on each pump and connect to a common header in the valve and header chamber adjacent to the pumps. A cross connection between the filter water and process water header will be made. Mains will be taken from this header for distribution.

Process Piping - Process water piping will include check and stop valves at each pump and connection from each process pump to a common header located in a header chamber adjacent to the pumps. The header will be valved to divide it into two (2) sections. One line will be extended to each clearwell from this header and each line will contain a stop valve, control valve and orifice plate, to measure the flow to the clearwell.

1. Clearwells - The "Process" water storage facility will consist of four (4) 5,250,000 gallon covered tanks. The tanks will be of welded steel plate construction, 176' inside diameter and 30' high. Steel tanks were selected over other types because they can be prefabricated, erected, and guaranteed by companies with long experience in the field.

The tank roof will be of steel plate on a system of purlins, beams and columns. An air filter, relief valve, roof hatch, two manholes and outside access ladder will be built into each tank.

An overflow collector system will be provided in each tank and connected to the new area sewer to prevent overflowing the tanks in event of failure of pump control system.

The supply line will enter the bottom of the clearwell and a riser pipe will deliver the water to the tank, approximately five feet below the normal water surface. This will prevent loss of storage in the event of line failure. At the filter plant the supply lines will be connected to a common pump header. Drains will be placed at the low point of each line.

The clearwells will provide a positive static head on the process pumps; and will be designed so that the tanks will discharge at reduced flow with water level 2 ft. above the bottom of the tanks without air entrainment. Foreign matter will be prevented from entering the pump lines by 6" steel weirs at each outlet. Welded steel plate bell mouth outlets will be used to collect water to each outlet pipe. Outlet pipes to the process pump house will be run in concrete tunnels with removable slab roofs. All inlet and outlet piping will be steel. The piping between the clearwells and process pumps is designed for the emergency condition of supply from three clearwells.

The tank foundation will consist of a 6" reinforced concrete slab with the edge of the slab carried down to act as a frost cut-off. The steel tank bottom will be supported on 1½" of oiled aggregate sand.

Inlet and outlet pipes will be encased in concrete where placed under the tanks.

The area between tanks and a three foot wide strip adjacent to the exterior of the tank walls will be paved.

The outside of the tank will be painted one coat of corrosion resistant primer and one finish coat. The underside of the tank roof and top two feet of the tank shell will be painted two coats of red lead and oil.

The selection of clearwell tank size for the 100-C Area resolved itself into one of relative economics. The curve drawn for steel tonnage of various diameter tanks with a constant volume, indicated the lightest tank to be about 150' in diameter and 41' high. When the increasing costs of motors, pumps and switchgear for various heads were superimposed, the economic tank head developed at about 31 ft. with a corresponding tank diameter of 170 ft. The final decision to use a diameter of 176' and height of 30 ft. was made to take advantage of the duplication of details already developed for the "DR" Area tanks.

j. Building Service - Fire and sanitary water from 183-B system will be piped around and within the area in conformance with the Hanford Works Fire Protection Standards, and service to the head house and filter building will be provided.

Filtered water at 100 psi will be pumped from the 183-C filter building pump room. This will be used for surface agitation, basin maintenance, hydraulic valve operation, and any miscellaneous services required. Since this water has not been subject to post-chlorination, it will be completely isolated.

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Steam at 225 pounds will be received from the steam distribution system, reduced in pressure, and used for building heating and service as required. All condensate will be wasted.

Toilet room fixtures in the head house will discharge into a septic tank and tile field conveniently located outside the head house. It will be designed for a load imposed by six persons on 24 hours schedule and will have 15 lineal feet of 8 inch tile per person and 15 cubic feet of tank volume per person as a minimum.

Toilet room fixtures in the filter building will discharge into a septic tank and tile field conveniently located outside the filter building. It will be designed for a load imposed by two persons on 24 hours schedule as outlined in the above paragraph.

For the purpose of supplying compressed air to the filter plant control system, two 150 cfm 100 psi reciprocating compressors, one motor driven and one steam driven will be installed in the compressor and equipment room in the head house. These compressors will be equipped with a separator, filter, aftercooler, and two receivers of 150 cubic feet capacity each located at opposite ends of the system. The motor will be connected to the emergency electrical system for emergency operation. One unit will be intended to be a maintenance spare.

Heating and ventilating of the 183-C filter plant will be accomplished in the following manner.

Head house - Unit heaters in storage and open spaces. Mechanical exhaust in toilet room, locker room, chlorinator equipment room, electrical room, and laboratory. Desert coolers in control room, laboratory, and other small rooms.

Filter Building - Unit heaters in filter building operating floor and pipe gallery. Mechanical exhaust in filter building operating floor.

The above system will be designed for the following conditions with all electrical and steam driven equipment in operation:

<u>Summer</u>		<u>Winter</u>	
<u>Outside</u>	<u>Inside</u>	<u>Outside</u>	<u>Inside</u>
105° DB	75° DB	-10° DB	70° DB
65° WB		-10° WB	

Drainage - Laboratory fixtures, drains, and overflows from chemical feeders, etc., and cooling water from air compressors in the head house will be collected and discharged into a sewer extended to the main sewer.

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A gantry crane will be provided on the roof over the pumps in the pump room in the filter building for handling the pumps. Hatches will be provided over each pump and over a working space.

k. Electrical - Transformers will be located outside the head house and outside the filter gallery pump space. Power will be supplied to the head house substation via one aerial 4160 Volt feeder from the 190-C Building. Power will be supplied to the filter gallery pump space via two aerial 4160 Volt feeders from the 190-C Building. The source will be three breakers on 4160 Volt switchgear in the 190-C pumphouse connected in the same manner as "DR" Area.

Aerial transmission will be used because of less cost, difficult routing of conduits underground through the area, and mechanical interferences and elevation changes. The lines will be dead ended on poles at the head house and filter gallery pump space.

Extension of both the normal and emergency circuits from dead-end poles at the head house and filter gallery pump space to the transformers will be by underground ducts.

Power circuits for the basins and filter house and communication and instrument circuits between head house and filter house will be run in conduit via walkways and trenches in basin structures.

Lighting intensities will generally follow IES industrial practice, using RLM dome fixture. Florescent lighting is proposed for offices and laboratories only.

Communication will follow standard procedure in other areas.

1. Freezing - Due to the larger volume of water than in other areas and a smaller amount of condenser water from the steam turbines in the process pump house it is not practical to pipe the condenser water to the head house as in DR Area. The only place where trouble from freezing might occur is on the surfaces of the clearwells and at the discharge weir of the sedimentation basins. It is proposed to use steam pipe coils at these locations if they are required after a study of water temperatures and flow conditions.

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V 190-C PROCESS PUMP HOUSE

a. General - The process pump house will take water from the clearwells and pump it to 105-C.

b. Normal Operating Conditions -

	Present Design Basis	Future
✓ Flow to 105-C Operating	62,000 GPM	80,000 GPM
✓ Flow to 105-C Shut-down (This can be supplied by pumps, using either motor or turbine drive or both types of drive)	6,000 GPM	6,000 GPM
At Operating Flow		
Pressure at top of 105-C Risers	525 psig-1210'	525 psig-1210'
Pipe friction loss from clearwells to top of risers (Approx.)	30'	40'
Elevation of top of risers above process pumps (Approx.)	50'	50'
Pressure at pump dis- charge	556 psig 1290'	560 psig 1300'
Elevation of clearwell water level above process pumps	33'	33'
Total dynamic head on pumps	1257'	1267'

c. Emergency Operating Conditions

Loss of condenser water - This will have no effect upon flow or water pressure at 105-C. Normal operation will continue.

Loss of steam supply to 190-C - This will have no effect upon flow or water pressure at 105-C. Process pumps will operate at same rate as before, with the motors picking up the load dropped by the turbines. (This feature is unique for 190-C and does not exist in the other 100 Areas). However, if steam could not be restored soon, 105-C would be shut down to avoid the possibility of being caught without either source of power in the event that electric power should be lost before steam were restored.

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Loss of one process pump - Operation would continue normally. The remaining pumps would automatically restore flow and pressure to the same values as before. Another pump would be placed in service to replace the one lost.

Loss of one quarter of total number of pumps operating - This could result from failure of a section of electrical bus, one section of suction header, or one section of discharge header. The remaining pumps would maintain flow and pressure to the best of their ability. Pressure at top of 105-C risers would decrease from 525 psig to approximately 485 psig.

Loss of one clearwell - All pumps could continue to operate, with all four sections of suction header supplied from the three remaining clearwells.

Loss of one of the six discharge lines from 190-C to 105-C - Normal operation could continue with the five remaining lines. The process pumps would automatically speed up slightly to compensate for the increased pipe friction.

Loss of BPA electric supply with process turbines operating either condensing or non-condensing - Pumps will decelerate, with riser pressure maintained above minimum requirements following trip-out, by flywheel connected to each pump. The pressure decay curve will be as shown by Curve "a" on Chart No. 2. Riser pressure will level off at a steady state value of approximately 116 psig at three minutes following loss of electric supply. Corresponding steady state flow to 105-C will be approximately 47 per cent of normal flow. The final steady state pressure and flow will be maintained by the process turbines using the same amount of steam as when they are fully loaded at normal flow conditions. There will be no acceleration of the turbines. They will slow down with the pumps, operating with a constant steam flow.

Within a few hours following loss of electric supply, pumps will be shut down, one by one until two or three pumps are left in operation, supplying the shut-down flow of 6,000 GPM. Steam pumps upstream of the clearwells will then be started to maintain this flow into the clearwells and also to restore the clearwell water level to its normal height.

Simultaneous and complete loss of both steam and electric supply to 190-C - Pumps will decelerate, with pressure decay as shown by Curve "b" on Chart No. 2, provided by flywheels. Top of riser pressure will have decreased to 55 psig 103 seconds after trip-out, and at that time the 187-C high tanks check valves will open and supply 17,000 - 20,000 GPM to 105-C.

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*what would be pressure drop
what happens to flow on other pumps.*

*Page 17
says all electric pumps*

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d. System Characteristic - As shown on Chart No. 1.

e. Pressure Decay and Pressure Requirements Following Loss of BPA Electric Supply - As shown on Chart No. 2.

f. Discussion of Process Pumps and Drives -

General - The magnitude of the pumping requirements in 190-C is much greater than the present areas. The amount of power required will be three times as great as for the present areas. The following tabulation shows the comparative requirements:

	<u>190-B</u>	<u>190-DR</u>	<u>190-C</u> <u>Design</u>	<u>Future</u>
Total GPM	30,000	36,000	62,000	80,000
Top of Riser Pressure	340 psi	375 psi	525 psi	525 psi
Total Horsepower	7,500	10,400	25,000	32,000

The only practical means of matching the system requirements and system characteristic is to use either two pumps in series with one of them having variable speed drive, or using one pump with variable speed drive. Constant speed drive cannot be used because at reduced flows, with either one or both power sources available, the pumps would be operating in the cut-off region with cavitation. This is because the system head varies approximately with the second power of the system flow, as compared with the customary system in which the head is mostly static and varies relatively little with flow.

The process pumps which have been used in the previously built 100 Arenas cannot be used for 100-C because they are inadequate for both the pressure and flow requirements.

A survey was made of all of the major manufacturers of pumps in the United States, to find what pumps had been built which would meet the requirements of the 190-C pump house. Only one manufacturer, Byron Jackson Company, has built such pumps.

Two distinctly different pumping arrangements can be provided, using pumps which Byron Jackson Company have built. All of these pumps were designed for, and are operating on, cross country pipe lines.

Two Pump Plan - (Not recommended)

Two of their pumps could be arranged in series, as in the existing 190 pump houses, to provide the total head required at a flow of 6,200 GPM per set. Ten sets would be required to operate

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CHART NO. 1

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CHART NO. 2

TOP OF RISER PRESSURE AFTER TRIPOUT

What is the basis for this safety margin?

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for a total flow of 62,000 GPM and two additional spare sets would be needed. Three more sets would have to be added to give a total flow of 80,000 GPM.

With this plan, the maximum possible head from the secondary (higher pressure) pump would be 870 feet. The remainder of the total head required would have to be provided by the primary pump. Thus, the division of total head between primary and secondary pump would be about the same as for the present areas.

The pressure requirements after loss of BPA electric supply have been relaxed for 100-C as compared with the existing areas. With a two-pump plan this would permit a smaller proportion of total head on the primary (steam driven) pumps. However, no pumps have been built which would provide this combination, and meet all other requirements.

With this two-pump plan, starting the flywheel and secondary pump would be a major problem. No 1600 horsepower motors have been built (a survey has indicated that probably no motors could be designed) which would be able to do this direct connected to the flywheel and pump without overheating greatly, to the extent that starts could be made only infrequently, and even then the motor life would be greatly shortened with the probability of early failure of the windings. The only practical way of starting the secondary pump would be to install a fluid coupling or possibly a centrifugal clutch between the motor and the flywheel pump combination, to allow the motor to come up to speed and then gradually accelerate the flywheel and pump. Even with this arrangement the motor in-rush current would be so great, equivalent to about 11,000 horsepower (700% x 1,600 horsepower) suddenly applied to the system that the system would suffer a severe voltage disturbance.

This flywheel starting problem would be more severe even than in the present areas (with motors only half as large as required for 100-C) where the voltage disturbance is great and the motor heating so severe that motors are being burned out.

One-Pump Plan - (Recommended)

Instead of using two pumps in series, it is recommended that one pump provide the total head. There has been only one pump built which will do this and meet the suction requirements. Byron Jackson Company designed and built two of these pumps. No other manufacturer has built such a pump.

This pump, for the operating conditions in 190-C, would supply approximately 8,000 GPM at the total head required. Eight such pumps would supply the 62,000 GPM flow, with two additional for spares. Two more pumps would be added for the 80,000 GPM future flow, making

a future total of twelve pumps.

The pump and drive arrangement for each will be as follows:

<u>Pump</u>	-	8,000 GPM, 1,260 ft. TDH, normally running at about 2,400 RPM, coupled to:
<u>Flywheel,</u>	-	Coupled to:
<u>Fluid Drive</u>	-	Coupled to:
<u>Gear</u>	-	2400/1780 RPM, coupled to:
<u>Motor</u>	-	3,200 horsepower, induction, coupled to:
<u>Steam Turbine-</u>		500 horsepower, geared, condensing

The overall length of this assembly of equipment will be approximately 44 feet.

The FLUID DRIVE will have its output speed controlled automatically to maintain top of riser pressure at the desired value. No over-pressure or back-up controls will be required. No other controls will be applied to any of the equipment. When starting a pump, the fluid drive controller will be set for minimum output speed and the motor and turbine brought up to full speed by means of the turbine only, then the motor switch closed (as the motor will be running at full speed at no load when the switch is closed, there will be no inrush current and no motor heating). Then the fluid drive will gradually accelerate the flywheel and pump, which acceleration will be done slowly enough so as not to overload the motor and overheat the oil in the fluid drive.

The FLUID DRIVE, in addition to its function of starting the flywheel will also provide the following features:

Automatic restoration of water pressure and flow upon loss of one pump.

Adjustment of water pressure to value desired for normal operating conditions, which pressure might be somewhat different than designed for.

Ability to supply any total flow desired between 6,000 GPM and 62,000 GPM. At low flows, either motor or turbine drive, or both can be used.

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Under all flow conditions the pumps will be operating very close to their best efficiency point, because the variable speed head-flow characteristic of the pumps will closely match the system head-flow characteristic.

The GEAR is necessary to match the motor speed to the pump speed. It also has the advantage of permitting the process water operating pressure to be increased, if desired in the future, by changing the gear ratio.

The MOTOR will have no starting duty, because of the turbine and fluid drive. It will be of sufficient capacity to supply the full horsepower of the pump without help from the turbine. This has two advantages:

It will permit normal operation with no load on the turbine and only a small amount of steam flow-through the turbine. The turbine will be operating on its speed control governor, with the speed setting of the governor slightly below the motor speed. This will result in a net yearly saving in fuel cost corrected for cost of increased electricity, of 1/4 million dollars for 100-C as compared with running the turbines at full load.

If in the future it is desired to raise the process water operating pressure by a change in gear ratio, operation of the turbines at full load will permit increasing the water pressure from present design of 525 psig to 572 psig without exceeding the rated load of the motors.

The MOTOR will be totally enclosed and water cooled by integral air coolers. This will markedly reduce the noise level in the pump house, keep the motor windings cleaner, and make it unnecessary to have an expensive and high capacity air conditioning system for the pump house. The saving in cost of the air conditioning system will pay for the cost of the totally enclosed motors.

The TURBINE will have sufficient capacity, operating either condensing or noncondensing, to supply the process water flow and pressure requirements after loss of BPA electric supply, being aided by the flywheel during the first three minutes following tripout. When starting a pump set the turbine capacity will be sufficient to bring the motor up to full speed before the motor switch is closed. Without the motors operating, and the pumps being driven by the turbines only, there can be supplied a process water flow of approximately 47 per cent of normal and a riser pressure of approximately 116 psig, and any flow and pressure less than these values, as desired. There will be no controls applied to the turbine. It will operate on its standard speed governor.

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Comparative Tabulation of Pumping Arrangements

	<u>190-B</u>	<u>190-DR</u>	<u>190-C</u>			
			<u>1-Pump Plan</u>		<u>2-Pump Plan</u>	
			Future		Future	
Total GPM	30,000	36,000	62,000	80,000	62,000	80,000
Number of Pump Sets:						
Installed	12	14	10	12	12	15
Operating	10	12	8	10	10	13
GPM per Pump Set	3,000	3,000	7,750	8,000	6,200	6,150
Horsepower						
Each Turbine	250	350	0-500	0-500	800	800
Each Motor	520	520	3120-2620	3200-2700	1,550	1,550
Percent of total head on Steam Drive	31%	40%			34%	34%
Total Steam - Lbs/Hr. (Add 17% for feed heating of this)						
Normal	76,000	70,000	0-64,000	0-80,000	128,000	167,000
Emergency	120,000	91,000	64,000	80,000	128,000	167,000

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Advantages of One-Pump Plan as Compared with Two-Pump Plan -

Net saving in operating cost of \$500,000 per year (62,000 GPM basis) by reason of 145,000 pounds per hour less steam consumption under normal operating conditions. On the future 80,000 GPM basis, the steam saving amounts to 188,000 pounds per hour resulting in a net yearly operating cost saving of \$650,000.

Saving in investment cost of approximately 3/4 million dollars because of no new boiler necessary in 184-B.

Regardless of whether or not a new boiler would be added with the 1-Pump Plan, use of the 2-Pump Plan would in any case require the addition of one more boiler than would the 1-Pump Plan because of the increased steam load at 170-C with the 2-Pump Plan.

More resistant to bomb damage, because even with loss of steam lines, the process pumps can continue to supply full flow to 105-C. With steam supply loss, the pumps could still be started, using the motors alone, using the fluid drive to essentially disconnect the flywheel and pump from the motor and allowing the motor to start unloaded and then bring the pump and flywheel up to speed gradually, with the motor running at full speed. This would be an emergency condition and would pull full inrush current on the motor only for the short time required to bring the motor by itself up to speed. Normally the motor would be brought to full speed by the turbine before closing the motor switch.

As there is only one pump instead of two in series, there will be no check valve by-pass around a primary pump and no inter-pump piping. This reduces suction piping head loss and eliminates the difficult fitting up job for inter-pump piping.

No motor starting duty and no system disturbance when starting motors.

Following loss of BPA electric power, the flywheel is more effective because the pump will always be working near its best efficiency as the pressure decays, and because there is no head loss from pumping through an idling secondary pump.

Controls are simpler

- (1) No back-up overpressure controls are required.
- (2) Same control functions regardless of whether motors or turbines are being used, and with any ratio of load division between them.

- (3) It appears, subject to further study, that the controls can be a direct proportioning type, without the necessity of automatic balancing of flows between pumps.

No pump suction stuffing box bleed-offs required, because suction stuffing box always under suction pressure only.

The flywheel WR^2 is nearly twice as effective with a normal operating speed of 2,400 RPM as it would be with a normal operating speed of 1,800 RPM. This results in a flywheel weighing only about half as much as other wise.

f. Description of Equipment (1-Pump Plan) (10 sets including 2 spare sets)

1. Pumps

8000 GPM, 1,260 feet TDH, 2,400 RPM, Byron Jackson 14 x 16 Double Volute, double suction, 2 stage, 19 inch diameter impeller, 85 per cent efficiency.

These pumps have been built and are in operation on The Trans-Arabian oil pipe line. They are designed for and are operating at 3,600 RPM, 6,000-10,000 horsepower at 800 psi and flows up to 12,000 GPM. These same pumps would be used, running at the lower speed of about 2,400 RPM.

The pumps are more than adequate for this purpose. The casings are cast steel, hydrostatically tested at 1,800 psi. First critical speed is above 3,600 RPM. Impellers are stainless steel. Alloy steel shaft.

Bearings are sleeve, with Kingsbury thrust. Pressure oil lubrication with emergency oil rings.

Shaft seals would be mechanical type. No water sealing would be necessary because under worst suction conditions with clearwells empty the pumps will still have a flooded suction.

Byron Jackson state that they could, if desired, rush through one pump at extra cost in four months and run reduced speed tests on it in their laboratory. These tests would be of a confirming nature, because the pumps already built were completely tested and this existing data would serve as a check on the new tests. They would then calculate the pump characteristics at full speed by using pump affinity laws, the validity of which have been proven to apply to this pump by actual tests already performed. Full speed tests cannot be run on this pump in Byron Jackson's laboratory because they do not have sufficient power supply for 3,000 horsepower. They guarantee that the actual pump performance will match the predicted performance exactly, because these same pumps have already had complete tests.

Both the Chief Engineer for Standard Oil of California, who was instrumental in having these pumps designed, and the Chief Engineer of Trans-Arabian Oil Company give unqualified approval of these pumps. They have been in continuous operation on a 1,000 mile pipe line for over a year, 24 hours a day, 7 days a week, without any trouble, operating at 6,000 horsepower or better at 3,400 to 3,600 RPM. The service is such that no interruptions can be tolerated.

Byron Jackson state that all ten pumps could be delivered in 9 to 10 months from date of order.

2. Flywheel

45,000 lb. ft. squared. Mounted on separate bearing pedestals. Byron Jackson Company will build the flywheels and mount on a common bedplate with the pump, using the same pressure oiling system for both.

3. Fluid Drive

This is a conventional fluid drive, with variable speed control. The power transmission is by kinetic energy of oil. Speed is varied by position of a scoop which regulates the thickness of the whirling oil ring. The fluid used is standard light turbine oil. Oil can be added to the reservoir with the drive operating. Drive will be totally enclosed.

American Blower Corp. is the only manufacturer in the United States making fluid drives of this capacity. They have built many units of about this size and some units of much larger capacity.

4. Gear

This would be a conventional unit.

5. Motor

3,200 horsepower, 1,800 RPM, 4,160 Volt, 3 phase, 60 cycle, induction. No starting requirements. Totally enclosed, water cooled. A survey has indicated that 13 KV motors of this rating would not be as reliable and rugged as the lower voltage motors.

6. Geared Turbine

500 horsepower at normal operating speed. Steam conditions 175 to 200 psig saturated, condensing. Capacity to supply 400 horsepower non-condensing. Standard speed governor. Multistage turbine.

7. Condenser

One for each turbine. Surface type. Mounted beneath turbine. Steam turbine driven condensate pumps. Condensers designed for 26" vacuum. The condenser water will not be returned to the head house of the filter plant because normally the turbines will be running at no load and there would be practically no head added to the condenser water. Even with the process turbines fully loaded, the amount of head added to the condenser water would be only sufficient to raise the temperature of the total flow through the filter plant by $1\frac{1}{2}^{\circ}$ F.

Atmospheric relief lines will be provided on the condensers.

Surface type condensers will be used instead of barometric type for the following reasons:

- (a) They will be less susceptible to bomb damage, being in the basement of the pump house, instead of above the roof.
- (b) They fit in better with the general arrangement of equipment and building. The building will have a full basement anyway to provide room for piping, and the surface condensers fit well into this arrangement.
- (c) No separate hot wells will be needed. This will simplify general arrangement and give building space.
- (d) The air ejectors will be installed at the operating floor, near the turbine, so all turbine and condenser operation will be centered there with no necessity of going outdoors at any time.
- (e) No vacuum condensate traps on turbine exhaust piping.
- (f) Exhaust piping between turbine and condenser will be very short, coming out the bottom of the turbine and entering the top of the condenser. The exhaust pipe will not cross the operating floor as it would with barometric condensers.
- (g) Air ejectors will be smaller capacity because they are not required to remove air from the condenser cooling water.

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- (h) There will be no freezing problem because the condensers will be indoors.

The hotwell of each condenser will have a high water alarm, actuating a sound signal and light at the instrument panel for that pump group. Similarly there will be an alarm for loss of vacuum, with alarm shut-off arrangement for when the unit is not operating.

Condensate pumps will discharge into the condenser cooling water discharge line.

8. Controls and Instruments

Process water pressure at top of risers will actuate the automatic control system. This will adjust the scoop position of the fluid drives and so control the speed of the pumps. At this time it is believed that automatic balancing of flow of each pump is unnecessary, as the position of the scoop will determine pump speed with sufficient precision. Manual control of the system pressure will be provided in the main control room. Manual control of individual pump pressure and speed will be provided at each of four panels on the operating floor. Controls will be air operated.

Instrumentation will be similar to that in 190-DR, with some simplification resulting from using one-pump instead of two in series.

Control and instrument panels will provide space for two future pump sets.

9. Compressed Air System

Air for controls and instruments to be supplied normally by two heavy duty motor operated air compressors each with receiver. Standby heavy duty steam driven compressors will be provided. Each of 4 compressors will have sufficient capacity to supply the total requirements of the 190-C.

10. Solids Feed Equipment

This will be provided as required.

11. Overhead Cranes

Will be provided for installing and servicing the pumps and drives.

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h. Process Pump Suction Conditions (1-Pump Plan)

Depth of Water in Clearwells	Water Storage Percent Minutes at 80,000 GPM	Height of Water Le- vel above Pump Suction	Positive Head on Pump Suc- tion	GPM Allow- able by pump manu- facturer	Maximum GPM at Suction Rating of Pumps
28.8'	100%	263	31.8'	28.8'	Above 80,000
6.0	21.8%	55	9.0	6.0	Above 80,000
4.0	13.8%	36	7.0	4.0	Above 80,000
2.0	6.9%	18	5.0	2.0	Above 80,000
0.0	0%	0	3.0	0.0	Above 80,000

Note: No harm can come to the pump as long as any water is left in the clearwells even if full process flow is maintained right down to only a few inches of water left in the clearwells. Any slight tendency toward cavitation which might occur under these extremely unlikely conditions of operation would be of very slight magnitude and hurt the pumps in absolutely no way. The stainless steel impellers would be in no way harmed. The pumps could never lose suction supply.

It is of interest, that with the only pumps available for the two-pump plan, the secondary pump would require a six foot positive suction head and with the primary pumps not running, this would be aggravated by the head loss through the check valve in the suction by-pass. So the one-pump plan imposes no limitations on suction conditions, and in fact provides the best suction conditions obtainable with any pumps which have been built and which fit the requirements.

1. General Arrangement

Along the 100-C longitudinal east-west centerline, the 190-C Building will have a central operating aisle with half of the pumps on each side of this aisle. The pumps will be spaced on approximately 16 foot centers. The pump end of the pump set will be toward the central aisle, with the turbines toward the north and south walls of the building.

The four operating panels for the pumps will be in the central operating aisle. A central control room at one end of this aisle will face out towards the four operating panels. The building will be considerably smaller than any of the existing 190 Buildings because of better space utilization resulting from grouping the pumps.

* There may be slight reduction in head provided by the pumps, if flows exceed these values under these low water conditions.

** Static head minus suction pipe friction loss.

*** On basis of no damage to any part of pump, even with operation for three months under these conditions.

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on both sides of a central aisle, and because of the reduced number of pumps in the building. As the building will be smaller and more nearly square it will simplify operation, cost less, and permit short piping headers, probably allowing elimination of all expansion joints and expansion bends. The suction headers will form a complete loop, increasing reliability. Motor operated valves can be grouped, simplifying control wiring.

The building will have a full basement for piping and condensers. In addition to improving the general arrangement, this will facilitate construction because no pipes nor conduit will be cast in place. Motor operated valves will extend up through the operating floor, with their manual operating wheels at a convenient level above the floor. There will be no floor trenches in the building.

The elevation of the operating floor will be at 479.0'. The basement floor will be approximately 15' below the operating floor. The centerline of the pumps will be at Elevation 483' approximately, which will be 3' below the bottom of the clearwells.

j. Drainage -

All continuous drainage, such as bearing cooling drains, will flow to sewer by gravity.

The basement of the pump house will have a weir outlet at a level below the operating floor, the bottom of the weir being above the top of the main sewer. The weir will prevent complete flooding of the basement under any condition.

Intermittent drainage into the basement will be removed by sump pumps, one steam turbine driven unit of high capacity and two motor driven units of smaller capacity.

The pipe tunnels from 190-C to 105-C will slope back and drain into the basement of 190-C.

Battery room and toilet room floor drains will discharge into the sanitary line to the septic tank. There will be no floor drains in the other rooms and offices.

The basement floor will be sloped to floor drains or drain culverts.

k. Piping Systems -

(All piping adequate for future flow of 80,000 GPM)

1. Suction Piping for Process Pumps

4. Pump Recirculation Piping

Arranged to permit constant recirculation from each pump discharge back to the suction header, as in 150-DR.

5. Cooling Water for Pumps and Drives

Approximately 1,250 GPM required (at 80,000 GPM process flow) for air coolers of motors and oil coolers of turbines, gears, process pumps, fluid drives, and air compressor aftercoolers. This to be supplied normally from filtered water, with emergency connection to condenser water. Water from coolers to be discharged to sewer. No gland seal water will be required.

6. Condenser Water Supply

Will come from an extension of the present condenser water system in 100-B. Will be discharged from the condensers to sewer by gravity.

7. Filtered Water Supply

Will come from the filtered water pumps in 183-C. For supplying process pump and drive cooling, air conditioning, and air compressor cooling.

8. Steam Supply

A main steam supply header segregated by valves into four sections will supply all steam demands in 190-C. This header will be supplied by two outside steam lines. The larger leads from the header will be equipped with strainers. Process pump turbine leads will be equipped with orifice flanges, all valves weld-end.

9. Air Piping

A main air supply header will be provided, segregated by valves into four sections and supplied at two points from the air compressors. Evacuation alarms will be connected to this air supply system.

10. Drains and Vents

Will be provided at all necessary points in the piping systems.

11. Fire and Sanitary

A header in 190-C supplied from new 100-C Fire and Sanitary Loop.

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1. Heating and Ventilating -

A ventilating and heating system will be provided to supply fresh air within the building at a rate of approximately 100,000 cfm. This air will be filtered.

No attempt will be made to maintain a positive pressure within the pump house because the wall siding being of friable material cannot be made sufficiently air-tight.

There will be no cooling of the ventilating air in the main pump room. The offices, control room, and locker rooms will have provision for cooling the air in the summer to 10°F. below outdoor temperature.

There will be provision for heating the ventilating air to provide an inside temperature throughout the building, of 70° with 10° F. outdoors. No mechanical exhaust fans will be provided. Ventilating air under positive pressure will be supplied to the auxiliary rooms.

m. Building Service -

1. Sanitary facilities -

Will be provided as described in the "Architectural" section of this report.

2. Sewage System

Will be provided to accommodate the sanitary facilities described above. This will include septic tank and tile drain fields.

3. Hot Water System

Will be provided, including electric hot water heater, to serve the sanitary facilities.

n. Electrical System -

The 4,160 Volt power distribution will be same as the 2,300 Volt system in DR Area. Two electrical switchgear rooms will be provided.

The final extension from the 2300 Volt emergency circuit will be by underground duct from the dead-end pole, routed into the north emergency transformer, and looped through to the south transformer.

Lighting intensities will generally follow IES industrial practice. Communication will follow standard procedure in other areas.

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VI POWER HOUSE ADDITION 184-B

a. General -

Two new condensing 750 KW turbine-generator units will be added. They will have surface condensers (for same reasons as their use in 190-C). There will be no additional boilers.

b. Steam Demands -

1. Steam demands for 100-B are as follows:

	<u>Summer</u>	<u>Coldest Day in Winter</u>
Normal	120,000 #/hr.	175,000 #/hr.
Emergency *	273,000 #/hr.	328,000 #/hr.

All of these demands include feed heating steam.

* Includes 35,000 #/hr. for 750 KW Emergency generator, and 6,000 #/hr. for feed heating of the 35,000 #/hr. OK

2. To reduce the Emergency steam demands it is proposed that the 750 KW emergency turbine generator unit (non-condensing) be abandoned and replaced with new equipment as discussed below. This will deduct 29,000 #/hr. from the Emergency demands for 100-B. A second condensing 750 KW unit will also be added to supply 100-C Emergency electric load.

This will have the following advantages:

It will, together with "3" below, eliminate the necessity of installing another boiler. This will make a net saving in investment cost of \$600,000.

It will provide more dependable Emergency electric supply. The new units will be spinning at full speed, at no load, on governor control, completely ready to pick up the Emergency electric load whenever required. The present non-condensing unit is at standstill normally and has to make a quick and automatic start under Emergency conditions.

The net load steam flow for both 750 KW condensing units will be only 1700 #/hr. each. This will be compensated for by the elimination of the warming steam flow continuously put through the present non-condensing unit, and by increased boiler efficiency resulting from fewer boilers operating, each at a higher per cent of capacity than would be the case if another boiler were in operation constantly in order that the boiler house would be ready to supply the larger steam demands of non-condensing emergency generators.

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If another operator were required on each shift, to take care of the two generators, this would be offset by the same additional manpower required by an additional boiler. Even if this were not the case, \$25,000 a year for operators would be insignificant compared with the saving of \$600,000 in investment resulting from installing condensing emergency generators instead of a new boiler.

3. To further reduce the Emergency steam demands, it is proposed that the acceleration be eliminated from the process turbines in 190-B. The acceleration does not start until after five seconds following tripout, as shown by the high-speed recorder charts included with the report made by Mr. H. C. Lee to Mr. H. F. Measley dated April 19, 1950. The actual pressure decay is shown as curve "a" on Chart No. 3. Curve "b" on Chart No. 3 shows the calculated pressure decay curve with no acceleration of the turbines. Also on Chart No. 3 is shown the estimated pressure requirements, Curve "c" for 105-B, which requirements fall well below the pressure decay Curve "b". The estimated pressure requirements for 105-B were taken as proportionate to those for 105-C, on a relative normal operating pressure basis.

The elimination of turbine acceleration in 190-B can be accomplished easily by simply lowering the speed governor setting. It will reduce the Emergency steam demand by 55,000 #/hr. (including feed heating).

4. The revised Emergency steam demands for 100-B will then be:

	<u>Summer</u>	<u>Coldest Day in Winter</u>
Before Deductions	273,000 #/hr.	328,000 #/hr.
Deduct non-condensing		
750 KW Emerg. Generator:	<u>41,000</u>	<u>41,000</u>
Deduct acceleration of	232,000	287,000
190-B Process Turbines:	<u>55,000</u>	<u>55,000</u>
	177,000	232,000
*Add new, condensing 750 KW Emerg. Generator for 100-B (14#/BHP Hr. steam rate) and feed heating steam for it (Full Load):	<u>12,000</u> ✓	<u>12,000</u>
Revised Emergency Demands for 100-B:	189,000	244,000

*This Emergency generator would normally run at full speed at no load using 1600 #/hr. of steam, and ready to pick up load instantly.

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CHART NO 3

TOP OF RISER PRESSURE FOLLOWING
TRIPOUT 105-B

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5. The revised Normal steam demands for 100-B will then be:

	<u>Summer</u>	<u>Coldest Day in Winter</u>
	120,000	175,000
Add no load steam for new, condensing, 750 KW emerg. generator, running at full speed - to serve 100-B:	1,700	1,700
Add feed heating for 1700#/hr.	300	300
Revised Normal demands for 100-B:	122,000 #/hr.	177,000 #/hr.

6. Estimated Normal Steam demands for 100-C (62,000 GPM basis):

	<u>Summer</u>	<u>Coldest Day in Winter</u>
190-C	4,000 #/hr.	4,000 #/hr.
105-C	28,000	28,000
Line Loss	4,000	4,000
Another condensing 750 KW emerg. generator running at full speed at no load to serve 100-C	1,700	1,700
Building Heating, including 19,000 #/hr. for 105-C:	0	40,000
Feed Heating	6,300	23,300
	44,000 #/hr.	91,000 #/hr.

7. Estimated Emergency Steam Demands for 100-C (62,000 GPM basis)

	<u>Summer</u>	<u>Coldest Day in Winter</u>
190-C	64,000	64,000
105-C	46,000	46,000
Line Loss	4,000	4,000
750 KW Emerg. generator, Condensing	10,500	10,500
Building Heating including 19,000 #/hr. for 105-C:	0	40,000
Feed Heating	20,500	27,500
	145,000 #/hr.	192,000 #/hr.

65,000 provided
for 105-C

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8. Total Steam Demands on 184-B Serving 100-C (62,000 GPM basis) and 100-B.

	<u>Summer</u>	<u>Coldest Day In Winter</u>
<u>Normal</u>		
100-B revised as above:	122,000	177,000
100-C	44,000	91,000
Total (62,000 GPM basis)	166,000 #/hr.	268,000
<u>Emergency</u>		
100-B revised as above:	189,000	244,000
100-C	145,000	192,000
Total (62,000 GPM basis)	334,000 #/hr.	436,000 #/hr.
Number of boilers operated	3	4
Load on each boiler - Normal	55,000 #/hr.	67,000 #/hr.
Load on each boiler - Emerg.	111,000 #/hr.	109,000 #/hr.

345,000
436,000
474,000

There are four boilers in 184-B, rated and capable of at least 115,000#/hr. ea. Boiler maintenance not to be done in the winter time.

c. Possible Future Increase of Process Water Pressure in 100-B -

There has been some talk of raising the top of riser pressure at 105-B from the present 350 psig to a new value of 475 - 500 psig.

If this were done, it would require complete new casings on the secondary pumps in 190-B, and increased operating speed of the primary pumps with resulting increased turbine power. With the present 190-B turbines, this would require another boiler. However, it would be better, instead of installing a new boiler, to replace the present inefficient turbines with new multistage, geared turbines which would be able to supply the increased load with the same total steam consumption as the present normal demands.

The new turbines installed would cost less than a new boiler and would save in fuel cost \$272,000 per year as compared with using the present turbines at the higher load.

d. If the acceleration were not eliminated from the 190-B turbines and/or if two new 750 KW condensing Emergency generators were not installed, a new boiler would be necessary in 184-B.

e. Steam Demands During Emergency, Following reduction in number of process pumps operating.

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Within a few hours following loss of BPA electric supply, the flow to both 105-B and 105-C will be reduced substantially and only two or three turbine driven process pumps be operating in each of 190-B and 190-C.

The steam made available by shutting down most of the process turbines will be used to operate steam driven pumps upstream of the clearwells in both 100-B and 100-C, to maintain the reduced flow and to refill the clearwells.

f. Steam Demands on 184-B - 100-B plus 100-C (80,000 GPM basis) (Future)

	<u>Summer</u>	<u>Coldest Day in Winter</u>
<u>Emergency</u>		
100-B and 100-C (62,000 GPM)	334,000	436,000
Add for 80,000 GPM (100-C) including feed heating:	<u>19,000</u>	<u>19,000</u>
Total (80,000 GPM)	353,000 #/hr.	455,000 #/hr.
Number of boilers operated	3	4
Load on each boiler - Emerg.	117,000 #/hr.	114,000 #/hr.

Thus, when and if the 100-C flow is increased to 80,000 GPM by the addition of more pumps and increased filter plant, it would still be unnecessary to add a boiler.

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VII HIGH TANKS - 187-C

Two high-tanks of 300,000 gallons capacity each will be provided. The elevation will be such that there will be a pressure of 55 psi at the top of the riser in 105-C with tanks full. The tanks will be located one on the north and one on the south side of 105-C. The valve pit will be of concrete construction and provide supports for the tank risers. The top of the footings for the tanks and the top of the valve pit will be at the same level as the 105-C operating floor.

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VIII RETENTION BASINS - 107-C

Retention basins will consist of two welded steel plate tanks providing a total storage capacity of 18,000,000 gallons.

Steel tanks were selected because they can be built more water-tight, erected in less time and can be prefabricated and guaranteed by companies with long experience in the field.

Baffles will be placed to prevent short-circuiting of flow within the tanks. A wind girder will be provided to brace the top of the tank. No. roof is contemplated. An economic study will be made to determine the diameter and depth of the tanks.

The tanks will have a connection to the B Area retention basins so water can be diverted from the C Area sewers to the B Area retention basins if necessary.

1
62,000
60
3,720,000

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*indigenous
lines*

IX OUTSIDE STEAM LINES

The existing outside overhead steam distribution system of 100-B Area will be extended to supply steam for the new 100-C Water Plant. This will be designed to provide two sources of steam always available to essential steam driven equipment. Sectionalizing valves will be installed where necessary to isolate portions of the line for service without interruption of supply to the various buildings.

Expansion loops and anchors will be provided to care for pipe expansion over the full working temperature range.

All lines will be sloped to drain and will be adequately trapped.

In non-traffic areas the lines will be carried on supports about three feet above ground. In traffic areas the lines will be supported with 14ft. clearance above roadways and 25 ft. clearance above railroad tracks.

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X PRIMARY SUBSTATION - 151-C

This work will be under the direction of the General Electric Company. The work of this office will be confined to coordination of pilot relaying design.

The electrical demand of the 100-C Area will be approximately 30,000 KVA. Added to the 100-B Area load of 12,300 KVA this makes a total load on 151-B substation of 42,300 KVA. Document HDC-2080 discusses this load and the ability of the 151-B substation to supply it.

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XI OUTSIDE UNDERGROUND LINES

a. Main Sewer - This sewer line will have a minimum slope of .005. It will be either a concrete box culvert or a concrete pipe. The sewer will be located to take the maximum flow from either of the following places:

Pit in tunnels near 105-C
Basement of pump house 190-C

Effluent flume from filter
basins
Effluent flume from filter
building

It will also be located to take the flow from the clearwell area in case of a tank failure and the flow from the lines emptying the clearwells. All yard drainage, condenser water and other miscellaneous drainage will go to this sewer.

The outfall will be located at a point east of the existing retention basins for B Area and will be designed to dissipate the head and prevent erosion of river bank.

b. Retention Basin Sewers - Two sewer lines each having a capacity of 80,000 GPM with a minimum slope of .005 will be built from the 105-C Building to the retention basins and from there to the river. These will be 66" welded steel pipe. They will be located at least 100 ft. apart and be cross connected to the sewer from 105-B through manholes at a point near 105-B.

c. Sanitary and Fire Line - A sanitary and fire line loop will be installed around the area and be connected at two points with B Area lines. This will be a cast iron pipe line. Fire hydrants will be located approximately 600 ft. apart.

d. Export Water Line - An export water line will be built to the 105-C Building from the existing export water line running east and west just south of B Area. This will be a 20 inch class 250 cast iron pipe.

e. Emergency Raw Water Line - An emergency raw water line will be run between the head house and the 182-B raw water reservoir. This will be a 24" steel pipe line. Additional pumping capacity will be added to 182-B for this purpose.

f. Condenser Supply and Return Lines - The condensers in the 190-C pump house will be supplied with raw water from the 182-B reservoir pump house through a new 24" steel pipe line connecting into the north end of 190-C. The condenser water will be returned to the main sewer through a 18" steel pipe line.

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g. Filtered Water Lines - A filtered water line will be run from the 183-C filter building pump room to the 105-C building and the elevated tanks. A cross connection will be made between this filtered water line and the B Area filtered water distribution system. Connections will also be made from 183-C filter building pump room to 190-C, 183-C filter building and head house.

h. Sodium Dichromate Lines - Sodium dichromate will be piped in two steel lines from the 185-B Building to the storage tanks in the north end of the 183-C head house.

i. Raw Water Lines - (See Section on RAW WATER LINES)

j.. Process Water Lines - (See Pump House)

add lines for sewage lift station (1655 sq. ft.)

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XII OUTSIDE ELECTRIC LINES

Underground duct construction will be built from the control house on the north side of 151-B substation to the 190-C process pump house and to the 105-C building. There will be four or more 13.8 KV feeders and the pilot relaying circuits to the 190-C pump house, and two 13.8 KV feeders to the 105-C building.

Overhead construction will be used for the 4,160 Volt distribution circuits, and for telephones, instrumentation, and alarms, in accordance with present practice.

One or two emergency 2300 Volt lines will be run on overhead construction from the 184-B power house and serve emergency transformers located in the 190-C pump house, 105-C Building, head house, and filter gallery pump space.

The main emergency lines will be tapped where necessary to go to those locations through fused disconnects. The lines will dead end on poles at these locations.

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XIII ROADS, RAILROADS, WALKS, FENCES

a. Roads - Roadways within the area of the water plant are classed as main and patrol roads. Main roads will be 20' wide and built up of a 6" base coarse, 2" leveling keystone coarse and topped with a 2" asphaltic concrete wearing surface. Patrol roads will be 14' wide and built up similar to the main roads except that the wearing surface will be water bound gravel.

b. Railroads - The railroad extensions to the head house and 105-C will be spurs from the existing 100-B Area tracks. They will be built according to the AREA specifications. Curvatures will be held to a maximum of 10 degrees and grades to a maximum of 2 per cent. Overhead clearance will be not less than 25 feet. Ballast will comply to AREA and general area requirements.

All ties will be croosote treated. Rails will be not lighter than 110 lbs. per yard. A bumper will be provided at the dead end of the spur.

c. Walks - Sidewalks will be of similar construction as the main roads and placed in all lanes of usual foot travel.

d. Fences - Fences will be of the chain link type with posts and mesh hot dipped galvanized. Gates will be of similar construction and all corners will be braced. Three strand barbed wire protection will be provided on all fence. Gates will have double latches and padlocks.

XIV STRUCTURAL DESIGN - ALL BUILDINGS

a. Soil pressure - Based on experience in other areas a maximum working soil pressure of 8,000 lbs. per square foot is conservative. The working values for soil pressure will be in accordance with the "Uniform Building Code" adopted by the Pacific Coast Building Officials Conference. The material will not stand on slopes steeper than 1-3/4 to 1 and a slope of 2 to 1 will be used for all permanent excavation slopes. Areas below floors and foundations poured against deeper vertical walls will be supported on lean concrete fill. All pipes will be laid on a sand bed in the bottom of the excavated trench except where they are encased in concrete for protection under roads and railroads.

b. Loadings - All building roofs will be designed for a live load of 25 lbs. per square foot.

All floor and platform loads will be established by the area use and erection conditions. These will vary but the following loadings are established:

Feeder bin floor in head house	- 350 lbs. per sq. ft.
Office Space	- 50 lbs. per sq. ft.

Wind pressure on structures will be assumed as 15 lbs. per square foot on the vertical projection.

Earthquake forces will be included for each structure and proper values for the Zone II area incorporated in the designs in accordance with the "Uniform Building Code", adopted by the Pacific Coast Building Officials Conference.

c. Bomb Blast - The superstructures of the 181-B River Pump House, 183-C Head House, 183-C Filter Building, and 190-C Process Pump House, will be Class II construction consisting of a steel frame with friable material for siding and roofing. In addition to the loadings given in (b) above the structural steel frame will be designed to take the following loads on the projected area of the steel frame after the siding and roofing has been "blown out".

Roof	- 150 lbs. per sq. ft.
Sides	- 100 lbs. per sq. ft.

The exterior walls of the 183-C Filter Basins will be designed as Class I structures by backfilling the exterior side of the walls with earth up to the water level. No attempt will be made to meet Class I design on the interior walls. Class I design requires a 1,000 lb. per sq. ft. load on all sides and top simultaneously.

The clearwell tanks and retention basins will not be designed for bomb blast protection.

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The elevated tanks will be designed in accordance with the "Standards of the National Board of Fire Underwriters" except they will be designed to resist earthquake in accordance with "Earthquake Resistant Design of Buildings, Structures and Tank Towers" of the Pacific Fire Rating Bureau.

The control room of the 190-C pump house will be enclosed with Class I constructed walls:

d. Concrete and steel design - Concrete and steel design will be based on the requirements of the "Uniform Building Code" latest revision, adopted by the Pacific Coast Building Officials Conference.

The ultimate 28 day concrete strength will be set at 3,000 lbs. per square inch, and the allowable working stress at 1,350 lbs per square inch. Allowable working stress in reinforcing will be 20,000 lbs. per square inch. All bars will be of intermediate grade steel and deformed. The concrete will be divided into two classes as follows:

- I. Lean concrete backfill
- II. Structural concrete (air entrained)

Structural steel will be designed with a working stress of 20,000 lbs. per sq. in. on the net section.

e. Foundations - Foundations will be of the spread footing type and designed to keep soil pressure at or below the allowable stress.

f. Superstructures - In general, building frames will be designed as rigid structures and continuity of steel structures will be achieved by the use of welding or Dardolet bolt connections. No field riveting will be used.

g. Drainage - Drainage will be provided around the periphery of all building foundations to carry off surface water to the main sewer. Drains in the clearwell area will be sized to carry off the water due to one tank failure. The ground at the clearwells and pumphouse will be graded in such manner that the pump house will not be flooded in case of a tank failure.

h. Clearwells - See Section "THE 183-C FILTER PLANT (1)

i. Sedimentation Basins - Basins will be of reinforced concrete with each wall designed as an independent tee section capable of carrying full differential water pressure on either side. The base slabs will be separated from the bases of the walls by expansion joints provided with molded rubber water stops and dehydrated cork.

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A system of open-joint pipe under-drains, installed in a gravel bed will be provided under the flocculation and sedimentation basins. A bitumastic penetrated bed under the drain system will act as a water cut-off. The drains will serve to reduce to a minimum the hydrastatic uplift on the basin slabs in case of a leak. Collected water will be carried to the main sewer.

Expansion joints with rubber water stops and dehydrated cork will be placed crosswise and longitudinally in the basin slabs to control cracking and to minimize leakage.

j. Retention Basins - See Section VIII RETENTION BASINS - 107-C

The basins will be located a sufficient distance apart to avoid any possibility of uplift due to one basin being empty at the same time as a bad leak occurs in the other. For this reason no drainage system is required and the tanks will be set on a sand bed placed directly on the ground.

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XV ARCHITECTURAL FEATURES - ALL BUILDINGS

a. Bomb Blast Construction - The superstructures of the 181-B Pump House, 183-C Head House and Filter Building, and 190-C Pump House will have corrugated asbestos siding and roofing. Transite insulation board will be used on the roof. It will also be used on the inside of the siding on the 190-C Pump House and on the first floor of the head house where required. These materials are expected to pulverize on bomb blast and not transmit any appreciable load to the steel framework. All interior partitions will be of cement asbestos on steel studs, glazed and insulated where required. The control room of the 190-C pump house will be enclosed with Class I constructed walls with narrow thermopane windows as small as can be used and still maintain proper operating functions.

b. Facilities included in the Buildings:

<u>181-B River Pump House</u>	<u>183-C Head House</u>	<u>183-C Filter Bldg.</u>	<u>190-C Pump House</u>
No office space or toilets	Laboratory Control room Compressor & Equipment Room Electrical Switch- gear Room Chlorinator Room Locker and lunch room Toilet & Shower Room	Pump Room Toilet Room Sample Room	Control Room Main Office Supervisor's Office Locker & Lunch room 2 Electric Switchgear Rooms 2 Battery Rooms 1 toilet & Shower Room

c. Roofs - All roofs will slope one half inch per foot and a metal gravel stop will be provided at all eaves. Metal gutters and downspouts will be provided only where water would spill on lower roofs or over doorways and walks. The roofs will be covered with 4-ply asphalt and gravel roofing.

d. Windows - There will be no windows in any building.

e. Doors - Doors in the 190-C pump house interior will be hollow metal type with steel frames and in all other buildings they will be steel industrial type with steel channel frames. Exterior doors in the 190-C pump house will be steel industrial type with channel frames except for the large access doors which will be rolling steel type. Equipment will be moved into and out of the 190-C pump house through large doorways where there will be sufficient room in the pump house opposite these doors so that a truck may be driven into the building under the crane. Emergency exit doors will be provided in each switch-gear room and a main entrance door will be provided in the main office.

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f. Stairs - Stairs will be steel with concrete filled pan-type treads, channel stringers and pipe railings.

g. Ceilings - In the 190-C pump house there will be ceilings approximately ten feet high over the toilets, lunchroom, storeroom, lockerroom, shower room, battery room, control room, and offices. These ceilings will be cement asbestos supported on a steel frame except the control room which will be concrete. The ceiling of the offices will be insulated with a sound absorbing material that will give approximately 75 per cent sound absorption.

h. Expansion Joints - Expansion joints will be provided in the roof and walls to match expansion joints in the steel framework.

i. Toilet partitions will be cement asbestos. Plumbing fixtures and lockers will be as follows:

181-B River Pump House	None
183-C Head House	1 shower stall 2 water closets 2 urinals 2 lavatories 1 slop sink 1 water cooler (in corridor) 15 lockers
183-C Filter Building	1 water closet 1 urinal 1 lavatory 1 water cooler (on main operating floor)
190-C Pump House	2 water closets 2 urinals 2 lavatories 3 shower stalls 2 water coolers (one in pump room) (one in main office) 20 lockers

j. Miscellaneous Items - Hatchways will be provided in the 190-C pump house operating floor for moving in pipe to the basement. Similar hatchways will be provided in the tunnels to 105-C.

The machinery pits under the chemical storage silos will be connected to the main valve pit by access corridors and doors.

The laboratory in the head house will be furnished as required by the Operating Division.

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k. Floors - All floors will be concrete except over the valve pit in the head house which will be steel grating.

l. Access - There will be a main road running east and west along the present export water line (see Drawing SP-5003) from which will be run access roads to the head house, filter building, clearwell area, and pump house and 105-C Building. The access road to the pump house will be along the east side and provide access to the main truck entrance doors at either end, the main entrance in the center, and to the transformer bays adjacent to the east side of the building.

~~SECRET~~

DRAWING LIST
(Drawings that accompany Design Report)

<u>Drawing No.</u>	<u>Title</u>
SP-5001	- Proposed Site Plan
SP-5002	- Filter Plant - General Arrangement
SP-5003	- General Arrangement Plan
SP-5004	- Flow Diagram

491045

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DECLASSIFIED

SECRET

PLAN-FILTER PLANT
Scale 1"=50'

SP 5002

REVISIONS

NO.	DATE	DESCRIPTION
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

APPROVED FOR CONSTRUCTION

DESIGNED BY: [Signature]

CHECKED BY: [Signature]

DATE: [Date]

SCALE: 1"=50'

U.S. ATOMIC ENERGY COMMISSION
HANFORD WORKS
GENERAL ARRANGEMENTS

PRODUCTION FACILITY

SP 5002

PLAN
Scale 1/30-0

LONGITUDINAL SECTION ON C PLANT
Scale 1/30-0

SP5003

REVISIONS		DATE		BY	
1	AS SHOWN	10-24-54	CHAS. T. MAIN, INC.	CHAS. T. MAIN, INC.	CHAS. T. MAIN, INC.
U.S. ATOMIC ENERGY COMMISSION HANFORD WORKS GENERAL ELECTRIC					
PROJECT: CHAS. T. MAIN, INC. DRAWING: 01-24 GENERAL ARRANGEMENT, PLAN					
PRODUCTION FACILITY SECTION

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