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ORNL 647
Chemistry-General

DEMINERALIZATION (807) BUILDING OPERATING MANUAL

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
CARBIDE AND CARBON CHEMICALS DIVISION
UNION CARBIDE AND CARBON CORPORATION
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OAK RIDGE, TENNESSEE

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ORNL 647*

This document consists of 95 pages.
Copy 8 of 124. Series A

Contract No. W-7405, eng 26

CHEMICAL TECHNOLOGY DIVISION
PILOT PLANTS SECTION

DEMINERALIZATION (807) BUILDING OPERATING MANUAL

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DATE ISSUED: NOV 22 1950

OAK RIDGE NATIONAL LABORATORY
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CARBIDE AND CARBON CHEMICALS DIVISION
Union Carbide and Carbon Corporation
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* Previously issued as CF 49-10-238.

TABLE OF CONTENTS

0.0 ABSTRACT

The revised operating procedures, equipment descriptions, and other information necessary to perform the routine operation of the water demineralization building (Building 807) are given, terminating two years of intermittent operational development work by the Pilot Plants Section of the Chemical Technology Division.

1.0 INTRODUCTION

Demineralized water is produced in Building 807 by the Permutit Demineralization Process. Metal ions in the filtered feed water are replaced with hydrogen by passing the water through a Permutit Zeo-Karb H resin bed, regenerated with a 2% solution of sulfuric acid. The mineral acid ions are absorbed by passing the Zeo-Karb H effluent through a Permutit De-Acidite resin bed regenerated with a 5% solution of soda ash. The De-Acidite effluent, high in oxygen (O_2) and carbon dioxide (CO_2), goes to a 10,000 gallon stainless steel storage tank located on the fourth floor of Building 807. The water may then be distributed as is or passed through a pre-heated vacuum deaerator. Water distribution is provided to the 105, 205, 101, and 807 buildings, and the Pile Mock-up.

Equipment additional to that needed for water demineralization is available for adding chemicals to meet demand specifications or to chemically simulate filtered water from any locale of the country.

The original purpose of the building was to chemically duplicate Columbia River for studying aluminum corrosion under pile irradiation conditions as a service for, and prior to, the startup of the Hanford Piles. Its purpose is now to supply large quantities of commercially distilled water for engineering studies throughout the plant site and as a coolant in various portions of the pile.

2.0 THEORY AND CHEMISTRY OF WATER DEMINERALIZATION

2.1 General Water Chemistry

Water impurities may be grouped under three headings: dissolved, suspended and colloidal. Of these three types of impurities, only the dissolved impurities are important in the 807 operations. The suspended and colloidal impurities are removed at the Oak Ridge filter plant and become significant only in that the chemicals added at the filter plant for clarification of the raw water affect the chemical composition of the filtered feed water to the demineralizing units. These additional chemical impurities must be removed along with the remaining original dissolved impurities.

The dissolved matter most commonly found in water are bicarbonates, sulfates, nitrates, and chlorides of sodium, magnesium, and calcium, iron and manganese compounds, silica, and alumina. In analyzing water it is not feasible to measure its content of mineral salts as the compound itself. It is feasible only to determine calcium, magnesium, etc. as such, without knowing if it is combined with the bicarbonate, sulfate, etc.

In the same way the bicarbonate, sulfate, etc. radicals are measured without it being known which metals are combined with them. The ingredients are reported usually as parts per million of calcium, magnesium, sulfates, etc.

Another method of reporting dissolved matter is: total hardness as calcium carbonate, methyl orange alkalinity as calcium carbonate, chloride as calcium carbonate, and sulfate as calcium carbonate.

Total hardness is determined by use of the standard soap test. Hardness due to calcium and magnesium may be determined by the same test by noting the milliliters of soap necessary to give a false end-point, one in which the lather does not last the necessary five minutes. This amount of soap is what the calcium requires. Further soap addition will give a more permanent lather, and this amount of standard soap solution will give total hardness. The difference between total hardness and calcium hardness is the magnesium hardness.

"Alkalinity" is equivalent to the bicarbonate radical (HCO_3^-) which is joined to the metals. If total hardness and alkalinity are reported in terms of calcium carbonate, alkalinity affords a measure of the carbonate hardness as compared to non-carbonate hardness. If the total hardness (measure of calcium and magnesium) is greater than the alkalinity (measure of bicarbonate), then the amount of calcium and magnesium present is more than enough to combine will all bicarbonate, and the difference gives the amount of calcium or magnesium combined with the sulfate and/or chloride. This, then, is also the measure of non-carbonate hardness.

A chemical analysis of water may also include determination of ingredients present in smaller amounts, namely: silica, iron, manganese, nitrate, organic matter.

To sum up, the ordinary chemical analysis includes the following: total hardness, calcium hardness, magnesium hardness, turbidity, sediment, color, and odor.

The standard 807 control analysis procedures will be discussed briefly in this section, but are discussed in more detail in Section 6.0 (Operation of Plant).

2.2 Ion Exchanger Theory

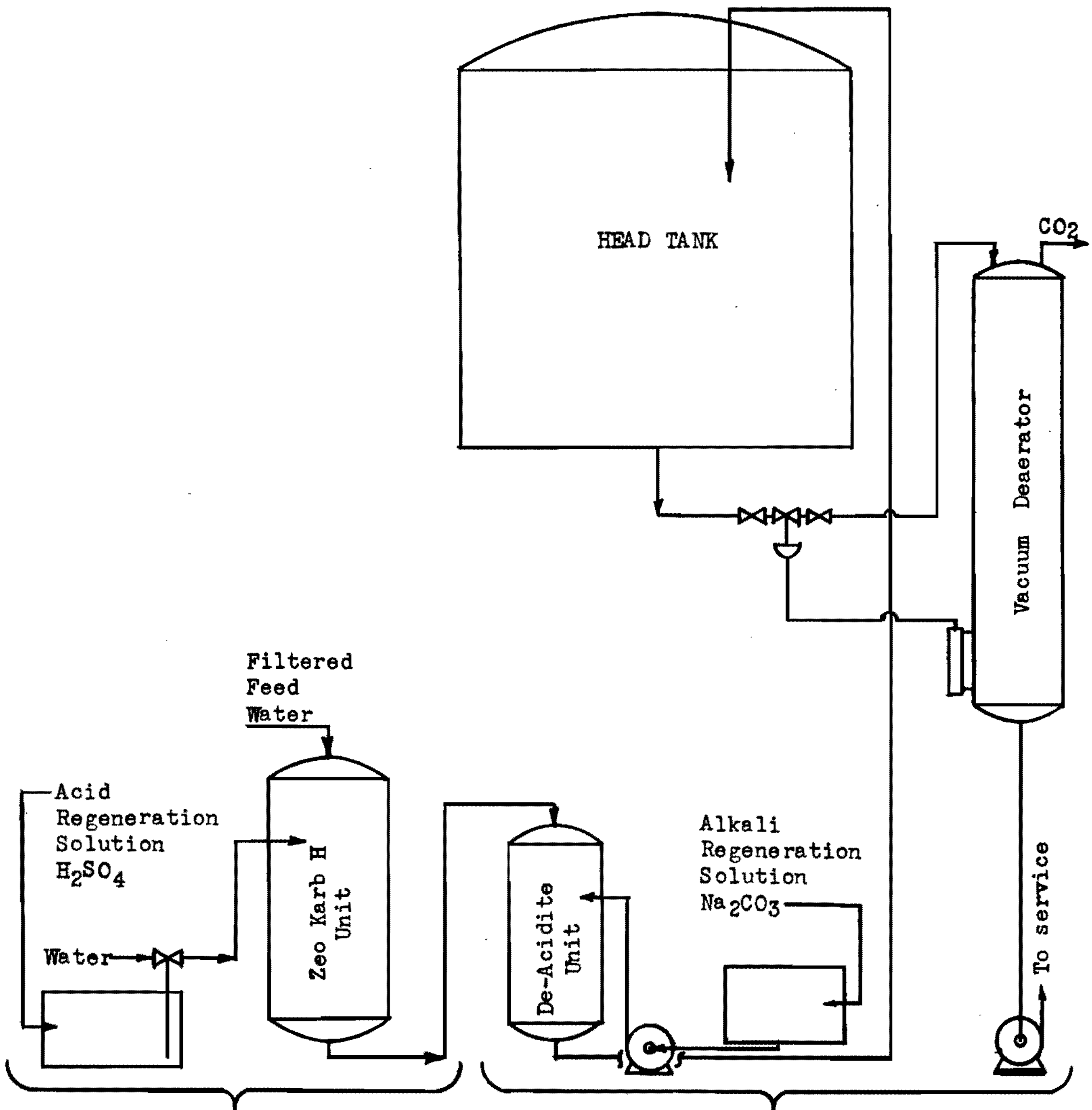
A single unit demineralizing and deaerating system consists of four primary tanks, plus auxiliary tanks, arranged to operate in the following sequence: Zeo-Karb H, De-Acidite, Head Tank, Deaerator. In the 807 operation, two parallel units of a Zeo-Karb H, De-Acidite sequence are utilized, with the Head Tank and Deaerator being common for both. This is done to permit continuous operation while any one or both of a Zeo-Karb H and/or De-Acidite is being regenerated. Figure 2.2-1 gives a schematic flow diagram of the operation.

Zeo-Karb H is a hard, black, granular, organic cation exchange material commonly called a carbonaceous zeolite. It is non-siliceous and acid resistant. Zeo-Karb H, or the hydrogen cycle which is regenerated with an acid, removes all metallic cations and bicarbonates, thus eliminating hardness and reducing alkalinity and total solids. It is made by an extensive special treatment of coal and is patented by the Permutit Company. Five advantages of Zeo-Karb H as listed by the Permutit Company are:

1. Only known method, other than distillation, for removing sodium bicarbonate.

2. Only method of water treatment which will eliminate hardness and simultaneously reduce alkalinity to any desired value.

3. Only practical method for removing all bicarbonates.



STEP No. 1

Replacement of metallic cation by hydrogen (H^+ ion) converts salts present in feed water into corresponding acids, viz. HCl, H_2SO_4 & H_2CO_3.

STEP No. 2

Removal of acids formed in step # 1. The HCl & H_2SO_4 are adsorbed in the De-Acidite unit & the H_2CO_3 decomposes into H_2O & CO_2, the CO_2 removed by the deaerator.

ION EXCHANGE OPERATIONS

4. Has an unlimited tolerance for acid water and will withstand the attack of acid indefinitely.

5. It is non-siliceous due to its carbon base and is suitable for softening raw water low in silica.

De-Acidite is a granular synthetic aliphatic amine resin and is known either as an acid adsorbent or as an anion exchanger. It is regenerated using soda ash and will remove all mineral acids by adsorption. It is also patented by the Permutit Company.

The reaction of each is as follows:

A. Reaction of Zeo-Karb H with Bicarbonates

$$\left.\begin{matrix} Ca \\ Mg \\ Na_2 \end{matrix}\right\} (HCO_3)_2 + H_2Z \longrightarrow \left.\begin{matrix} Ca \\ Mg \\ Na_2 \end{matrix}\right\} Z + 2\ H_2O + 2\ CO_2$$

Soluble Insoluble Insoluble

The filtered feed water containing metal cations, combined with bicarbonates and carbonates, are replaced by the H in the Zeo-Karb H to form carbon dioxide and metal Zeo-Karb. The carbon dioxide is eliminated by the deaerator unit.

B. Reaction of Zeo-Karb H with Sulfates and Chlorides

$$\left.\begin{matrix} Ca \\ Mg \\ Na_2 \end{matrix}\right\} \begin{matrix} SO_4 \\ Cl_2 \end{matrix} + H_2Z \longrightarrow \left.\begin{matrix} Ca \\ Mg \\ Na_2 \end{matrix}\right\} Z + \begin{matrix} H_2SO_4 \\ 2HCl \end{matrix}$$

Soluble Insoluble Insoluble Soluble

The filtered feed water containing metal cations, combined with sulfates and chlorides, are replaced by the H in the Zeo-Karb H to form the acids and metal Zeo-Karb. These acids cannot be eliminated by deaeration and so must be removed by de-acidizing as described under the De-Acidite unit.

As mentioned previously, chemicals are added to the water at the filter plant in order to clarify it. The De-Acidite effluent cannot be greater than 0.2 gpg ($\sim$ 1 ppm) in free chlorine as the chlorine attacks and destroys the Zeo-Karb H resin. It is therefore necessary to eliminate chlorine before the water reaches the units. This is accomplished by adding sodium sulfite to the filtered water prior to its entrance into the Zeo-Karb H. The reaction is as follows:

$$Cl_2 + Na_2SO_3 + H_2O \longrightarrow 2\ NaCl + H_2SO_4$$

The sodium chloride is changed to hydrochloric acid and sodium Zeo-Karb in the Zeo-Karb H exchanger. The resulting hydrochloric acid, plus the previously formed sulfuric acid, is then removed by the De-Acidite exchanger.

C. *Regeneration Reaction of the Zeo-Karb H*

$$\left.\begin{matrix}Ca\\Mg\\Na_2\end{matrix}\right\} Z + H_2SO_4 \longrightarrow H_2Z + \left.\begin{matrix}Ca\\Mg\\Na_2\end{matrix}\right\} SO_4$$

Insoluble   Soluble   Insoluble   Soluble

The regeneration is a reverse chemical reaction of demineralization and is illustrated by the above equation. Upon reaching the rated capacity of the Zeo-Karb H unit, as determined from free mineral acidity, the unit is cut out of service, back-washed, and regenerated with dilute sulfuric acid. Concentrated sulfuric acid is diluted with water in the sulfuric acid makeup tank and then further diluted and injected into the Zeo-Karb H unit by means of a water jet. The rate of addition is controlled by means of stop cocks to give a water flow of 16 gallons per minute through the ejector and an inlet acid concentration to the resin bed of approximately 2% ± 0.5% sulfuric acid. Should the acid concentration vary from this the water to the jet should be adjusted by a stop cock.

After acid addition, the Zeo-Karb H is rinsed free of the calcium, magnesium, and sodium salts and excess acid and is then ready to be put back on the line. The rinse may be stopped when the free mineral acidity is 10 above normal.

D. *Reaction of De-Acidite with Sulfuric and Hydrochloric Acids*

$$D + \begin{matrix}H_2SO_4\\2\ HCl\end{matrix} \longrightarrow D \left\{\begin{matrix}H_2SO_4\\2\ HCl\end{matrix}\right.$$

Insoluble   Soluble   Insoluble

As the acid effluent from the Zeo-Karb H unit flows down through the unit, the De-Acidite granules remove the acids formed by the preceding step by adsorption. The carbon dioxide formed previously passes through the De-Acidite and is removed by the deaerator. Any silica present also passes through unchanged, and thus must be removed by another pretreatment if its removal is required.

E. *Regeneration of the De-Acidite*

$$D \left\{\begin{matrix}H_2SO_4\\2\ HCl\end{matrix}\right. + Na_2CO_3 \longrightarrow D + Na_2 \left\{\begin{matrix}SO_4\\Cl_2\end{matrix}\right. + 2\ H_2O + CO_2$$

Insoluble   Soluble   Insoluble   Soluble

Upon reaching the rated capacity of the unit, as determined by the methyl orange alkalinity, the unit is removed from the line, back-washed, and regenerated.

The regeneration step is a reverse chemical reaction of the demineralization steps as shown by the above equation. A 3% solution of soda ash is made up in the alkali regeneration tank and pumped through the De-Acidite at approximately 12 gallons per minute. The unit is then rinsed, using Zeo-Karb H water, to waste until the solu-bridge reading drops to 8 gpg. Further rinsing is done by recycling Zeo-Karb H water through both the Zeo-Karb H and the De-Acidite units at 32 gallons per minute until the solu-bridge reading drops to 0.3 gpg. Figure 2.2-2 gives the rinse curve for the De-Acidite unit.

2.3 Demineralization Control Chemistry

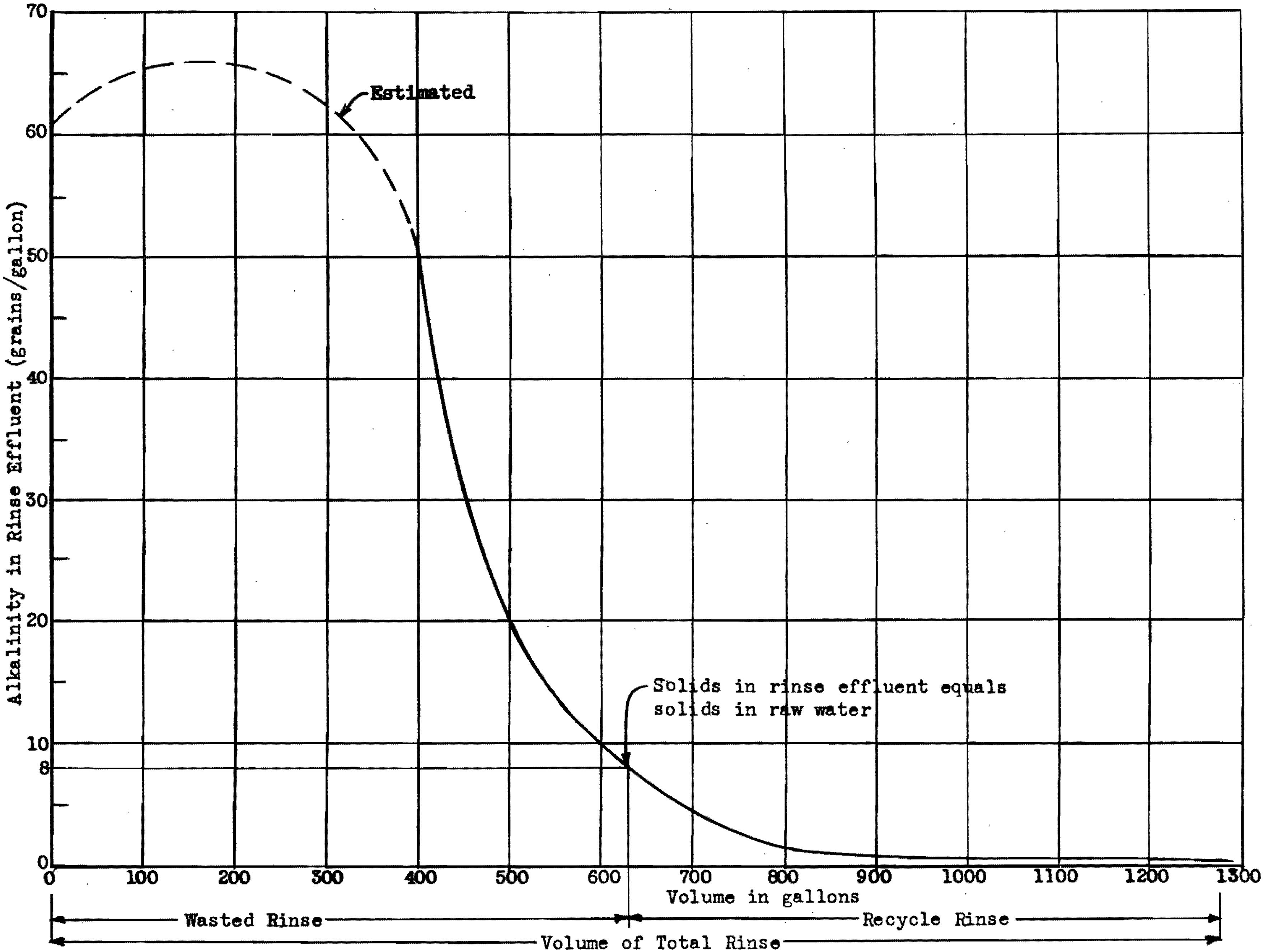
A periodic check of the methyl orange alkalinity of the filtered feed water and the free mineral acidity of the Zeo-Karb H unit must be made in order to calculate the original expected capacity of a freshly regenerated unit, as well as to correct the expected capacity as the unit is being used. At the present the maximum capacity of a Zeo-Karb H is conservatively rated at 50,000 gallons and the De-Acidite at 120,000 gallons with average ORNL water.

Table 2.3-1 lists expected capacities as determined by the above mentioned methyl orange alkalinity and free mineral acidity determinations.

There are six standard control procedures in use in the 807 operations which are: total hardness, methyl orange alkalinity, free mineral acidity, *p*H, solu-bridge conductivity, and resistivity. A short analysis of their meaning is given below.

Total hardness is the measure of calcium and magnesium present in the water and is made by the standard B and B soap test. The sample for this analysis is pulled from the Zeo-Karb H effluent and gives the efficiency of the unit. A rise of 0.1 cc soap hardness above the blank requires a regeneration.

Methyl orange alkalinity is a measurement of the bicarbonate hardness and is made by the standard sulfuric acid titration with methyl orange as indicator. A methyl orange alkalinity is taken on both the filtered feed water and the De-Acidite effluent. This measurement on the De-Acidite effluent is one of the three methods dictating regeneration of the De-Acidite unit. This measurement on the filtered feed water, in conjunction with the free mineral acidity, gives an estimated capacity of the Zeo-Kark H unit as shown in Table 2.3-1.



DE-ACIDITE RINSE CURVE

Dwg. 9459
Figure 2.2-2

TABLE 2.3-1

Expected Capacity of *ZK* and *DA* Units

(These ratings are conservative and should be used for estimating purposes only; not for determining operation.)

FILTERED WATER MO PLUS FMA (ppm)	CAPACITY OF ZEO-KARB H (gals.)	FMA (ppm)	CAPACITY OF DE-ACIDITE (gals.)
100	73,500	10	337,500
102	71,800	12	280,000
104	70,400	14	240,500
106	69,150	16	210,500
108	67,900	18	186,300
110	66,500	20	168,200
112	65,400	22	153,000
114	64,200	24	141,000
116	63,100	26	130,000
118	62,000	28	120,400
120	61,000	30	112,700
122	60,050	32	105,400
124	59,000	34	99,300
126	58,100	36	93,800
128	57,200	38	88,700
130	56,300	40	84,200
132	55,400	42	80,400
134	54,700	44	76,600
136	53,900	46	73,400
138	53,100	48	70,200
140	52,200	50	67,600
142	51,600	52	65,300
144	50,900	54	62,400
146	50,200	56	60,100
148	49,600	58	58,200
150	48,800	60	56,300
152	48,200		
154	47,600		
156	47,000		

Free mineral acidity is a measurement of the free mineral acid and is made on the Zeo-Karb H effluent. This test reveals the amount of sulfates and chlorides in the raw water which have been converted to free mineral acid. A drop of 10 ppm below normal requires a regeneration.

The estimated capacity of Zeo-Karb and De-Acidite units are calculated from the methyl orange alkalinity and free mineral acidity analyses. The capacity of the Zeo-Karb is dependent on the total of methyl orange alkalinity plus the free mineral acidity. The sum of these analyses is the relative total metallic ion content of the feed water which is the determining factor in obtaining the processing capacity of the *ZK* resin. The free mineral acidity analysis determines the capacity of the De-Acidite resin because only the acids indicated by this analysis are adsorbed in the De-Acidite resin.

*p*H is a measure of the H ion concentration in a solution and is measured in this case on the De-Acidite effluent. The *p*H of good quality demineralized water is between 4.5 and 4.7. A drop in *p*H indicates an increase in H ion concentration and suggests the possibility that the De-Acidite unit is in need of regeneration. A rise in *p*H shows a decrease in H ion concentration or an increased bicarbonate concentration, and in which case the Zeo-Karb H unit may be in need of regeneration.

Solu-bridge conductivity is read on the De-Acidite effluent and is a permanent installation on the line to the demineralized water head tank. The operation range is 0.25 - 0.45 gpg and should it rise to 0.5, the De-Acidite unit may require regeneration. A more detailed description of this instrument is included under "Instrumentation," Section 5, of this report.

The resistance of the deaerated water is taken off the down stream side of the booster pump and is measured and recorded as ohms resistance. A specific resistivity of 100,000 ohms plus is desired from the units and results in an average deaerated resistance of 400,000 - 500,000 ohms. In summarizing, the analytical control specifications for the units that indicate regeneration is necessary, are:

For the Zeo-Karb H because it means the "breakthrough" of basic metal ions.

1. A drop of 10 ppm below normal free mineral acidity.
2. A rise of 0.1 cc (2 drops) soap hardness.
3. A rise in *p*H above 4.7.

For the De-Acidite because it means the "breakthrough" of the strong acid ions.

1. A drop in methyl orange alkalinity from 6-7 to 4.
2. A rise in solu-bridge conductivity to 0.5.
3. A drop in *p*H below 4.5.

3.0 GENERAL AREA LAYOUT

3.1 Building Location and Description

Building 807, a four-story building with two one-story wings on the north and south sides, is constructed of steel I beams and six inch drop siding. The ground floor is of poured concrete with the then remaining floors being wood serviced by metal stairways. An entrance is located in each wing with an emergency exit from the third floor by means of an exterior stairway. Figure 3.1-1 gives the general area layout of building 807 with respect to the surrounding buildings.

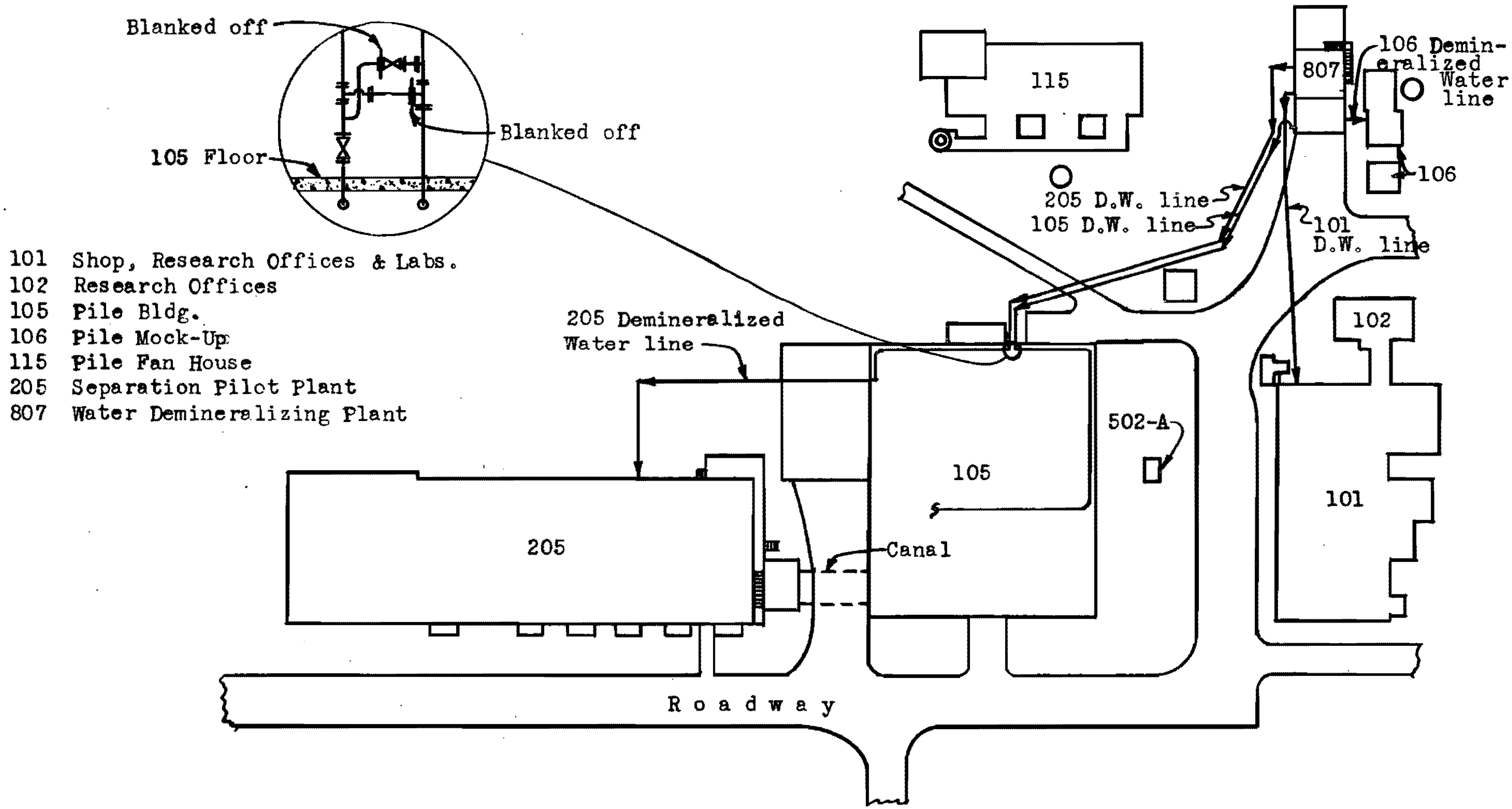
Two Permutit Water Demineralizing Units, piped to operate in parallel, along with the major portion of their auxiliary equipment are located on the ground floor. A small Operations Division Laboratory is located on the second floor. A lunch room for personnel is located in a single room on the third floor. The fourth floor houses the deaerator, with its control instruments, and the demineralized water head tank. Figure 3.1-2 is an elevation view of the building giving location of deaerator and head tank. Figure 3.1-3 shows a plan view of the main floor with the relative location of the major equipment.

3.2 Demineralizing Equipment Flowsheet

A complete Demineralizing Plant Flowsheet is given in Fig. 3.2-1. This flowsheet is relative only in its vertical aspect. The listing of the valves are in accord with the operational instructions, Section 6.0.

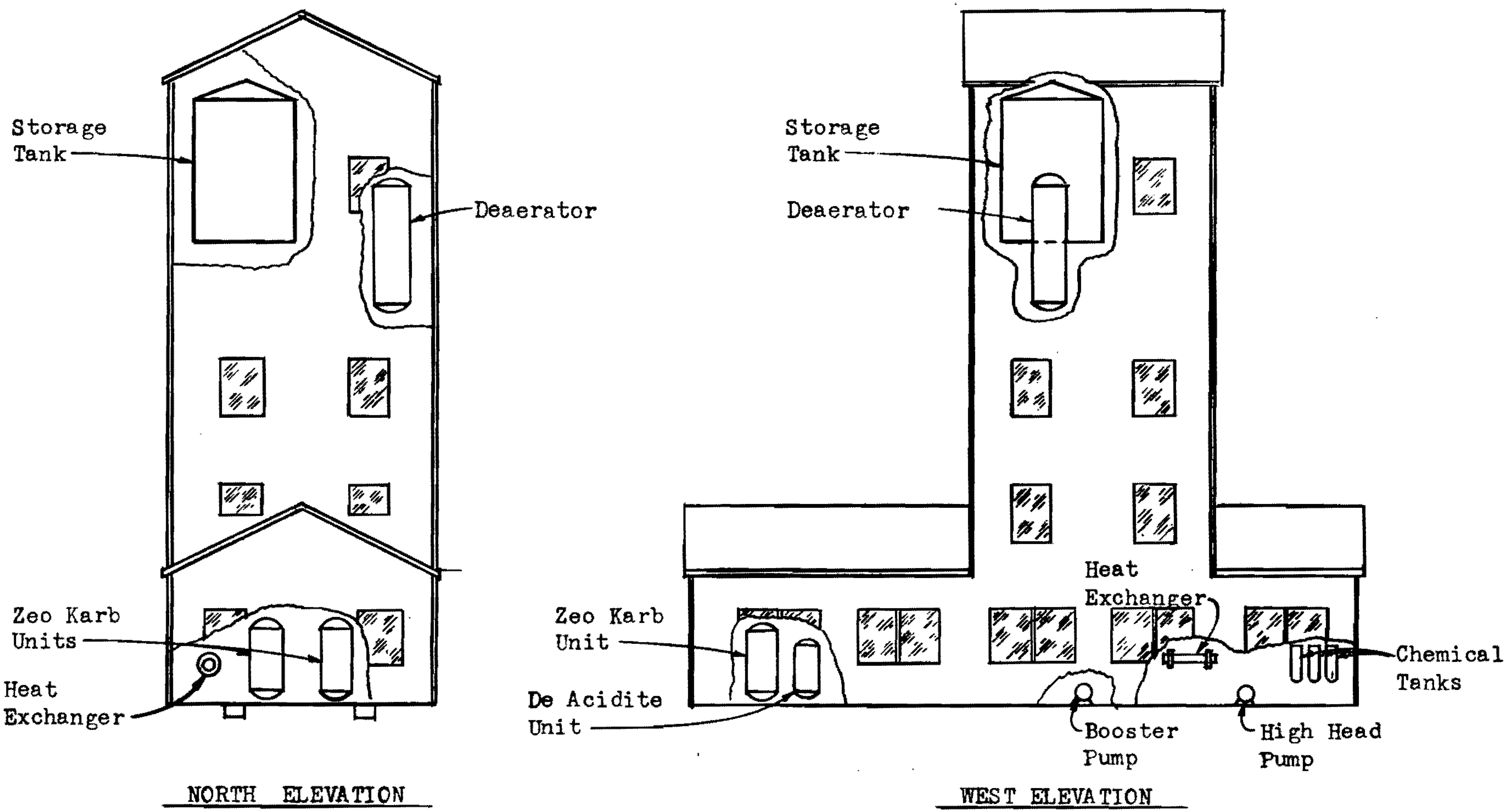
3.3 Demineralized Water Distribution System

Figure 3.1-1 shows the distribution of demineralized water to the various buildings serviced as well as a valving cross-tie arrangement located in Building 105. With this arrangement, demineralized water to Buildings 105 and 205 may be taken from either of the outlet lines leaving 807. All piping is of stainless steel.



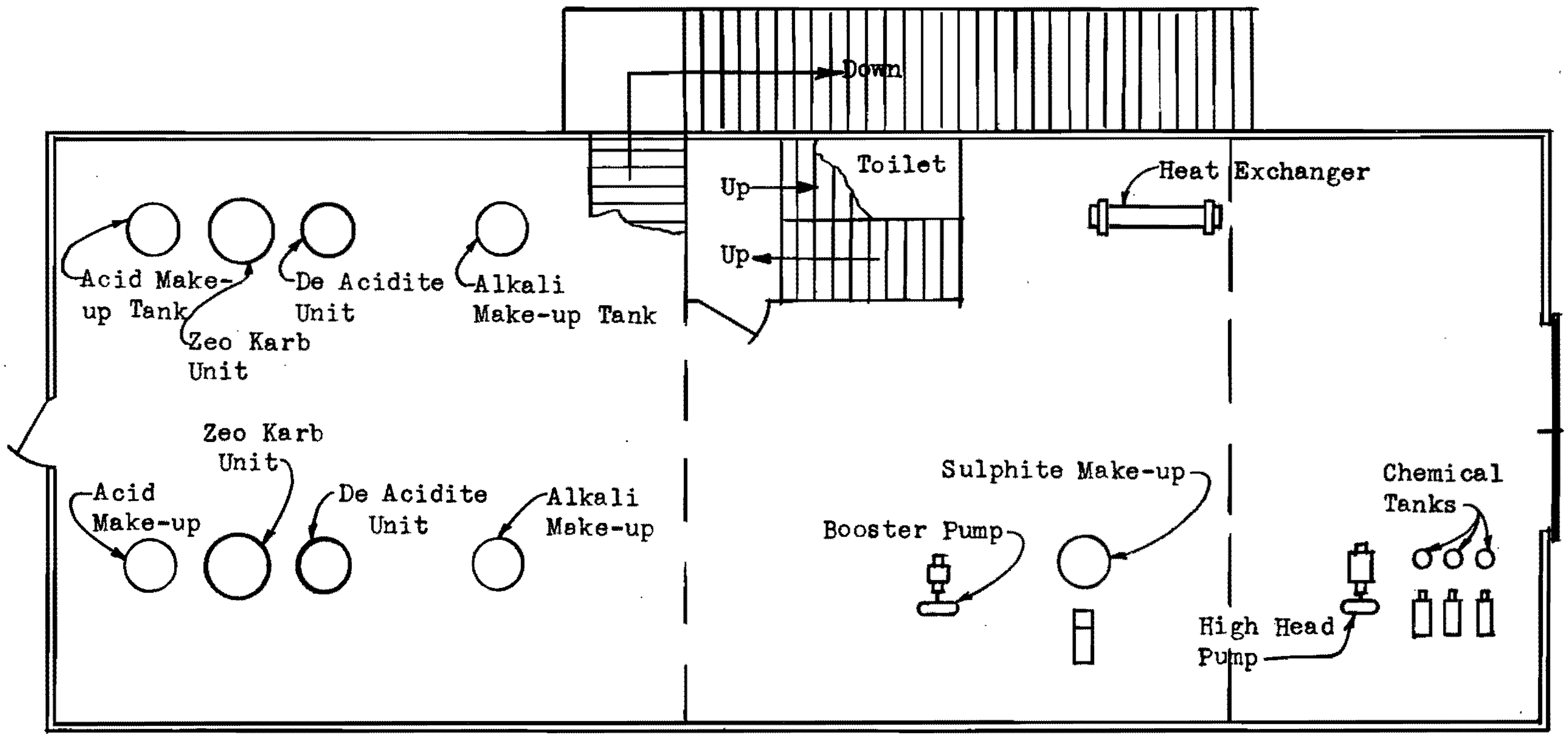
AREA LAYOUT
&
DEMINERALIZED WATER DISTRIBUTION

Dwg. 9460
Figure 3.1-1



ELEVATION VIEW
807 BLDG.

Dwg. 9461
Figure 3.1-2



PLAN VIEW

MAIN FLOOR OF 807 BUILDING

Dwg. 9462
Figure 3.1-3


[redacted]
Valve, Check
Valve, Pneumatic
Valve designation letter or no.
Valve, Manual
Gauge designation letters
Gauge or instrument
B Solubridge
C Controller
F Flow
H pH
I Indicator
L Liquid Level
P Pressure
R Recorder
T Temperature
V Vacuum
S Conductivity
Filtered Water To Units
Demineralized Water
Demineralized & Deaerated Water
Strainer
Steam Blowdown
Float Control
Head Tank
Vent Condenser
Booster Ejector
First Stage Ejector
Second Stage Ejector
Intercondenser
Steam Trap
Deaerator
Liquid Level Controller
Filtered Water for Jet Condensers
Steam for Ejectors
Steam Supply
To Unit Heaters
Steam
Sulphite
Vent through roof
Crest Meter
Zeo-Karb H Unit Blanked Off
Multiport Valves
Filtered Water, Process Service
Air
Acid, Strong
Filtered Water, Bldg. Service
Demineralized Water
Blanked
Strong Acid Measuring Tank
Lead Lined Acid Make-up Tank
Air Sparger
Jet
De-Acidite Unit
Orifice
Agitator
Alkali Make-up Tank
Sump
Drain
Alkali & Rinse Recycling Pump
Process Service
Bldg Service
No. 1 Unit
No. 2 Unit
Chemical Make-up Tank
Acid Tank
Acid Drip Pan
To Bldg. Service
To Pile Mock-up 105 Bldg
Flexible Hose
Chemical Addition Tanks
Sight Glass
Heat Exchanger
Sulphite Make-up Tank
Booster Pump
To 205 Bldg
Recirculating Pump
Milton-Roy Proportioning Pump
Valves 21, 22, 23, 24 & 32 are instrument valves.
Top of Weir
High Head Pump
Hot Well
To 101 Bldg
To 105 Bldg
[redacted]
DO NOT SCALE THIS DRAWING
APPD DATE
OAK RIDGE NATIONAL LABORATORY
TECHNICAL DIV — P.O. BOX P — OAK RIDGE, TENN
807 BLDG
DEMINERALIZED WATER BLDG
EQUIPMENT FLOWSHEET
DRAWN BY
DATE 11-24-49
SCALE None
CHECKED BY
DATE
DRAWING NO. F-6712
REV
REV. NO. REVISION APPD DATE

Figure 3.2-1

4.0 EQUIPMENT

The equipment used in Building 807 for water demineralization may be listed under three headings: (1) Ion Exchangers, (2) Deaerator, (3) Distribution. The function, description, and operation of each of the three groups, along with their auxiliary pieces of equipment, is given in this section. Actual operating procedure for the water demineralization plant is included under Section 6.0.

For the convenience of the reader, an outline of equipment is given below:

4.1. Ion Exchangers and Auxiliary Equipment

1. The Permutit Ion Exchange Units
2. Multiport Valves
3. Dilute Acid Make-Up Tank
4. Strong Acid Head Tank
5. Strong Acid Measuring Crock
6. Alkali Make-Up Tank
7. Lightnin' Portable Mixer
8. Weinman Unipump
9. Sodium Sulfite Make-Up Tank
10. Milton Roy Proportionating Pump
11. Demineralized Water Head Tank

4.2. Vacuum Deaerator and Auxiliary Equipment

1. Vacuum Deaerator
2. Ingersoll-Rand Steam Jet Ejectors
3. Direct-Contact Heat Exchangers
4. Double Pass Tube Heat Exchanger
5. Durco Centrifugal Pump

4.3. Distribution Equipment

1. Weil High Head Pump
2. Durco Booster Pump
3. Chemical Head Tank
4. Proportioneer Inc. Simplex Adjust-O-Feeder Pump

4.1 Ion Exchangers and Auxiliary Equipment

Operation of the demineralizing plant centers about the ion exchangers with all other equipment and instrumentation acting in an auxiliary capacity. The function and chemistry of the ion exchangers are given in detail in Section 2.0 and their operation is given in Section 6.0.

Two duplicate parallel demineralizing units are employed, each consisting of the following:

1 - 48 in. diameter by 8 ft vertical Zeo-Karb H softener unit
1 - strong acid measuring crock
1 - 54 in. diameter by 30 in. dilute acid tank
1 - 36 in. diameter by 6 ft 0 in. vertical De-Acidite unit
1 - 48 in. diameter by 30 in. alkali tank

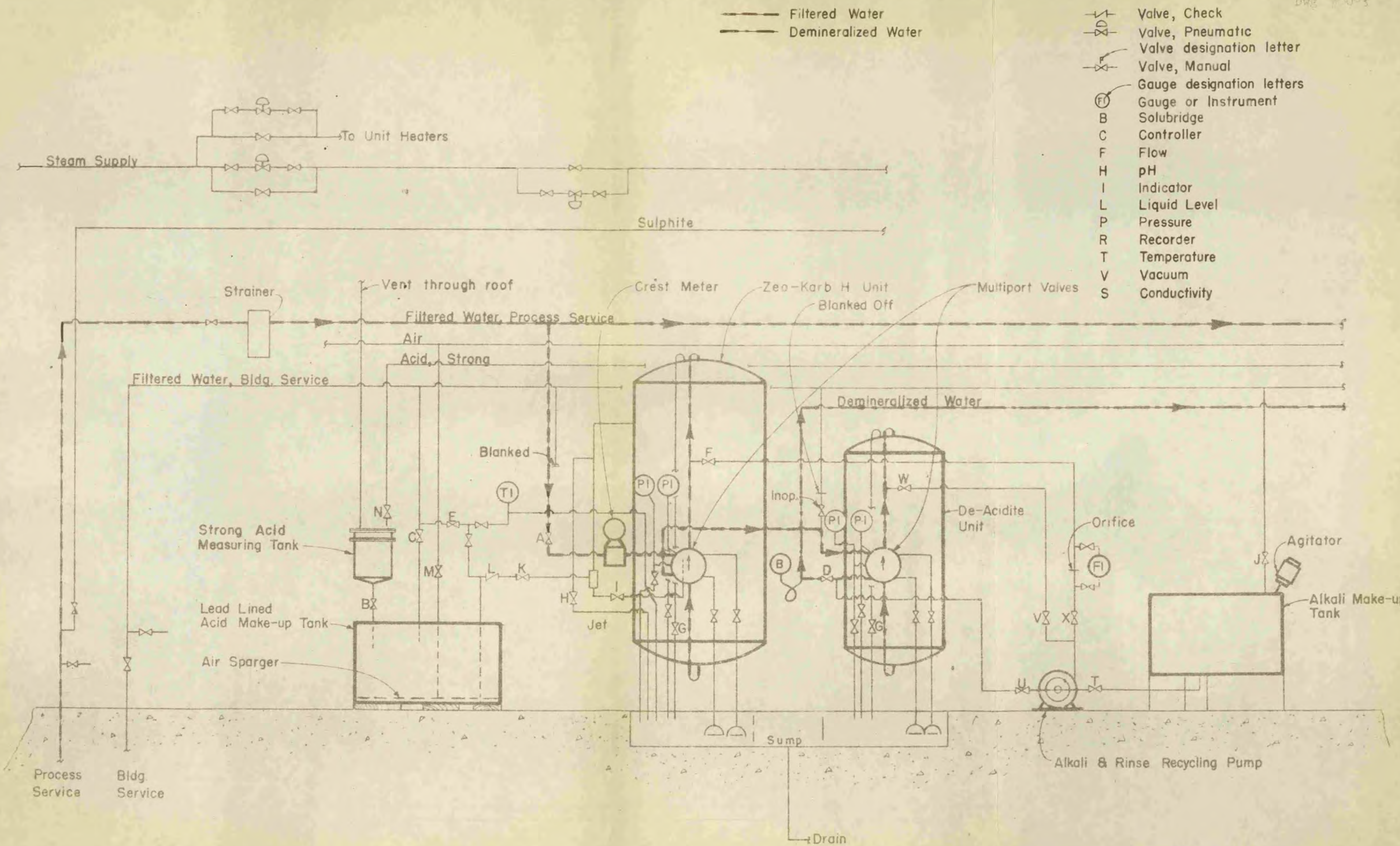
The Zeo-Karb H Unit is a 48 in. diameter by 8 ft 0 in. vertical cast iron shell with hard rubber lining. It is supported by four jack legs for leveling purposes. The acid regeneration distributor is constructed of hard rubber pipe and extends downward to within 6 inches of the Zeolite bed. The water inlet and effluent lines are 2-1/2 in. wrought iron rubber lined pipe with a bronze distributor on the inlet line which extends downward to within 2 ft 10 in. of the bed. The Zeolite bed depth is 4 ft 3 in.

The De-Acidite Unit is a 36 in. diameter by 6 ft 0 in. vertical cast iron shell with hard rubber lining. It is supported by four jack legs for leveling purposes. The water inlet and effluent lines are 2-1/2 in. wrought iron with rubber lining. The De-Acidite bed depth is 28 in.

Maximum recommended flow rate through both units during softening is 40 gallons per minute. Decreasing the flow to less than 25 gpm results in poor water due to the increased hold-up time of the water in the units causing the water to pick up a brown color (sour). Increasing the flow too much above 40 gpm results in poor water due to insufficient contacting time between water and resin bed. The equipment flowsheet for one set of the units is given in Fig. 4.1-1.

The zeolite beds are supported at the bottom of the units by a gravel bed consisting of three gradient size layers. Figure 9.1-1 shows the bed loading for each unit.

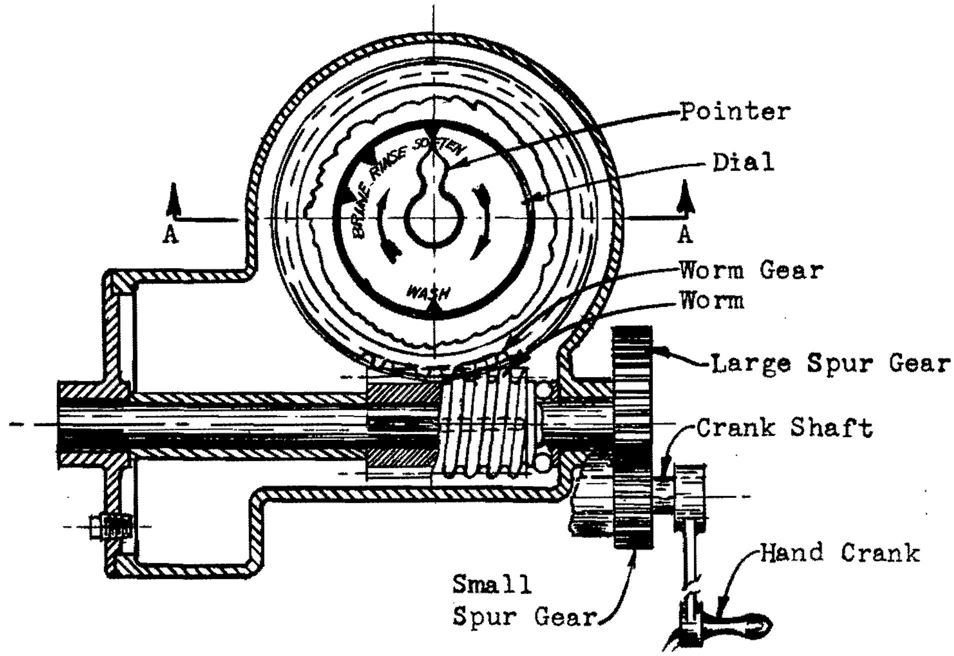
A manually operated *Multiport Valve* is used on each unit for routing the solutions to the exchangers. The valve contains a slotted slide assembly which selectively routes the incoming solution into the exchanger through the proper line, replacing a large number of manually operated conventional valves. Figure 4.1-2 gives the cross-sectional and plan views of the multiport valve. With the pointer setting at *soften*, the incoming filtered water passes through the valve, into the feed line to the top of the exchangers, through the exchanger and out the effluent line at the bottom, through the valve and to either the next unit or the head tank. In like manner, the positions of Brine, Rinse, and Wash routes the solutions through the corresponding correct lines.

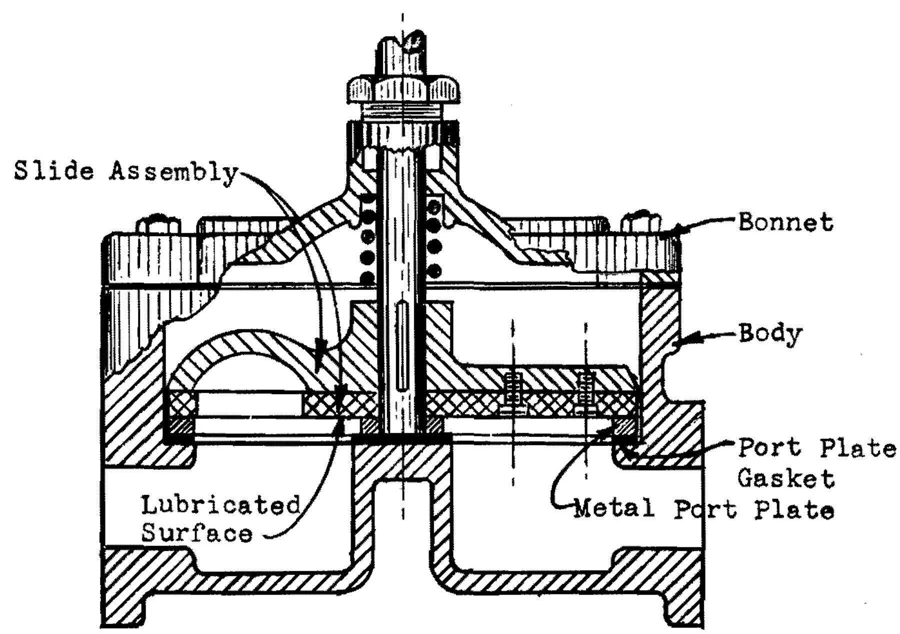


ZEO-KARB H & DEACIDITE UNIT FLOWSHEET

 [redacted]

Dwg. 9463
Figure 4.1-2





Section "A-A"

MANUALLY OPERATED MULTIPORT VALVE

A Dilute Acid Make-Up Tank is provided for make-up of the dilute sulfuric acid used for regeneration of the Zeo-Karb H exchanger. The tank is a 54 in. diameter by 30 in. vertical lead-lined cast iron tank with a 2 in. thick wood cover. Agitation is provided by means of a lead coil air sparger at the bottom of the tank.

A Strong Acid Head Tank for holding up to 400 pounds of concentrated sulfuric acid is located in the ceiling of the main floor. The tank is a 24 in. by 24 in. standard steel tank. The acid is transferred from carboys to the tank by vacuum and flows from the head tank to the measuring crock by gravity.

A Strong Acid Measuring Crock is provided directly above the make-up tank for measuring the volume of concentrated sulfuric acid necessary for one regeneration. The crock is a lead lined cast iron vessel 14 in. OD by 8 in. high holding 108 lbs of acid. The concentrated acid is dropped by gravity from the head tank to the crock, where the acid is measured, and then dropped to the make-up tank.

The dilute acid is injected into the Zeo-Karb H unit by means of a *Water Jet Ejector*. Water to the ejector is set by a stopcock so as to give a 2% acid concentration entering the unit.

An Alkali Make-Up Tank is provided for make-up of a 3% sodium carbonate solution used for regeneration of the De-Acidite unit. The tank is a 48 in. diameter by 30 in. vertical cast iron open-top tank. Agitation is provided by a *Lightnin' Portable Mixer*, model S, clamp mounted with a 30 in. long shaft, and 2-4 in. diameter propellors. It is powered by a 1/3 hp, 1725 rpm, 110 volt, 1 phase, 60 cycle, open induction motor. A centrifugal pump is provided for pumping the soda ash solution through the De-Acidite unit or recycling rinse water. This pump is a *Weinman Unipump*, type 1-1/4 K-1-4 with 1-1/2 in. × 1-1/4 in. suction discharge openings and an operating capacity of 35 gpm flow against 125 psi pressure. It is driven by a 1 hp, 1725 rpm, 440 volt, 3 phase 60 cycle Master Electric splash proof induction motor.

The Sodium Sulfite Make-Up Tank for preparation of a 0.3% solution in a 30 in. diameter by 24 in. vertical cast iron rubber lined tank using manual agitation. The sodium sulfite solution is added to the filtered water by means of a *Milton Roy Proportionating Pump*. The pump is a plastic postive displacement piston pump, Model MDI-14-25P, containing dual ball check valves on both the suction and discharge sides of the piston with a maximum capacity of 3 gph at a discharge pressure of 50 psi. Pumping rate may be varied from zero to full capacity by varying the stroke length. It is driven by a 1/6 hp, type KH, 1 phase, 60 cycle, 110 v General Electric gear motor. Figure 4.1-3 shows the pump.

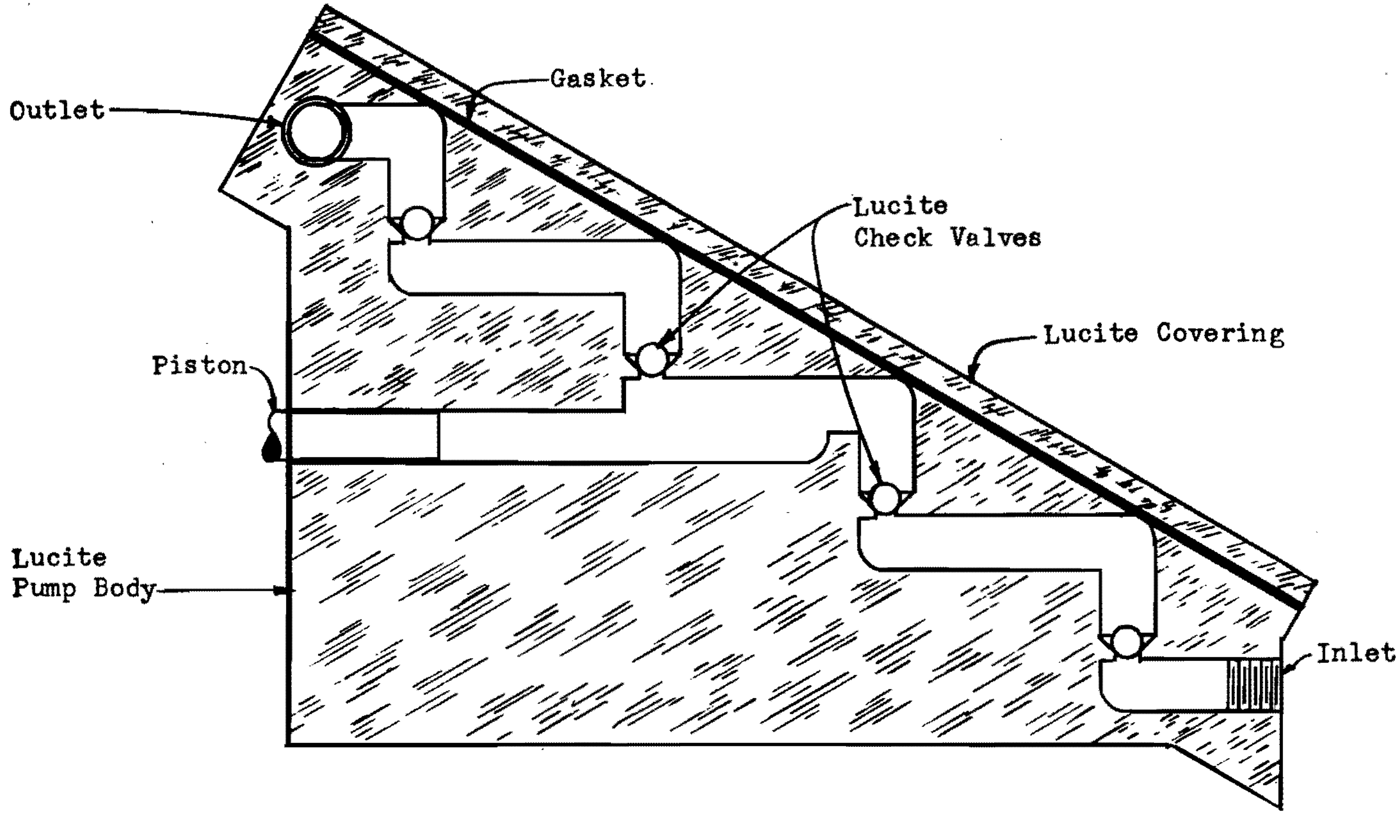
A Demineralized Water Head Tank is located on the fourth floor of the building to provide storage for demineralized water and to furnish head pressure for the service buildings. The tank is constructed of 3/16 in. stainless steel with horizontal bands and vertical angle irons for reinforcement of the sides. Water inlet is through a 4 in. rubber lined pipe at the top. A stainless steel cover, welded to the sides, is provided with a manhole for inspection and cleaning of the tank. Figure 4.1-4 illustrates the head tank. Water level is indicated by a mercury well manometer located on the main floor. Overflowing the tank is prevented by means of a cut-off float valve in the inlet line.

4.2 Vacuum Deaerator and Auxiliary Equipment

A Vacuum Deaerator is provided in the demineralized process for removal of gases, primarily carbon dioxide formed previously by the action of the Zeo-Karb H exchanger or the water soluble air, from the water. The deaerator is located 35 ft above the main floor in order to provide sufficient height for the barometric leg, to insure a positive suction on the head of all pumps, and to prevent any air infiltration into the system while operating at maximum vacuum. The deaerator is a 3 ft 0 in. by 14 ft 1-1/2 in. standard deaerator with a rubber lining to insure against contaminating the demineralized water, and with a minimum capacity of 100 gpm. It is equipped with a staggered slatted wooden tray stack and a distribution plate for increased contacting surface between the rising steam and falling water. A vent condenser, located at the top of the deaerator, increases the capacity of the ejectors by condensing some of the vapor. Figure 4.2-1 shows the deaerator, ejectors, and condensers.

Vacuum deaeration is accomplished by reducing the absolute pressure within the deaerator by means of the steam-jet ejectors. The reduced pressure lowers the temperature at which water boils driving off the non-condensible gases. The insoluble gases are removed through the vent condenser by means of the steam ejectors.

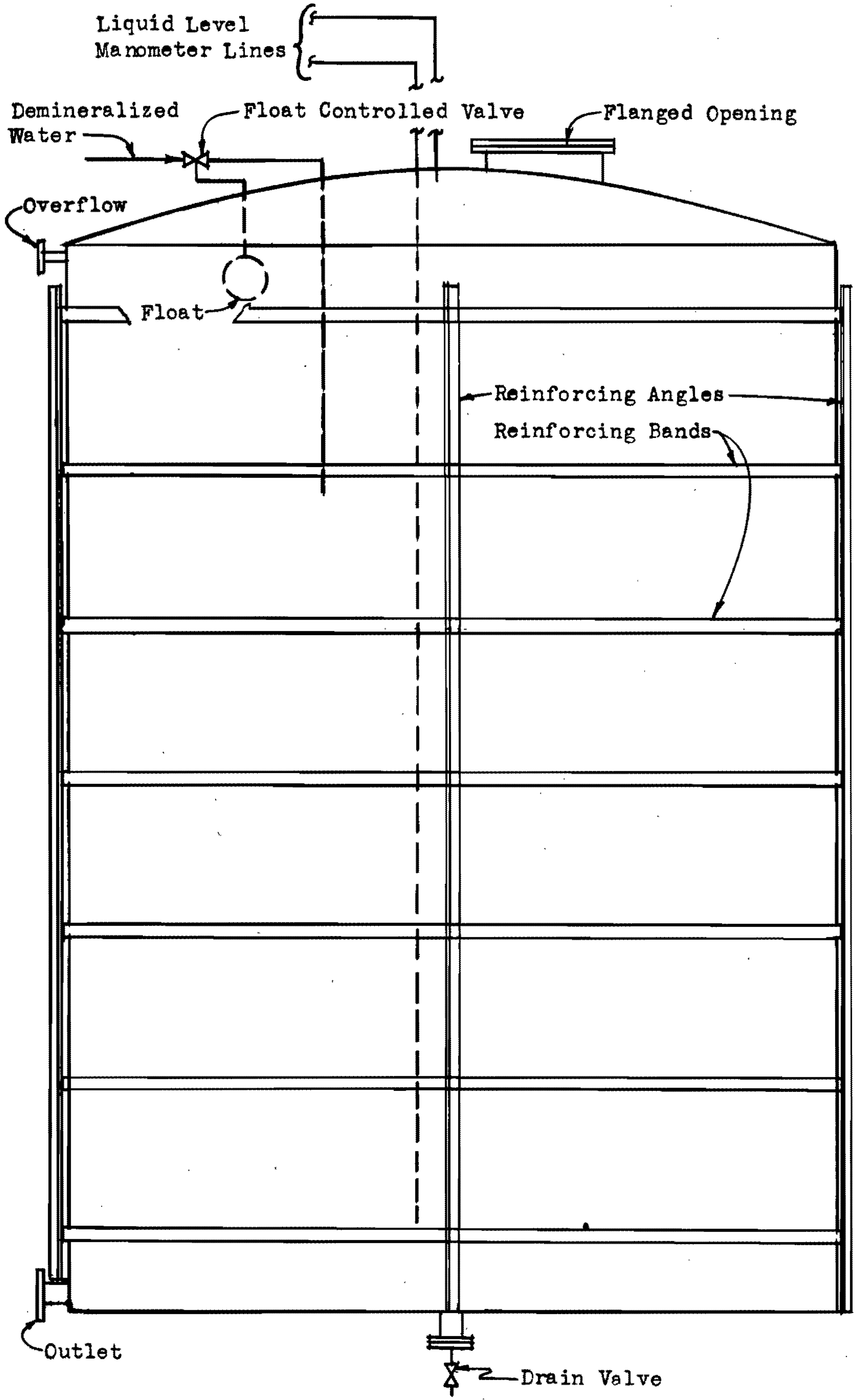
These Steam Jet Ejectors are a simple form of vacuum pump utilizing the ejector action of a high velocity jet of steam. The ejector consists essentially of a nozzle discharging a jet of steam across a suction chamber and



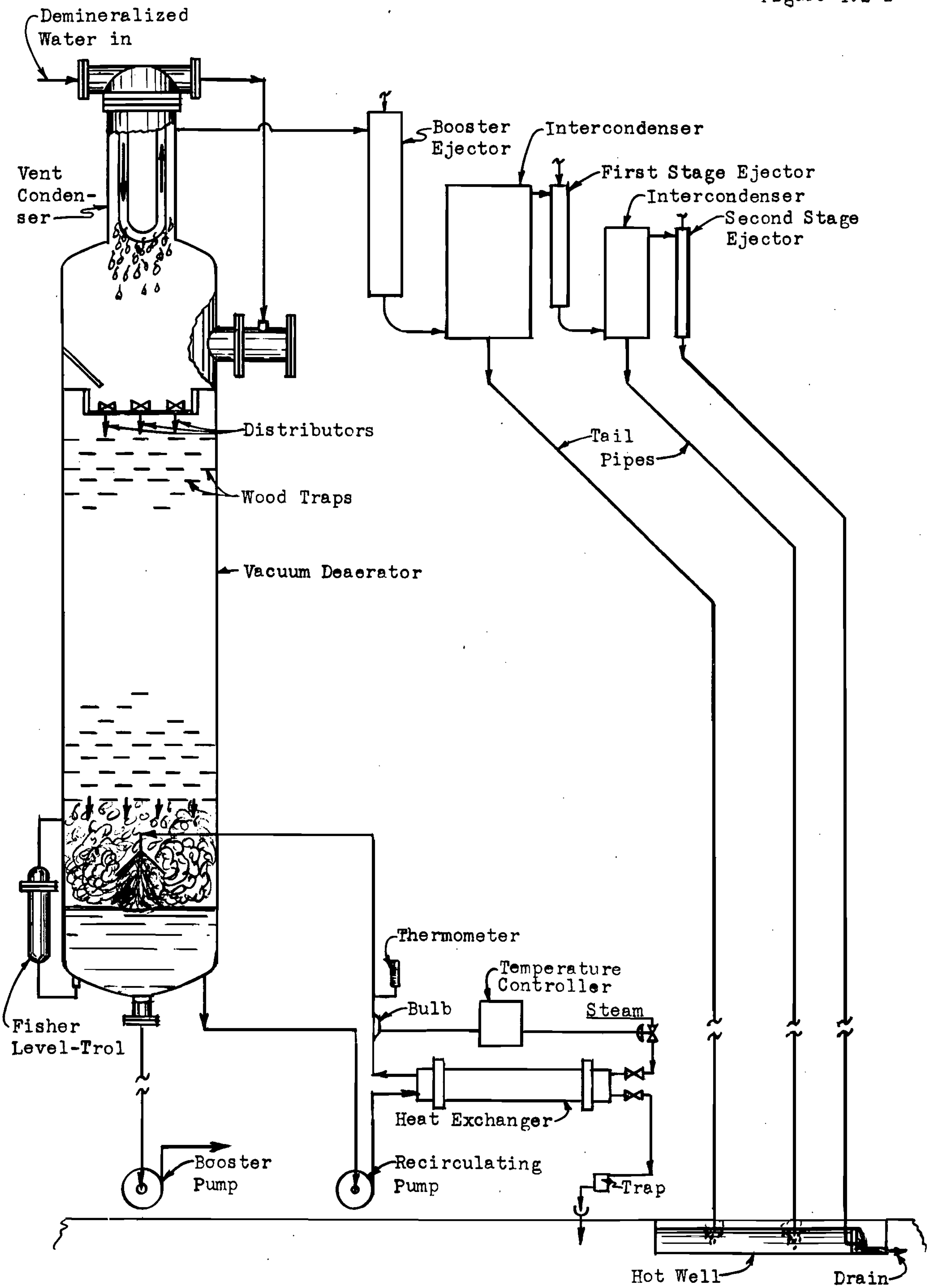
MILTON ROY PROPORTIONATING PUMP

Dwg. 9464
Figure 4.1-3

Dwg. 9465
Figure 4.1-4



D E M I N E R A L I Z E D   W A T E R   H E A D   T A N K



VACUUM DEAERATOR

through a venturi-shaped diffusion or compressor tube. The gases being evacuated enter the ejector suction, entrained by the steam, and are discharged through the throat. The booster ejector and the first stage ejector discharges are cooled by means of a direct-contact heat exchanger. The second stage ejector discharges directly into a hot wall. Figure 4.2-2 shows the ejector-condenser system for the deaerator.

A Direct-Contact Heat Exchanger, or condenser, consists of a chamber for mixing the incoming steam discharge from the ejectors and cooling water. The steam-water mixture is drained through a barometric leg to the hot well. The air and non-condensible vapors are removed by the next stage.

Operating instructions for the ejector system are contained in Section 6.0. A few points of interest on operation, installations, etc., are included here.

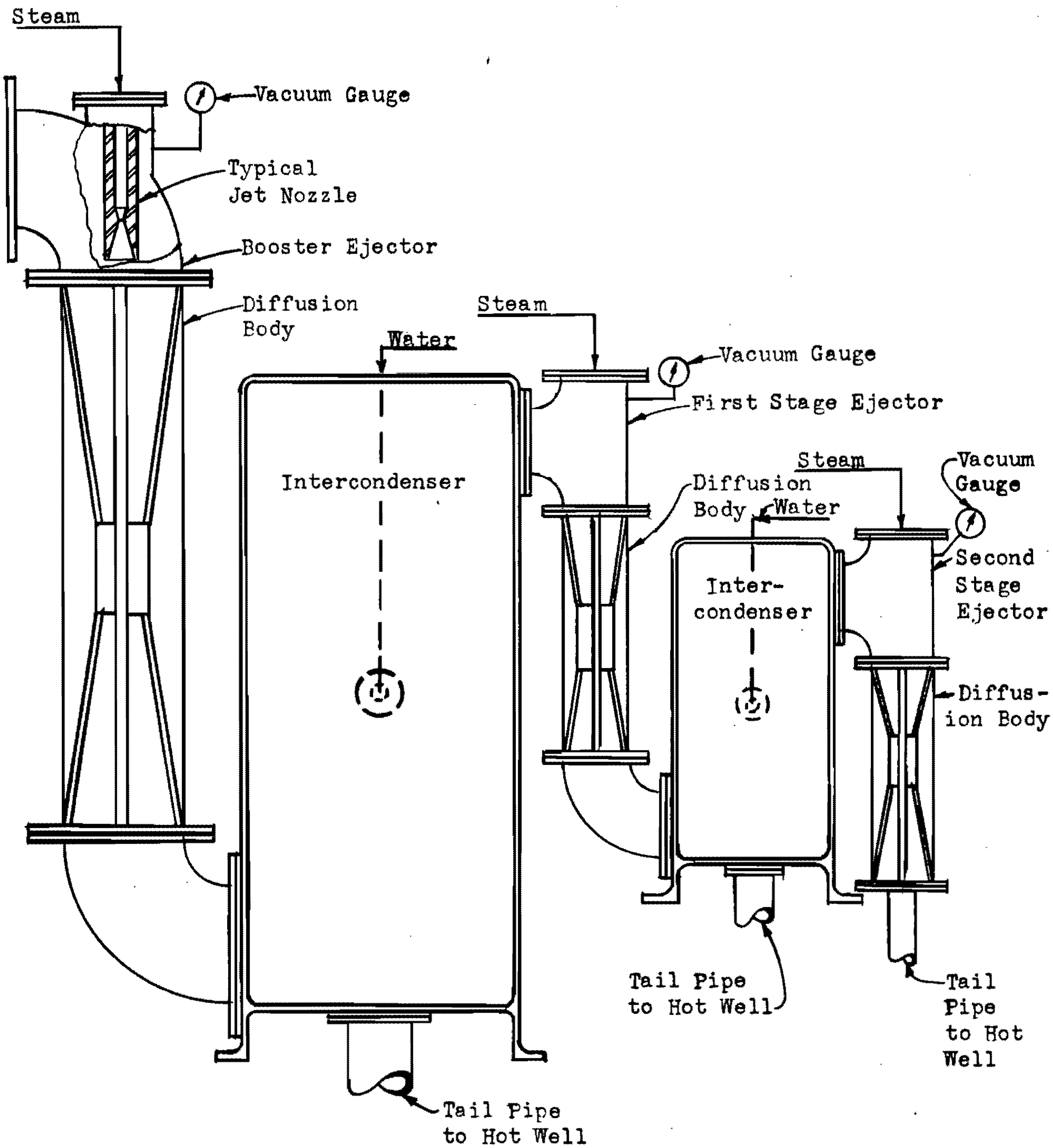
1. Prevent dirt in the steam from reaching the ejector nozzle.
2. Operate in the specified steam pressure range.
3. Use dry steam, as water in the steam will erode the nozzles and water slugs will cause unstable operation.

A Double Pass Tube Heat Exchanger, located on the main floor, is provided to maintain the temperature in the deaerator. This is accomplished by recirculating deaerated water from beneath the tray stack of the deaerator through the steam heated exchanger back to the deaerator. The outlet temperature is controlled by an air operated diaphragm valve through a Brown Electronik Recording Controlling Potentiometer. The exchanger is a forced feed double pass stainless steel tube exchanger with stainless clad steel heads and a carbon steel shell. Figure 4.2-3 shows the heat exchanger.

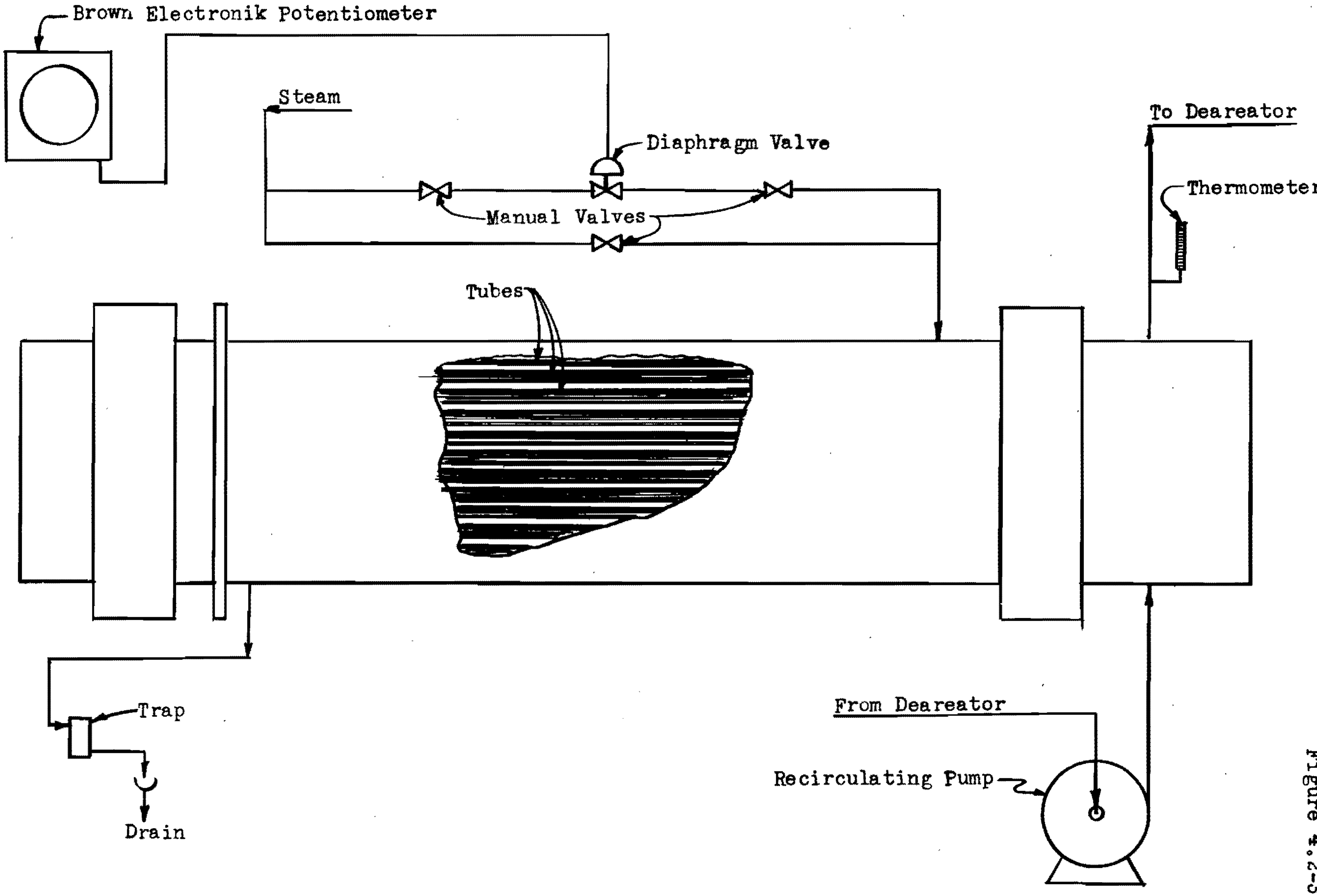
A Durco Centrifugal Pump withdraws the water from the deaerator at approximately 75 gpm for recirculating through the heat exchanger. This is a Duriron Company Model 40, Series 4 MD-Z, size 2 in. × 1-1/2 in. single suction, closed impeller centrifugal pump made of Durco KA 2S MO metal.

It has a maximum capacity of 100 gpm against a 30 ft head. It is driven by a 2 hp, 440 v, 2 phase, 60 cycle, 1800 rpm, synchronous continuous duty, 40°C temperature rise, normal starting current open, horizontal sleeve bearing, squirrel cage General Electric induction motor.

The recirculated, heated, and deaerated water returns to the storage compartment of the deaerator where part of the absorbed heat evolves as steam. This steam passes upward through the wood tray stack counter-current



STEAM JET EJECTORS
for
VACUUM DEAREATOR



Dwg. 9468
Figure 4.2-3

RECIRCULATING HEAT EXCHANGER

to the flow of water, further treating the water and scrubbing away non-condensible gases.

Water level in the deaerator is maintained through a float valve, Fisher Level-Trol, and air operated diaphragm valve linkage. The diaphragm valve is located in the line from the head tank to the deaerator. Description of the above instruments are included in Section 5.0.

4.3 Distribution Equipment

Demineralized water distribution from Building 807 is accomplished through stainless steel transfer lines by either head pressure from the storage tank or pump pressure. The rate of flow and integrated flow are recorded on individual Bailey flow meters. Description of the Bailey meters are included in Section 5.3 of this manual.

A High Head Pump for giving water pressure of 400 psi is located on the main floor. It is a EM Weil centrifugal 2 in. × 2-1/2 in. two stage enclosed impeller, horizontal splitcase, ball bearing pump constructed of stainless steel. Casing and internal parts are designed for water pressure of 400 psi, and to deliver 100 gpm of water against 810 ft head. The drive motor is a 60 hp, 440 v, 3 phase, 60 cycle, 3600 rpm, continuous duty with 40°C temperature rise, normal torque, normal starting current, open ball-bearing squirrel cage General Electric induction motor.

A Durco Booster Pump, located on the main floor, is for normal distribution to Building 205, 105, and 101. The pump suction is connected so that water may be pumped directly from the deaerator, the head tank, or the units. In case of failure of this pump, the pump may be by-passed and head tank pressure utilized. The specifications for the Booster pump are the same as those for the deaerator pump given in Section 4.2 under Durco centrifugal pump.

The Pile Mock-up receives water through a 2 in. stainless steel line utilizing head tank pressure. Due to a continuously changing liquid level in the head tank, flow to the Mock-up may vary.

Three Chemical Head Tanks are located on the main floor of Building 807 for the purpose of holding solutions of sodium dichromate and sodium hydroxide for addition to the demineralized water going to the Pile Mock-up. The tanks are all welded, totally enclosed, 18 in. diameter by 48 in. vertical steel and/or stainless steel tanks setting 42 in. off the floor and supported by 1-1/2 in. × 1-1/2 in. angle iron legs. Chemical addition is through a funnel at the top of the tank, the solutions having been previously made up in a *Make-Up Tank* in the second floor laboratory. Discharge is through the bottom into the suction side of the chemical addition pumps. One of the two stainless steel tanks is for the sodium dichromate, the other acting as a spare, while the steel tank is for the sodium hydroxide. Sight glasses are mounted in front for indication of solution level in the tank. Flow from the tanks is shown in Figure 3.2-1.

Three Proportioneer Inc. Simplex Adjust-O-Feeder Pumps are connected to the discharge of the chemical make-up tanks for pumping the solutions into the Mock-up feed water. The pumps are positive displacement piston, 5/8 in. × 1 in. with a capacity of 3.5 gph at 48 strokes per minute against 500 lbs pressure. Each is driven by a 1/4 hp, 1 phase, 60 cycle, 110 v, 40°C temperature rise, normal starting current open General Electric constant speed motor through a speed reducer operating an eccentric cam driving device. The two for pumping sodium dichromate have stainless steel cyclinders and trim with 1/4 in. built in check valves. The one for pumping sodium hydroxide is of the same size but of steel.

5.0 INSTRUMENTATION

The instruments described are classified as to the three main divisions of equipment they service: (1) Ion Exchangers, (2) Deaerator, (3) Distribution. A list of the instruments is given below:

5.1 Ion Exchangers Instrumentation

1. Trident Crest Meter
   (Neptune Meter Co.)
2. Permutit Rate of Flow Indicator
   (The Permutit Company)
3. Type C36 Bailey Fluid Meter
   (Bailey Meter Company)
4. Micromax *p*H Recorder
   (Leeds Northrup Company)
5. Model M Beckman *p*H Meter
   (National Technical Laboratories)
6. Solu-Bridge Controller
   (Industrial Instruments, Inc.)
7. Model RC-1 Conductivity Bridge
   (Industrial Instruments, Inc.)
8. Burettes
   (Betz Company)
9. Mercury Well Manometer
10. Head Tank Level Direct Acting Cutoff Valve

5.2 Deaerator Instrumentation

1. External Float Gauge
   (Fisher Governor Company)
2. Fisher Level-Trol
   (Fisher Governor Company)
3. Brown Circular Chart Electronik Potentiometer Pyrometer
   (Brown Instrument Company)
4. Air Operated Diaphragm Valve
   (Fisher Governor Company)

5. Taylor Fulscope Recording Controller for Deaerator
(Taylor Instrument Company)

6. Taylor Motosteel Evenactor Valve
(Taylor Instrument Company)

7. Manometer
(Bailey Meter Company)

5.3 Distribution Instrumentation

1. Micromax *p*H Continuous Recorder Controller
(Leeds and Northrup Company)

2. Micromax Four-point *p*H Recorder
(Leeds and Northrup Company)

3. Micromax Four-point Conductivity Recorder
(Leeds and Northrup Company)

4. Type C36 Bailey Fluid Meter
(Bailey Meter Company)

5. "C" Tube Bourdon Pressure-Vacuum Gauges
(U. S. Gauge Company)

6. Wallace and Tierman Direct Feed Ammoniators
(Wallace and Tierman Company, Inc.)

7. Low Water Control Mercoid Switch Type 123-156
(Mercoid Corporation)

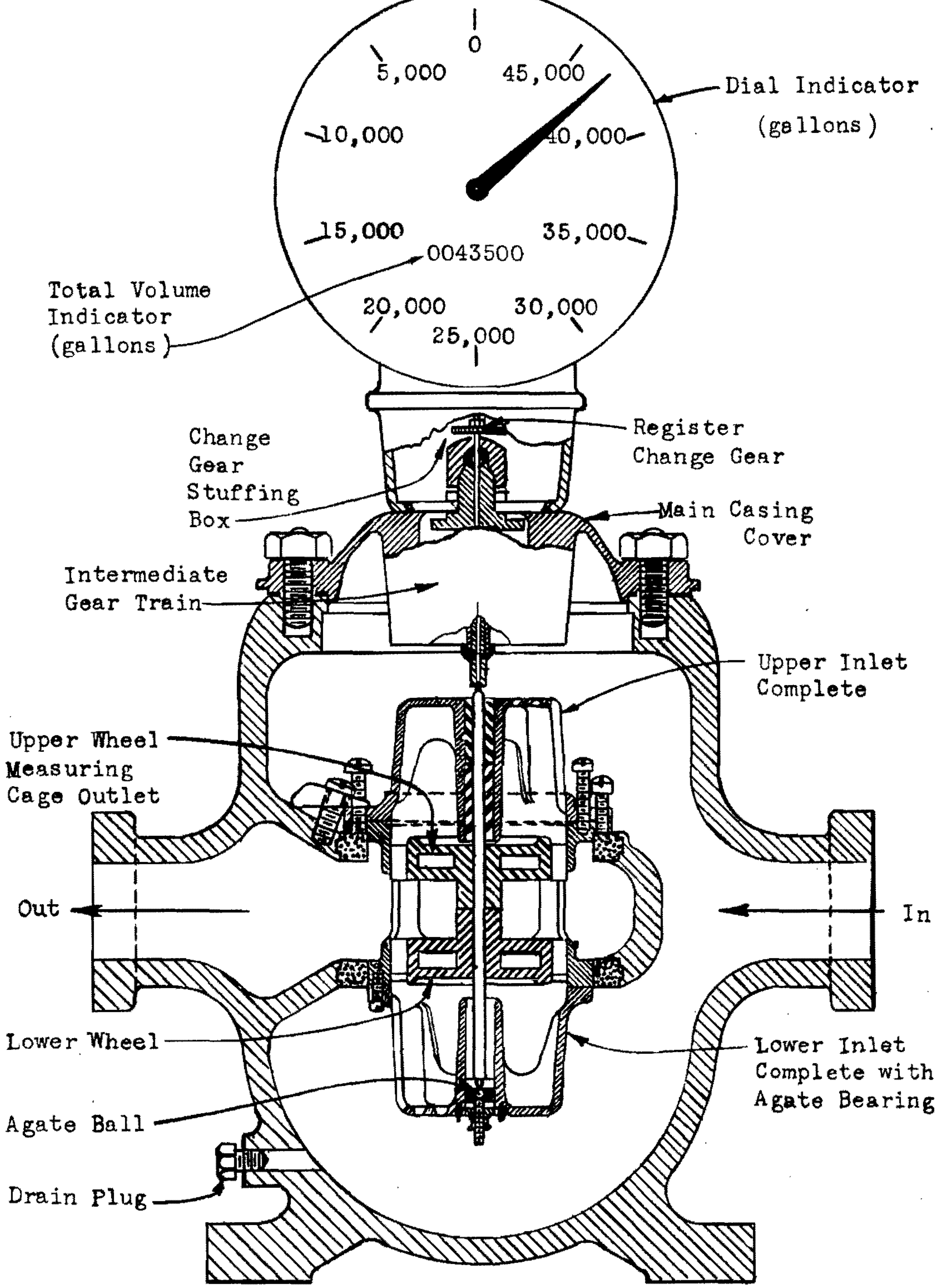
5.1 Ion Exchangers Instrumentation

The instruments used in conjunction with the exchangers are for measuring and controlling the quality and quantity of water produced.

The Trident Crest Meters measure the volume of the incoming filtered feed water to the Zeo-Karb H exchanger. The meter furnishes a flow measurement as well as an integrated total volume measurement. The flow measurement is used to check flows during brine, rinse, wash, and softening. The integrator furnishes expected run data for both the Zeo-Karb H and the De-Acidite units as well as a monthly inventory check on water used. Figure 5.1-1 shows the Trident crest meter.

A Permutit Rate of Flow Indicator is located on the discharge side of the alkali pump. The indicator operates by the pressure drop across an orifice installed in the recycling rinse line and indicates the rinse rate for the De-Acidite bed during one step of the regeneration. The indicator, consisting

Dwg. 9469
Figure 5.1-1



TRIDENT CREST METER

of two diaphragms, transmits the pressure drop across the orifice to an arm which is calibrated to read in gpm. Figure 5.1-2 gives a pictorial diagram of the hook-up.

A Bailey Fluid Meter for recording rate of flow and total volume of demineralized water from the units is located on the main floor. A check between this meter and the crest meter indicates the efficiency of the units. Description of the Bailey meter is included under 5.3.

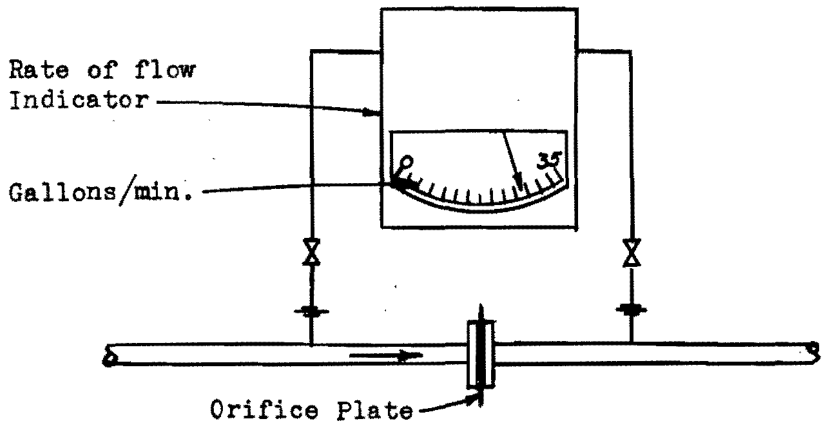
A Micromax pH Recorder, located on the main floor, is used for a continuous record of the *p*H of the water leaving the units. This instrument is used in conjunction with the Beckman *p*H meter. Description of the Micromax is included under 5.3. As explained under Section 2.0, periodic checks are made of the filtered water to the units, demineralized water to the head tank, and deaerated water from the deaerator. These checks are made using the following instruments.

A Model M Beckman pH Meter is used to measure the *p*H of water leaving the units or leaving the head tank. It is used in conjunction with the four point Micromax *p*H recorder and acts as a check for the recorder.

*p*H is a measure of the H^+ ion concentration in a solution, the concentration of which may vary from one gram equivalent of disassociated ions per liter, to less than one million-millionth. This results in fractions which may be expressed as powers of ten, *e.g.*, $1 = 10^0$, $0.1 = 10^{-1}$, etc. The negative exponent is the logarithm of the reciprocal of a given concentration (or the negative exponent), so that an H^+ ion concentration of 0.1 is expressed as *p*H of 1. A one normal solution of hydrochloric acid approaches a one gram equivalent of disassociated H^+ ions giving a *p*H approaching 0. A one normal solution of sodium hydroxide approaches a one million-millionth of a gram equivalent of disassociated H^+ ions giving a *p*H approaching 14. Pure water gives a *p*H of 7.

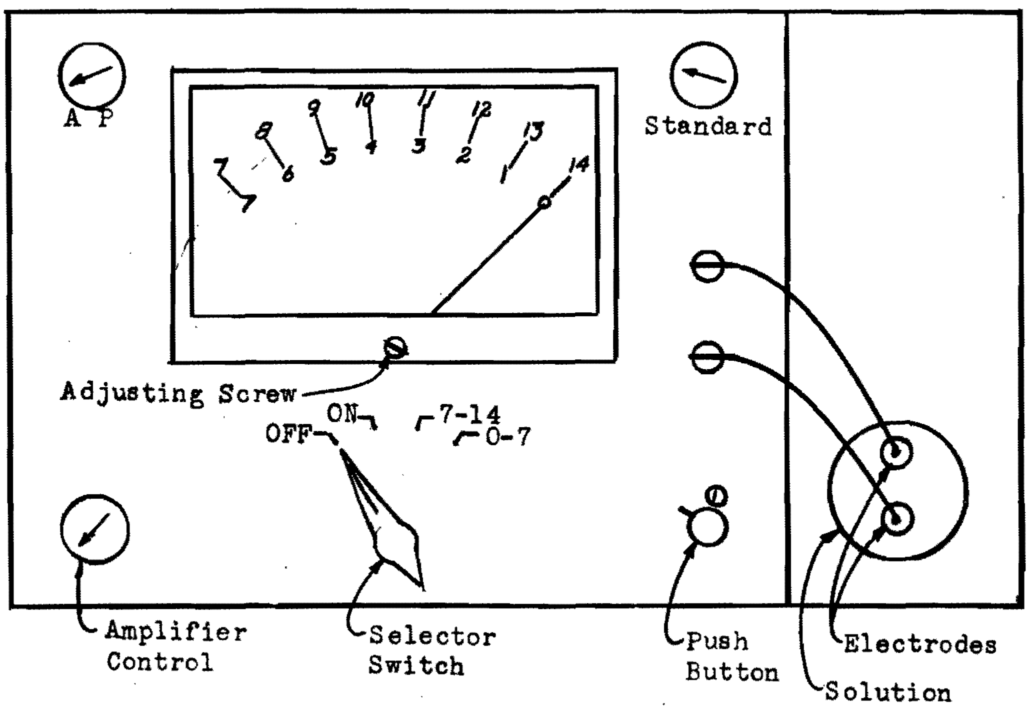
For an aqueous solution, therefore, it may be said that an acid is a substance capable of supplying H^+ ions to the solution and a base is a substance capable of supplying very few H^+ ions or supplying the electro-negative OH^- ion. Thus, *p*H affords a method measuring a solution's acidity or alkalinity.

A *p*H meter measures the difference of potential between two electrodes submerged in the test solution. One of the electrodes assumes the potential dependent upon the *p*H of the solution while the other electrode assumes a constant potential. The meter utilized a potentiometer to measure the potential difference, the potentiometer scale being calibrated to read directly in *p*H. Discussion of the potentiometer is given under "The Solu-Bridge Controller" and "The Brown Circular Chart Electronik Potentiometer Pyrometer."



PERMUTIT
RATE OF FLOW
INDICATOR

Figure 5.1-3



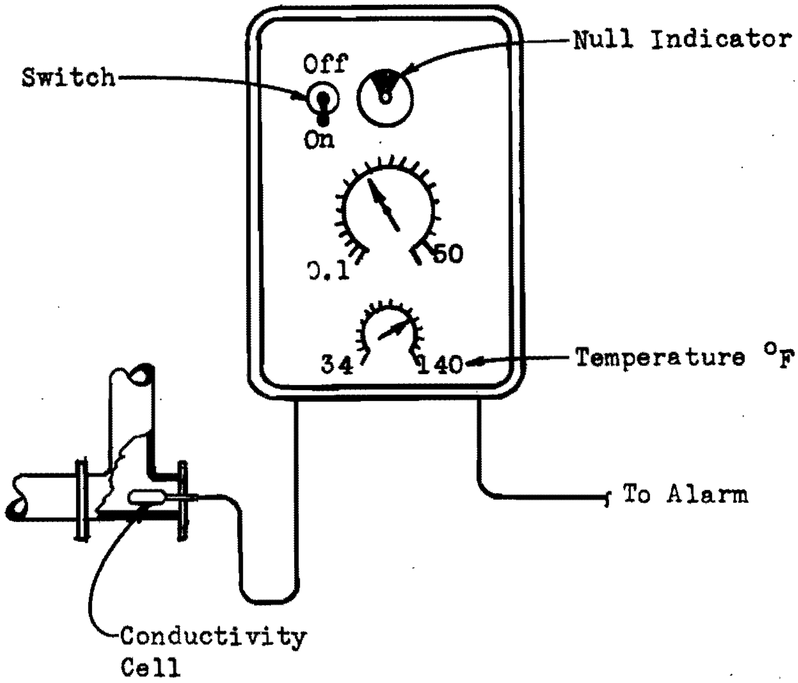
BECKMAN pH METER
MODEL M

Figure 5.1-3 is a pictorial view of the Beckman *p*H meter. Operation of it is given as follows:

1. With the selector switch in *off* position, adjust pointer to read 7 using the adjusting screw.
2. Leaving the push button in the *up* position, turn selector switch to *on* and allow to warm.
3. Turn selector switch to 7-14 range and adjust meter to read 7 using the amplifier control knob.
4. Turn selector switch to 0-7 range and adjust to read 7 using the standard knob.
5. Immerse electrode in a buffer solution of known *p*H and press push button.
6. Adjust meter to this reading using the AP knob.
7. Clean the electrode and immerse in test solution.
8. Press button and read *p*H from scale. Should the needle go off scale, switch to other scale.

The Solu-Bridge Controller, RE-E4, is a modified Wheatstone bridge with cathode ray tube as a null indicator. In conjunction with the measurement circuit this solu-bridge controller has a self-incorporated vacuum tube relay circuit operating on the unbalance of the bridge to accurate a 110 v a-c current of up to two amperes for operating a warning signal when the ion concentration exceeds the point at which the indicator rests on the dial. There are two sets of solu-bridge controllers on each demineralizing unit, one on the De-Acidite effluent and one on the demineralized water line to the storage tank. In regenerating a De-Acidite unit, rinsing is done using the solu-bridge controller on the De-Acidite effluent line until a predetermined reading is reached. When the units are on the line to the storage tank, the solu-bridge controller on the storage tank feed line is used to check the water. However, in this case either of the controllers could be used, but only the solu-bridge instrument in the line to the head tank has the alarm in its circuit. Figure 5.1-4 gives a schematic hook-up diagram for a solu-bridge controller.

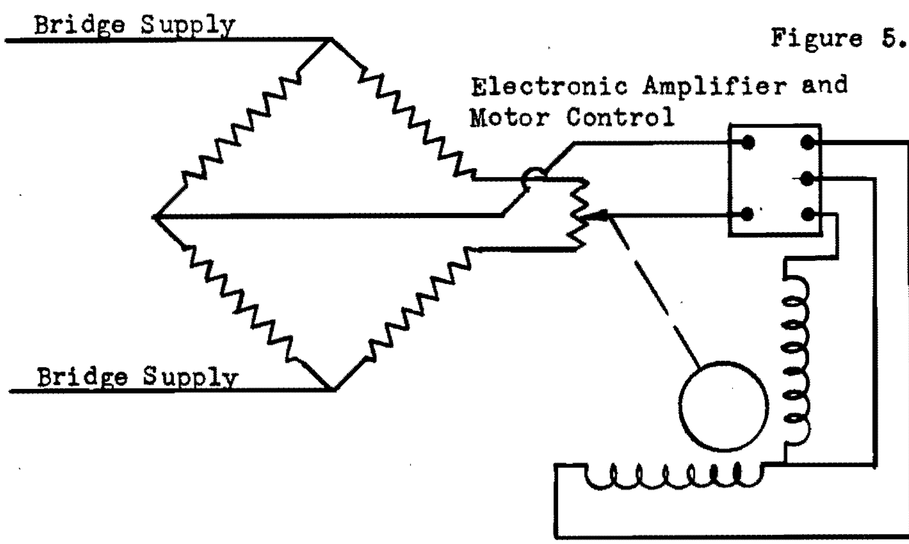
Figure 5.1-5 gives a schematic diagram of a Wheatstone bridge circuit as used in the solu-bridge controller. The circuit includes (1) an unknown resistance between the electrodes of the conductivity cell, (2) standard resistance which is wirewound for manual temperature compensation, (3) and (4) the wirewound end resistors and slidewire constituting the variable ratio arms.



S O L U - B R I D G E   C O N T R O L L E R

R E - E 4

Figure 5.1-5



W H E A T S T O N E   B R I D G E   C I R C U I T

A Model RC-1 Conductivity Bridge is used to measure the conductivity of demineralized water to the head tank and of the water leaving the building.

The conductivity bridge is an adaption of the Wheatstone bridge with a cathode ray tube as a null indicator. Model RC-1 operates directly from the power line and is completely self-contained. The resistance measurements are made by means of an a-c bridge with a source voltage of less than three volts obtained from a step-down transformer.

Two adjustments are required for the measurement of any measured resistance between 2 to 2,500,000 ohms. The main control drives a potentiometer which changes the ratio in the arms of the bridge. A multiplier switch is provided to change the reading on the calibrated dial by factors of ten.

To place in operation insert the line cord plug in the power line receptacle, snap toggle switch to *on* position, and allow one minute for tubes to heat. The line cord is a three-pronged plug providing a ground, and neither terminal of the conductivity cell or resistor under measurement is grounded. The metal water container is placed on a dry paper. If this paper is wet and permits the water, resistor under measurement, to become grounded the balance will be affected. Figure 5.1-6 gives a pictorial diagram of the conductivity bridge and cell.

Burettes are used in the operations for checking soap hardness, free mineral acidity, and methyl orange alkalinity. The burettes are calibrated to 0.5 cc, pressure filled, self-zeroing, and operated by a stopcock.

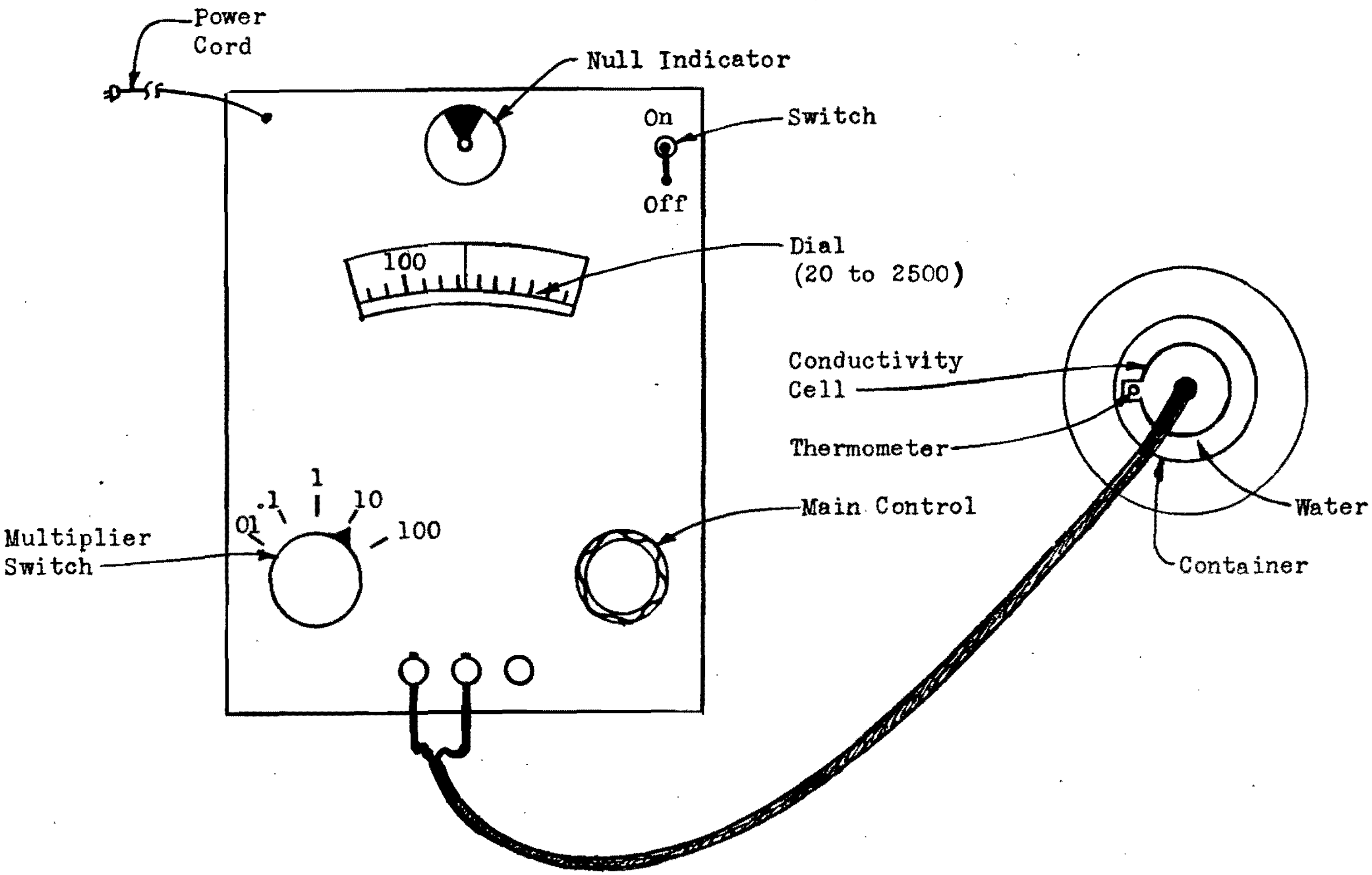
The Head Tank Mercury Well Manometer is located on the main floor for indicating water level in the head tank.

A Head Tank Direct Acting Cut-Off Valve is installed in the demineralized water line to the head tank at the top of the tank. The valve is operated by means of a direct connected float, located inside the tank, thus eliminating the possibility of overflowing the head tank. Should the valve leak, in a closed position, with the units still on the line an overflow line will carry the water to the hot well sump.

5.2 Deaerator Instrumentation

The instruments used in conjunction with the deaerator are for controlling the temperature, vacuum, and liquid level in the deaerator.

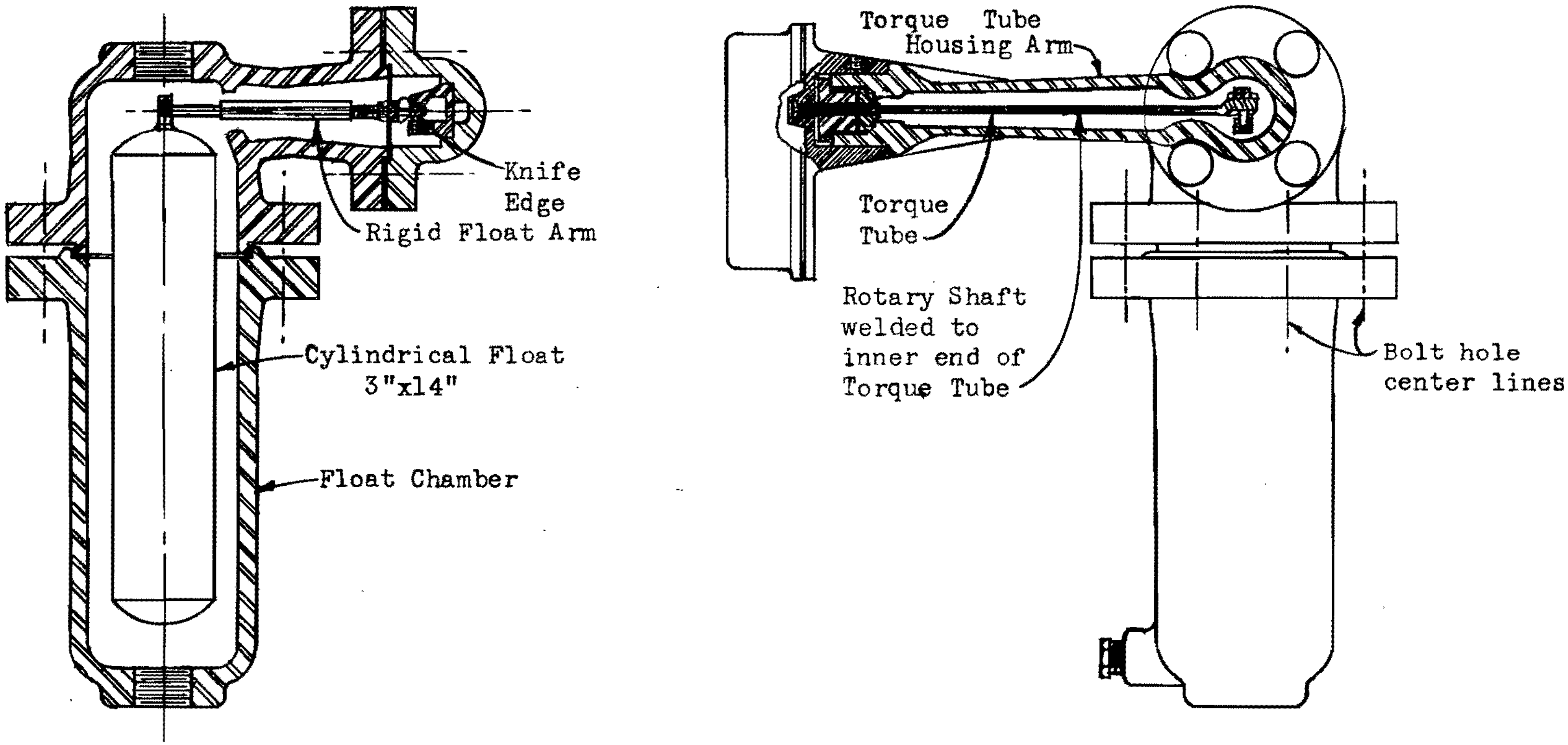
An External Float Gauge, operating in conjunction with a Fisher Level-Trol and a diaphragm valve, controls the water level in the deaerator. Figure 5.2-1 illustrates the construction of the gauge. The gauge is connected to the deaerator by two equalizing pipes. The lower pipe is connected to



C O N D U C T I V I T Y   B R I D G E

Dwg. 9472
Figure 5.1-6

UNCLASSIFIED



EXTERNAL FLOAT GAUGE

Dwg. 9473
Figure 5.2-1

UNCLASSIFIED

the water space and the upper pipe to the steam space, thus giving the water in the gauge the same level as that existing in the deaerator. The equalizing pipes are provided with cut-off valves so that the gauge may be serviced.

When no liquid is present in the float gauge, the entire weight of the float is supported by the tongue-tube in torsion which causes it to untwist. This rotary shaft to the outside of the cage and to the Fisher Level-Trol which in turn operates a diaphragm valve.

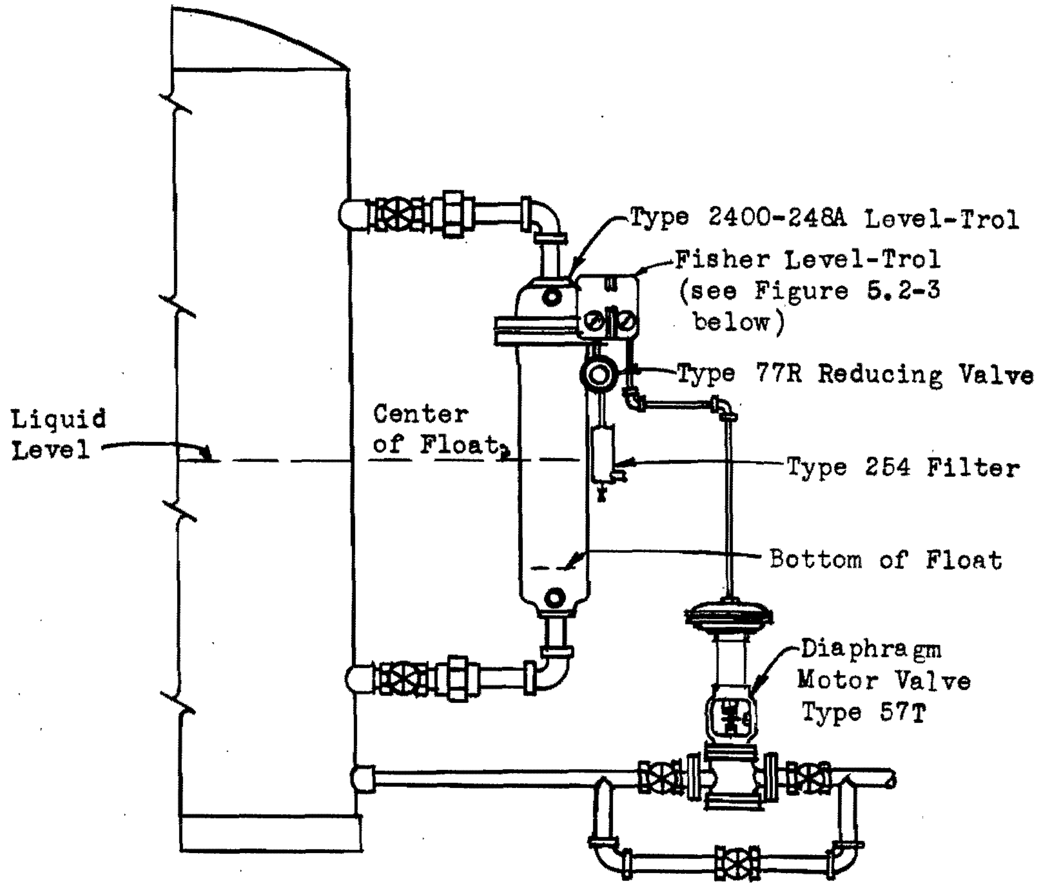
The Fisher Level-Trol, type 2400-248, is a direct acting throttling pilot using a Bourdon tube assembly. A type 254 filter and a 1/4 in. type 77R reducing valve are used with the pilot.

Figure 5.2-2 gives an overall picture of the controlling equipment. Figure 5.2-3 is an exterior view of the pilot, and Figure 5.2-4 gives the schematic view of the pilot.

In operation, a rising liquid level in the deaerator increases the diaphragm pressure to the pilot. This in turn will close the motor valve and thus control the inlet flow of water from the head tank. Figure 5.2-8 shows a diaphragm valve.

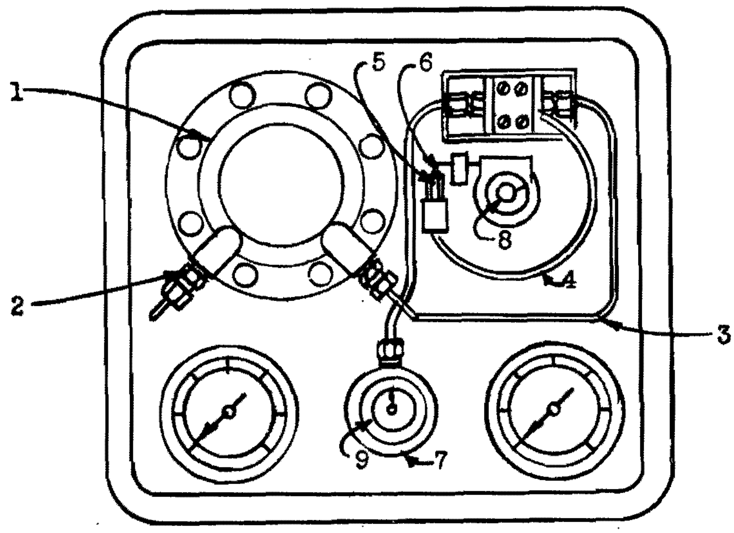
To accomplish the above control, the pilot incorporates an intermittent bleed relay actuated by a conventional primary orifice system and a pneumatic throttling range adjustment. Noting Figs. 5.2-3 and 5.2-4, 20 psi pressure is supplied to the relay (1) and to the primary orifice system which consists of a removable orifice (2) in the tubing fitting in the relay diaphragm casing, a tubing (3) from the relay diaphragm to the compensator tube (4), and a small tubing soldered inside the compensator tube, leading to the nozzle (5). The flapper (6) is attached to the rotary shaft and rotates with it as the level in the deaerator changes, controlling the pressure on the relay diaphragm. A pressure change on the relay diaphragm operates the main valve of the relay to change the pressure to the diaphragm motor of the motor valve. The diaphragm pressure to the motor valve is also utilized to actuate the compensating Bourdon tube (4) through the throttling range adjustment assembly (7). The desired level in the deaerator may be changed by turning the knob (8) in the center of the Bourdon tube. The throttling range of the controller is adjusted by turning the knob (9).

The Brown Circular Chart Electronik Potentiometer Pyrometer used to control and record the temperature of the water from the heat exchanger on the recirculation water line from the deaerator is located on the first floor of the building. The control is obtained through an air operated Fisher diaphragm valve on the steam to the heat exchanger with the air being regulated by the Brown controller. It employs a conventional null balance

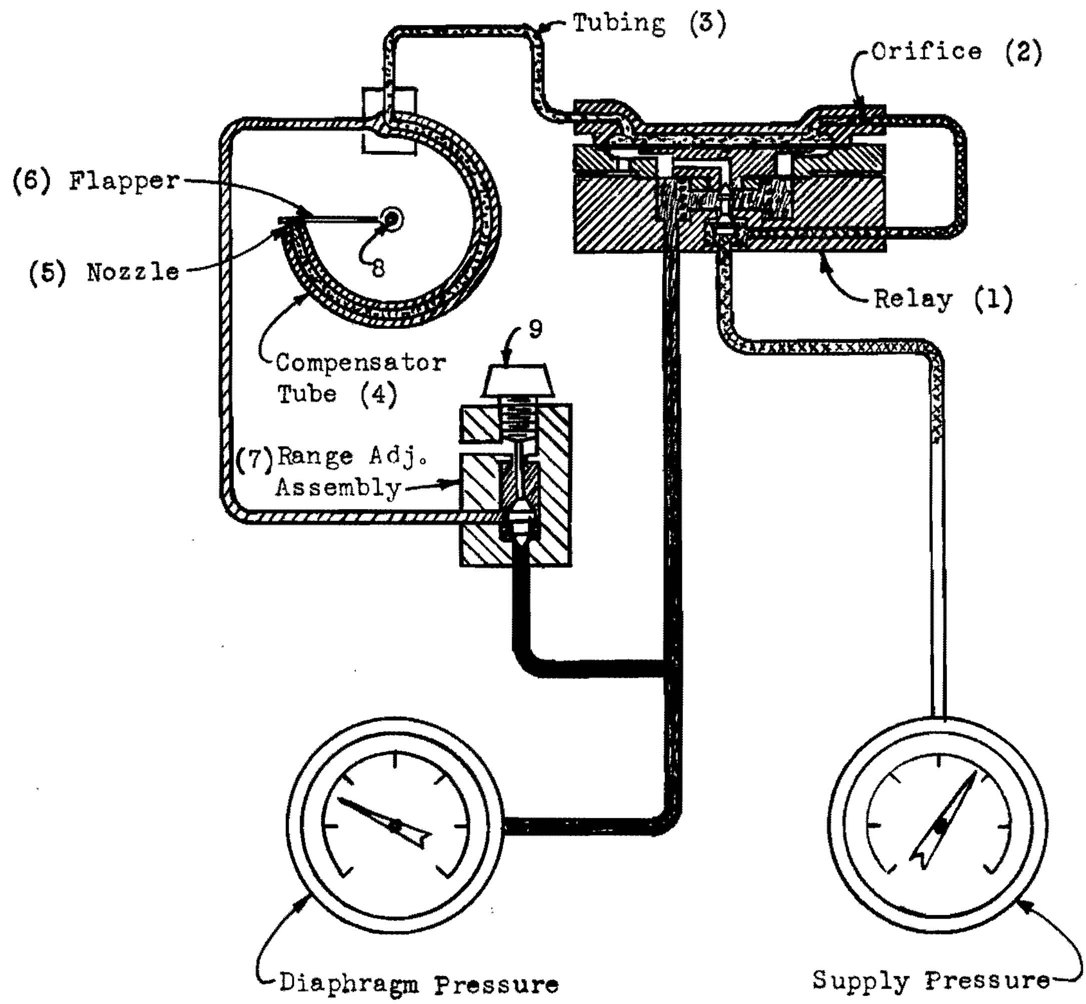


D E A R E A T O R L I Q U I D L E V E L C O N T R O L L I N G E Q U I P M E N T

Figure 5.2-3



F I S H E R L E V E L - T R O L E X T E R I O R V I E W



F I S H E R L E V E L - T R O L

S C H E M A T I C F L O W D I A G R A M measuring circuit using the Brown "continuous balance" unit instead of the usual galvanometer. The "continuous balance system" is designed for use with several types of self-balancing measuring devices.

The "continuous balance system" is made up of four units, each of which is described below, and is located at the back inside of the cover.

The conversion stage is composed of the converter and transformer, which converts the unbalanced d-c potentiometer voltage to a proportional a-c voltage. The converter is a single-pole, double-throw switch operating in synchronism with line voltage and is polarized by means of a permanent magnet so that the contacts will always be closed; one during the positive half-cycle of the supply voltage, and one during the negative half-cycle. The transformer acts as a coupling device between the measuring circuit and the electronic voltage amplifier to supply an a-c voltage, whose phase is dependent upon the direction of the unbalance.

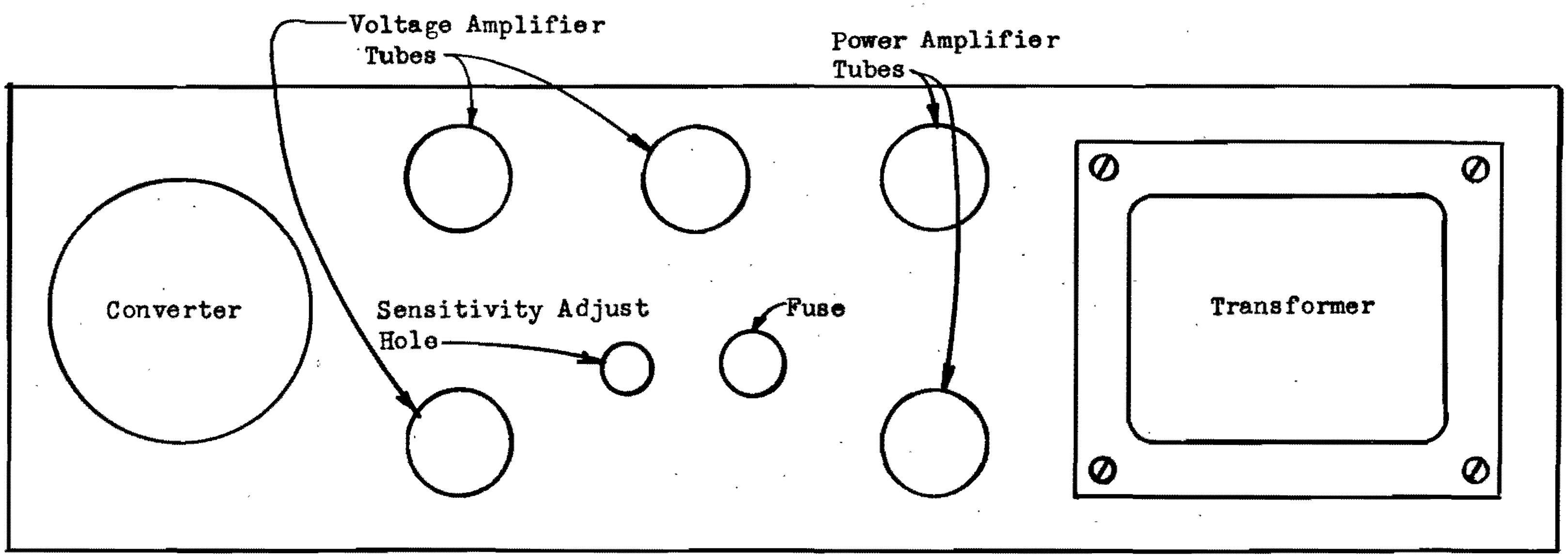
The voltage amplifier multiplies the a-c voltage put out by the transformer at *BB*, Fig. 5.2-6, from one of the order of microvolts to one of several volts at *CC*.

The power amplifier is controlled by the voltage from the voltage amplifier, *CC*, Fig. 5.2-6, and delivers driving power, *DD*, to the balancing motor. Both the phase and magnitude of the driving power are directly controlled by the voltage from the voltage amplifier and hence is controlled by the unbalance of the measuring circuit.

The balancing motor is a brushless, reversible, variable-speed induction motor which recognizes the phase of the driving power and accordingly balances the instrument. One of the motor windings is continuously energized by line voltage while the other winding is energized by the power amplifier, with a current whose phase with respect to the line current determines the direction of rotation of the motor. The slide-wire contactor, pen, and pointer are directly connected to this motor.

Figure 5.2-5 gives a pictorial plan view of the "continuous balance" unit.

The measuring circuit used with this "continuous balance" unit is the potentiometer. A potentiometer consists of a calibrated slide-wire resistor through which a standard current passes and hence gives a calibrated voltage drop. A portion of this voltage, as determined by the slide-wire contactor, is opposed to the potential across the pyrometer, and when these two voltages are equal, the contactor is at the point of balance. The contactor is linked to an indicating pointer which records and indicates the temperature. Figure 5.2-7 is an outside view of the instrument.

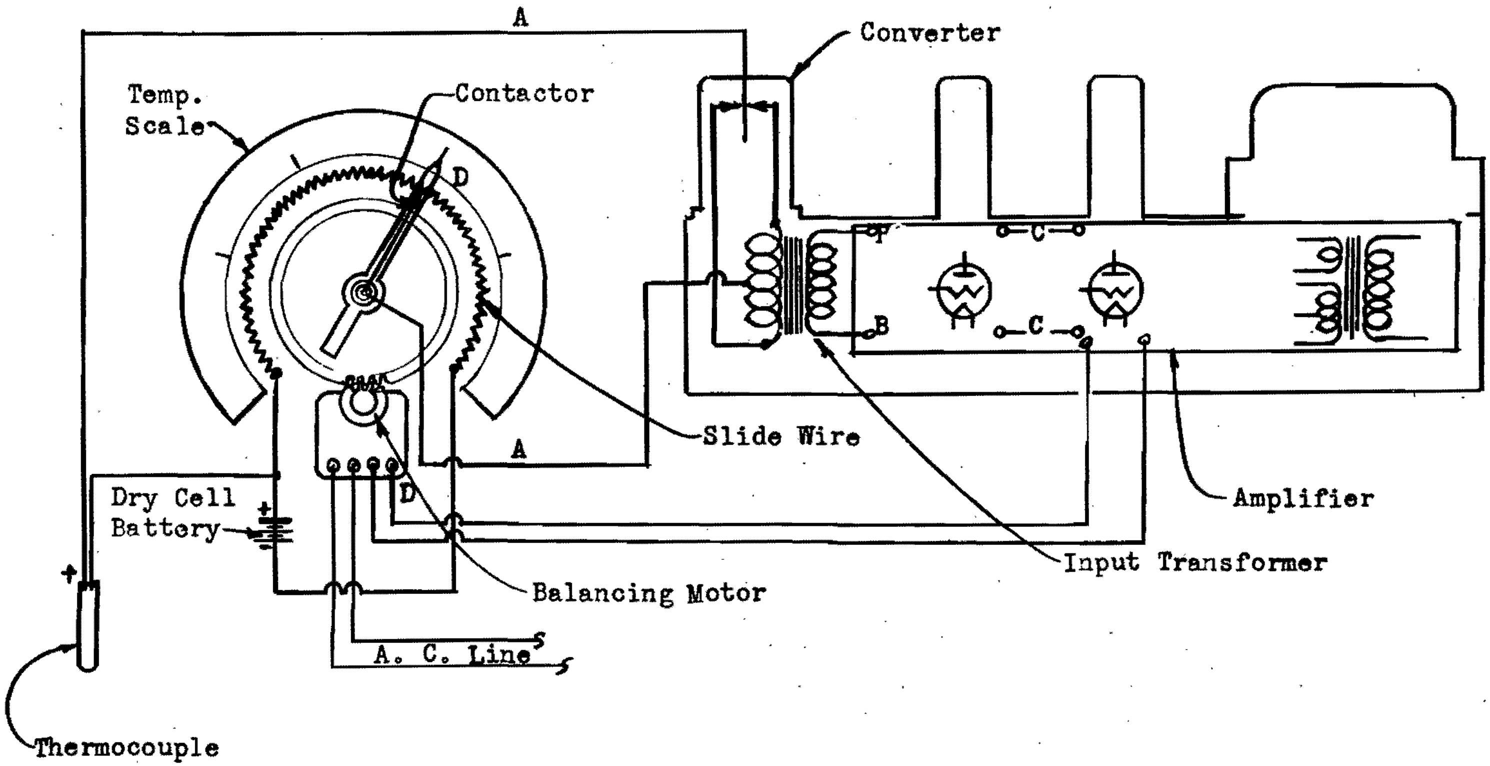


BROWN CIRCULAR CHART

POTENTIOMETER PYROMETER

CONTINUOUS BALANCE UNIT

Dwg. 9476
Figure 5.2-5



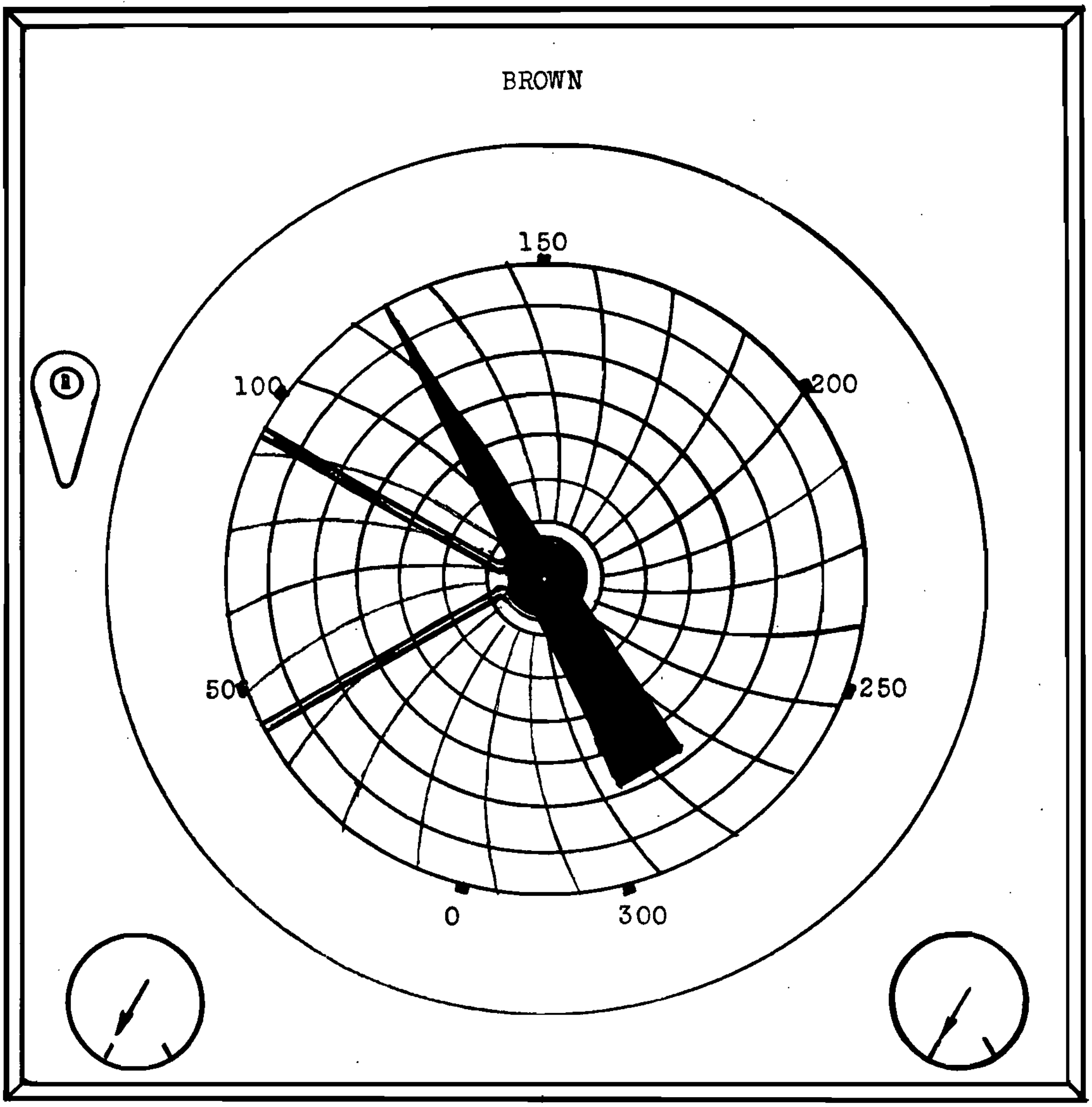
BROWN CIRCULAR CHART

POTENTIOMETER PYROMETER

DETECTING BALANCING SYSTEM

Dwg. 9477
Figure 5.2-6

Dwg. 9478
Figure 5.2-7



BROWN CIRCULAR CHART
POTENTIOMETER PYROMETER
OUTSIDE VIEW

Figure 5.2-6 is a diagram of the detecting and balancing system used in the Brown Electronik. An unbalance between the thermocouple and slide-wire voltages will appear across *AA* as a voltage whose polarity will depend upon the direction of unbalance. This voltage at *AA* is converted by the "continuous balance" unit to drive the "balancing motor," as described above.

An Air Operated Diaphragm Valve, operated by the Brown Electronik potentiometer, is located on the steam line to the heat exchanger for regulating the flow of steam so as to maintain a constant temperature in the water recirculated to the deaerator. Figure 5.2-8 gives a schematic diagram of the valve.

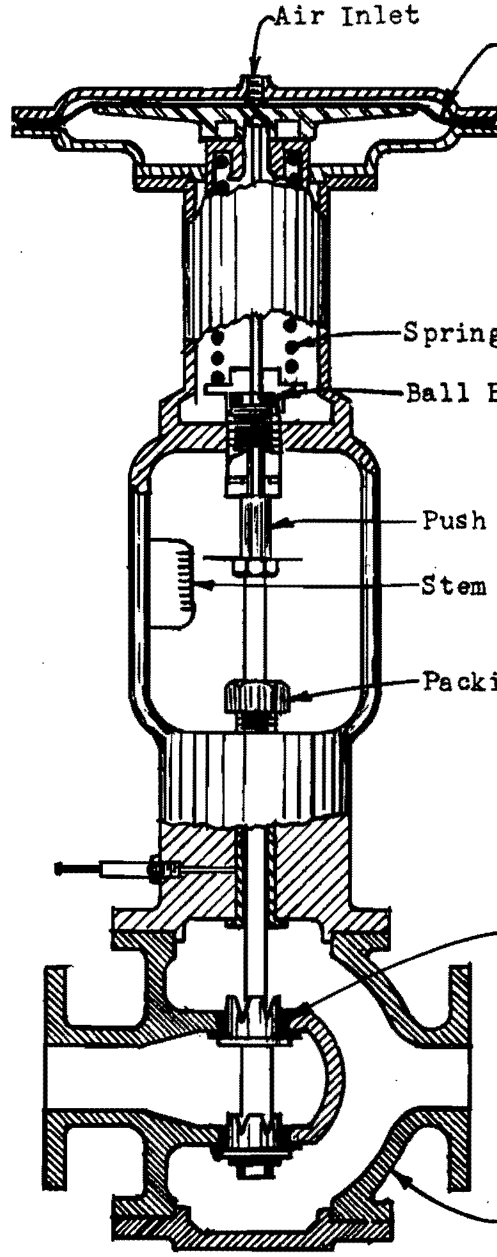
The Taylor Fulscope Recording Controller is located on the fourth floor. This instrument, used to control the vacuum on the deaerator, is a single-duty controller with adjustable sensitivity and automatic reset. Vacuum control point is set at the desired point and control is accomplished through a Taylor Motosteel Evenactor Valve. As the deaerator vacuum deviates from the control point the controlled air to the valve is varied allowing air to be bled in at such a rate as to maintain a constant value.

Figure 5.2-9 shows a pictorial view of the inside face of the controller. The following numbered points may be located on the figure.

(1) Sensitivity adjustment,
(2) Automatic reset,
(3) Chart-locking mechanism, and
(4) Orifice cleaner in the relay air valve.

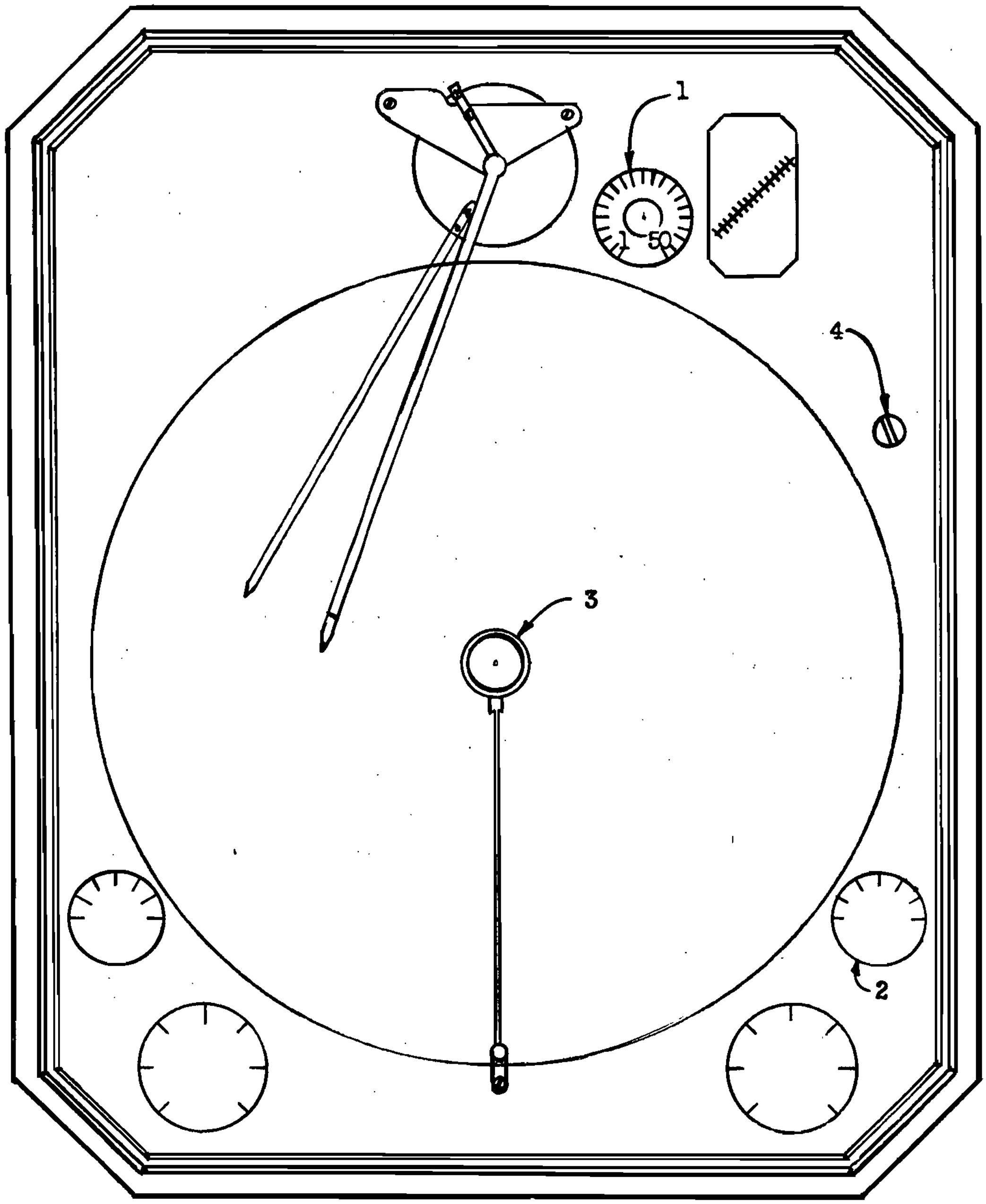
Two control effects listed by the manufacturer are: (1) proportional response which causes an output pressure change proportional to the pen or pointer deviation from the set point, and (2) automatic reset response which causes an output pressure change proportional to the magnitude and duration of the pen or pointer deviation from the set point.

Figure 5.2-10 is a schematic flow diagram of the controller with some of its parts listed. Noting the figure, if the recorder is below the control point (if vacuum is less than required), the circular baffle rests on the nozzle preventing free flow of air through the nozzle. The resulting back pressure on the capsular chamber causes it to inflate, raising the relay ball, cutting down the air to the diaphragm valve. The reduced pressure to the valve allows it to close, thus decreasing the volume of air bled into the deaerator. The adjustable sensitivity and automatic reset are utilized to minimize overshooting and hunting when the control point is changed or when pen deviation occurs.



AIR OPERATED

DIAPHRAGM VALVE



TAYLOR FULSCOPE CONTROLLER

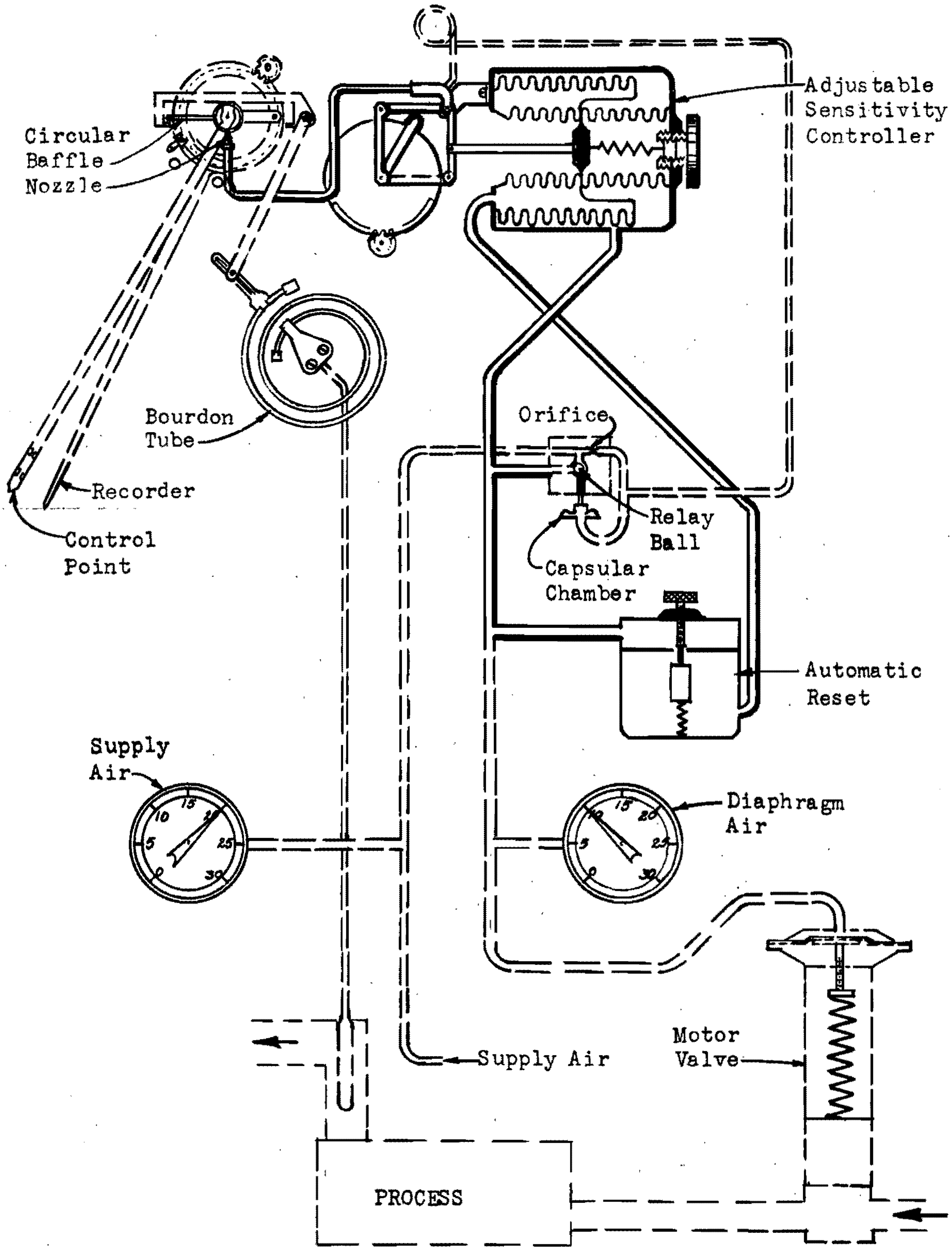
1 Sensitivity Adjustment.

2 Automatic Reset.

3 Chart-locking Mechanism.

4 Orifice cleaner.

Dwg. 9481
Figure 5.2-10



TAYLOR FULLSCOPE CONTROLLER
FLOW DIAGRAM

The Taylor Motosteel Evenactor Valve is similar in construction and operation to the air operated diaphragm valves.

5.3 Distribution Instrumentation

The water leaving the 807 building to the serviced buildings is metered by instruments which are mainly of a recording or a recording controlling nature. Three of the instruments have been mentioned in parts 5.1 and 5.2. Further description of these instruments along with the other instruments connected with distribution, are included below.

A Micromax pH Continuous Recorder Controller is located in the southwest corner of the main floor for controlling the sodium hydroxide addition to and recording the pH of the demineralized water to the Mock-up. The controller operates an air valve which is placed on the discharge of the sodium hydroxide proportioneer pump.

The controller is a Model S Micromax, strip-chart, using a d-c potentiometer balancing mechanism in conjunction with a glass-electrode assembly. The control mechanism is a Micromax pneumatic control. Figure 5.3-1 shows a glass-electrode assembly and Fig. 5.3-2 is a pictorial view of the Micromax, and Pneumatic Control.

The electrode assembly consists of a highly sensitive detecting electrode, a reference electrode, and a temperature compensator. These are mounted as a unit with the sensitive ends of the electrodes in a flow chamber through which moves a continuous stream of water. An emf is developed between the two electrodes by the flowing water, this emf being balanced by the Micromax. The temperature compensator modifies this balanced voltage according to the temperature of the water and the modified balanced voltage is continuously recorded as *p*H. Any deviation of measured *p*H from the control point is transmitted through the controller to actuate the pneumatic control which in turn operates the control valve.

The pneumatic control is factory-assembled utilizing two air connections, (1) directly to the plant air supply, and (2) directly to the diaphragm valve. A pilot valve translates the above mentioned *p*H change to a corresponding pressure change. The pneumatic balance is in equilibrium only when the caustic is flowing at the required rate to hold the *p*H at the control point.

A Micromax Four-point pH Recorder continuously records the *p*H of the water at four points in Building 807, to (1) head tank, (2) Building 205 (3) Building 105, and (4) Pile Mock-up.

The four point recorder is similar to the recorder controller in that the detecting device is the glass electrode assembly (Fig. 5.3-1), the balancing mechanism is a d-c potentiometer, and it is a strip chart Model S Micromax. There is no control mechanism attached; the prime purpose being to furnish a continuous *p*H record at the four points using the Beckman *p*H meter as a check. The continuous record furnishes a means for determining the quality of the water.

A Micromax Four-point Conductivity Recorder records the conductivity, in ohms of resistances, at the same four points as the *p*H. The detecting device is a standard conductivity cell, as used with the conductivity bridge, immersed in a continuous stream of water taken from the same point as for the *p*H recorder. The balancing mechanism in the Micromax is an a-c Wheatstone bridge, explanation of which is included under "The Solu-Bridge Controller," part 1 of this section. The Micromax is a strip-chart Model S (Fig. 5.3-2).

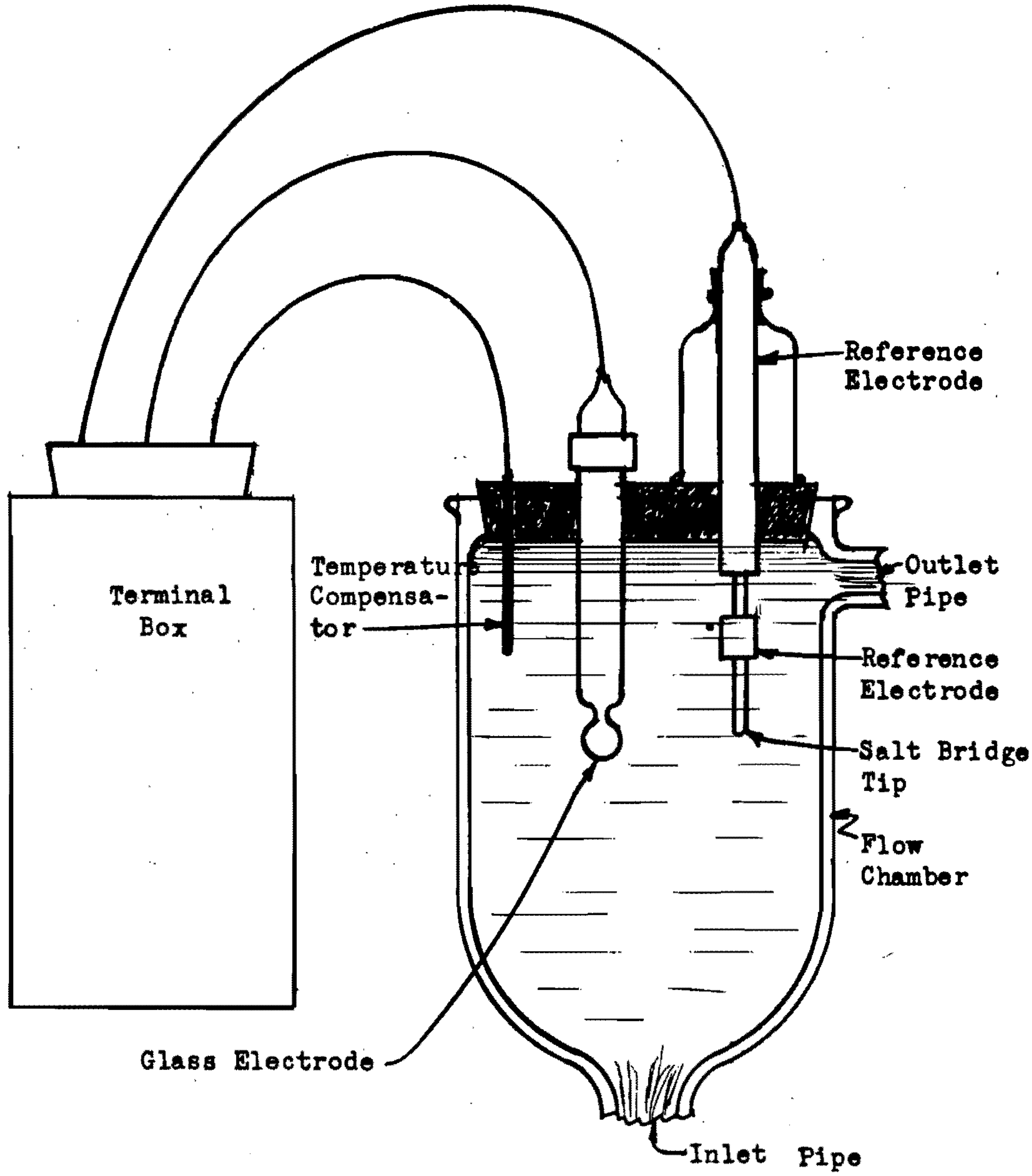
The recorder together with the conversion factors noted on the instrument door furnishes a continuous record of the specific conductivity of the water at the four points as well as a check against the conductivity bridge. The continuous record enables the operator to determine water quality quickly and easily.

Four Type C36 Bailey Fluid Meters are in operation in Building 807; one on the demineralized water line to the head tank and one each on the water lines to Buildings 105, 205, and Pile Mock-up. They indicate and record past and present flow and integrate the current flow to give total quantity having passed through the line. The meter measures the pressure differential across an orifice and translates it into units of flow for indicating, recording, and integrating. Figure 5.3-3 gives the flow mechanism of the Bailey meter.

The pressure at the inlet side of the primary element is applied to the interior of the mercury sealed Ledoux bell, and the pressure on the outlet side is applied to the exterior of the bell. A differential pressure change moves the bell up or down, this movement being transmitted to the direct-connected recording pen which is directly proportional to the changes in rate of flow. The flow mechanism is operated directly from differential pressure and requires no external source of power.

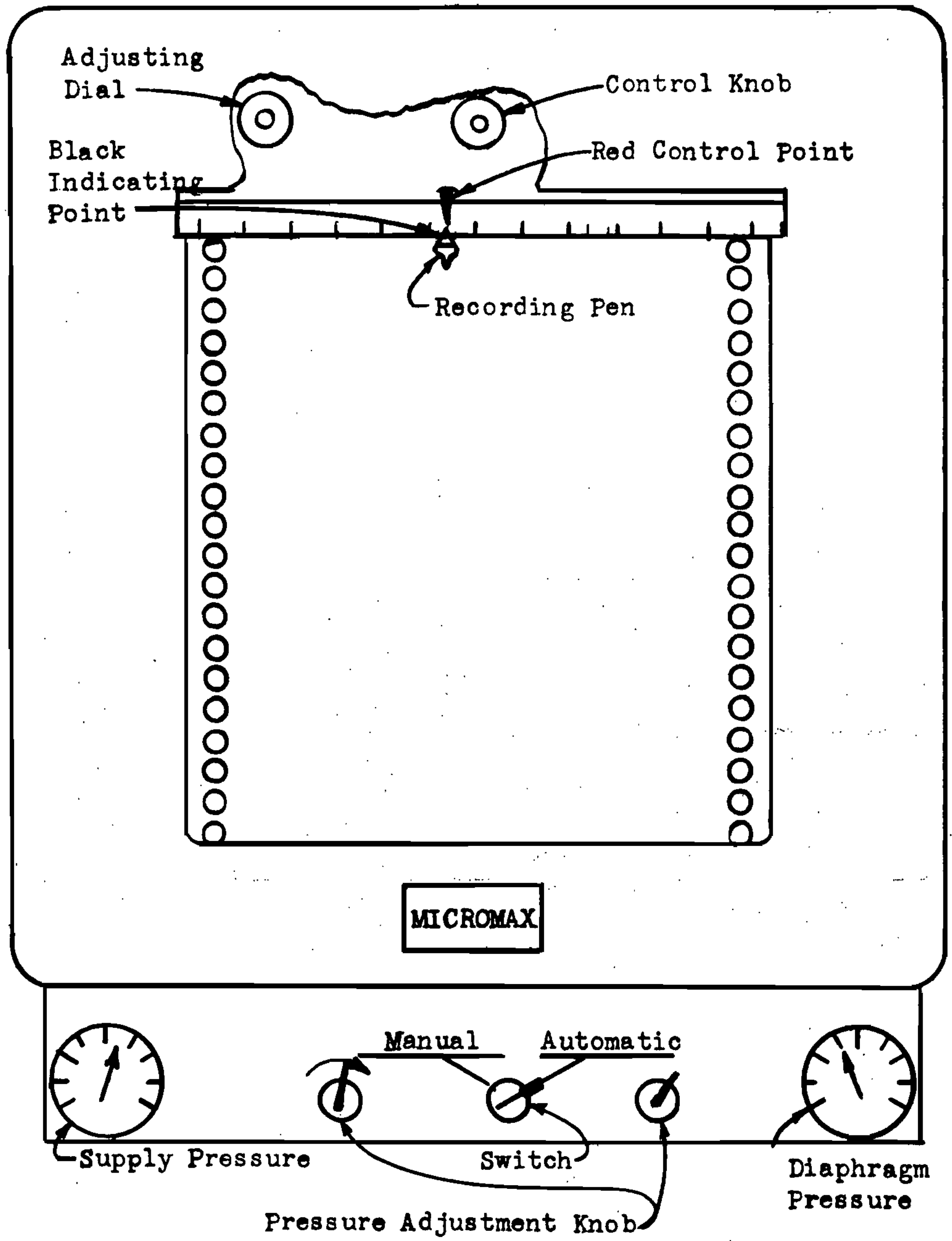
The meter is provided with a rubber plate located at the top of the Ledoux bell which comes in contact with the shut-off under sudden overloads or reversals of flow, making it theoretically impossible for mercury to enter the connecting lines. The connecting link is to prevent the bell from rubbing

Dwg. 9482
Figure 5.3-1



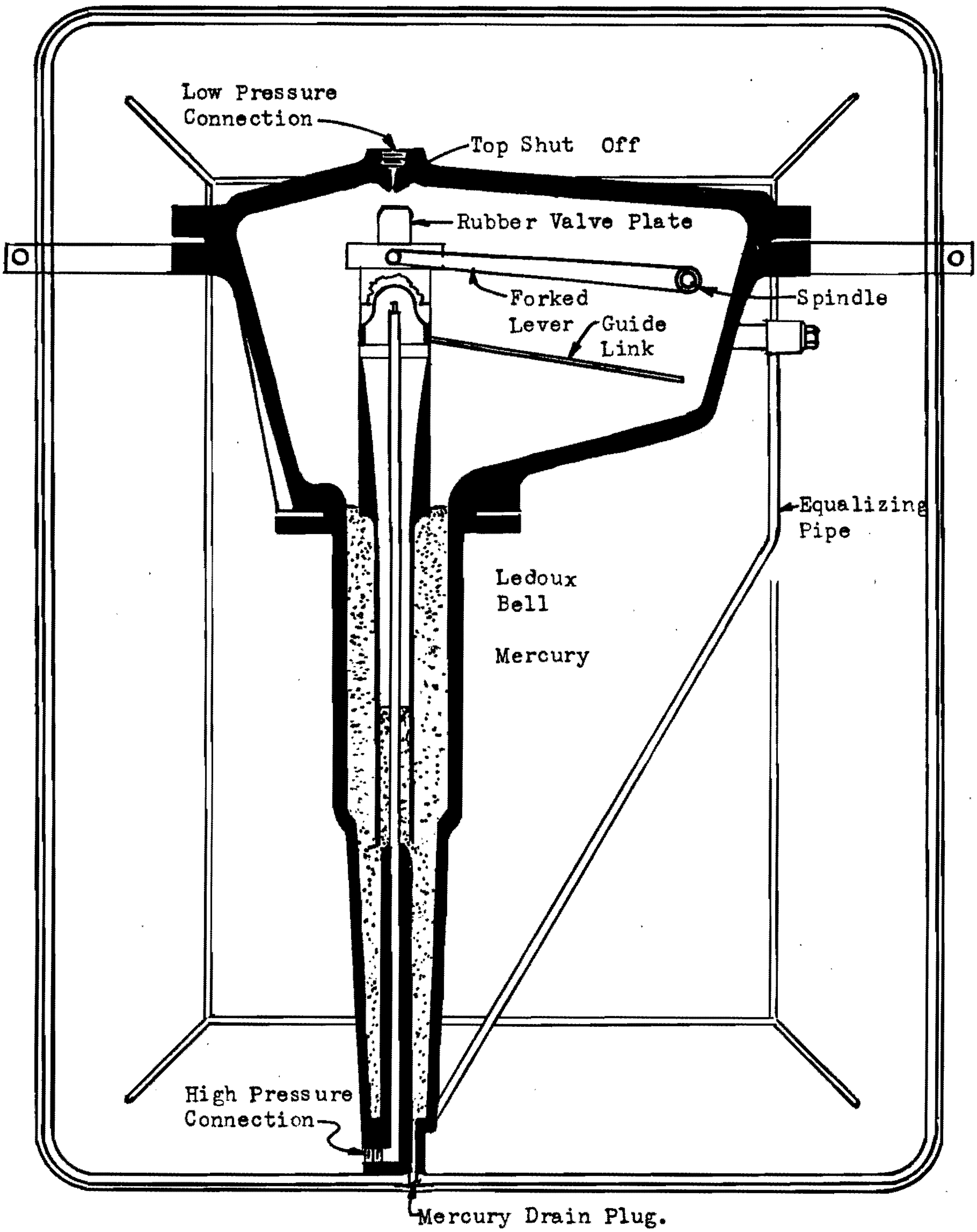
GLASS ELECTRODE ASSEMBLY

Dwg. 9483
Figure 5.3-2



MICROMAX
and
PNEUMATIC CONTROLLER

Dwg. 9484
Figure 5.3-3



B A I L E Y F L O W M E T E R M E C H A N I S M against the standpipe when the meter is not level.

"C" Type Bourdon Pressure Vacuum Gauges are installed in the steam and water lines for indicating pressures and on the deaerator ejectors for indicating vacuum.

Two Wallace and Tierman Direct Feed Ammoniators, type MDPAM, are located on the first floor in stand-by condition. The ammoniators were used for regulating the injection of CO_2 and O_2 into demineralized water for water specification duplication at other locales. Each have a meter calibrated for 2 lb to 12 lb CO_2 per 24 hours versus water pressure of 30 lb to 35 lb and/or for 0.2 lb to 1.2 lb O_2 per 24 hours versus water pressure of 30 lb to 35 lb.

A Mercoid Low Water Control, type 123-156, is installed in the drop leg from the deaerator to the recirculating pump. The control has a 30 lb pressure rating with the circuit to the pumps opening if liquid level lowers.

6.0 OPERATION OF PLANT

The routine operating procedure for Building 807 is given in this section with references being made to the Demineralizing Equipment Flowsheet (3.2-1) and to various individual pieces of equipment listed in Section 4.0. The Unit Flowsheet is shown in Fig. 4.1-1 with the valve lettering indicated. For the convenience of the operator, an outline of this section is given below.

6.1 Valve Nomenclature

- 6.11 Valve Nomenclature for Demineralizing Units
- 6.12 Valve Nomenclature for Building Services

6.2 Solution Make-up

- 6.21 Dilute Sulphuric Acid
- 6.22 Soda Ash Solution
- 6.23 Sodium Sulfite Make-up
- 6.24 Sodium Dichromate
- 6.25 Sodium Hydroxide
- 6.26 Refilling Strong Acid Head Tank

6.3 Demineralization Operation

- 6.31 Operation of the Zeo-Karb H Unit
- 6.32 Operation of the De-Acidite Unit
- 6.33 Preparation of Units for Reuse

6.4 Operation of the Deaerator

- 6.41 Starting Deaerator
- 6.42 Shutting Deaerator Down

6.5 Distribution Operation

- 6.51 Operation of the High Head Pump
- 6.52 Controlling Water Specifications to the Pile Mock-up

6.6 Water Analyses

- 6.61 Boutron and Boudet Soap Test
- 6.62 Determination of Methyl Orange Alkalinity, "Alkalinity A"
- 6.63 Determination of Free Mineral Acidity

6.7 Miscellaneous Duties

- 6.71 Routine Readings
- 6.72 Miscellaneous Instructions
- 6.73 Periodic Equipment and Instrument Checks

6.1 Valve Nomenclature

6.11 Valve Nomenclature for Demineralizing Units

VALVE	FROM	TO
A	Filtered Water Line	Units
B	Strong Acid Measuring Crock	Dilute Acid Mix Tank
C	Filtered Water Inlet	Dilute Acid Mix Tank
D	Demineralized Water From Units	To Storage Tank
E	Filtered Water Flushout	Dilute Acid Line
F	Alkali Pump	Zeo-Karb H Unit (Recycling Rinse Line)
G	Zeo-Karb H and De-Acidite Units	Vent Valve
H	Zeo-Karb H Dilute Acid	Sample Valve
I	(Stock Cock) Multiport Via Jet	Zeo-Karb H Unit
J	Filtered Water Line	Alkali Mix Tank
K	Dilute Acid Tank Via Jet	Zeo-Karb Units
L	(Stop Cock) Dilute Acid Tank Via Jet	Zeo-Karb Units
M	Air Supply to Agitator	Dilute Acid Mix Tank
N	Strong Acid Cut-Off	Measuring Pots
T	Alkali Mix Tank	Pump Suction
U	Pump Suction from De-Acidite Units	Recycling Line
V	(Stop Cock) Alkali Pump Discharge	De-Acidite Units
W	Alkali Pump Cut Off	De-Acidite Units
X	Alkali Pump Discharge	Zeo-Karb Units Via Rate of Flow Indicator
1-S	*ZK* Brine and Rinse	Discharge to Sump
1-S	*ZK* Wash	Discharge to Sump
1-S	*DA* Brine and Rinse	Discharge to Sump
1-S	*DA* Wash	Discharge to Sump
2-S	*ZK* Brine and Rinse	Discharge to Sump
2-S	*ZK* Wash	Discharge to Sump
2-S	*DA* Brine and Rinse	Discharge to Sump
2-S	*DA* Wash	Discharge to Sump
#1-*DA* Sample		#2-*DA* Sample
#1-*ZK* Sample		#2-*ZK* Sample

6.12 Valve Nomenclature for Building Services

1	Units	Storage Tank
2	Units	Line Cut-off
3	Storage Tank	Line
4	Storage Tank	Line Check Valves

VALVE	FROM	TO
5	Storage Tank	Deaerator
6	Storage Tank	Deaerator
7	Deaerator	Booster Pump
8	Booster Pump	Line
9	Storage Tank	Booster Pump
10	Booster Pump	205 Bldg.
11	Booster Pump	105 Bldg.
12	Storage Tank	205 Bldg.
13	Demineralized Water	807 and 101 Bldg.
14	Storage Tank	Booster Pump
15	Storage Tank	Booster Pump
16	Storage Tank	105 Bldg.
17	Units	105 Bldg. Cut-off
18	Storage Tank	Mock-up Orifice
18-A	Storage Tank	Mock-up Bldg.
19	Chemical Cut-off	Mock-up Bldg.
20	Controller By-Pass	Mock-up Line
21	Storage Tank Resistance and *p*H	Mock-up Bldg.
22	Resistance and *p*H	205 Bldg.
23	Resistance and *p*H	105 Bldg.
24	Units Resistance and *p*H	Storage Tank
25	Demineralized Water	High Head Pump
25-A	High Head Pump	Storage Tank
26	High Head Pump	105 Bldg.
27	High Head By-Pass	105 Bldg.
28	Demineralized Water	101 Bldg.
29	Pressure Reducer By-Pass	105 Bldg.
30	Pressure Reducer Valve	105 Bldg.
31	Pressure Reducer Valve	105 Bldg.
32	Mock-up	*p*H Controller
33	Deaerator	Circulating Pump
34	Circulating Pump	Heat Exchanger
35	Heat Exchanger	Deaerator
36	#1 Units Cut-off	Storage Tank
37	#1 Units to Storage Tank By-Pass	#2 Units
38	#1 Units to Storage Tank By-Pass	#2 Units
39	Booster Pump	Pile Mock-up
40	H. H. Pump	Pile Mock-up

6.2 Solution Make-up

6.21 Dilute Sulphuric Acid

1. Put on safety glasses.
2. Add 26 in. (to indicator) of water to dilute acid tank.
3. Open Valve *M* enough to give a vigorous agitation.

4. Check to see that drain valve from strong acid measuring tank (Valve *B*) is closed.
5. Crack inlet valve on strong acid line to measuring tank (Valve *N*).
6. Add acid until liquid shows in saran tubing in vent line from measuring tank.
7. Close Valve *N*.
8. Open Valve *B*.
9. Agitate for five minutes.
10. Close Valve *B*.
11. Turn air off (Valve *M*).
12. NEVER ADD WATER TO ACID.

TABLE 6.21-1

Effect of Sulphuric Acid Concentration on Specific Gravity

SPECIFIC GRAVITY	H_2SO_4 (Percent)
1.0051	1.0
1.0118	2.0
1.0184	3.0
1.025	4.0

6.22 Soda Ash Solution

1. Add 24 in. (to indicator) of water to soda ash tank.
2. Start Mixer,
3. Put on goggles.
4. Add 50 lbs (1/2 sack) of soda ash to water in tank.
5. Agitate for 30 minutes.

6.23 Sodium Sulfite Make-up

1. Add 45 gal (15 in.) demineralized water to mix tank.
2. Add 1 lb of sodium sulfite and agitate manually until dissolved.

6.24. Sodium Dichromate

1. Rinse out mix tank on second floor.
2. Close outlet valve at bottom of tank.
3. Add 26.42 gallons or (15 in.) demineralized water.
4. Add 1-1/4 lb of sodium dichromate.
5. Turn on lightnin' mixer until all is dissolved.
6. Check to see that rubber hose is in right tank for filling dichromate head tank.
7. Open valve and drop solution by gravity to dichromate pump head tank.

6.25 Sodium Hydroxide

1. Rinse out mix tank on second floor level, (one mix tank is used for both sodium hydroxide and sodium dichromate make-up).
2. Add 26.42 gallons or (15 in.) demineralized water to mix tank.
3. Add 10 lbs of flake caustic and agitate until dissolved. (same procedure as sodium dichromate for adding to caustic pump head tank).

6.26 Refilling Strong Acid Head Tank

1. Sufficient acid should be available at the end of the day shift to last 24 hours.
2. Put on safety goggles and rubber gloves.
3. Check acid for specifications:
   (a) Specific Gravity - 1.82 ± .1
   (b) Color - Water White
   (c) Suspended Materials - None to very Slight

Check with supervision on off specification materials to be returned to stores

4. Check to see that valves in strong acid line to measuring pots are closed.
5. Close vent line from strong acid storage tank.
6. Put stainless steel hose in acid carboy.
7. Turn air to ejector on.
8. Watch level of storage tank sight glass stopping acid addition about 3/4 way full.
9. Turn air to ejector off.
10. Remove hose from carboy rinsing outer surface of hose, and allow to drip into drain.
11. Wash carboy immediately and tag empty.

6.3 Demineralization Operation

6.31 Operation of the Zeo-Karb H Unit

1. *Preliminary*

After passing through the Zeo-Karb H unit, the chlorides and sulfates will be transformed to HCl and H_2SO_4. The sum total of this free mineral acidity, expressed as $CaCO_3$, is referred to as the "FMA". This can be computed as 0.88 × ThMA, where ThMA is the Theoretical Mineral Acidity.

2. *Specifications*

   a. Capacity: 50,000 gallons in 23.4 hours based on water having a compensated cation content of 11.5 gpg. per U. S. gallons.

   b. Maximum flow rate of softening: 40 gal/min.

   c. Wash rate: 75 gal/min.

   d. Rinse rate: 50 gal/min.

   e. Acid required to regenerate unit: 108 lbs 66°Be. sulfuric acid, equivalent to acid in measuring device up to marker strip.

NOTE: Free chlorine and chlorine as chloramine should not exceed 0.2 gpg in influent water. A sulfite feed is used to remove excess chlorine by pumping in a 0.3% solution of sodium sulfite into the filtered water at 3 gph. This is sufficient for both units to operate simultaneously, and no effort is made to reduce the flow if only one demineralization unit is in use.

During the regeneration of the unit, while rinsing out the regenerating acid, the acidity of the effluent will be high and will gradually drop off until it reaches approximately the ThMA of the raw water. The softening run may be started *if the effluent is also free of hardness* as determined by soap test. During the course of the run, the FMA of the effluent should remain fairly constant in the 24-34 ppm range, and the run may be considered completed when the FMA drops off 10 ppm below average. Under these conditions, the effluent should be free from hardness throughout the run. However, the run should be terminated and the unit regenerated *if hardness* appears in the effluent, regardless of the FMA.

It is quite conceivable that the characteristics of the water supply will vary from time to time. When the chlorides and sulfates in the raw water vary, the FMA of the effluent of the Zeo-Karb H unit varies accordingly. In such cases, *the softening run should be terminated when the FMA of the effluent drops below* the mean (average) FMA during the middle of the run, or at the first sign of hardness in the effluent.

3. *Operation of Unit:*

ALWAYS ROTATE MULTIPORT VALVE IN THE DIRECTION INDICATED BY ARROWS

3a. *Softening:*

When unit is in service, multiport valve is kept in *soften* position. Open valve in air vent line from time to time during operation to relieve air from top of unit. When softening run of 50,000 gallons is completed or when capacity of unit is exhausted, as evidenced by FMA dropping about 10 ppm below average FMA of effleunt during softening run, or by the presence of hardness in effluent as shown by soap test, or rise in *p*H to 5 or above, the unit must be washed, regenerated, and rinsed.

3b. *Washing*

Turn multiport valve to *wash* and at the same time adjust the valve in wash outlet line to maintain water level in sump at upper marker (8-1/2 in. above center line of lower orifices) of orifice board, equivalent to washing at the rate of 75 gpm. Wash at this rate for approximately 10 minutes or until wash water is clear.

3c. *Regenerating*

After the acid has been added to the dilution water, slowly open Valve *M* on air supply for agitation and mixing. Agitate thoroughly for 5 minutes to insure a completely uniform dilute acid solution.

Turn multiport valve to *brine*. Open Valve *K* and Cocks *I* and *L*. As the acid ejected into the unit must be diluted to approximately 2%, regulate Cock *I* so that 271 gallons of water pass through the meter in 17 minutes. Regulate Cock *L* so that the dilute acid is introduced into the unit in the same period of time. Once Cocks *I* and *L* are set, their adjustment should not be disturbed. Table 6.21-1 gives density of sulfuric versus percent sulfuric acid to check the concentration of regenerating solution. Adjust Cocks *I* and *L* to maintain the 2% solution of sulfuric.

After all the acid has been ejected, open Valve *E* on flushout line for approximately 30 seconds, so that any acid remaining in lines will be flushed out.

Then close Valves *E* and *K*.

3d. *Rinsing*

Turn multiport valve to *rinse*. Adjust valve of rinse outlet line to maintain water level in sump at lower marker (3-3/4 in. above center line of lower orifices) of orifice board, equivalent to rinsing at rate of 50 gpm.

Rinse at this rate for approximately 40 minutes or until the FMA drops 10 ppm above the average FMA for the previous run and *the rinse water is free of hardness as shown by soap test.*

Turn multiport valve to *soften.* The unit is back in service.

6.32 Operation of the De-Acidite Unit

1. *Preliminary*

THIS UNIT MUST BE OPERATED ONLY ON THE ACID EFFLUENT OF ZEO-KARB H UNIT, WHICH EFFLUENT MUST BE FREE OF CALCIUM AND MAGNESIUM.

2. *Specifications*

A. Capacity: 120,000 gallons in 48.1 hours based on a Theoretical Mineral Acidity (ThMA) content of 2.6 grains per U. S. gallon.

NOTE: The capacity of the De-Acidite Unit is approximately 2 times the capacity of the Zeo-Karb H Unit. Therefore the De-Acidite Unit is regenerated every second time the Zeo-Karb H Unit is regenerated.

B. Maximum flow rate in service: 40 gallons per minute.

C. Wash rate: 40 gallons per minute.

D. Rinse rate: 16 gallons per minute.

E. Re-cycling rinse rate: 32 gallons per minute.

F. Alkali required to regenerate unit: See "Making up Alkali Solution".

3. *Operating Unit*

ALWAYS ROTATE MULTIPORT VALVE IN THE DIRECTION INDICATED BY ARROW.

3a. *In Service*

When unit is in service, the multiport valve is kept in the *soften* position. Open Valve *G* in air vent line from time to time during operation to relieve air from top of unit.

During softening run, Valve *D* is to be set for a flow rate of 40 gpm.

As the capacity of the unit is approximately double the capacity of the Zeo-Karb H unit, it will be regenerated every other time the Zeo-Karb H unit is regenerated. When both units are to be regenerated, regenerate the Zeo-Karb H unit *first* and then the De-Acidite unit. The De-Acidite unit should be regenerated only if the Zeo-Karb H unit has had less than 50,000 gallons put through it since the last Zeo-Karb regeneration. If more than 50,000 gallons have been put through the Zeo-Karb, regenerate it before regenerating the De-Acidite unit.

3b. *Washing*

When the unit has become exhausted as indicated by the solu-bridge run endpoint indicator the unit must be washed, regenerated, and rinsed.

Rotate multiport valve to *wash* position and at the same time adjust vavle on wash outlet line to maintain water level in sump at marker (9 in. above center line of lower orifices) of orifice board, equivalent to washing at a rate of 40 gpm. Wash at this rate from 5 to 10 minutes or longer if necessary to obtain clear effluent water.

3c. *Regenerating*

Close Valve *A* and turn multiport valve of De-Acidite unit to *brine*. Open Valve *W*. Open Valve *T* in suction of alkali pump and start pump. Open Cock *V* in pump discharge line and pump alkali regenerating solution (part 2, this section) into the unit. Cock *V* is set to empty alkali solution tank in approximately 10 minutes. When all the solution has been introduced into unit, close Valves *W* and *T*. Cock *V* is to be left set for subsequent regenerations. Stop pump.

3d. *Rinse to Waste*

Turn multiport valve of De-Acidite unit to *rinse*. Adjust valve in rinse outlet line to maintain water level in sump at lower marker (2 in. above centerline of lower orifices) of orifice board, equivalent to a rinsing rate of 16 gpm.

The rinse time is to be determined in the field by the solu-bridge indicator. Rinsing to waste is to be considered complete when the solu-bridge reads 8 gpg, indicating that the total dissolved solids in the rinse effluent are equal to or less than that of the raw water. At this point the re-cycling rinse is to be started.

With the multiport valve of the Zeo-Karb H unit in *soften* position and multiport valve of De-Acidite unit in *soften* position close Valve *A*, open Valve *U* on alkali pump suction line, open valve *F* on Zeo-Karb H unit. Start pump and adjust Valve *X* to give 32 gpm on rate of flow indicator.

Continue recycling until total dissolved solids drop to 0.2 gpg as NaCl as indicated by Solu-Bridge reading. The alkalinity should be checked at this point. Take sample of recycling rinse water from pet cock on pump casing. If alkalinity is 6 ppm or less and total dissolved solids 10 ppm, recycling may be considered complete. Close Valves *U*, *X*, and *F*, and stop alkali pump and open Valve *A*.

With *ZK* multiport in *soften* position and *DA* multiport in rinse position, rinse both units until the effluent is water white and has a resistance above 100,000 ohms.

6.33 Preparation of Units for Reuse

1. If the units have not been used for one hour, they must be rinsed to avoid colored poor quality (sour) water from entering the system.
2. Rinse the *ZK* unit until the FMA is within ten ppm above the average during previous time it was used.
3. Rinse the *DA* unit until the effluent has a resistance above 100,000 ohms and is water white and checking to be sure all water analysis meet specifications.
4. Put unit on line.

6.4 Operation of the Deaerator

6.41 Starting Deaerator

1. Check water level in sump on first floor; the tail pipes from ejectors and deaerator overflow line are water sealed.
2. Open Valves #5 and #6 on inlet to deaerator.
3. Start recirculating pump and adjust flow 50-75 gal/min by opening valve #33 on suction side of pump.
4. Check to see that the Brown Electronik Potentiometer has 20 pound air supply.
5. Open drain valve and steam trap by-pass blowing out all steam condensates.
6. Close both steam drain and trap by-pass valves.
7. Set Brown Electronik Potentiometer at 50°C = 122°F.
8. Check to see temperature controller is working properly.
9. Proceed to third floor.
10. Check to see that air supply pressure on Fisher Level-Trol is approximately 20 psi.
11. Proceed to top floor.
12. Check to see that air supply pressure to Taylor Fulscope Controller is approximately 20 psi.
13. Check to see that valve in emergency vacuum relief line is closed.
14. Check to see that valve in automatic vacuum relief line is open.
15. Crack valves in cooling water lines to intercondensers.

16. Check to see that steam pressure is 90 to 125 pounds.
17. Check to see that steam to strainer is dry.
18. Open the steam valve to second ejector (smallest one).
19. Check to see that tail pipe from second ejector is hot; if not, adjust cooling water to keep tail pipe hot.
20. Set Taylor Controller to desired vacuum (approximately 26 in.).
21. When gauge on second stage shows 10 in., open steam valve to first stage ejector (middle ejector).
22. When gauge on first stage shows approximately 15 in., open steam valve to booster ejector (large one).
23. Check to see that Taylor Controller is operating correctly.
24. Check to see that the tail pipe from inter-condenser is not more than slightly warm. If so, open cooling water valve until temperature lowers. Too much cooling water should not be used because of flooding the condensers and causing inefficient operations.
25. After descending to first floor, open valve on discharge of booster pump #8, open valve to 205 (#10), or if desired, valve to 105 (#11).
26. Start up booster pump and open valve from deaerator to booster pump #7.
27. Close valve from storage tank to 205 Building (Valve #12), and if deaerated water is desired in 105 Building, open Valve #11 and close Valves #14, #15, and #16.
28. After water is being taken from the deaerator, check to see that the level controller is working properly. The level should be maintained about 3/4 of the way up the sight glass.
29. The booster pump may be operated when deaerator is down if so desired by opening Valves #9, #14, and #15 on suction side of pump and Valve #8 on discharge side. The direction of flow is to be governed by Valve #10 to 205 Bldg. and Valve #11 to 105 Bldg.
30. If booster pump is desired on 105 line, check that Valve #16, booster pump by-pass to 105, is closed.

6.42 Shutting Deaerator Down

1. If water is being taken from deaerator the by-pass valves should be opened (Valves #14, #15, #16 for 105 line and Valve #12 for 205 line). The booster pump inlet Valve #7 and outlet Valve #8 should be closed and pump stopped in this order before shutting down deaerator.
2. Shut off steam to circulating heat exchanger and open trap by-pass.

3. Shut off steam to booster ejector (large one).
4. Shut off steam to first ejector (intercondenser).
5. Shut off steam to second ejector (small one).
6. Shut off cooling water to both intercondenser and second stage ejector.
7. Open emergency vacuum relief valve.
8. Stop recirculating pump.
9. Close inlet Valves #5 and #6 to deaerator.

6.5 Distribution Operation

6.51 Operation of the High Head Pump

Starting

1. Check to see that the pressure reducer instrument has 18 - 20 pound air pressure.
2. Check to see that both Valves #30 and #31, before and after reducer valve, are open.
3. Close Valve #29, pressure reducer by-pass to 105 Bldg.
4. Check to see that high head pump by-pass to 105 is open.
5. Close Valve #26, high head pump to 105 Bldg.
6. Open Valve #25 on suction side of high head pump.
7. Open Valve 25A, high head pump to storage tank.
8. Throw high head pump wall switch on.
9. Push button to start motor.
10. Slowly open high head pump to 105 (Valve #26), closing high head pump to storage tank (Valve #25) at the same time to get required pressure and flow.
11. Close high head pump to 105 Bldg.; by-pass Valve #27.
12. Check to see that Leslie controller instrument is working properly; if not, have maintenance adjust.
13. Check pump bearings frequently. If flow of water is cut below 25 gpm, open valve to storage tank relieving enough pressure to prevent heating. Also water may be used to cool bearings.

Stopping

1. Throw main switch on wall to off position.
2. Open high head pump to 105, by-pass Valve #27.
3. Close high head pump to storage tank, Valve #25A.
4. Open pressure reducer by-pass to 105, Valve #29.

5. Close line to high head pump, Valve 25.
6. Valve #26 may be left open for use of other outlets in building.

6.52 Controlling Water Specifications to the Pile Mock-up

Controlling *p*H from 6.0 to 6.5 and sodium dichromate at 5.0 ± 0.5 ppm.

Starting Flow

1. Check to see that the proportioneer head tanks have sufficient chemicals for start up. If not, proceed to second floor laboratory where chemical mix tank is located and make up chemicals needed (see chemical make-up).
2. Check to see that the air pressure on Micromax *p*H controller is 18 pounds.
3. Check to see that the valves preceding and after controller are open.
4. Check to see that controller by-pass is closed, Valve #20.
5. Check to see that controller valve is open.
6. Open chemical cut-off Valve #19.
7. Check to see that storage tank to orifice, Valve #18, is open.
8. Check to see that Valve #32 to *p*H controller electrode box is open (small flow is sufficient).
9. Check to see that the sodium hydroxide pump is set at maximum stroke. The caustic pump has an 80 pound popoff valve with return line to head tank. This gives an even flow through the controller valve.
10. Check and set sodium dichromate pump (2.6 cc/min × actual reading on chart). See pump calibration for correct setting, Table 6.52-1.
11. Push starter button on caustic pump.
12. Push starter button on dichromate pump.
13. Open and adjust Valve #18-A to desired flow rate in gallons per minute. By the use of Table 6.52-1 and the Hillige colorimeter adjust the $Na_2Cr_2O_7$ pump to result in the water to the Mock-up being 5 ± 0.5 ppm in $Na_2Cr_2O_7$.
14. Check *p*H and $Na_2Cr_2O_7$ content of the water hourly adjusting when necessary.

Stopping Flow

1. Push stop button on caustic pump.
2. Push stop button on dichromate pump.
3. Close chemical cut-off Valve #19.
4. Close Valve #18-A.

TABLE 6.52-1

Chemical Make-Up for Mock-Up Demineralized Water

Based on 100 liter make-up.
10# NaOH to 15 inches water in make-up tank.
1-1/4# $Na_2Cr_2O_7$ to 15 inches water in make-up tank.
For approximate $Na_2Cr_2O_7$ pump setting (actual flow on chart × 2.6 cc/min) set proportioneer pump to required stroke.

Proportioneer Pump Calibrations:

NaOH PUMP		$Na_2Cr_2O_7$ PUMP	
PUMP SETTING	cc/min	PUMP SETTING	cc/min
1	16	1	23
2	42	2	48
3	68	3	74
4	93	4	99
5	116	5	125
6	142	6	150
7	167	7	176
8	191	8	200
9	221	9	225
10	241	10	248

6.6 Water Analyses

6.61 Boutron and Boudet Soap Test

Apparatus	*Reagents*
1 - 40 ml shaking bottle	1/2 pint Boutron and Boudet soap solution
1 - dropper bottle for soap solution	

PROCEDURE

1. Measure out 40 ml of softened water into the shaking bottle.
2. Add soap solution dropwise from the dropper bottle.
3. The bottle should be shaken vigorously after the addition of each drop. If lather forms, the bottle should be placed on its side. A "permanent lather" indicates the true end point is obtained when the lather covers the entire liquid surface and persists for at least 5 minutes.
4. The number of drops required to obtain a "permanent lather" is an indication of the hardness of the water being tested.
5. This method is generally used for testing the hardness of zeolite softener effluents. Where the water to be tested is the effluent from a salt regenerated softener, the method is used as outlined above. Where the water to be tested is the effluent from an acid regenerated zeolite the sample must be neutralized as follows: To a 50 ml sample of the water add 2 or 3 drops of phenophthalein indicator. Then add sodium hydroxide solution cautiously from a burette, with constant stirring, until a faint pink color appears. Then measure out 40 ml of this neutralized water and proceed as in 1-4 above.

6.62 Determination of Methyl Orange Alkalinity, "Alkalinity A"

Apparatus	*Reagents*
1 - 10 ml automatic burette	1 qt. N/50 sulfuric acid
1 - 100 ml graduated cylinder	1 - 4 oz. methyl orange indicator (in dropping bottle) (0.05%)
1 - porcelain dish, 5 in. diameter	
3 - glass stirring rods, 6 in. long	

PROCEDURE

1. Place a 100 ml sample of water, measured in a glass cylinder, into a clean porcelain evaporating dish.
2. Add two to three drops of the methyl orange indicator.

3. Fill the burette with the N/50 sulfuric acid solution to the zero mark.

4. Add this solution cautiously from the burette with constant stirring until the color changes from yellow to the faintest pink discernible.

5. Every one-tenth of a ml of the sulfuric acid solution added is equivalent to one ppm of methyl orange alkalinity expressed as $CaCO_3$ or:

MO Alk. = ppm methyl orange alkalinity expressed as $CaCO_3$

MO Alk. = 10 × (ml of sulfuric acid solution added).

6.63 Determination of Free Mineral Acidity

Apparatus

1 - 10 ml automatic burette

1 - 100 ml graduated cylinder

1 - porcelain dish, 5 in. diameter

3 - glass stirring rods, 6 in. long

Reagents

1 qt. N/50 sodium carbonate solution

4 oz. methyl-orange indicator (in dropping bottle)

PROCEDURE

1. Place 100 ml sample of the water (measured in a graduated glass cylinder) in a clean porcelain evaporating dish.

2. Add 2 or 3 drops of methyl orange indicator.

3. Fill the burette with the N/50 sodium carbonate solution to the zero mark.

4. Add the sodium carbonate solution cautiously from the burette with constant stirring, until the faint pink color disappears and changes to a faint yellow color.

5. Each ml of sodium carbonate added is equivalent to 10 ppm of free mineral acidity, expressed as calcium carbonate.

FMA = ppm free mineral acidity, expressed as $CaCO_3$.

FMA = 10 × ml sodium carbonate added.

6.7 Miscellaneous Duties

6.71 Routine Readings

Instructions See (Permutit Tests #1, #8, and #13)

A. *Tests* (NOTE: "Water Treatment Plant Daily Log" example sheets)

1. Free mineral acidity (FMA), soap hardness, and *p*H of Zeo-Karb H units are to be taken hourly when units are on line.

2. Methyl orange alkalinity (MO), *p*H Solu-Bridge conductivity, and resistance by portable meter are to be taken hourly from the De-Acidite effluent when units are on line.

3. Methyl orange alkalinity of filtered water is to be taken once each shift.

4. Deaerator readings are to be taken every two hours.

B. *Log Sheet Information of Regenerations*

Both Zeo-Karb H and De-Acidite units are run until they are nearly exhausted as determined by chemical analyses. As an operational aid records are kept to estimate the expected run of each unit. The approximate conservation run of the Zeo-Karb H units (under present water conditions) is 50,000 gallons with all the water to Zeo-Karb H and De-Acidite units passing through one crest meter on the inlet to the Zeo-Karb H unit.

The record for the units is kept on the following form which is made out complete whenever a unit is regenerated.

Example

B. *Log Sheet Information*

	Zeo-Karb	De-Acidite
Date on		
Time on		
Meter Reading On	3,162,000 (1)	3,052,600 (6)
Expected Run (A)	58,550 (2)	135,500 (7)
Meter Reading Off	3,220,550 (3)	3,188,100 (8)
D-A Cumulative (B)	109,400 (4)	
A plus B	167,950 (5)	
Free Mineral Acidity	25 (9)	
Filtered Water MO	100 (10)	
Total	125 (11)	

NOTE: If A plus B exceeds expected run of *DA*, calculate *DA*. Meter Reading off; otherwise leave blank.

The following numbers refer to similar numbers shown on form above:

(1) This is meter reading at end of regeneration of *ZK*.

(2) This is expected run of *ZK* unit and is found by taking the sum of FMA. (9) and filtered water MO (10) which is 125 (11) on above form and looking up in Table 6.71-1 and obtaining the capacity of *ZK*.

(3) This is the sum of (1) and (2).

(4) This is the amount of water that has passed through the *DA* unit up until this time (since last regeneration). (1) minus (6).

(5) The sum of A plus B or (2) plus (4). This figure would give the new *DA* cumulative at the end of this run except where it is in excess of the expected run on *DA*. (As it is in the figure above).

(6) This is the meter reading at end of last regeneration of *DA*.

(7) This is expected run of *DA* unit and is found by taking the FMA (9) of *ZK* effluent and looking in Table 6.71 and obtaining the *DA* unit capacity.

(8) This is the meter reading at end of run on *DA* unit. Since A plus B is greater than the expected run of *DA*, you have to calculate the *DA* meter reading off (see note on bottom of form). To do this, subtract the *DA* cumulative (4) from the *DA* expected run (7). This gives 135,500 - 109,400 = 26,100 gallons that can still be put through the *DA* unit. At present the meter reading is 3,162,000 (1) which when you add 26,100 becomes 3,188,100 (8) or is the meter reading at the end of run on the *DA* unit.

6.72 Miscellaneous Instructions

1. Wash and rinse discharge valves should be open when units are on soften position and closed only when water header is turned off bldg. to prevent leaking of multiports.
2. Multiports should be turned *forward only* to prevent stripping rubber lining on the inside.
3. When the soda ash brine is being added to the *DA* unit the filtered water header to the unit should be closed. This is to take header pressure off the small brine pump. After the brine is all in open the header for rinsing purposes and then close it as usual for the recycling step.
4. Unit that is to go on the line and has stood for one hour *is to be rinsed.* Rinse the *ZK* unit first for 10 minutes and check the water for FMA and clarity to make sure all soured water is out of the tank. Rinse *DA* until it is ready to go on line. The resistance should be held between 90,000 and 190,000 ohms and a *p*H of 4.4 to 5.0 of the demineralized water.
5. Every Monday grease multiports with multiport grease. Gun to be loaded with this grease and applied through the grease cocks in rear of each multiport.

6.73 Periodic Equipment and Instrument Checks

1. *Hourly and/or Daily.* Record the routine readings as listed under 6.71.
2. *Semi-Monthly.* Check the calibration of the pen on the four Bailey Flow Meters using stop watch and portable scale tank.

TABLE 6.71-1

Expected Capacity of *ZK* and *DA* Units

(These ratings are conservative and should be used for estimating purposes only; not for determining operation.)

FILTERED WATER MO PLUS FMA (ppm)	CAPACITY OF ZEO-KARB H (gals.)	FMA (ppm)	CAPACITY OF DE-ACIDITE (gals.)
100	73,500	10	337,500
102	71,800	12	280,000
104	70,400	14	240,500
106	69,150	16	210,500
108	67,900	18	186,300
110	66,500	20	168,200
112	65,400	22	153,000
114	64,200	24	141,000
116	63,100	26	130,000
118	62,000	28	120,400
120	61,000	30	112,700
122	60,050	32	105,400
124	59,000	34	99,300
126	58,100	36	93,800
128	57,200	38	88,700
130	56,300	40	84,200
132	55,400	42	80,400
134	54,700	44	76,600
136	53,900	46	73,400
138	53,100	48	70,200
140	52,200	50	67,600
142	51,600	52	65,300
144	50,900	54	62,400
146	50,200	56	60,100
148	49,600	58	58,200
150	48,800	60	56,300
152	48,200		
154	47,600		
156	47,000		

OAK RIDGE NATIONAL LABORATORY

Water Treatment Plant Daily Log
Sheet 1

Date ____________________

TIME	STORAGE LL	ZK EFFLUENT				DA EFFLUENT							
		NO. 1		NO. 2		NO. 1				NO. 2			
		FMA	SOAP HARD	FMA	SOAP HARD	MO	pH	SOLU-BRIDGE	RESISTANCE	MO	pH	SOLU-BRIDGE	RESISTANCE
12 MM													
1 AM													
2 AM													
3 AM													
4 AM													
5 AM													
6 AM													
7 AM													
8 AM													
9 AM													
10 AM													
11 AM													
12 N													
1 PM													
2 PM													
3 PM													
4 PM													
5 PM													
6 PM													
7 PM													
8 PM													
9 PM													
10 PM													
11 PM													

OAK RIDGE NATIONAL LABORATORY

Water Treatment Plant Daily Log

Sheet 2

Date ____________

Shift	12 to 8	8 to 4	4 to 12
Filtered Water MO			
Carboys Acid on Hand			
Bags Soda Ash on Hand			

Deaerator Check

LEVEL	TEMPERATURE	RESISTANCE 30°C	pH	VACUUM			FLOW	BOOSTER PUMP ON
				1	2	3		
1 AM								
3 AM								
5 AM								
7 AM								
9 AM								
11 AM								
1 PM								
3 PM								
5 PM								
7 PM								
9 PM								
11 PM								

Estimated Gallons Left in Unit

UNIT	1 AM	9 AM	5 PM
No. 1 *ZK*			
No. 1 *DA*			
No. 2 *ZK*			
No. 2 *DA*			
Operator			

An error greater than ± 5% should be reported to the Instrument Maintenance Section in Building 105. These tests should be started on Monday of every other week, beginning with the Bailey to Building 105. Check to make sure that no water will be needed or used during the check.

3. *Monthly.* Make out the monthly water inventory as of 0000 on the 1st of each month. In compiling this inventory, note that the Bailey integrators are within reasonable range.
4. *Annually.* Inspect resin beds in the units determining condition and necessity of addition and/or replacement of the resins.

7.0 RAW MATERIALS

Chemicals are the only raw materials used in Building 807 operations. Following is a listing of the chemicals along with their uses and specifications.

7.1 Sulfuric Acid (H_2SO_4)

Baume technical grade (66°) sulfuric acid is used in regenerating the Zeo-Karb H units. One hundred eight (108) lbs of acid is used per regeneration resulting in an average consumption of 3 lbs/1000 gal of demineralized water. The acid is transferred to the acid storage tank from carboys by vacuum and is then dropped by gravity to either of the acid measuring crocks as needed.

The analysis of technical 66° Baume sulfuric acid, as listed by the manufacturer, is as follows:

Sulfuric (H_2SO_4) = 93.2% minimum
Freezing Point = 29°F - below zero
Non-Volatile Matter = 0.0005%
Chlorine (Cl) = 0.006%
Nitrates (NO_3) = 0.0002%
Ammonia (NH_4) = 0.0003%
Sulfite (SO_2) = 0.0005%
Arsenic (As) = 0.000003%
Heavy Metals as Pb = 0.0005%
Heavy Metals as Fe - 0.0001%

7.2 Soda Ash (Na_2CO_3)

Soda Ash (99-100%) with 58% available sodium oxide is used in regenerating the De-Acidite units. Fifty (50) lbs of soda ash is required per regenerating resulting in an average consumption of approximately 3/4 lbs/1000 gal of demineralized water. The soda ash is obtained in 100 pound sacks and is transferred to the make-up tank by hand.

The analysis of the soda ash, as listed by the manufacturer, is as follows:

Sodium Carbonate (Na_2CO_3) - 99-100%
Sodium Oxide (Na_2O) - 58%
Insoluble matter - 0.01%
Moisture - 1.0%
Chlorine (Cl) - 0.003%
Phosphate (PO_4) - 0.002%
NH_4OH ppt. - 0.015%

Silica (SiO_2) - 0.005%
Sulphates (SO_4) - 0.004%
Aluminum (Al) - 0.002%
Arsenic (As) - 0.0001%
Lead (Pb) - 0.0005%
Iron (Fe) - 0.0005%
Potassium (K) - 0.02%

7.3 Sodium Sulfite (Na_2SO_3)

As explained previously, the excess chlorine in the filtered feed water is removed by sodium sulfite addition to the water prior to its entry into the Zeo-Karb H unit. One pound of sodium sulfite per 45 gal of solution is used for each make-up resulting in an average weekly consumption of approximately seven pounds of sodium sulfite. It is obtained in 100 pound sacks from the Power House supply.

The analysis of the commercial sodium sulfite, as listed by the manufacturer, is as follows:

Sodium Sulfite (Na_2SO_3) - 93% minimum
Insoluble Matter - 0.01%
Free Acid - no reaction
Free Alkali (Na_2CO_3) - 0.25%
Chlorine (Cl) - 0.02%
Thiosulfate (S_2O_7) - no reaction
Arsenic (As) - 0.0002%
Heavy Metals as Pb - 0.002%
Iron (Fe) - 0.001%

7.4 Flake Caustic (NaOH)

Demineralized water to the Mock-up is adjusted to a pH of 6.0 - 6.5 by addition of a caustic solution. The caustic solution is made up in a make-up tank located in the second floor laboratory and dropped by gravity to the pump head tank. Ten pounds of flake caustic per 100 liters of water is required per make-up resulting in a consumption of 8 pounds caustic per 24 hours when the flow of water to the mock-up is 25 gpm.

The analysis of the commercial flake caustic, as listed by the manufacturer is as follows:

Sodium Hydroxide (NaOH) - 96-98%
Sodium Oxide (Na_2O) - 76%
Sodium Carbonate (Na_2CO_3)
Chlorine (Cl) - 0.01%
Sulfate (SO_4) - 0.005%
Phosphate (PO_4) - 0.005%
Silica and Ammonia
ppt. (SiO_2 and NH_4OH) - 0.02%
Nitrogen (N) - 0.001%
Iron (Fe) - 0.002%
Silver (Ag) - 0.003%

7.5 Sodium Dichromate ($Na_2Cr_2O_7$)

A solution of commercial sodium dichromate is added to the demineralized water to the Mock-up at a rate to give 5 ± 0.5 ppm of color as determined by comparison on a colorimeter. The dichromate is made up in the second floor laboratory and dropped by gravity to the correct pump head tank. One and one-fourth pounds of dichromate per 100 liters of water is used for each make-up resulting in a consumption of one pound of dichromate per 24 hours when the flow of water to the Mock-up is 25 gpm.

The analysis of the Technical Sodium Dichromate, as listed by the manufacturers, is as follows:

Sodium dichromate ($Na_2Cr_2O_7$)	- 98-99%
Insoluble Matter	- 0.01%
Chlorine (Cl)	- 0.005%
Sulfate (SO_4)	- 0.03%
Aluminum (Al)	- 0.02%
Calcium (Ca)	- 0.005%

8.0 SAFETY RULES

8.1 Sulfuric Acid

Sulfuric acid is both an oxidizing and a dehydrating acid and will cause severe burns upon contacting the skin. While working with acid, face shields, goggles, rubber gloves, and standard protective clothing should be worn. In case of any large spill on the person, use of the safety shower should be made as quickly as possible. No gloves, face shield, etc., should be removed until after the outside surfaces are clean. For small drops of acid on the clothing or skin, wash with a large amount of water. Quick use of water will prevent the acid from eating through clothing onto the skin.

8.2 Soda Ash

The soda ash used in 807 is a fine powder and will be picked up by the air while it is being dumped into the make-up tanks. This is quite irritating to the nose and throat and respirators may be used to eliminate this irritation.

Gloves and goggles should be worn while making up regenerating solutions to prevent any soda ash solution from splashing into the eyes or getting on the hands.

8.3 Caustic

Flake caustic acts as a dehydrating agent and will cause severe burns when coming into contact with the skin. Caustic is exothermic when it is being dissolved, giving off considerable heat. Hot concentrated caustic solutions are especially severe on the skin. Dilute and concentrated solutions of caustic cause a slick, soapy feeling on the skin which will dry and cause the skin to become hard and cracked.

Face shields and rubber gloves should be worn while working with either flake caustic or strong caustic solutions. Use of a safety shower should be made as quickly as possible after any spill of caustic on the person.

8.4 Sodium Dichromate

Solutions of dichromate are somewhat dehydrating in that they tend to dry the skin upon contact. Both the solid dichromate and solutions stain the skin and are extremely difficult to remove. Gloves should be worn while working with dichromate.

8.5 Sodium Sulfite

Normal safety precautions should be used when handling either the solid or solutions of sodium sulfite. Care should be taken to prevent solutions from splashing into the eyes or mouth.

9.0 MISCELLANEOUS MAINTENANCE ITEMS

9.1 Demineralization Unit Repacking

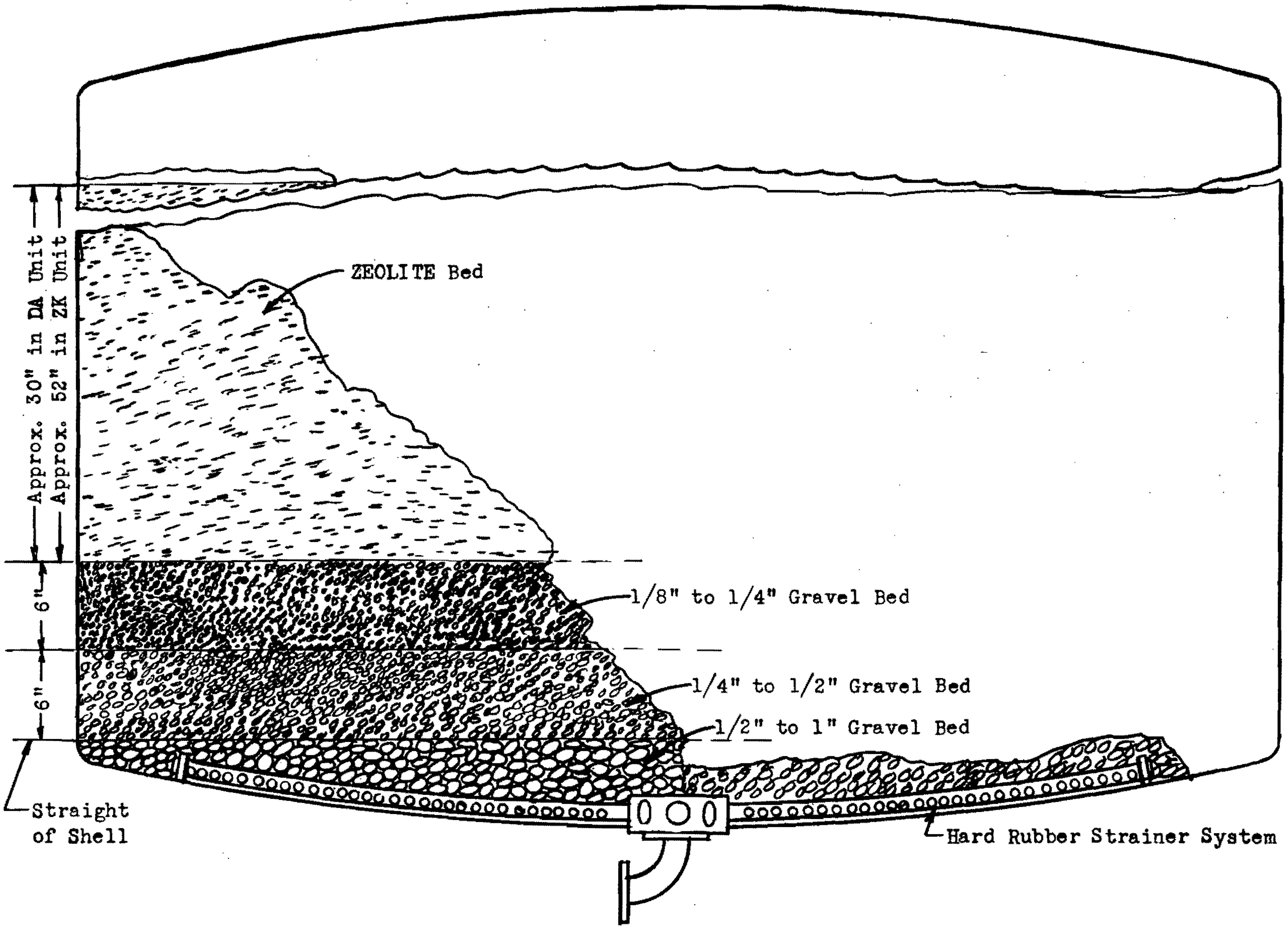
In March, 1947, operation of the Demineralizing Plant in Building 807 was transferred from the Power Department to the Pilot Plants Section of the Technical Division. The units were operated as received, using the original resins, until March, 1949, when it became increasingly evident that demineralized water could not be supplied to meet the anticipated demand for quality and quantity. During this two year period, however, several improvements were made to increase the quality of the water, efficiency of the units, and standardization of operations. New instruments were installed for recording flows, *p*H, resistance, etc., and the original instruments and equipment were checked for accuracy and operation. The final instrumentation of the building was completed as of November, 1949, and the final equipment repair completed as of October, 1949.

In March, 1949, the units were inspected to determine the condition of the resins. Inspection showed the resin to have been attacked severely by the free chlorine while the De-Acidite resin was worn out. Samples from each exchanger were submitted to the Permutit Company for analysis and upon their recommendations the old resin was discarded and replaced with completely new Zeo-Karb H and/or De-Acidite resins.

The units were replaced during a slack demand period with one set of units refilled at a time. This was done in order to supply a minimum water supply to the service buildings. Figure 9.1-1 shows the lower section of bed for the Zeo-Karb H unit as an example of the method of filling a unit.

Following is the list of material used in replacing the units:

Zeo-Karb Units	
½ in. × 1 in. gravel	580 lbs/two units
¼ in. × ½ in. gravel	1260 lbs/two units
1/8 in. × ¼ in. gravel	1260 lbs/two units
Zero-Karb H Resins	105.0 cubic ft/two units



Dwg. 9485
Figure 9.1-1

LOWER SECTION

ZEO-KARB & DE ACIDITE

UNITS

De-Acidite Units	
1 in. × 1½ in. gravel	240 lbs/two units
½ in. × 1 in. gravel	380 lbs/two units
¼ in. × ½ in. gravel	380 lbs/two units
1/8 in. × ¼ in. gravel	620 lbs/two units
De-Acidite Resins	34 cubic ft/two units

9.2 807 Building Spare Parts

Given below is a list of spare parts:

9.21 Spare Parts for Demineralization Units

Item No.	Description	Minimum	Maximum
	ZK Unit Spare Parts		
66-840	Gasket, Port Valve, F/2 ½ in., Multiport Valve (Partially lined).	6	10
67-105	Assembly, Slide F/2 ½ in. non-convertible partially lined Multiport Valve.	2	4
67-106	Plate, Port, F/2 ½ in. non-convertible partially lined Multiport Valve.	2	4
	DA Unit Spare Parts		
66-841	Gasket, Port Valve, F/2 ½ in. Multiport Valve (Completely lined).	6	10
67-103	Assembly, Slide, F/2 ½ in. non-convertible completely rubber lined Multiport Valve	2	4
67-104	Plate, Port, F/2 ½ in. non-convertible completely lined Multiport Valve	2	4
	General Spare Parts		
66-603	Spring, Slide F/Multiport Valve	2	4
66-605	Screw, Port Plate (Multiport Single Valve)	2	4
67-11	Cement, Rubber F/water softener	2	4

9.22 Spare Parts for Distribution System

Weil Centrifugal Pump

Item No.	Description	Minimum	Maximum
66-870	Rings, Wearing (1st and 2nd stage) F/Weil EM-2 in. SS pump	3	3
66-871	Rings, Wearing (2nd stage back) F/Weil EM-2 in. SS pump	1	1
66-872	Rings, Wearing (casting and suction side) F/Weil EM-2 in. SS pump	1	1
66-873	Rings, Wearing (between stages) F/Weil EM-2 in. SS pump	1	1
66-874	Sleeves, Shaft, F/Weil EM-2 in. SS pump	2	4
66-875	Collar, Packing, F/Weil EM-2 in. SS pump	2	2
66-876	Ring, Water Seal, F/Weil EM-2 in. SS pump	1	2
66-877	Packing Gland (sets) F/Weil EM-2 in. SS pump	2	2
66-878	Ball Bearings, F/Weil EM-2 in. SS pump	2	2
99-342	Weil EM-2 in. SS High Head Pump	1	1
66-664	Marlin Rockwell bearings, F/Weil EM-2 in. SS pump	0	1

Pump

Item No.	Description	Minimum	Maximum
66-1022	Pump, Centrifugal SS (not included base or motor) to duplicate existing Durco pumps of serial numbers 6563 and 6562 (In K-6 warehouse)	1	1

Milton Roy Pump

Item No.	Description	Minimum	Maximum
66-10	Valve, complete assembly F/MR	1	1

Proportioneer Pump

Item No.	Description	Minimum	Maximum
72-87	Reagent and Packing F/Proportioneer Pump	3	6
72-88	Rings, Lantern, F/Proportioneer Pumps	2	3
72-89	Check Valve, Seats and Balls, F/Proportioneer Pumps	2	3

Item No.	Description	Minimum	Maximum
	Miscellaneous		
67-107	Elbow, 4 in. 90°, Rubber lined flanged F/Permutit Units	2	3
67-108	Reducer, 4 in. × 3 in., Rubber lined, flanged Wallace and Tierman F/O_2 and CO_2	0	1
67-12	Controller, wide range L.L., Fisher Gas Co.	0	1
66-1023	Hose SS, Type 316 Flexible with Braided Cover, 5/8 in. ID with ½ IPS	3	6
66-1024	Control Pilot for Leslie Controller, Type PDA, pressure range 100-200 psi	0	1
72-90	Burette, 25-0 ml, automatic	3	6

10.0 DRAWING LIST

10.1 Permutit Drawings

Given below is a list of the major portion of the present Permutit Company drawings which pertain to the 807 Building and equipment. Listing is subdivided according to equipment.

10.11 807 Building

Drawing	Description
J 3079-1	Layout - Zeo-Karb H and De-Acidite Unit
G 6872	Foundation and Sump Details
G 6892	Flow Diagram
J 3159-5	Flow Diagram
B 14130	Assembly of Jack Legs
K 1570-4	Plan Layout (1st floor) pumps, exchangers, etc.
J 3209	
K 1563-4	Elevation-Section *A-A* (4 floors)
K 1578-2	Elevations-Section *D-D*, *E-E*, *F-F*, (1st floor) Section *G-G*, (4th floor)
K 1571-4	Elevations-Section *A-A*. *B-B* (1st floor)

10.12 Zeo-Karb H Softener Unit

Drawing	Description
G 5433	Internal Assembly - Lower
B 18301-1	Arrangement of Piping in Rear of Multiport Valve
C 3562	Strainer System as per B/M 2442
B 22416	Pressure Gauge Piping - Galv. W. S.
B 17028	Pressure Gauge Piping - Allegheny Metal
B 10814	Air Vent Piping
B 18066-1-X	Assembly Drawing
B 18068	Upper Distribution
B 18017	Acid Distribution

10.13 De-Acidite Unit

Drawing	Description
B 20643	Arrangement of Piping in Rear of Multiport Valve
E 1033-7-X	Shell, Complete
G 6747-X	Wash Distributor

10.14 Regenerating Equipment

Drawing	Description
B 15554-1	Dilute Acid Tank
B 23104	Steel Tank
C 4316-1	Strong Acid Measuring Crock
B 8547	Baffle, Complete
8546	Baffle, Complete
B 19100	Alkali Tank
G 6833-1	Mounting Panel - Rinse Line
B 22702-1	Strainer Basket
H 3134	Rate of Flow Indicator
G 6725 X	Pipe Mounting Assembly of Rate of Flow Indicator
B 23150-1	Strong Acid Storage Tank
C 4275	Acid Mixing Chamber
B 16691	Assembly - 40 Gallon Acid Pot

10.15 Vacuum Deaerator

Drawing	Description
H 5006-1	Flow Diagram of Vacuum Deaerator
J 3079-3	Layout Permutit Demineralizing Plant Showing Interconnecting Pipe with Vacuum Deaerator
K 1558-5	Layout Plan and Elevation of Vacuum Deaerator, Storage Tank, Condensers, and Jets
B 23464	Assembly Detail for Orifice and Nozzles
B 23504	Piping Arrangement for Bailey Flow Indicator
G 7062	Recirculating Heat Exchanger
G 7063-1	
K 1557	Shell
B 23349	Tank Specifications
B 22976	Distribution Installation
B 23195	1 - Valve Spray Heaters
B 23200	30 Sq/ft. Vent Condenser Assembly

10.16 Calgon and Peroxide

Drawing	Description
J 3181-2	Layout of Equipment
J 3181-1	Layout of Solution Feeds
H 5025-1	Foundation Details
B 23180-2	Peroxide Solution Tanks
B 23199-1	Calgon Solution Tank
B 23030	Calgon Air Bubblers
B 23202	Peroxide Air Bubblers
B 21930-1	Tell Tale Sticks
A 3803	Sketch of O_2 and CO_2 Assembly

10.2 DuPont Drawings

Given below is a list of the major portion of the present DuPont Company drawings which pertain to the 807 Building and equipment. Listing is subdivided according to equipment.

10.21 807 Building

Drawing	Description
W 70132	Plans and Details Plumbing and Drainage
W 70050	Sections and Elevation Architecture
W 70293	Sections and Details, Electrical
W 70683	Heating Systems
W 69077	Plans - Light and Power, Electrical

10.22 Softener Units

Drawing	Description
W 69118	Arrangement, Sections No. 1
W 69117	Arrangement, Plan Sheet No. 1, 1st Floor

10.23 Vacuum Deaerator

Drawing	Description
W 69118	Arrangement, Sections No. 1
W 69117	Arrangement, Plan Sheet No. 1, 1st Floor

10.24 Calgon and Peroxide

Drawing	Description
W 69118	Arrangement, Section No. 1
W 69117	Arrangement, Plan Sheet No. 1, 1st Floor

10.25 Distribution

Drawing	Description
W 69118	Arrangement, Section No. 1
W 69117	Arrangement, Plan Sheet No. 1, 1st Floor
W 70435	Arrangement, Section Sheet No. 3