

City of Chandler
IPWTF Operation and Maintenance
Manual

Reverse Osmosis System

Volume One

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PWTF REVERSE OSMOSIS SYSTEM OVERVIEW

The IPWTF Reverse Osmosis Treatment Unit is made up of two independent process systems. The feed water for both systems is INTEL waste water, but the origin and quality of the two waste streams are quite different. The differences in the feed water quality account for the differences in the two R.O. systems. This overview describes the two systems.

The RO 100 System Overview

The RO 100 System has been designed to process waste water generated by the manufacturing process at the INTEL facility. The original design provided the capacity to treat 1200 gpm of waste water with four 300 gpm trains operating and one 300 gpm train as a spare. Changes in waste water quality has reduced the RO 100 System capacity to somewhere in the range of 960 gpm.

The RO 100 waste water passes through the IPWTF Pretreatment System before it is pumped into the RO Process Room. Sulfuric Acid and Caustic chemical addition systems are used to adjust the waste water pH to acceptable levels. The constituents of the waste water encountered to date have required that the pH be adjusted to 5 pH to provide acceptable RO 100 feed water. This relatively low pH discourages semi-soluble salts from precipitating out of solution and fouling the membrane surfaces. An anti-scalant chemical is also added to the RO 200 waste water during pretreatment. Anti-scalants (also called scale inhibitors or dispersants) inhibit scaling by inhibiting salt crystal growth. After pretreatment, the RO 100 feed water is pumped into the RO Process Room.

RO 100 System Components

Cartridge Filters

The RO 100 feed water first passes through the RO 100 Cartridge filters before being processed by a RO train. Three cartridge filter vessels - each configured to accommodate 52 ea. thirty inch filter elements - are available to filter the RO 100 feed water. Each vessel is designed to process 600 gpm. The vessels are identified as CF-100A, CF-100B and CF-100C with the "A" unit being the most westerly. A variety of filter cartridges can be used in these vessels to produce the desired quality of feed water. The filters are rated by the size of particles that will pass through the filter. A "one micron" filter will stop smaller particles from passing through it than will a "five micron" filter. A "one micron - absolute" filter will consistently stop smaller particles than will a "one micron - nominal" filter.

The Engineer will decide what type of filter to use based on variables such as filter run time, filter element cost, finished water quality requirements and available manpower. Guidelines will be established for the Operators which will indicate when the filter elements must be changed.

Increasing differential pressure across the filter and rising turbidity values in the filter effluent are indications that the filters should be changed. Normally, two filter vessels will be "in service" and one vessel will be an available spare unit.

RO 200 System Overview

The RO 200 System has been designed to process waste water generated by the INTEL ultra-pure water treatment facilities. The original design provided the capacity to treat 650 gpm of waste water with two 325 gpm trains operating and one 325 gpm train as a spare. Changes in waste water quality has reduced the RO 200 System capacity to somewhere in the range of 540 gpm.

The RO 200 waste water passes through the IPWTF Pretreatment System before it is pumped into the RO Process Room. Sulfuric Acid and Caustic chemical addition systems are used to adjust the waste water pH to acceptable levels. The constituents of the waste water encountered to date have required that the pH be adjusted to 6.3 pH to provide acceptable RO 200 feed water. While the RO 200 feed water stream presents less potential for scaling, other problems such as the possibility of overdosing anti-scalant and the increased potential for biological fouling complicate the pretreatment process. An anti-scalant chemical is added to the RO 200 waste water during pretreatment. Anti-scalants (also called scale inhibitors or dispersants) inhibit scaling by inhibiting salt crystal growth. After pretreatment, the RO 200 feed water is pumped into the RO Process Room.

RO 200 System Components

Cartridge Filters

The RO 200 feed water first passes through the RO 200 Cartridge filters before being processed by a RO train. Three cartridge filter vessels - each configured to accomodate 28 ea. thirty inch filter elements - are available to filter the RO 100 feed water. Each vessel is designed to process 325 gpm. The vessels are identified as CF-200A, CF-200B and CF-200C with the "A" unit being the most westerly. A variety of filter cartridges can be used in these vessels to produce the desired quality of feed water. The filters are rated by the size of particles that will pass through the filter. A "one micron" filter will stop smaller particles from passing through it than will a "five micron" filter. A "one micron - absolute" filter will consistently stop smaller particles than will a "one micron - nominal" filter.

The Engineer will decide what type of filter to used based on variables such as filter run time, filter element cost, finished water quality requirements and available manpower. Guidelines will be established for the Operators which will indicate when the filter elements must be changed. Increasing differential pressure across the filter and rising turbidity values in the filter effluent are indications that the filters should be changed. Normally, two filter vessels will be "in service" and one vessel will be an available spare unit.

High Pressure Pumps

After being filtered, the RO 200 feedwater flows into a distribution header which feeds the suction of the three High Pressure Pumps (HHP) - one pump per train. The pumps are identified as HPP-2A, HPP-2B and HPP-2C. Each HPP is dedicated to a corresponding RO unit. The pumps, manufactured by Afton Pumps, Inc. of Houston, Texas, are Medium Pressure Vertical (MPV) 6 stage turbine pumps, mounted in "barrels" set in the RO Process Room foundation. They are sized to provide 200 to 325 gpm to the RO units at a total discharge head of 179 to 203 ft. The pumps are driven by 30 HP Siemens motors which are controlled by Allen-Bradley Adjustable Frequency Drives. Operators control these pumps via the SCADA system. As this system is designed to operate automatically, the control system will start and stop any pumps enabled by the Operator as required by RO 200 Wet Well levels. Manual starts and stops and manual speed control is also available to the Operator at the SCADA control center. The only local control feature is an emergency stop push button located at each pump.

RO Units

Three identical RO units comprise the RO 200 system. The units are identified as RO 200A, RO 200B and RO 200C with the "A" unit being the most northerly. The units are designed as single stage, 2 array systems with 8 pressure vessels in the first array and 4 in the second. Nanofiltration membrane elements are used. A pressure control valve is installed in the 1st stage permeate header to maintain a back pressure on the 1st stage membrane elements and thereby limit the amount of permeate produced by the 1st stage elements. These units are an assembly containing the following components.

- | | | |
|------------------------|---|--|
| Unit Support Structure | - | The support structure, or frame, is designed to carry the weight of all other system components. It is constructed of carbon steel, welded to ANSI B31.3 specifications and coated with two layers of fusion bonded epoxy. |
| Pressure Vessels | - | The pressure vessels house the RO membrane elements. They are state of the art, side-ported vessels manufactured by Advanced Structures, Inc. These vessels are constructed of fiberglass reinforced plastic and they are built to comply with ASME pressure vessel code requirements. The vessels are rated for a maximum working pressure of 400 psi at 120' F. There are 12 pressure vessels in each of the RO 200 units. |

- High Pressure Piping - Schedule 40, 316 SST piping is used to carry the filtered RO feed water / concentrate from the discharge of the high pressure pumps to the inlet ports of the first array pressure vessels, from the outlet of the first array to the inlet of the second array and from the outlet of the second array to recycle or to waste. Piping connections are made by either flanges or Victaulic fittings. The piping has been passivated to improve corrosion resistance and remove impurities that could foul or damage the membrane elements.
- Low Pressure Piping - Schedule 80 PVC piping is used to collect and carry the permeate from the the pressure vessels to the product or waste piping. Piping connections are made by either flanges, pipe thread or solvent welds. All solvent welding was performed following the procedures outlined in ANSI B31.3. PVC pipe spools are also used to carry Reject and Waste water from the unit to the appropriate collection piping.
- Low Pressure Valves - There are four lug style butterfly valves equipped with electric actuators on each unit that control the flows of low pressure streams. These valves are either fully open or fully closed, and they are under the control of the PLC in normal operation. The valves can be operated manually using local switches or a manual handwheel. The valves and their function are listed below. The tag numbers of the valves are identical except for the letter that identifies the train. For example, LP-2A1 is the flush inlet valve on the "A" train. A "X" has been substituted for the identifying letter in the descriptions below.
- LP-1X1 - Flush Inlet valve. This valve is normally closed when the train is offline and during RO train operation. The valve will open, allowing flush water to enter the unit, when the train shuts down. Not all shutdowns will initiate a flush. The automatic control description located in the "Flush System" manual details the flush sequence.
- LP-1X2 - Flush to Waste valve. This valve is normally closed when the train is offline and during RO train operation. The valve will open, allowing flush water from the feed / concentrate side of the membrane to exit the unit, when the train shuts down. Not all shutdowns will initiate a flush. The automatic control description located in the "Flush System" manual details the flush sequence.

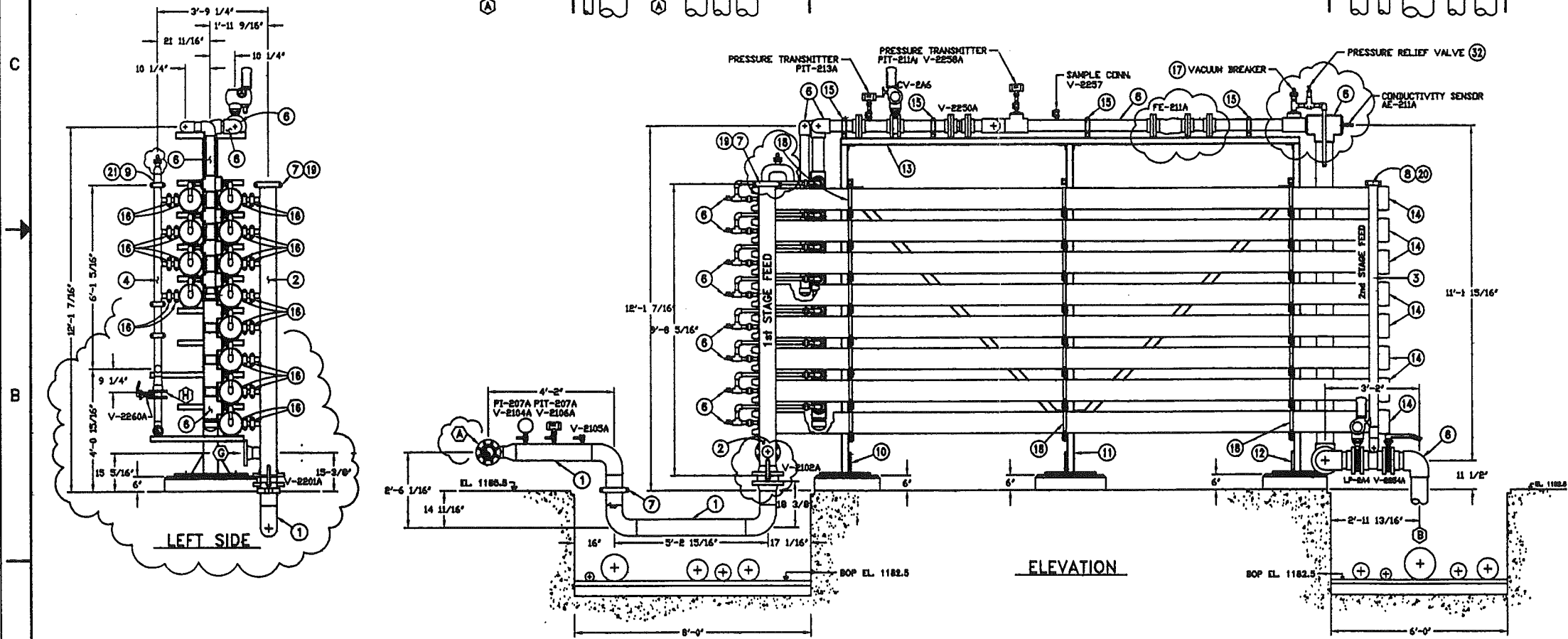
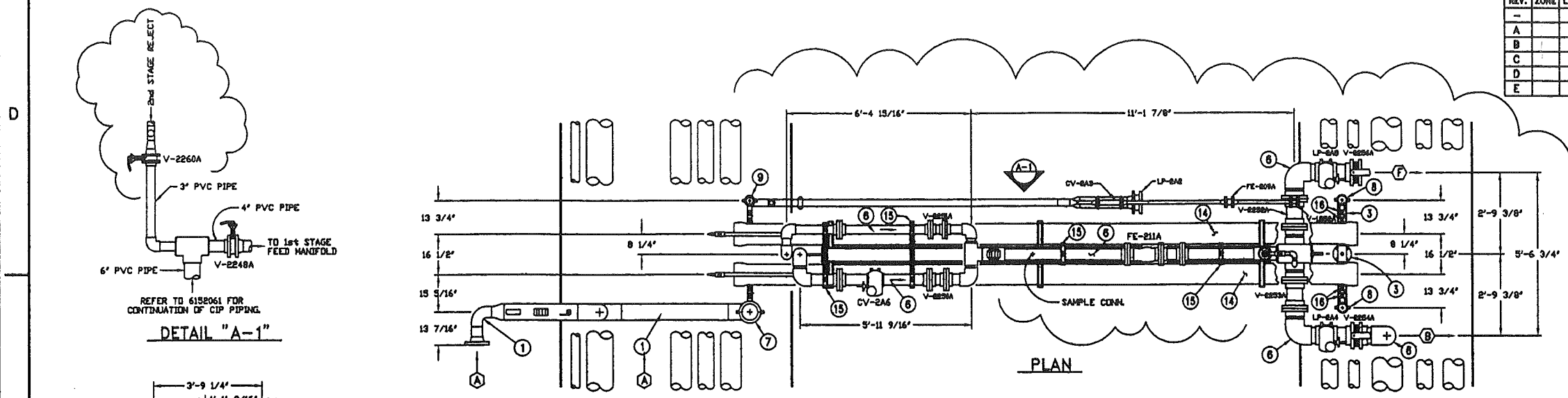
- LP-1X4 - Permeate to Product valve. This valve is normally closed when the train is offline and normally open during RO train operation. When a train starts, this valve will be closed with the permeate being diverted to waste. After a time delay and after the permeate conductivity falls to an acceptable level, the valve will open, allowing permeate to flow into the combined permeate header.
- LP-1X5 - Permeate to Waste valve. This valve is normally closed when train unit is offline and normally closed during RO train operation. When a train starts, this valve will be open with the permeate being diverted to waste. After a time delay and after the permeate conductivity falls to an acceptable level, the valve will close, allowing permeate to flow into the combined permeate header through LP-1X4.
- Control Valves - There is one flanged plug valve equipped with an electro-hydraulic actuator on each unit that control the flows of Reject Brine to waste. This valve is a modulating control valve that can be positioned over its full travel range as required by the control system.
- There is one lug style butterfly valve equipped with an electric actuator on each unit that controls a back pressure on the 1st stage permeate. This valve is a modulating control valve that can be positioned over its full travel range as required by the control system.
- The valves can be manually positioned from the SCADA system or locally by operating the switches provided at the valves. The valves and their function are listed below. The tag numbers of the valves are identical except for the letter that identifies the unit. For example, CV-2A3 is the Reject to Waste control valve on the "A" unit. A "X" has been substituted for the identifying letter in the descriptions below.
- CV-2X3 - Reject to Waste Control Valve. This valve is normally closed when the train is offline and opens to 50% during the RO train start-up sequence. When the train start-up sequence concludes, the valve will modulate to control the rate of flow of Reject Brine from the unit at the rate selected by the operator.

- CV-2X6 - 1st Stage Permeate Back Pressure Control valve. This valve is normally closed when the train is offline and opens to 35% during the RO train start-up sequence. When the train start-up sequence concludes, the valve will modulate to control the back pressure applied to the 1st array membrane elements at the pressure selected by the operator.
- Membrane Elements - The membrane element used in the RO 200 System are FILMTEC 8" NF700-400 Nanofiltration Elements. Please reference the FILMTEC literature.

Review

The RO 200 System treats waste water generated by the INTEL ultra-pure water treatment facilities. After chemical pretreatment, this water is filtered by flowing through a bank of cartridge filter vessels. The filtered feed water then flows to one of the three RO trains. The RO trains consist of a High Pressure Pump and a RO unit. The high pressure pump delivers filtered feed water to the RO membranes at a pressure sufficient to produce the desired amount of permeate at the specified recovery rate. Low pressure valves and control valves direct the flow of the permeate, reject brine and flush water through the unit. Normally, the units will be under automatic control and they will start and stop as required by the flowrate from INTEL.

REVISIONS				
REV.	ZONE	LTR	DESCRIPTION	DATE
-			ORIGINAL ISSUE	
A			DESIGN REVISED	6/28/95 HANY SAID
B			GENERAL REVISION	7/10/95 HANY SAID
C			REVISED PER B&V COMMENTS	15 AUG 95 CAG
D			DESIGN REVISIONS	13 NOV 95 AJF
E			REVISED PER B & V 12-1-95 COMMENTS	15 DEC 95



TAG	SIZE	RATING	DESCRIPTION	SERVICE
A	4"	150#	6" FLANGE, STN. STL.	FEED FROM H.P. PUMP
B	6"	150#	6" FLANGE, PVC	FINAL PRODUCT
C	3"	150#	3" FLANGE, STN. STL.	BRINE REJECT
D	1-1/2"	150#	1-1/2" FLANGE, STN. STL.	BRINE RECYCLE
E	4"	150#	4" FLANGE, STN. STL.	BRINE FLUSH
F	6"	150#	6" FLANGE, PVC	PRODUCT FLUSH
G	4"	150#	4" FLANGE, STN. STL.	1st STAGE CLEANING CONN.
H	3"	150#	3" FLANGE, STN. STL.	2nd STAGE CLEANING CONN.

- NOTE:**
1. REFER TO DWG. 6152012 FOR MATERIAL LIST.
 2. PERMEATE (PVC) HEADERS ARE SUPPORTED BY UNIT FRAME. REJECT (STN. STL.) PIPE SUPPORTS ARE FITTED IN THE FIELD.
 3. REFER TO DETAIL "A-1" FOR CIP CONNECTIONS.

4. REFER TO IONICS DWG. 6152053 SHEET 2 OF 2 FOR INSTRUMENT DIMENSIONS.
5. REFER TO IONICS DWG. 6052061 SHEET 2 OF 3 AND 6152063 FOR CLEANING VALVE CONNECTIONS.

ADVANCED ENVIRONMENTAL SYSTEMS

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CUSTOMER REF PROJECT NO. 99403 401RB

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ENG APPROVAL DATE

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WATERTOWN, MASS. 02172, U.S.A.

R.O. ASSEMBLY - 200 A/B/C

CITY OF CHANDLER, ARIZONA
INDUSTRIAL PROCESS WATER TREATMENT FACILITY
REVERSE OSMOSIS SYSTEM

SIZE **6152013** REV **E**

SCALE: 1/2"=1'-0" FILE: 6152013 SHEET 1 OF 1

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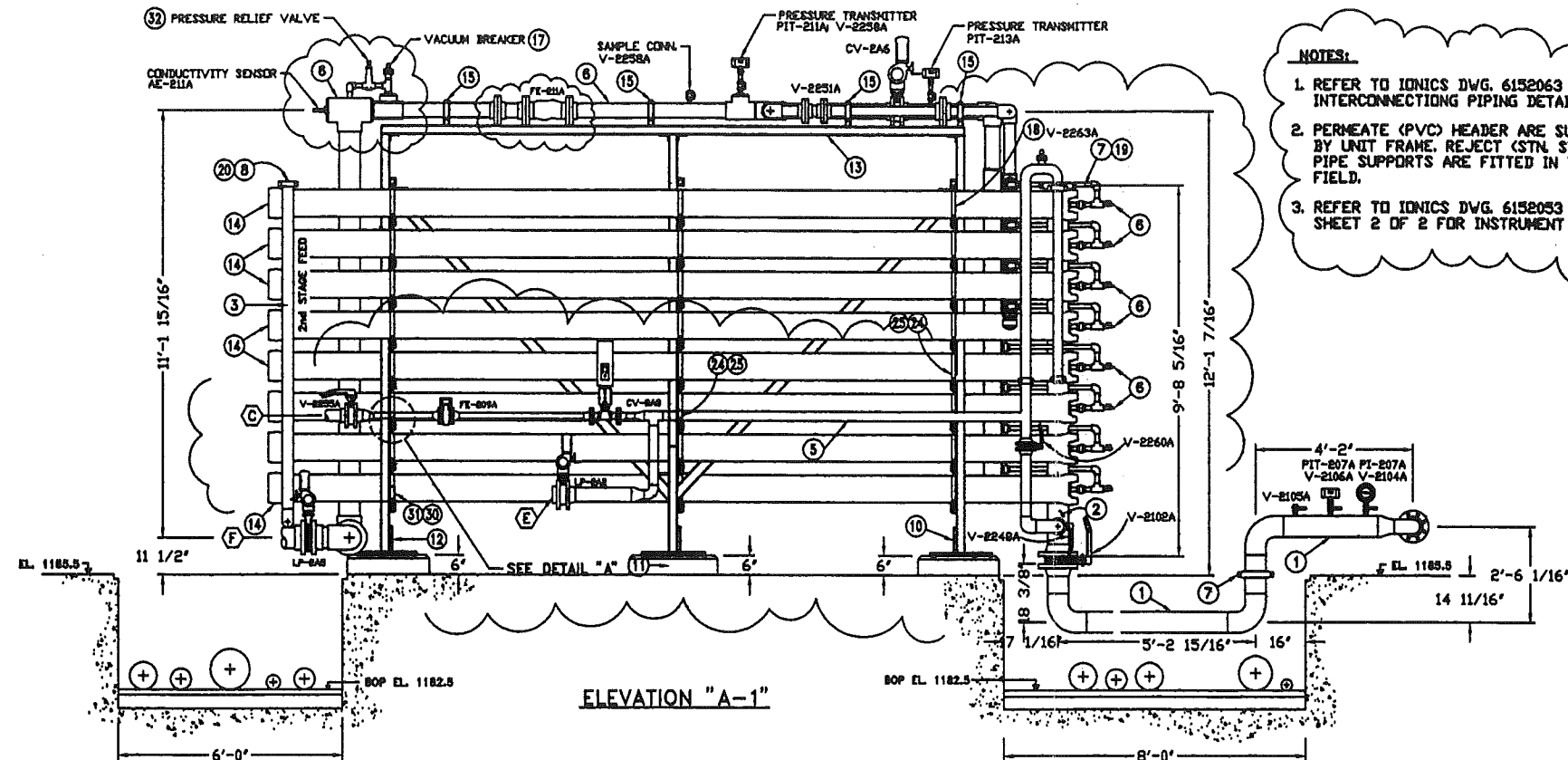
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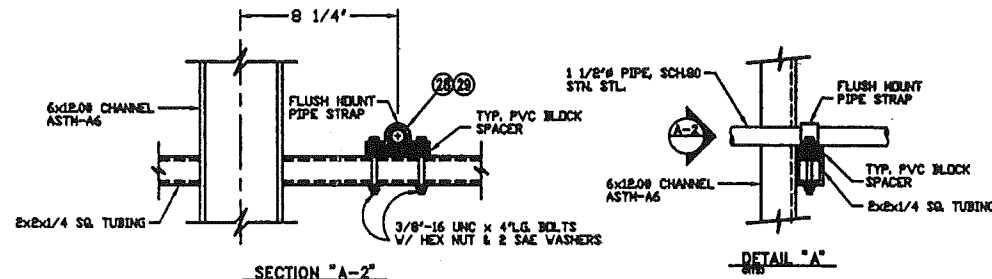
REVISIONS				
REV.	ZONE	LTR	DESCRIPTION	DATE
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A			DESIGN REVISED	8/29/95 HANY SAID
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C			REVISED PER B&V COMMENTS	15 AUG 95 CAG
D			DESIGN REVISIONS	13 NOV 95 AJF
E			REVISED PER B & V 12-1-95 COMMENTS	



NOTES:

1. REFER TO IONICS DWG. 6152063 FOR INTERCONNECTING PIPING DETAILS.
2. PERMEATE (PVC) HEADER ARE SUPPORTED BY UNIT FRAME, REJECT (STN. STL.) PIPE SUPPORTS ARE FITTED IN THE FIELD.
3. REFER TO IONICS DWG. 6152053 SHEET 2 OF 2 FOR INSTRUMENT SIZES.

TAG	SIZE	RATING	DESCRIPTION	SERVICE
A	4"	150	4" FLANGE, STN. STL.	FEED FROM H.P. PUMP
B	6"	150	6" FLANGE, PVC	FINAL PRODUCT
C	3"	150	3" FLANGE, STN. STL.	BRINE REJECT
D	1-1/2"	150	1-1/2" FLANGE, PVC	BRINE RECYCLE
E	4"	150	4" FLANGE, STN. STL.	BRINE FLUSH
F	6"	150	6" FLANGE, PVC	PRODUCT FLUSH
G	4"	150	4" FLANGE, STN. STL.	1st STAGE CLEANING CONN.
H	3"	150	3" FLANGE, STN. STL.	2nd STAGE CLEANING CONN.



TYP. PIPE SUPPORT FOR BRINE MANIFOLD

REV.	ZONE	LTR	DESCRIPTION	DATE
—			ORIGINAL ISSUE	
A			DESIGN REVISED	8/29/95 HANY SAID
B			GENERAL REVISION	7/10/95 HANY SAID
C			REVISED PER B&V COMMENTS	15 AUG 95 CAG
D			DESIGN REVISIONS	13 NOV 95 AJF
E			REVISED PER B & V 12-1-95 COMMENTS	

ITEM	QTY.	P/M	MATERIAL	DESCRIPTION	REMARK
32	1		PVC	1" PRESSURE RELIEF VALVE	PLAST-O-MATIC
31	2		C.S.	1/2" UNF x 3/4" NPT V/ NUT & 2 SAE WASHERS	TOL CH
30	1		C.S.	4" PIPE MOUNT PIPE STRAP	TOL CH
29	2		C.S.	3/8" UNF x 1/2" NPT V/ NUT & 2 SAE WASHERS	TOL CH
28	1		C.S.	1 1/2" PIPE MOUNT PIPE STRAP	TOL CH
27					
26					
25	4		C.S.	3/8" UNF x 1/2" NPT V/ NUT & 2 SAE WASHERS	TOL CH
24	2		C.S.	2 1/2" PIPE MOUNT PIPE STRAP	TOL CH
23	2		C.S.	3" PIPE CLAMP ASSEMBLY	TOL CH
22	1		C.S.	4" PIPE CLAMP ASSEMBLY	TOL CH
21	4		S.S.	2.875" x 0.625" THK. DISK	DLHTG
20	2		S.S.	3.500" x 0.625" THK. DISK	DLHTG
19	1		S.S.	6.625" x 0.625" THK. DISK	DLHTG
18	36			PRESSURE VESSEL STRAP ASSEMBLY	
17	1		PVC	1/2" VACUUM BREAKER, FIBER	
16	48		C.S.	1 1/2" VICT. COUPLING STYLE 77	EPOXY COATED
15	12		C.S.	1 5/8" x 1 5/8" x 6" PLG. UNISTRUT	
14	12		FIBERGLASS	Code Line PRESSURE VESSEL ORDN. 68/3P	
13	1		C.S.	RD FRAME ASSEMBLY	DVG #6151238
12	1		C.S.	RD FRAME (RIGHT)	DVG #6151239
11	1		C.S.	RD FRAME (CENTER)	DVG #6151244
10	1		C.S.	RD FRAME (LEFT)	DVG #6151235
9	2		C.S.	2 1/2" VICT. COUPLING STYLE 77	EPOXY COATED
8	4		C.S.	3" VICT. COUPLING STYLE 77	EPOXY COATED
7	2		C.S.	6" VICT. COUPLING STYLE 77	EPOXY COATED
6	1		PVC, SCH80	PRODUCT MANIFOLD	DVG #6152050
5	1		316 S.S.	BRINE MANIFOLD	DVG #6152049
4	1		316 S.S.	BRINE MANIFOLD	DVG #6152049
3	1		316 S.S.	2nd STAGE FEED MANIFOLD	DVG #6152049
2	1		316 S.S.	1st STAGE FEED MANIFOLD	DVG #6152049
1	1		316 S.S.	1st STAGE FEED MANIFOLD	DVG #6152049

MATERIAL LIST

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WATERTOWN, MASS. 02172, U.S.A.

R.O. ASSEMBLY - 200 A/B/C

CITY OF CHANDLER, ARIZONA
INDUSTRIAL PROCESS WATER TREATMENT FACILITY
REVERSE OSMOSIS SYSTEM

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REV. DWG. NO.
CUSTOMER REV. PROJECT NO. 98403 401RB
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CHECKED BY DATE
PROJ./DESIGNER DATE 12 JULY 95
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SIZE D
6152014
REV E
SCALE: 1/2" = 1'-0" FILE: 6152014 SHEET 1 OF 1

ADVANCED ENVIRONMENTAL SYSTEMS

DATE: 12 JULY 95

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