Project： WATER TREATMENT FACILITY RO+EDI

TECHNICAL SPECIFICATIONS

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Guam Power Authority

Taiwan Electrical and Mechanical
Engineering Services, Inc.

RO+EDI TECHNICAL REQUIREMENTS
FOR Water Treatment Facility

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Water Treatment Facility RO+EDI

TECHNICAL REQUIREMENTS

1. SCOPE OF WORK

This specification covers the design, fabrication and installation of a combination reverse osmosis/electrodeionization system at Guam's Cabras Generating Station. Every effort will also be made to minimize waste and recover all wastes economically recoverable.

2. GENERAL REQUIREMENTS

The water treatment system shall be capable of treating station raw water to produce 86,400 gallons per day net output of demineralized water in accordance with the conditions of service, required performance, materials and construction stated in this specification.

The water treatment system shall consist of a pretreatment section, reverse osmosis (RO) section and a post-treatment section. The pretreatment section will condition the water before it goes into the RO section. The pretreatment section shall include filtration and dechlorination, softening and ultraviolet sterilization. Softening equipment shall include a saturation tank and regeneration facilities. Booster pumps in the pretreatment section will supply the necessary pressure to drive water through the RO elements and the post-treatment equipment.

The RO section shall be divided into two 100% capacity trains. Each train shall have a minimum of two-stages in which Concentrate water from the first stage feeds the second stage.

The post-treatment system will remove the remaining dissolved solids. It will consist of one membrane based degasifier and two electrodemineralizers which will treat the water to boiler make-up water specifications.

Environmental regulations do not permit GPA to discharge "hazardous waste" from the plant. At no time shall any waste stream produced by the supplier's equipment have a pH that is less than 6 or greater than 9. Any chemical added by the Supplier to any water stream must be first approved by GPA.

3. WORK FURNISHED BY SUPPLIER

The major items of equipment furnished by the Supplier shall include, but not be limited to the following:

A. Two 100% activated carbon/multimedia filters (capable of flowing 100% when the second unit is in backwash), two 100% sodium cycle softeners, two 100% 5µ cartridge filters, one 100% ultraviolet sterilizer, two booster pumps, two 100% reverse osmosis trains, piping to and from one 100% membrane degasifier and to and from two 100%

electrodemineralizers and along with connections and piping into GPA's demineralized water storage tanks (Condensate tanks).

Pumps for backwashing softeners and filters using Reclaim water tank shall also be provided.

B. Regeneration equipment for softeners as specified in Secton 6.5.

C. Local and CRT based controls and instrumentation as required for the automatic and/or manual operation of the water treatment system in accordance with Section 6.14 of this specification.

D. Integral and interconnecting piping, valves and fittings within the limits as specified in Section 6.15

E. Technical Services Representative, Construction Manager and Startup Engineer.

F. Labor for unloading, handing and erection of all apparatus at the job site.

G. Concrete foundations, trenches, sumps and anchor bolts as required.

H. Piping and controls to reclaim storage tank for water reuse.

I. Interface electrical wiring, conduit, grounding and connections between the skids and from skids to the control board.

J. Motor starters for all motors with local MCC for system isolation.

K. Piping, valves and fittings within Supplier's terminal limits specified in Section 6.15.

L. All pneumatic lines with Supplier-furnished control panel.

M. A concrete building or buildings to house control panel, pretreatment and post-treatment equipment and suitable to withstand wind from typhoons.

N. 120 V AC single phase and 480 V AC three-phase power source for control and motors, respectively.

O. Brine saturator tank and brine pumps.

P. CS+FRP Lining Reclaim water tank for reclaiming RO reject and rinse water.

Q. The space for a small Chemical Lab. Inside building which as used to perform manual analysis for quality control.

4. SERVICES & MATERIAL FURNISHED BY GUAM POWER AUTHORITY (GPA)

Guam Power Authority (GPA) shall furnish only the following services and materials:

A. Demineralized water storage tanks (Condensate tanks).

B. Raw water and Raw water tank.

C. Instrument air 70-80 psig.

D. 480 V AC three-phase 60Hz power source for controls and motors. This is available at GPA's local 480V AC three-phase motor control center.

5. CONDITIONS OF SERVICE – PROCESS DESIGN

5.1 CAPACITY

A. There are two trains reverse osmosis/EDI water treatment system, each Train shall have the capacity to deliver a net output of 86,400 gallons per day (equivalent to 60 gpm per train), the two Trains Alternate operation of the water quality specified in 5.8.

B. The net output of the water treatment system is defined as the amount of demineralized water actually available for make-up use and excludes water discharged to waste during the normal operation of equipment or used for backwashing filters or softeners.

C. Each softener bed shall have sufficient ion exchange material to operate at least for 24 hours continuously before requiring regeneration.

5.2 SPACE AVAILABLE

The space available for installation of the reverse osmosis water treatment system, pretreatment equipment and post-treatment equipment is 27'-3" feet by 117'-4" feet with a maximum height of 15 feet. Brine tank and associated regeneration pumps can be located adjacent to this area. The reclaim water tank will be located adjacent to the raw water tank.

5.3 SERVICE WATER TO BE TREATED

The raw water to be treated will typically have the following analysis.

Temperature	80-90°F (Ave 85°F)
pH	7.0-7.4
Silica (as SiO_2)	13 ppm
Conductivity	<400 µS/cm @ 25°C
Turbidity	Less than 0.5 NTU
Carbon Dioxide	12 ppm
Free Chlorine	1.6 ppm
Silt Density Index (SDI)	4.0-5.0

(Elapsed Time, 15 min.)

T.O.C.(as C)	500 ppb
Total water Hardness	400ppm (as Ca CO_3) including：
Cations：Calcium, Magnesium, Sodium	
Potassium and Strontium 0.095ppm(as Sr)	
Barium 0.006ppm(as Ba)	
Anions：Bicarbonate, Chloride, Sulfate	
Nitrate and Fluoride 0.6ppm(as F)	

GPA/TEMES cannot guarantee the feed quality will not vary but certifies that this represents typical water quality seen at the station.

5.4 PRETREATMENT EFFLUENT REQUIREMENTS

A. The effluent from the pretreatment section of the water treatment system shall be designed to produce a silt density index (SDI) of 3 or less, using an elapsed time of 15 minutes.

B. The effluent from the pretreatment section of the Apparatus shall have the following properties.

Total Cl_2	Less than 0.02 ppm
Total Hardness	Less than 0.5 ppm as $CaCO_3$

5.5 REVERSE OSMOSIS MODULES

The reverse osmosis system shall reduce the feedwater conductivity by at least 98% and reduce the feedwater silica by 99% operation.

5.6 Membrane Cleaning and Chemical dosing

A. Membrane Clean-In-Pace (CIP) system

Contractor shall provide an individual and removable Clean-In-Place (CIP skid for Reverse Osmosis membrane cleaning/disinfection purposes. Portable skid design shall consist of control/monitor panel (switches and indicating lamps for main power, motor starter and tank immersion heater etc. are panel mounted) with extension lead power supply cable, pre-piped and pre-wired free-standing and open-top 250 gallons FRP cleaning solution preparation/storage tank, 316 stainless steel single-stage centrifugal transfer pump, immersion heater, flowmeter, pH meter,

thermometer, CIP inlet/outlet quick connections, isolation valves, CIP outlet cartridge filter (25-micron), and provide quick connected transfer hoses for the system demands.

The RO machine shall be provided with equipped (pre-piped) to perform a periodic cleaning of the RO membrane elements in order to restore lost product flow and/or product quality. The cleaning process shall be performed manually with the membranes remaining in the housings and the RO machine shutdown. The cleaning solution shall be recirculated through the RO membranes via CIP. And the RO machine shall be equipped with CIP inlet/outlet isolation valves and quick connect cleaning connections.

The EDI machine shall be equipped with CIP inlet/outlet isolation valves and quick connect cleaning connections, to perform cleaning in order to restore lost product flow and/or product quality.

B. CHEMICAL DOSING SYSTEMS

Contractor shall provide each RO train with two chemical injection systems, one for membrane fouling prevention and pH adjustment the other one for membrane scaling prevention.

For membrane fouling prevention and pH adjustment, injection of chemical liquid shall be provided. The injection system shall consist of an electronic positive displacement metering pump with PVC wetted parts, 35-gallon polyethylene day solution tank, electric solution mixer, liquid level switch, and foot valve. The pump is to be field-wired to the RO control panel to prevent the dosage of chemical during a machine shutdown or placed in stand-by. A status alarm shall be added to the control system during low chemical tank level.

For membrane scaling prevention, injection of anti-scalant shall be provided. The injection system shall consist of an electronic positive displacement metering pump with PVC wetted parts, 35-gallon polyethylene day solution tank, electric solution mixer, liquid level switch, and foot valve. The pump is to be field-wired to the RO control panel to prevent the dosage of chemical during a machine shutdown or placed in stand-by. A status alarm shall be added to the control system during low chemical tank level.

5.7 POST-TREATMENT

A. The post-treatment section shall consist of membrane base degasifier for carbon dioxide removal and electrodeionization equipments.

B. The outlet pressure after the electrodeionizers (EDI) shall be at least 60 psig.

C. The electrodemineralizers shall polish the water to the specifications given

in Section 5.8. Electrodemineralizers shall be operated at over 90% recovery. Supplier shall provide sufficient controls to allow each EDI train to be operated over the flows specified in 6.12 with minimal operator adjustments.

5.8 Effluent Quality from Electrodeionization

A. The Electrodionization Units, when operating at the warranted rates of flow, shall reduce constituents in the effluent to the following acceptable values:

Conductivity	0.08 μ S/cm @ 25℃
Silica (as SiO_2)	<10 ppb

B. Test methods used to determine the performance of the unit shall be as follows:

Test	ASTM Method
Silica	D 859 Referee Method B
Conductivity	D 1125

5.9 OPERATING CONDITIONS

Apparatus shall be installed indoors in a supplier furnished building, except for the brine and reclaim systems.

Equipment installed outdoors may be exposed to rain, high winds (including typhoons), blowing sand, salt mist or spray and ambient temperatures of 50 to 105℉.

6. DESIGN AND FABRICATION

A. The Supplier shall provide detail design control wire diagram, Layout, flow diagram including specify manufacturing and Model of all instruments, controller, Pumps, RO section needs to show detail flow from one vessel to another vessel in each stage. etc. for GPA/TEMES Review within two months from award of the contract.

B. The Supplier shall furnish the pretreatment equipment, reverse osmosis modules and pumps, and softener regenerant equipment assembled and mounted on skids for ease of installation.

C. The Supplier shall complete the electrical wiring on the skids and complete the necessary interconnections among the controls, instrumentation and to the terminal boxes. Instrument wiring shall no the run through conduit with power wiring. Terminal boxes and conduit shall

be dust-tight, weather-tight, and corrosion resistant.

6.1 ACTIVATED CARBON/MULTIMEDIA FILTERS

A. The activated carbon/multimedia filters shall be designed for the dual function of chlorine removal and suspended solids reduction.

B. Each activated carbon/multimedia filter shall have sufficient freeboard height to permit bed expansion of 50 percent. Freeboard provided shall be based on total volume of media; activated carbon, quartz and garnet.

C. Each activated carbon/multimedia filter shall be provided with vent valving at the highest point and a drain connection at the lowest point.

D. Each activated carbon/multimedia filter shall have an 3 inch by 12 inch observation window centered at the top of the settled media bed.

E. The internal systems and components for each tank shall be constructed of 316L stainless steel.

F. Each activated carbon/multimedia filter tank shall have a neoprene rubber lining throughout.

G. Two activated carbon/multimedia filters shall be provided. The filters shall have a minimum activated carbon bed depth of 3.0 feet. Support beds will have the following minimum bed depths:

#20 Quartz - 9 inches
30 by 40 Garnet - 5 inches
#8 Garnet - 4 inches
Quartz subfill as necessary for distribution of backwash water.

The maximum in-service 100% flow rate for each filter shall be below 10 gpm/ft^2. Each filter shall be designed to handle 100% of the normal feedwater flow and the complete flow when the other filter is in backwash.

H. All piping downstream of the multimedia filters shall be schedule 80 CPVC.

I. Vendor shall provide all media needed and shall be responsible for loading the media.

J. Activated Carbon supplied shall be the following criteria:

Carbon shall be hydrochloric acid-washed Calgon F200 12 X 40 Bituminous Grade Virgin (not reprocessed) carbon suitable for potable water use.

6.2 Sodium Cycle Softeners

A. Each softener shall have sufficient freeboard height to permit bed expansion of 50 percent without loss of resin unless using packed-bed

technology.

B. Each softener shall be provided with vent valving at the highest point and a drain connection at the lowest point.

C. Each softener shall have an observation window centered at the top of the settle media bed and at the normal backwashing level (unless using packed-bed technology). The observation windows shall be vertical with minimum dimensions of 3 inches by 12 inches.

D. The internal systems and components for each tank shall be constructed of 316L stainless steel. Laterals shall be screened with 50 mesh Wedgewire.

E. Each softener tank shall have 3/16-inch thick sheet Neoprene rubber lining throughout.

F. The softeners shall have a minimum bed depth of 3.0 feet. The maximum in-service 100% flow rate shall be 3 gpm/ft^3.

G. All piping downstream of the softeners shall be schedule 80 CPVC.

H. Softener shall be designed for downflow service and upflow regeneration (countercurrent regeneration).

6.3 Ion Exchange Resins for Softeners

Ion exchange materials for the softeners shall be provided consisting of properly graded and chemically stable uniform particle size bead strong-acid cation resins. (the Resin is Amberlite or Dowex)

6.4 Resin Trap Strainer

A strainer shall be provided in the common effluent line of the sodium cycle softeners to prevent passage of resin. The strainer shall be designed to withstand the maximum system pressure. The strainer shall retain all particles larger than 50 mesh (U.S. Sieve Series) and shall utilize Johnson wedgewire.

6.5 Brine System

A. Brine Pumps

1. Two Brine pumps shall be provided. One of the pumps shall be a spare.

2. Each pump shall be sized to deliver 150 percent of the maximum regenerant flow rate required.

3. Materials of construction for wetted parts in contact with the regenerant shall be Type 316 stainless steel for brine service.

B. Brine Mixing Tees

1. A brine mixing tee shall be provided for the regenerant system,

capable of thoroughly mixing the incoming regenerant and dilution water to provide a continuous dilute solution of 10% w/w sodium chloride the dilution water come from Reclaim water Tank.

2. Materials of construction shall be 316L stainless steel for brine service. The end connections shall be flanged.

C. Salt Tank

1. A FRP brine saturator with a minimum capacity of 5 tons shall be provided along with lines and compartments to allow dry salt to be delivered and saturated salt solutions to be made up for regeneration the softeners. A manhole will be provided to minimize external contamination. Supplier will provide salt and fill up the tank for the initial operation of the system.

2. Filling of the brine saturation compartment shall be provided locally, Filtering of suspended material from the saturated brine shall be provided using sand or other suitable media drawing from a lateral system.

3. A ladder shall also be provided to allow access to the top of the saturator.

4. Level indication shall be provided for both dry salt and saturated liquid.

5. A drain line and flush connections shall also be provided for tank cleanout.

6.6 Cartridge Filters

A. Two 5µ cartridge filters shall be provided with each be sized for 100% flow.

B. Cartridge filters shall have the following features:

1. Filters shall be constructed in single 40 inch length, will be 2.5 inches in diameter and have a single open end with a Buna-N "o"-ring.

2. Filters shall be made entirely of polypropylene.

3. Cartridges shall have rating of 5 micron absolute.

C. Filter element changeout shall be accomplished with no loose parts. No tie rods shall be used to secure elements. Housing design shall allow filter changeout in less than one hour. Cover shall be hinged and fastened with swing bolts. Tube sheet adapters shall be raised to prevent dirty fluid downstream during changeout. Sufficient cartridges shall be provided to maintain a differential pressure of less than 4 psid across the housing at a

flow rate of 95 gpm with new filters.

D. Each cartridge filter housing shall be constructed of 316L stainless steel and shall have both a vent and drain valve.

6.7 Ultraviolet Sterilizer

A. An ultraviolet sterilizer shall be provided to minimize bacteria in the feed to the RO system. Sterilizer shall allow easy changeout of ultraviolet lamps.

B. Sterilizer shall be constructed of stainless steel and designed for a flow rate of 95 gpm.

6.8 Booster Pumps

A. Two booster pumps, complete with motor driver, coupling and baseplate, shall be provided. The pumps shall increase pressure to drive the water through the RO elements, the EDI, and to the top of the demineralized water storage tanks. Vents shall be provided on the discharge of the pumps.

B. The pumps shall be of the multistage centrifugal, each sized for 100% of the required system flow. Each pump shall be capable of delivering approximately 95 gpm at a discharge pressure from 150 to 300 psig. Pump and motor shall be encapsulated in a fiberglass pressure vessel for noise reduction. Pump shall be torpedo style pump from Pumps Unlimited.

C. Materials of construction for the wetted parts shall be 316 stainless steel.

6.9 RO Elements and Pressure Vessels

A. The reverse osmosis elements shall be 8” polyamid TFC membranes in a spiral wound configuration. Each of the two trains will have a minimum of 2 stages. The average flux for the RO membranes will not exceed 12 GFD. Supplier will provide computer projections for RO performance.

B. The pipe, valves and fittings (including tubing) used to interconnect the reverse osmosis permeator shall be 316L stainless steel Use of victaulic couplings is permitted only for pipe J bends.

C. The reverse osmosis elements shall be arranged into 2 different trains on a common pressure rack.

D. RO flow will be maintained 67GPM per train will be controlled by the VFDs. RO reject shall be routed back to the Reclaim Tank for reuse using CPVC piping furnished by Supplier. Reject flow rate will be maintained at a constant flow rate independently of the permeate flow. The timer and level switch in RO water tank shall be control the duty and stand by for each RO Unit and Can change it with PLC.

6.10 RO Flushing

Flushing of RO modules shall occur automatically upon shutdown or placed in stand-by and will be done using softened water from the pretreatment system. An automatic dump valve shall be provided to protect the RO membranes upon shutdown or placed in stand-by as a means of reduces membrane scaling and fouling.

6.11 Degasifier system

A. Permeate from the one RO trains shall be routed to three 6-inch Celgard membrane contactors to reduce carbon dioxide prior to the electrodemineralizers.

B. Membrane contactors shall include a blower and vacuum pump for carbon dioxide removal. Air removal equipment shall produce sufficient flow to reduce the carbon dioxide level below 4 ppm under all flow conditions. Blower shall produce oil-free air and will include a filter to meet the membrance manufacturer's warrantee.

6.12 Electro-Demineralizers

A. An electrodelionizer system consisting of two 67 gpm trains shall be provided. Each will operate at over 90% recovery. Electrodeionizers shall be selected from one of the following EDI models: E-Cell MK-3 or CDI-LX. These are the only acceptable electrodeionizers.

B. Waste streams from the electrodemineralizers shall be routed back to GPA's Raw Water Tank or Recycle for reprocessing using CPVC piping furnished by Supplier.

C. Each electrodemineralizer train shall be capable of meeting the limits defined in section 5.8 over a flow 60 gpm.

D. Flow rate through the EDI units will be controlled by varying the RO flowrate using the VFDs. Any adjustments on the concentrate flow or pressure will take place automatically.

E. EDI voltage and or amperage can be done manually by the system operator.

6.13 Building and Construction

A. All equipment with the exception of the service water pumps, backwash pumps, the Reclaim water tank and the brine tank shall be enclosed within a concrete building supplied by the supplier. Building(s) shall include all necessary lighting to furnish lighting to 80 foot candles. Floor drains shall also be provided under the RO and EDI trains, each filter and softener.

Contractor is responsible for demolition and removal or relocated of old

equipment, as well as installation of new equipment.

B. A CS+FRP Lining Reclaim tank shall be supplied to recover RO rinse and reject water. Tank shall be 20 feet in diameter with a height of 15 feet. Tank shall be used as a Reclaim water source for all softener Regenerate operations and for activated carbon/multimedia filter backwashes. In addition, the controls shall allow the water to also be used for other purposes within the power plant as long as their is sufficient volume remaining to perform a complete softener regeneration. Reclaim tank overflow line will terminate two inches above supplier-furnished funnel which will be connected to supplier's pipe which will empty in storm drain.

C. Construction of the entire water treatment system shall be the responsibility of the supplier. Construction shall include but is not limited pouring to all concrete pads (including those for the recovery water and the brine tanks), erection of the building and placement of all equipment within the building. In addition, electrical wiring from GPA's electrical panel shall be included in the scope of the project. All electrical, controls and air connections will be the responsibility of supplier. Project is to "turn-key". Wiring from EDI skid-mounted control panel and instruments to PLC is also Supplier's responsibility.

D. Minimum Electrical Test requirements: Contractor "Turn Key" Project

1. GPA will provide a 480V AC feeder supply and assure the correct operation and settings of all feeder protection.

2. Contractor shall be responsible for "ringing out" all new wiring prior to the initial energization and for modifying the construction drawings to an "as built" condition.

3. Contractor shall megger all new wiring prior to initial energization.

4. Contractor shall be responsible for dynamic testing (where possible) of all new circuit protection devices prior to initial energization.

E. Contractor supplier shall provide specifications for the equipment enclosure/building. It shall meet be designed to meet all Federal and Local Codes and Seismic Zone 4 criteria. The design and specifications shall be reviewed and certified (signed) by a Registered Professional Engineer licensed to Practice and do business in the Territory of Guam. Design shall include but not limited to providing calculations, specifications and drawings for construction.

The Contractor of the building/enclosure shall posses a current license to perform work in the Territory of Guam. The Contractor and its employees shall have a minimum of five (5) years experience in a similar project.

The Contractor shall obtain all necessary permits and pay for all

associated fees for construction and operation.

6.14 Controls & Instrumentation

A. General

1. Instruments and controls shall be of the solid-state electronic type and shall be suitable for use with pneumatic operated valves and shall be protected from the environment as described in Section 5.9.

2. The automatic control systems, using PLC control (two sets and could transfer Automatically while operating set failed) shall be capable of the following functions：

a. Place the water treatment system in service or stand-by condition with on-line operator interfacing using CRT touch screen or on-line mouse.

b. Provide for a gradual start up when the water treatment system is placed in service. The filter effluent shall be directed to reclaim tank until proper turbidity and the removal of total chlorine has been confirmed. The softener effluent shall be directed to reclaim tank until hardness and conductivity are verified. The RO product stream shall be directed to reclaim tank until the proper conductivity is verified. The electro demineralizer product stream shall be directed to reclaim tank until the proper conductivity is verified.

c. Place each activated carbon/multimedia filter in backwash when initiated with on-line operator interfacing using PLC control. Following initiation, the backwash cycle shall be completely automatic. After backwash and rinse, the filter shall be held in stand-by condition until returned to service with on-line operator interfacing using computer control.

d. Alarm on high differential pressure to indicate when the activated carbon/multimedia filters require backwashing.

e. Regenerate each softener when initiated with on-line operator interfacing using PLC control. Only one softener shall be regenerated at a time so that the operation of the water treatment system is not interrupted. Following initiation, regeneration shall be completely automatic. After regeneration, the softener shall be held in stand-by condition until returned to service with on line operator interfacing using computer control when the other softener exhausts.

f. Alarm on high differential pressure to indicate when the cartridge filters require replacement.

g. Rinse the RO elements for a minimum of ten minutes when the water treatment system is Continued operation. The booster pumps and Raw water pumps will continue to operate. At the lower RO feed pressure and/or with the appropriate valve actuation, no product shall be produced. All of the RO feed shall exit through the second stage concentrate water lines.

h. Control pressure of influent water to provide constant pressure conditions for maintaining constant flow rates during filter backwashes.

i. Accomplish other functions as required for the proper operation of the water treatment system. Failure of any automatic operation to reach completion within the predetermined time interval, based on the quality end point criteria, shall be annunciated. Any such failure shall stop progress for the automatic process until correct conditions have been established.

j. Filling of brine saturator salt tank shall be manually initiated and controlled by the operator. Automatic high level shut-off switches shall be supplied to prevent overfilling.

3. The Suppler shall provide the means for manually accomplishing every operation from the water treatment system control panel which is performed by the automatic control systems.

B. Instrumentation Requirements

1. The two activated carbon/multimedia filters shall be provided with a differential pressure indicator and a high differential pressure alarm. Each filter shall be provided with flow meter.

2. A turbidity analyzer shall be provided downstream of the activated carbon/multimedia filters. The turbidity analyzer shall be equipped with a high turbidity alarm and a high high turbidity shut down which shall shut down the water treatment system without rinsing the RO elements.

3. Each of the softeners shall be provided with a flow indicating totalizer. One common total hardness analyzer shall be provided for monitoring the effluent of the softener in-service. After a preset gallonage limit has elapsed, an alarm will annunciate to notify the operator that one of the softeners requires regeneration and the "exhausted" softener will continue to operate. In the event of high total hardness, the operated RO train shall be shut down for rinsing the RO elements.

4. The two 5µ filters shall be provided with a differential pressure indicator for the combination, a differential pressure transmitter, and high differential pressure alarm.

5. Each booster pump shall be provided with a low suction pressure shut down, a high discharge pressure shut down, suction and discharge pressure gauges and a pressure relief valve. In addition, a discharge pressure transmitter shall be provided. The high and low pressure shut downs shall shut down the system.

6. The combined permeate from both RO trains shall be equipped with a conductivity indicator and a high conductivity alarm. High conductivity shall shut down the operated RO train and put another RO train in service Automatically/or manually.

7. The effluent of each electrodemineralizer train shall have a conductivity monitor. An alarm shall annunciate in the event of high conductivity. Each train shall be provided with an inlet and outlet pressure indicators.

8. The softener resin trap shall be provided with a differential pressure indicator and a differential pressure alarm.

C. Specific Requirements

In addition to the items listed below, the equipment provided by Supplier shall have the following features.

1. The programmable controller shall control all functions associated with softener regeneration, filter backwashing, RO module rinsing and electro demineralizer operation.

2. All indicators and transmitters shall read out in engineering units. All flow indicators and transmitters shall read out directly in gallons per minute (gpm). All pressure indicators and transmitters shall read out directly in pounds per square inch (psi). All transmitters shall have linear output.

3. Flow indicators, locally mounted, shall measure the water flow rate each of the activated carbon/multimedia filters, the RO feedwater flow to each RO train, and concentrate water from each RO train.

4. A flow indicator, locally mounted, shall measure the flow of dilution water to the brine mixing tee. Also a brine concentration meter to measure the concentration of the diluted brine used to regenerate the softeners shall be provided. Meter can be local and shall read out in percent sodium chloride.

5. A flow indicating, locally mounted “in-line” type, shall measure the flow rate of saturated brine. This indicator shall be sized for at least 150 percent of the expected flow rate.

6. A flow indicating totalizer, locally mounted, shall measure the flow through each softener, from the RO permeate of each train and the

demineralized water flow to the storage tank. They shall indicate flow rate and shall have contacts to actuate the "volume exhausted" alarm point for the softeners.

7. A turbidity analyzer shall be provided for monitoring the activated carbon/multimedia effluent. Turbidity analyzer shall be Hach Model 1720D or equivalent.

8. A hardness analyzer shall be provided to monitor the effluent of the in-service softener. Hardness analyzer shall be a Hach Model 510 or equivalent.

9. A silica and TOC analyzer shall be provided for the combined EDI effluent. Silica analyzer shall be Hach Series 5000 or equivalent.

10. One annunciator, board mounted, with separate buzzer, to contain points as required for monitoring operation. The annunciator shall have a relay contact to transmit any of the aforementioned alarm to a single alarm window in the main control room. Wiring from the annunciator to GPA's main control room shall be provided and installed by Supplier. Wiring shall be terminated at a single point in a terminal box. A test switch shall be provided to test operation of the annunciator lamps.

The annunciator board shall include, but shall not be limited to, the following items:

High Turbidity, Filter Effluent

High Differential Pressure, Filters

Volume Exhausted, Softener 1

Volume Exhausted, Softener 2

High Hardness Softener

Brine Concentration High/Low

High Differential Resin Trap

High Differential Pressure, Cartridge Filters

High Conductivity, RO Permeate

High Conductivity, EDI effluent

High Silica EDI effluent

System Shutdown

6.15 Piping, Valves & Fittings

A. Regenerant system mixing tee and associated regenerant and dilution water control valves, each with check valves, shall be provided.

B. Check valves shall be provided after each RO train to prevent backflow.

C. Supplier shall provided sample lines for the following list of points:

Sample points located on the suction side of a pump shall be able to provide a sample when the pump is running.

1. Influent to activated carbon/multimedia filters.
2. Effluent of each activated carbon/multimedia filter.
3. Effluent of each softener.
4. Overall RO feed.
5. Overall RO permeate and permeate from each RO
6. RO reject combined
7. Gas Membrane effluent
8. Effluent of each electrodeionizer module and combined effluent

D. All piping shall be schedule 80 CPVC. The use of fire hose (or other flexible hose) for interconnecting piping is not permitted in the design. Rigid piping shall be used.

E. Each valves shall have specific S.S name plate, and put clearly flow directions on each piping as necessary.

6.16 Seismic and Wind Load Requirements

A. Seismic Loading

Systems, equipment or components shall be designed to comply with the seismic provisions of Chapter 23 of the Uniform Building Code for Seismic zone 4 or a minimum of 0.2g equivalent static loading, whichever is greater, applied in any horizontal direction. The design load shall be applied at the center of gravity of each part, unit or appendage.

B. Typhoon

Guam is in an area of high typhoon activity. Equipment shall be designed to withstand winds of up to 155 miles per hour with a gust factor of 1.0.

6.17 Acoustic Requirements

Supplier shall warrant that the Apparatus shall meet OSHA requirements with respect to airborne noise.

6.18 Equipments Loading Data and Hoist Unit

Select Hoist for Equip installation and Maintenance：Electricals Hoist 6 Ton, 6 Directions.

7. TECHNICAL SERVICES REQUIREMENTS

A. Supplier shall furnish the services of a service an construction engineer. Supplier work shall consist of the following:

1. Erection and installation of the Apparatus.

2. Startup of the entire Apparatus.

3. Instruction on operating procedures on all phases of the system.

4. Contractor/supplier shall train and test GPA/TEMES personnel on the operation and maintenance of the system. Training shall be done in the classroom and actual operation of the system. Upon completion of the training, supplier shall provide certification to all trained operators.

5. Final control adjustments and placing of the Apparatus in commercial operation.

GPA/TEMES Representative or personnel he may designate shall be kept advised by the supplier's engineers as to progress made during erection and startup operation. The service engineer shall report any difficulties experienced during this period with corrective recommendations and/or action being taken by him.

When supplier service engineer requires the assistance of any subcontractor personnel relating to the Apparatus furnished, such assistance shall be obtained at Supplier's expense.

B. Supplier shall provide an onsite supervisor/operator to perform maintenance and oversee operations for the duration of the contract. Supplier personnel shall provide any necessary training to GPA operators for operations of equipment.

8. WARRANTIES

A. Performance warranties stated in Statements 5.4, 5.5, and 5.8 shall apply.

B. Equipment, installation and construction work shall warrant for a period of one (1) year.

C. Warranty shall commence upon final completion and acceptance of the acceptance of the system.

9. ACCEPTANCE

A. Factory Test

Owner's Representatives shall conduct an inspection of the completed system/unit prior to shipment. Supplier shall notify the GPA/TEMES 20 days in advance of the date of inspection. Supplier shall pay for all expenses including airfare, lodging, transportation to and form lodging area and place of inspection, and per diem for three representatives of the Owner who will conduct the inspection. The factory inspection does not waive the requirements for the acceptance test after installation and commissioning.

B. Startup and Acceptance Tests

Startup and Acceptance tests shall be performed in accordance with Sections 5.4, 5.5, 5.7 and 5.8 of this Specification to test the warranted performance conditions stated in Statement, Item 1, 3 through 4, 5 through 7.

C. Training of Temes/GPA Personnel

Contractor shall provide training to GPA/Temes personnel on the operation and maintenance of the system. Training shall include but not limited to classroom instructions and actual operation and maintenance of the system. Contractor shall ensure that Owner's operators are familiarized with the operation and maintenance before the system is turned over to the Owner. A training syllabus shall be submitted to the Owner for approval two weeks prior to the actual training.

D. Acceptance Criteria

GPA/TEMES shall accept Apparatus upon satisfactory completion of startup, and Acceptance tests per Item B, above.

E. Five (5) copies of final reports shall be submitted to GPA/TEMES after acceptance test completed.

10. SPARE PARTS LIST

A. No later than three months before receipt of Apparatus at the jobsite, supplier provide as a bid option cost of spare parts need to be kept as inventory by GPA/TEMES.

B. Supplier shall provide enough quantity of consumables good for the first 2 months of operation after startup and commissioning. It shall include but not limited the following consumables:

a. Cartridge Filter 5 micron minimum of 2 of each set.

b. Ultraviolet lamp minimum of 4 each.

11. OPERATING INSTRUCTIONS

Supplier shall submit 5 complete copies of the installation, detail operation and

maintenance instructions, including identification lists for each item of Apparatus. Control and operation instructions for the system as a whole shall be included as well as those applying to subcontractor items. Instructions shall be specific to the Apparatus provided.

Five(5) copies of the control and operation instructions for the water treatment system RO+EDI as a whole, but excluding those instructions specific to subcontractor items shall be submitted for approval at least one month prior to start up and commissioning of the system.

Fire (5) copies of procedures as following shall be provided for GPA/TEMES Review 3 months before installations.

(a) start up test procedures

(b) Operations procedures

(c) Maintenance procedures (including trouble shooting)

12. Attachment

12.1 Instruments List

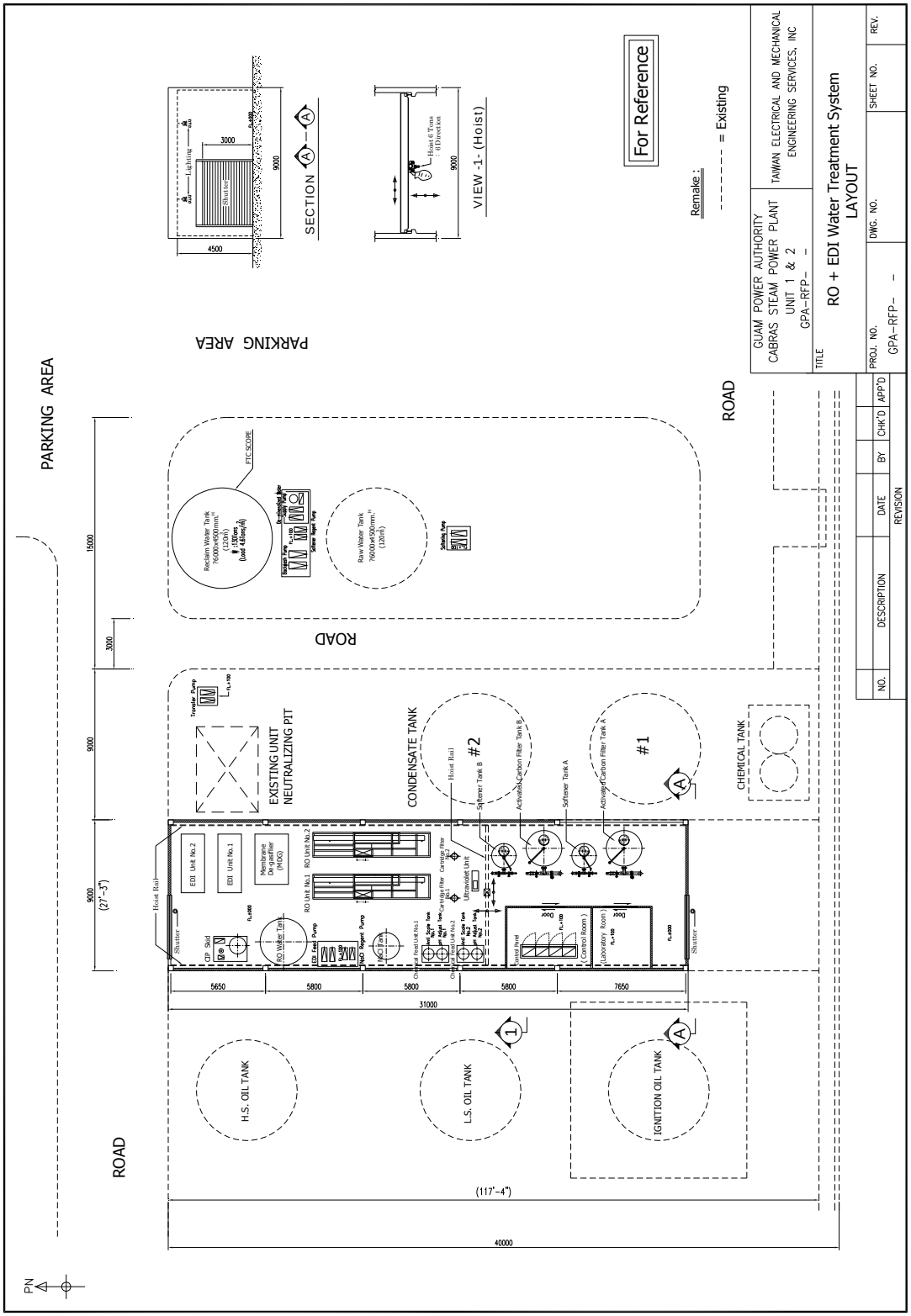
Instruments List

Description	*USE Site*	*Q'TY*	*UNIT*	*REMARK*
Pressure indicator (0~6 kg/cm^2)	RAW Transfer Pump A/B outlet	2	set	
Pressure indicator (0~6 kg/cm^2)	RO high-pressure Pump A/B outlet	2	set	
Pressure indicator (0~6 kg/cm^2)	RO Reclaim Pump A/B outlet	2	set	
Pressure indicator (0~6 kg/cm^2)	RO Permeate water transfer Pump A/B outlet	2	set	
Pressure indicator (0~6 kg/cm^2)	RO clean Pump A/B outlet	1	set	
Pressure indicator (0~6 kg/cm^2)	Vacuum Pump outlet	1	set	
Pressure indicator (0~6 kg/cm^2)	EDI circulation pump outlet	2	set	
Pressure indicator (0~6 kg/cm^2)	ACF TOWER A/B inlet	2	set	
Pressure indicator (0~6 kg/cm^2)	ACF TOWER A/B outlet	2	set	
Pressure indicator (0~6 kg/cm^2)	Softener A/B inlet	2	set	
Pressure indicator (0~6 kg/cm^2)	Softener A/B outlet	2	set	
Pressure indicator (0~6 kg/cm^2)	Prefilter A/B inlet	2	set	
Pressure indicator (0~6 kg/cm^2)	Prefilter A/B outlet	2	set	
Pressure indicator (0~15 kg/cm$^{2)}$	RO Stage 1 inlet	2	set	
Pressure indicator (0~6 kg/cm$^{2)}$	RO Stage 2 inlet	2	set	
Pressure indicator (0~6 kg/cm$^{2)}$	RO Stage 2 outlet	2	set	
Pressure indicator (0~6 kg/cm^2)	MDG inlet	1	set	
Pressure indicator (0~6 kg/cm^2)	MDG outlet	1	set	
Pressure indicator (0~6 kg/cm^2)	EDI A/B inlet	2	set	
Pressure indicator (0~6 kg/cm^2)	EDI A/B outlet	2	set	
D/P indicator	ACF Tower A/B	2	set	
D/P indicator	Softener A/B	2	set	
Pressure Switch	RO unit A/B	2	set	
Level Switch	Raw Water Tank	1	set	
Level Switch	NaCl Storage Tank	1	set	
Level Switch	RO Clean Tank	1	set	
Level Switch	Reclaim Water Tank	1	set	
Level Switch	Demineralized Water Tank	1	set	
Conductivity Meter	RO unit inlet	1	set	
Conductivity Meter	RO unit outlet	1	set	

Instruments List

Description	***USE Site***	***Q'TY***	***UNIT***	*REMARK*
Conductivity Meter	EDI inlet A/B	1	set	
Conductivity Meter	EDI outlet A/B	1	set	
Flow transmitter	RAW Transfer Pump outlet	1	set	Burkert or Equivalent
Flow transmitter	RO outlet A/B	1	set	Burkert or Equivalent
Flow transmitter	EDI outlet A/B	1	set	Burkert or Equivalent
Flow transmitter	USE POINT	1	set	Burkert or Equivalent
Flow indicator	RAW Transfer Pump outlet	1	set	
Flow indicator	Softener inlet	1	set	
Flow indicator	RO unit inlet	1	set	
Flow indicator	RO Unit Concentrate inlet	1	set	
Flow indicator	RO Permeate water transfer Pump A/B outlet	1	set	
Flow indicator	RO Reclaim Pump A/B outlet	1	set	
Flow indicator	Pure Pump outlet	1	set	
Turbidity meter	ACF Tower outlet A/B	1	set	
Hardness meter	Softener outlet A/B	1	set	
Silica analyzer(4 Channel)	EDI outlet A/B	1	set	
T.O.C Analyzer	EDI outlet A/B	1	set	

12.2 RO+EDI Water Treatment System Layout



12.3 RO+EDI Water Treatment System Flow Block Diagram