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DETAILED EQUIPMENT SPECIFICATION

MRO-8 SERIES REVERSE OSMOSIS SYSTEMS

1.0 SCOPE

- 1.1 Provide as indicated a factory assembled reverse osmosis (RO) system shipped for ease of installation and start up. The system shall be of an approved design as fabricated by a manufacturer regularly engaged in the production of water treatment equipment. All equipment and material shall be supplied per the specifications as intended for a complete and operational system.
- 1.2 Qualified manufacturers of water conditioning equipment shall be engaged in the manufacture of this type of equipment for a period of not less than (10) years. Acceptable manufacturers are Marlo, Inc. or engineer's approval equal.

2.0 GENERAL DESCRIPTION

- 2.1 The system, in compliance with equipment specifications, is described as an _____
- 2.2 The system specifications are based on Marlo Model MRO-_____

3.0 DESIGN DATA

3.1 DESIGN PARAMETERS

Design System Flow _____ GPM (RO make-up rate)
Design System Flow _____ GPM (Distribution)
Daily Water Usage _____ Gallons / Day
Daily Hours of Water Demand _____ Hours / Day
Operating Temperature Range _____ °F
Operating Pressure Range (System) _____ PSIG
Electrical Requirements _____
System Dimensions (LxWxH) _____
Desired Storage Capacity _____ Gal.

3.2 WATER ANALYSIS

(insert accurate feed water quality report here)

3.3 DESIRED WATER QUALITY

(insert final water quality parameters here)

4.0 EQUIPMENT DESCRIPTION

4.1 RO MEMBRANE ELEMENTS

The RO elements shall be thin-film composite type (TFC), 8" diameter x 40" long with an FRP overwrap, anti-telescoping device and u-cup brine seal. Each element shall be rated for 9,000 GPD product flow and an average salt rejection of 99.5% based on 2000-PPM water and 225 PSIG at 77 degrees F.

4.2 RO ELEMENT HOUSINGS

The RO element housings shall be constructed of composite FRP with a high gloss white polyurethane exterior finish. Feed and concentrate discharge connections shall be side-entry, victaulic grooved couplings constructed of 316 stainless steel. Housing end-cap closures shall be constructed of PVC thermoplastic with stainless steel retaining rings and ethylene propylene seals. Product water connections shall be threaded and constructed of PVC. Membrane housings shall contain between 3-6 elements each depending on the RO machine model. Membrane housings shall be rated for 300 psig maximum allowable working pressure with an ASME Code Stamp available as an option. The housings shall have a multi-port design allowing the vessel concentrate discharge from one bank of housings to directly enter the feed port of the next bank of housings thereby eliminating the need for interconnecting manifolds.

4.3 HIGH PRESSURE PUMP AND MOTOR

The high pressure feed pump shall be a multistage centrifugal type constructed of 304 stainless steel casing, shaft, impellers, inlet and discharge castings. The mechanical seal shall be silicon carbide and pump bearings shall be tungsten carbide and ceramic. The pump shall have a cast iron frame with flanged suction/discharge connections. A NEMA standard C-faced TEFC motor shall be mounted to an adapter supported on the pump-bearing frame. The motor shall be rated for a 3500 RPM, 460 VAC, three-phase, 60 Hz. power supply.

4.4 ELECTRICAL CONTROL SYSTEM

A fully automatic system shall be provided and consist of a separate control / monitor panel and a motor starter panel. The control / monitor panel shall consist of an Allen-Bradley MicroLogix Series programmable logic controller (PLC) with sufficient inlet/output cards, memory, and processing speed for the application. The PLC shall be housed in a NEMA-4 electrical enclosure and pre-wired with all necessary internal wiring, terminal blocks, relays, and fuses. The PLC panel front door shall be provided with operator selector switches, status/alarm lights, elapsed run time meter, and alarm horn. Pressure switches shall be provided with adjustable alarm set-points for low inlet water pressure and high pump discharge pressure. The pump motor starter shall be housed separately from the PLC panel in a NEMA-4 electrical enclosure. The starter shall be IEC style with an overload trip range appropriately sized for the actual site voltage and motor horsepower.

4.5 INSTRUMENTATION

Two (2) panel-mounted, digital-display flowmeters shall be provided for the product and concentrate outlet lines. Panel-mounted, 2.5-inch face pressure gauges shall be provided for the feed inlet, cartridge filter outlet, RO membrane feed, RO concentrate discharge, and RO product. Pressure gauges shall be constructed of 316 stainless steel and liquid filled. A panel-mounted conductivity monitor shall be provided to measure the RO product water quality (in microsiemens/cm). The conductivity monitor shall have a digital display, alarm relays, and automatic temperature compensation. The conductivity probe shall be mounted in the RO product outlet line and pre-wired to the conductivity monitor.

4.6 VALVES

The pump throttle valve, concentrate throttle valve and recycle throttle valve shall be an in-line ball style, constructed of stainless steel and rated over 300 PSIG. The automatic inlet shutoff valve shall be a butterfly type, pneumatically actuated, normally closed, and constructed with a cast iron body and nylon coated disc. The inlet isolation valve, product and concentrate check valves and sample valves shall be PVC with EPDM seats and seals. Sampling valves shall be provided for the cartridge filter inlet/outlet, concentrate outlet, product outlet, and at each membrane housing product port. The machine shall be equipped with an automatic membrane flush valve in order to purge the RO membranes with fresh water when the machine shuts down as a means of reduces membrane scaling and fouling.

4.7 CARTRIDGE PRE-FILTER

A cartridge filter housing shall be provided in the RO machine inlet line and constructed of 304 stainless steel and include a manual air vent and drain valve. The filter element shall be constructed of spun-wound polypropylene and rated at 5-micron nominal. The hydraulic loading of the prefilter shall not exceed 5 gpm per 10-inch of filter length.

4.8 SKID AND FRAME ASSEMBLY

The entire RO machine shall be built on a skid and frame constructed of structural carbon steel and completely electrically welded. The entire surface shall be sand-blasted and finish painted with a "Safety Blue" self-priming, high solids epoxy overcoat.

4.9 PIPING

All low pressure piping (75 psig or less) shall be constructed of Sch 80 PVC. Low pressure control and pressure gauge tubing shall be constructed of polyethylene.

All high pressure piping (75 psig and higher) shall be constructed of 304 stainless steel. High pressure control and pressure gauge tubing shall be 1000 psig burst nylon.

4.10 INSTRUCTIONS

A set of three (3) complete Installation, Operation and Maintenance manuals shall be provided in three-ring binder form. As-built general arrangement, process and instrument, and electrical drawings shall be included. All component data, manuals, calibration documents shall also be included. A recommended "on-hand" spare parts list shall be provided.

4.11 WARRANTY

The manufacturer shall provide an 18-month materials and workmanship warranty from the date of equipment shipment. Membrane element warranty is per the selected RO element manufacturer standard warranty.

4.12 FIELD-SERVICE

On-site startup or service shall be made available from the factory or the local manufacturers representative. Technical service phone support and spare parts must also be available from the manufacturers factory. Rates and prices to be clearly stated in the operation and maintenance manuals.

5.0 OPTIONAL EQUIPMENT (RO PRE-TREATMENT)

5.1 MULTI-MEDIA FILTER

A duplex parallel multi-media filter properly sized for the inlet flow rate of the RO machine shall be provided for suspended solids removal down to the order of 10-20 micron. Media tank to be constructed of carbon steel with an epoxy lined interior and designed for 100 psig working pressure. A pre-piped internal backwash distributor and filtered water collector shall be provided. The filter media shall consist of a top layer of anthracite, middle layer of silica sand, and bottom layer of multi-grade garnet. The filter media shall be provided separately in one (1) cubic foot bags and installed at the job-site. The automatic backwash cycle shall be performed by a side-mounted, pre-piped configuration of diaphragm valves with a pre-sized drain line flow control orifice. The backwash cycle to be initiated by an adjustable seven (7) day electro-mechanical calendar timeclock. One (1) filter unit shall be sized to intermittently handle the full RO feed flow during a backwash cycle without the need to shutdown the RO machine.

Basis of Design: Marlo MID Series

5.2 ACTIVATED CARBON FILTER

A duplex parallel activated carbon filter properly sized for the inlet flow rate of the RO machine shall be provided for the removal of chlorine and prevention of RO membrane damage. Media tank to be constructed of carbon steel with an epoxy lined interior and designed for 100 psig working pressure. A pre-piped internal backwash distributor and filtered water collector shall be provided. The filter media shall consist of a 12 x 40 mesh, acid-washed, bituminous coal based activated carbon. The filter media shall be provided in one (1) cubic foot bags and installed at the job-site. The automatic backwash cycle shall be performed by a

side-mounted, pre-piped configuration of diaphragm valves with a pre-sized drain line flow control orifice. The backwash cycle to be initiated by an adjustable seven (7) day electro-mechanical calendar timeclock. One (1) filter unit shall be sized to intermittently handle the full RO feed flow during a backwash cycle without the need to shutdown the RO machine.

Basis of Design: Marlo ACA Series

5.3 WATER SOFTENER

A duplex alternating water softener properly sized for the inlet flow rate of the RO machine and incoming water hardness shall be provided to prevent the scaling of RO membrane elements. Resin tank to be constructed of carbon steel with an epoxy lined interior and designed for 100 psig working pressure. A pre-piped internal backwash distributor and soft water collector shall be provided. Softening resin shall have an exchange capacity of 30,000 grains per cubic foot when regenerated with 15 lbs of salt. The brine tank shall be constructed of rotationally molded polyethylene with snug-fitting cover. A float operated, air-check brine valve shall be provided to automatically measure the correct amount of brine to the softener unit and re-fill with fresh water.

The softener regeneration shall be performed by a side-mounted, pre-piped configuration of diaphragm valves with a pre-sized drain line flow control orifice and brine injector. A remotely located water meter shall monitor the volume of water processed and automatically initiate softener regeneration. An alternator controller shall be provided to permit only one vessel in service at any time. The second tank is to be in either regeneration or stand-by mode at any time. Basis of Design: Marlo MR/MHC Series

5.4 CHEMICAL DOSING SYSTEMS

As an alternative to activated carbon filtration for chlorine removal, an injection of liquid sodium bisulfite 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. A status alarm shall be added to the control system during low chemical tank level.

As an alternative to water softening for membrane scaling prevention, an injection of a polymeric scale inhibitor 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. A status alarm shall be added to the control system during low chemical tank level.

5.5 INLET pH MONITOR

A panel-mounted, digital display pH monitor shall be provided for the RO inlet feed water line. It shall be provided with adjustable high/low alarm setpoints and a temperature compensated pH probe.

5.6 INLET ORP MONITOR

A panel-mounted, digital display oxidation-reduction potential (ORP) monitor shall be provided for the RO inlet feed water line. Designed to detect the presence of chlorine in the feedwater. It shall be provided with adjustable high/low alarm setpoints and a temperature compensated pH probe.

5.7 SDI APPARATUS

A Silt Density Index (SDI) apparatus shall be provided to measure the degree of suspended solids feeding the RO membranes. It consists of a pressure regulator pressure gauge, filter holder, 600 mL beaker, sample valve, tubing and 0.45 micron filter papers.

5.8 WATER TEST KIT

A comprehensive water quality testing kit shall be provided to field-measure total water hardness, total iron, free chlorine, and pH.

6.0 OPTIONAL EQUIPMENT (RO POST-TREATMENT)

6.1 ATMOSPHERIC STORAGE TANK

The free-standing RO product water storage tank shall be constructed of linear polyethylene in one piece, seamless construction and closed-top, flat bottom design. The tank shall have a top manway for convenient access. PVC bulkhead fittings shall be installed for high / low-level switches, RO permeate inlet, RO permeate discharge, and drain. A 0.2-micron tank vent filter shall be installed at the top head of the tank.

6.2 STORAGE TANK LEVEL CONTROL

An adjustable float switch assembly shall be provided for the product storage tank. Switches shall signal start and stop to the RO unit. A secondary adjustable float switch shall be provided for low tank level, and shall signal the shut-off of the repressurization pump.

6.3 RO WATER RE-PRESSURIZATION PUMPS

Two (2) close coupled, single-stage centrifugal pumps suitable for the distribution of RO water shall be provided. One pump is designed as a dedicated piped and wired spare. Wetted components shall be constructed of 316 stainless steel with flanged suction / discharge connections. Motors shall be ODP and rated for 3500 RPM, 460 VAC, three-phase, 60 Hz power supply. A NEMA-4 pump control panel shall be provided with prewired motor starters, pump selector switch, pump run lights, low tank level alarm light, hand / off / auto switch, and pump run hour meters.

Basis of Design: G&L NPE or SSH Series

6.4 ULTRAVIOLET LIGHT

An ultraviolet water disinfection light shall be provided for the effective destruction of water bacteria present in the storage tank and distribution line. The lamp wavelength shall be 254 nm with a 9,000 hour life. The pressure vessel shall be 316 stainless steel with NPT or flanged inlet / outlet connections. The UV lamp shall be housed in a heavy-duty quartz jacket. A NEMA-3R electrical control cabinet shall include an elapsed run time meter and ballast power indicator light. The ON / OFF control shall be wired through the pump control panel. Basis of Design: R-Can Sterilight Series

6.5 POST-FILTER HOUSING

Designed to trap contaminants downstream of the storage tank and UV light. Filter housing shall be constructed of 316 stainless steel and include a manual air-vent and drain valve. The filter element shall be spun-wound polypropylene and rated for 1.0 micron nominal. The hydraulic loading of the prefilter shall not exceed 5 gpm per 10-inch of filter length.

6.6 MEMBRANE CLEAN-IN-PLACE (CIP) SYSTEM

The RO machine shall be provided with equipment 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 prepared in a free-standing polyethylene storage tank with a conical-bottom and open-top. The cleaning solution shall be recirculated through the RO membranes via a 316 stainless steel single-stage centrifugal pump that is mounted and wired directly on the RO machine. The system shall include CIP inlet/outlet connections, isolation valves, transfer hoses, CIP inlet cartridge filter (25-micron), CIP inlet flowmeter, thermometer, and tank immersion heater.