SECTION 01 74 00 MEMBRANE SYSTEM AND MODULE WARRANTY

PART 1 -- GENERAL

1.01 SUMMARY

A. Section includes:

1. Membrane system and module warranty information.

2. This section covers the membrane system equipment and module warranty. This section addresses the requirements in conjunction with the provisions of Paragraphs 9.01, 9.03 and 9.04 of the General Conditions.

B. Related specification sections include but are not necessarily limited to:

1. Division 00, Procurement and Contracting Requirements.

2. Division 01, General Requirements.

3. Section 11 30 00, Hollow Fiber Membrane Equipment

1.02 QUALITY ASSURANCE

A. Referenced standards:

1. ASTM International:

a. D6908, Standard Practice for Integrity Testing of Water Filtration Membrane Systems.

B. Seller's Quality Assurance/Quality Control (QA/QC) Procedures

1. Submit for approval, prior to the shipment of the membrane modules, reports in letter format for each membrane module. At a minimum, the reports shall include:

a. The membrane module model and part number, manufacturing lot number and serial number. Indicate the nominal and absolute pore size, inside and outside fiber diameter, effective fiber length, and effective feed side surface area of the membrane module.

b. The membrane module normalized specific flux (permeability, gfd/psi at 20°C).

c. A certification by the membrane module supplier that:

1) Each membrane module has passed the Seller's QA/QC (integrity) tests.

d. Certification of wet testing for each membrane module conducted at the Seller's facilities. Seller shall certify that each membrane module has passed the QA/QC tests for membrane element integrity. Acceptable QA/QC tests include bubble point or pressure hold tests above the minimum value recommended by the Seller and approved by the Engineer.

e. Identify modules that have undergone pinning or repair for more than 0.1 percent of original fibers at the factory.

2. Certificates of Warranty

a. Submit a listing of chemical constituents, concentrations and exposure times that would void the membrane warranty.

1.03 DEFINITIONS

A. Log Reduction Value (LRV): The filtration removal efficiency expressed as $\log_{10}$ for a target organism or surrogate.

B. Membrane Module(s): Hollow fiber membranes arranged as a module that is a sub-assembly of a MF/UF Unit.

C. Membrane Integrity Failure Occurrence:

1. A loss of integrity (e.g., partial or complete fiber breaks) that results in less than 4-log (LRV of 4 or 99.99 percent filtration efficiency for a removal of 3 micron or larger particles) as determined by an air pressure based Direct Integrity Test such as the:

a. Pressure Decay Test.

b. Diffusive Airflow Test.

c. Correlated Airflow Measurement Test:

1) A pressure decay test, applying Hagen-Poisseville equation per ASTM D6908.

d. Other conforming integrity tests that satisfy the criteria for test resolution and sensitivity as described by any recognized independent method developed by a consortium of membrane module manufacturers or described and accepted as a method by the primacy agency.

2. MF/UF System: The complete MF/UF System is comprised of multiple MF/UF Units and all ancillary equipment.

D. MF/UF Unit(s): One (1) complete filtration unit including valves, pumps, controls, and piping capable of producing filtered water.

E. Substantial Completion: See Division 0, General Conditions.

1.04 SUBMITTALS

A. Shop Drawings

1. Membrane Warranty

a. Submit design calculations to substantiate the 4-Log Membrane LRVs for air pressure integrity testing. Perform calculations based upon a broken fiber·lumen(s) or a microporous defect of 3 microns to determine the worst-case membrane integrity defect scenario.

b. Provide a listing of chemical constituents, concentrations and exposure times that would result in voiding the membrane warranty.

c. For each of the above chemical constituents, identify the instrumentation required and alarm limits necessary to satisfy the warranty provisions of this section.

2. MF Membrane Modules:

a. Include module construction details.

1) Materials of construction.

2) Dimensions.

3) Standard commercial part numbers and materials for elastomeric seals. Note that Buna-N seals are not acceptable.

b. Include standard performance parameters.

1) Operating temperature.

2) pH and oxidant tolerance (continuous and intermittent).

3) Range of membrane flux.

4) Clean water normalized specific flux (permeability or resistivity).

5) Minimum bubble point or maximum pressure decay test parameters.

c. Include storage and handling requirements.

d. Provide standard operating and maintenance data including storage solutions (concentration and volume) used during shipment and recommended rinsing solutions (concentration and volume) and long-term/short-term storage protocols.

B. Factory Test Reports

1. Prior to delivery of the membrane modules, submit the following:

a. Seller shall identify each membrane module by a unique serial number and indicate the membrane lot.

b. Seller shall provide the membrane specification sheets that specify each membrane module's normalized specific flux (gfd/psi at 20°C), nominal pore size, and the nominal inside and outside surface area of the filter module.

c. Certification of wet testing for each membrane module conducted at the Seller's facilities. Seller shall certify that each membrane module has passed the QA/QC tests for membrane element integrity. Acceptable QA/QC tests include bubble point or pressure hold tests above the minimum value recommended by the membrane module supplier and as approved by the Engineer.

C. Certificates of Warranty

1. The listing of chemical constituents, concentrations, and exposure time that would void the membrane warranty.

1.05 MEMBRANE SYSTEM WARRANTY

A. During the Correction Period, the Seller shall furnish an equipment warranty certificate assuring the containerized membrane filtration units and system (including membrane modules) will meet the service conditions specified in Section 11 30 00, Hollow Fiber Membrane Equipment, Paragraph 2.01.

B. Seller warrants satisfactory performance of the Goods to achieve equipment performance (e.g., design flows, water recovery, backwash, chemical washing, and Clean-In-Place (CIP) intervals) and water quality (e.g., integrity failure) objectives and complies with the concept of linear scalability as defined in the Agreement.

C. In the event that the Buyer does not believe that the Goods meet the specifications, including the criteria of linear scalability, the Buyer shall notify the Seller that the conditions for a breach of contract exist. Seller shall provide at no cost to the Buyer pilot equipment of the type and kind evaluated during the pilot testing, if not available to the Buyer, to verify the compliance with the specifications. In the event that the Buyer determines that the equipment does not comply with the specifications including the concept of linear scalability, the Seller shall provide an acceptable remedy to the Buyer in accordance with the General Conditions. If an acceptable remedy is not obtained, the Buyer shall notify the Seller that a breach of contract exists.

D. If the Goods are non-conforming and unable to conform to the equipment performance objectives for criteria other than linear scalability, the Buyer will notify the Seller in accordance with the procedures identified in Paragraph 9.03 of the General Conditions. Buyer shall make available to the Seller electronic records for Seller review. Seller shall be given 10 days to develop a plan to remedy the non-conformance.

E. If within 60 days after the notification to the Seller it has become apparent to the Buyer that the remedy is not acceptable, the Buyer will provide notice to the Seller that the conditions for breach of contract exist. If within 30 days an acceptable remedy is not obtained, the Buyer shall notify the Seller that a breach of contract exists.

F. Buyer recognizes that to remedy system warranty provisions, the Seller may need to modify operational protocols. Seller recognizes that any change to the operational protocols must be acceptable to the Buyer. Buyer recognizes that any changes to operational protocols by the Seller pursuant to this warranty provision are acceptable under the following conditions:

1. That the specified design parameters (e.g., production capacity, water quality, system recovery, and chemical cleaning interval) are obtained.

2. That the change in operational parameters and protocols (e.g., backwash, chemical washing, or chemical cleaning) will not represent an increase in operational or membrane replacement costs to the Buyer.

1.06 MEMBRANE MODULE WARRANTY

A. General:

1. Seller warrants that the membrane modules will be used for the treatment of water for drinking purposes and that in accordance with Paragraph 5.08 of the General Conditions the membrane modules are fit for the intended purpose.

2. Membrane modules and elements purchased by the Buyer or otherwise provided under the Agreement or as a future membrane replacement shall be provided with the same warranty as the membrane modules and elements provided as part of the original equipment installation.

3. Seller warrants that the membrane modules and elements will be free from non-conformance in:

a. Materials.

b. Workmanship.

c. Membrane integrity failure.

d. Irreversible flux loss.

B. Membrane Module and Element Warranty Periods

1. Seller shall warrant the performance of the supplied MF/UF membrane modules for a period of not less than ten (10) years (inclusive of the three (3) years full replacement warranty period) from the date of Substantial Completion.

a. The warranty shall guarantee the performance of the membrane modules so as to meet the MF/UF system design and performance criteria specified in Section 11 30 00, Hollow Fiber Membrane Equipment.

b. Membrane modules that within the first year become non-conforming, as defined by the requirements specified herein, must be replaced with new membrane modules at no cost to the Buyer.

2. Seller’s membrane module and element warranty periods have been established in the Proposal.

a. Seller’s membrane module warranty period shall commence with the date of Substantial Completion and continue until the end of the pro-rata warranty period submitted by the Seller with the Bid.

b. The membrane module and element warranty periods shall consist of two (2) parts: a full replacement warranty period and a pro-rata warranty period.

1) The full replacement warranty period shall last for a period of at least three (3) years after the date of Substantial Completion as described below:

a) For membrane modules or elements supplied as part of the original equipment installation, the date of Substantial Completion is when the full replacement warranty period commences.

b) For membrane modules or elements provided after the start of Substantial Completion, the full replacement warranty period begins the date the membrane module or element is placed into service.

c) Buyer shall record and maintain records of the date of installation for all membrane modules and elements.

2) The pro-rata warranty period of seven (7) years shall commence with the end of the full replacement warranty period and last until the end of the pro-rata warranty period as submitted by the Seller in the Bid.

C. In the event that the Goods do not meet the performance requirements specified, including the criteria of linear scalability, the Buyer shall notify the Seller in writing requesting warranty replacement modules.

1. Following return notification, the Seller shall have an optional 10-day period to provide on-site troubleshooting and/or repair of the defective Goods.

D. In the event that the capacity or quality cannot be regained through these efforts, an adequate number of modules will be replaced as per the terms of the warranty to recover system performance within the parameters specified in Section 11 30 00, Hollow Fiber Membrane Equipment.

E. If within 60 days after the notification to the Seller it has become apparent to the Buyer that the remedy is not acceptable, the Buyer will provide notice to the Seller that the conditions for breach of contract exist.

1. If within 30 days following such notice an acceptable remedy is not obtained, the Buyer shall notify the Seller that a breach of contract exists.

F. Buyer recognizes that to remedy system warranty provisions, the Seller may need to modify operational protocols.

1. Seller recognizes that any changes to the operational protocols must be acceptable to the Buyer.

2. Buyer recognizes that any changes to operational protocols by the Seller pursuant to this warranty provision are acceptable under the following conditions:

a. That the specified design parameters (e.g., production capacity, water quality and system recovery) are obtained.

b. That the change in operational parameters and protocols (e.g., backwash, chemical cleaning, or recovery cleaning) will not represent an increase in operational or membrane replacement costs to the Buyer.

c. Revised protocol is subject to review and approval by the Buyer and/or Engineer.

G. Limitation of Membrane Module and Element Warranty

1. Buyer recognizes that the occurrence of any of the following shall void the membrane module and element warranties:

    a. Physical damage or faulty installation of the membrane modules or elements by anyone other than Contractor, Seller, or Seller's authorized representative.

    b. Unauthorized alteration of components manufactured by the Seller.

    c. Catastrophic exposure to chemicals or deleterious substances not normally associated with water treatment as a result of accidents, vandalism or other acts that are outside the bounds of routine and normal water treatment plant operations.

    d. Use of water treatment chemicals, chemical cleaning solutions or cleaning procedures other than chemicals, solutions and procedures approved by the Seller.

    e. Exposure of the membrane modules or elements to treated water or water treatment chemicals at concentrations above levels or contact times acceptable to the Seller.

        1) Seller is responsible for providing the Buyer a listing of the known water treatment and cleaning chemicals and concentrations and times of exposure that could result in membrane damage.

        2) Operation or cleaning of any membrane module or element outside the stated chemical limits shall void the remaining portion of the membrane module or element warranty.

    f. Improper maintenance of equipment, as defined in the Technical/O&M Manual.

    g. Failure of the Buyer to maintain operational logs as required by the Seller.

        1) The maintenance of electronic logs is subject to the following conditions:

            a) Seller is responsible for providing the Buyer a listing of the operational data points that are to be electronically logged.

            b) Seller is responsible for the control programming of data points that are to be electronically logged.

            c) Seller shall identify minimum frequencies of logging of all operational data points required by the Seller to maintain membrane module and element warranty provisions.

            d) Seller shall establish the alarm and shutdown limits that would result in the operation of the equipment outside of Seller acceptable limits.

            e) Seller shall be solely responsible for the identification and programming of system interlocks that would result in the operation of the system outside of the parameters required by the Seller.

                (a) Buyer will not be responsible for errors in Seller developed programming that would result in improper operation of the system.

h. In the event of a warranty claim, failure of the Buyer to provide the Seller with operational logs.

2. Buyer will assume responsibility of maintaining a hand-written log if an occurrence develops that is totally outside the bounds of routine and normal operation or automated operation.

   a. Such items would include obtaining water analyses, or catastrophic events (e.g., discharges of foreign objects or chemicals that are outside the normal operation of a water treatment facility).

3. Changes in the Seller established operational and maintenance guidelines cannot be applied retroactively to invalidate the membrane module or element warranties.

4. Seller is solely responsible for the identification of water quality parameters normally associated with water treatment and water treatment chemicals and cleaning solutions (for procedures approved by the Seller), and for identification of instrumentation and control programming required to satisfy and maintain membrane module and element warranty provisions for operation and cleaning.

5. Buyer recognizes that to satisfy warranty requirements, the Seller may provide membrane replacement modules or elements that embody changes in module or element design and construction features.

   a. Buyer recognizes that the replacement of membrane modules or elements pursuant to this warranty with a different membrane module or element is acceptable under the following conditions:

      1) That the specified design and operational parameters (e.g., design flows, water quality, system recovery and chemical cleaning intervals) are obtained.

      2) That the change in membrane modules or elements will not represent an increase in the operational or membrane module or element replacement costs to the Buyer.

      3) The revised module or element must also be in compliance with regulatory requirements.

H. Membrane Module and Element Pricing

~~1. Seller shall establish the membrane module and element prices (as indicated in the Proposal Pricing Form) and guarantees that:~~

~~a. Membrane modules and elements have been provided to the Buyer at prices not exceeding the prevailing market price.~~

~~b. In the Proposal Pricing Form, the Seller shall indicate the cost escalated Consumer Price Index (CPI) used to calculate the replacement price.~~

~~1) The CPI adjustment is the most recent Month CPI Index divided by the CPI Index for the month of the Bid submittal.~~

~~c. The CPI Index to be used shall be the "CPI-U, US City Average, all Items (non-seasonally adjusted)" as compiled by the U.S. Department of Labor.~~ [Addendum #3]

2. During the full replacement warranty period, the Seller shall provide replacement modules and elements for non-conforming modules and elements at no cost to the Buyer.

~~3. Module and element prices during the pro-rata warranty period shall be calculated as follows:~~

~~a. Pro Rata Module Price = (Module Price x applicable CPI adjustment x Months of Beneficial Use)/Membrane Module Pro-Rata Warranty Period (Months).~~ [Addendum #3]

I. Membrane Module Integrity:

1. Membrane Integrity Test Frequency:

a. Membrane Integrity testing shall be performed daily.

2. LRV Determination

a. The operating Log Reduction Value (LRV) shall be determined at the maximum design flux and maximum Transmembrane Pressure (TMP), if calculated using the test result on an intermittent basis.

b. The LRV shall be determined at the operating flux and TMP, if calculated using the test result on a continuous basis using the result of the last direct integrity test.

c. The LRV calculation shall include the applicable adjustment for the "concentration factor" as described in the Direct Integrity Test provisions of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

d. If empirical data is used for the calculation of LRV, the Seller will provide adequate evidence (e.g., results of challenge testing at the Seller membrane integrity test pressure, air and water flow/pressure drop data) to support the correlation between air pressure integrity test result and LRV based upon a "flow limiting orifice" criteria for a broken lumen at the membrane - membrane pot interface for approval by the Engineer.

3. Membrane Integrity Failure

a. Membrane modules shall be considered to have non-conforming integrity failure if the number of Membrane Integrity Failure Occurrences per membrane unit exceeds three (3) occurrences in a three (3) month period or six (6) occurrences in a 12 month period. A failing membrane integrity test shall be considered a Membrane Integrity Failure Occurrence if the problem is resolved by pinning of a membrane fiber. [Addendum #5]

1) Seller will define the number of fiber breaks per Unit that constitutes Membrane Integrity Failure Occurrence for their particular membrane module.

b. If a Membrane Integrity Failure Occurrence is identified:

1) Module(s) may be isolated from service and the system retested. If isolation of the modules(s) restores Unit integrity requirements, the Unit may be placed back into service.

2) The individual modules shall be pin repaired, or replaced if pin repair is not possible, and the Unit will be retested and returned to service. The membrane module serial number and number of membrane fibers repaired shall be recorded. The Membrane Integrity Failure Occurrence shall be documented by the Buyer.

3) For subsequent Membrane Integrity Failure Occurrences, module(s) may be isolated from service and the Unit placed back into service unless the cumulative area isolated from the Unit reduces the MF/UF System Firm Capacity below that which is required.

4) If module(s) cannot be isolated from service, then all defects in that Unit shall be repaired or replaced (if repair is not possible), and the Unit retested and placed back into service.

5) The membrane module serial number and number of membrane fibers repaired shall be recorded.

c. Individual membrane module(s) shall be considered to have integrity failure under the following conditions:

1) Prior to Acceptance Testing

a) If more than ~~0.05~~ 0.25 [Addendum #5] percent of the fibers are pinned prior to commencement of the Acceptance Testing.

2) After Acceptance Testing

a) If for a single membrane module, more than 0.05 percent of the fibers have required repair (e.g., by pinning or gluing) in any 12 consecutive months.

3) Anytime

a) An individual membrane fiber shall be defined as requiring repair if it visually leaks during an air pressure integrity test at the integrity test pressure.

b) If a module assembly fails the air pressure integrity test and cannot be repaired by pinning or gluing, then the module is considered defective.

c) If the cumulative repairs from the date of manufacture raise the flux rate 0.1 percent above the design flux rate.

d) If more than ~~0.2~~ 0.5 [Addendum #5] percent of the fibers have required repairs over the life of the membrane module. An individual membrane fiber shall be defined as requiring repair if it visually leaks during an air pressure integrity test at the integrity test pressure.

d. If a membrane unit exceeds the maximum amount of Membrane Integrity Failure Occurrences, all membrane modules within the membrane unit shall be replaced unless:

1) Seller can demonstrate, through lot traceability, that the Membrane Integrity Failure Occurrence is attributed to a specific lot of membrane modules within a previously defined range of consecutive serial numbers.

2) The lot size shall be established by the membrane module manufacturer but shall not be less than 25 modules.

3) The number of membrane modules that are accountable for the Membrane Integrity Failure Occurrences are “localized” to less than 10 percent of the membrane modules located on the membrane unit.

e. If it is demonstrated that the membrane integrity failure defect is attributed to a specific lot or localized, then all membrane modules that have had more than a single previous occurrence of repair shall be replaced, even though they may be located in another membrane unit or may not have exceeded the criteria for individual membrane module integrity failure.

f. If more than two (2) membrane units require complete replacement within a 12 month period, the Buyer shall retain the option to replace all remaining membrane modules.

g. After Final Acceptance, if a membrane module is determined to be non-conforming with respect to membrane integrity, the Seller will remedy in accordance with the requirements set forth in this section.

1) Non-conforming membrane modules may be returned to service under the conditions outlined in this section.

2) If within 60 days after the notification to the Seller it has become apparent to the Buyer that membrane modules are not able to meet the provisions of the warranty, the Buyer will provide the Seller with a breach of warranty claim.

J. Irreversible Flux Loss

1. Membrane modules or elements shall be considered to have non-conforming irreversible flux loss under the following condition.

Definition of “clean water” resistance: The temperature corrected membrane resistance is defined as the “clean water” membrane resistance, as indicated in the Proposal Pricing Form, taken at a minimum of one (1) hour after startup of the membrane unit after completion of the chemical cleaning process, and taken five (5) minutes after completion of the most recent backwash. The temperature correction shall be calculated at 20°C using a viscosity correction factor. The equations and units used to calculate “clean water: resistance are as follows:

$$R = \frac{\Delta P}{J\mu}$$

Where: R = Membrane Resistance (psid/gfdcp)
J = Membrane Flux (gfd)
μ = Viscosity of water (cp)
∆P = Differential Pressure (psid)

a. Irreversible Flux loss will be stated to have occurred if the MF/UF Units are not able to obtain a minimum of a 30-day clean-in-place (CIP) intervals respectively for 3 consecutive CIP intervals when operated at or below the temperature adjusted membrane design capacity using backwash (MF/UF Units only) and chemical washing procedures and frequencies established and demonstrated for the particular system during the Performance Testing Period.

b. Prior to the end of the first year or operation, each unit will be tested for permeability.

1) Prior to the permeability test, a CIP will be performed.

a) Seller will be allowed to observe the automated CIP cycle.

b) Bid temperature corrected flux rate will be set for each cell prior to the permeability test.

c) The permeability test duration will be run for a minimum of 5 minutes.

2) If the permeability is not at least 95 percent of the ~~bid permeability~~ baseline permeability established following a CIP performed after at least 30 days of initial operation at the design capacity [Addendum #5], the modules will be considered to have non-conforming irreversible flux loss.

2. In the event that the Seller does not believe that the feed water quality is similar to that defined as the design water quality in Section 11 30 00, Hollow Fiber Membrane Equipment, then the Seller may seek relief from its warranty obligations hereunder to the extent that its failure to meet these obligations is caused by a change in the influent water quality that is outside the range of the design influent water quality parameters.

a. However, relief shall require demonstration that there is a defensible water quality parameter and/or duration that is outside of the influent water quality range that caused the warranty violation.

3. Should the Buyer and the Seller fail to agree on the cause of the warranty violation that is related to influent water quality, the matter shall be sent to binding arbitration.

a. The Buyer and the Seller shall jointly select an arbitration panel consisting of water treatment professionals appointed by each party.

b. The panel will consist of two members of each party or other mutually agreed upon number.

c. The panel will then select 1 additional member as mutually agreed upon.

4. The Buyer recognizes that to remedy warranty provisions for irreversible flux loss, the Seller may modify operational protocols.

a. Seller recognizes that changes to the operational protocols must be acceptable to the Buyer.

b. The Buyer recognizes that the changes to operational protocols by the Seller pursuant to this warranty provision are acceptable under the following conditions:

1) That the specified design parameters (e.g., production capacity, water quality, system recovery and CIP interval) are obtained.

2) That the change in operational parameters and protocols (e.g., backwash, Maintenance Clean or CIP) will not represent an increase in the operational or membrane replacement cost to the Buyer.

c. If more than two units require membrane replacement at any time within Membrane Module Warranty Period for irreversible flux loss, the Buyer shall retain the option to replace all remaining membrane modules using the applicable membrane module price.

PART 2 -- PRODUCTS – (NOT USED)

PART 3 -- EXECUTION – (NOT USED)

PART 4 -- SUPPLEMENTAL INFORMATION

4.01 MEMBRANE LIMITS

Normal Operation

Transmembrane Pressure	-3 bar to + 3 bar (-43.5 psi to + 43.5 psi)
pH	1 to 10
Temperature	0 to 40 degrees C. Consult Pall before using any water treatment polymers

Membrane Cleaning (Includes CIP/MC Processes)

The following values are listed as maximum values that would potentially void the module warranty. Typical CIP and EFM values should be provided by Seller. [Addendum #5]

Temperature	40 degrees C. maximum
Sodium Hypochlorite	5,000 mg/L maximum
~~Hydrogen Peroxide~~	~~200 mg/L maximum~~ [Addendum #5]
NaOH	20~~40~~ g/L maximum [Addendum #5]
Citric Acid	100 ~~300~~ g/L maximum [Addendum #5]

Membrane Storage

Store modules ~~between 1 and 40 degrees C. Do Not Freeze.~~

~~Short Term Storage: If not in use, flush daily with up to 100 mg/L of free available chlorine.~~

~~Long Term Storage: First perform a Clean in Place, store wet, completely filled with 50-mg/L sodium hypochlorite solution.~~ according to seller requirements [Addendum #5]

END OF SECTION