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STANDARD WARRANTY FOR SPIRAL WOUND ELEMENTS 3 YEAR STANDARD WARRANTY

GENERAL

TriSep provides all data in good faith and believes the information and data contained herein to be accurate and useful. However, since any assistance furnished by TriSep with reference to the proper use and disposal of its products is provided without charge, and since use conditions and disposal are not within its control, TriSep assumes no obligation or liability for such assistance and does not guarantee results from use of such products or other information herein. TriSep assumes no liability for results obtained or damages incurred through the application of the presented information and data. It is the user's responsibility to determine the appropriateness of TriSep's products for the user's specific end uses.

The total system operation performance is out of the control of TriSep Corporation personnel and we are not "on-site" to monitor the proper operation of our products in the systems. TriSep's product performance is affected by such operational variables including, but not limited to, pretreatment, operators and training, system breakdowns, feedwater changes, system components and component changes and other possible variables.

This warranty applies to all sales of spiral wound elements on or after December 1, 1999

1.0 MODELS

TriSep X-20, ACM, CA, XN40, TS80, UE50 and TM10 membrane elements.

1. APPLICATIONS

The following warranty applies to TriSep spiral wound elements used in "water" applications. "Non-water" applications such as chemical processing, food processing, or wastewater treatment are not covered by the performance warranty in section 4.3.

2.0 TYPE AND LENGTH OF WARRANTIES

2.1 "Water" Applications

	X-20, ACM, CA, XN40	UE50, TM10
A. Initial Performance	24 hours	24 hours
B. Materials and Workmanship	12 months	12 months
C. Extended Element Performance	36 months	Contact TriSep

2.2 "Non-Water" Applications

	All elements
A. Initial Performance 24 hours	24 hours
B. Materials 12 months	12 months

C. Extended Element
Performance

Contact
TriSep

3.0 WARRANTY START DATE

Warranties for extended element performance commence on the date of plant start-up or 3 months after initial shipment date from TriSep's facility, whichever occurs first.

4.0 WARRANTIES AND LIABILITIES: SPIRAL WOUND PRODUCTS

4.1: Materials and Workmanship:

TriSep warrants that its spiral element(s) will be free of mechanical defects, as determined by TriSep, due to faulty materials or errors in manufacturing workmanship for a period up to twelve (12) months after the Warranty Start Date. Claims made under this portion of TriSep's warranty must specify the alleged defect in materials of construction or manufacturing workmanship on which such a claim is based. All claims must be documented by the customer for TriSep processing.

4.1.1: TriSep Liability:

TriSep will repair or replace, at no charge, any element which is found by TriSep to be mechanically defective, due to errors in manufacturing or faulty material, as specified in 4.1 above.

4.2: Initial Performance:

TriSep warrants for a period up to the Warranty Start Date per Paragraph 3 that the individual element(s) will have 85% of the initial minimum product flow specified and the initial minimum salt rejection as specified by TriSep in its published product specifications when such elements are tested under specified Standard Test Conditions. The test period for determining minimum product flow shall be limited to no more than 24 consecutive hours.

4.2.1: TriSep Liability:

TriSep reserves the right to repair or replace such element(s) as TriSep determines to be necessary to correct any deficiencies, as specified in 4.2 above.

4.3: Three-year Element Performance:

The three-year performance warranties set forth in 4.3.1 start on the Warranty Start Date, apply to individual element(s) only and incorporate by reference all Conditions of Warranties described in paragraphs 5.1 to 5.5.

4.3.1: X-20, ACM, CA, TS80, XN40 Element Performance:

For a period of three (3) years the minimum product water flow for X-20, ACM, CA, TS80, and XN40 elements under Standard Test Conditions will be at least 70 percent of the TriSep specified initial minimum flow. The maximum overall salt passage X-20, ACM, CA, TS80, and XN40 element(s), under Standard Test Conditions and pressure required to give the initial specified flow, will not be more than 2 times the TriSep initial maximum level. Standard Test Conditions, and the specified product water flow and salt passage for X-20, ACM, CA, TS80, and XN40 element are set forth in product specification sheets provided by TriSep.

4.3.5 Periodic Cleanings

Periodic cleanings of the membranes will be required to maintain this performance. TriSep will not be responsible for any costs associated with these element and/or system cleanings. Membrane cleaning protocols are to be approved by TriSep. Required frequency of cleaning will be determined during operation of the system, and may vary with time of year, feedwater temperature, feedwater contaminants, and microbial challenge level. Other variables not mentioned above may also effect the required cleaning frequency.

If TriSep determines that replacement is required under this warranty, TriSep will credit the Customer 1/36 of the original purchase price of the element(s), per Terms and Conditions of Sale, for each unexpired month of the warranty period. This credit will be toward the purchase of TriSep replacement element(s) at the then current selling price set by TriSep.

5.0 CONDITIONS OF WARRANTIES

5.1: Limitation of Warranties:

5.1.1: Occurrence of any of the following as determined by TriSep shall void all warranties hereunder:

- (a) Operation of the elements that deviates from the "Guidelines for Operation of Spiral Wound Elements" attached.
- (b) Fouling and/or Scaling of the elements that cause system and/or membrane element failures and/or damage and/or loss of element performance.
- (c) Physical abuse or misuse of element(s);
- (c) Faulty installation of element(s);
- (d) Alteration of any parts originally supplied by TriSep with element(s);

5.2: Standard Guidelines:

All element Warranties are conditioned upon TriSep's determination that shipping, storage, system design, installation, operation and maintenance of elements are in accordance with all Guidelines specified by TriSep in the attached Guidelines for Operation. Any reviews of system design or inspections of facilities made by TriSep are intended to assist in detection of system faults to subsequently cite matters which were not discovered in such reviews or inspections as violations of Guidelines, voiding warranties hereunder:

5.3: Additional Equipment:

TriSep assumes no liability for any additional equipment that may be deemed necessary after plant operation has begun, including materials, equipment, and labor required to install additional elements or pressure vessels.

5.4: Warranty Maintenance:

To maintain the Warranty described herein, plant operating records from initial start-up date of claim must be maintained and made available to TriSep upon request. Documentation must be provided in the detail as specified in 5.5: Below in order to: a) Verify uninterrupted compliance with Guidelines; and b) establish liability (TriSep's or Customer's) for element(s) replaced or repaired under warranty.

5.5: Notification and Verification of Performance Deficiency:

All claims filed hereunder shall be made in writing within Thirty (30) days of identifying a deficiency in warranted performance and shall present a detailed analysis of the system and individual element data showing the performance deficiency, and must include:

- (a) The serial number(s) of the element(s) involved, and
- (b) The individual element(s) documented operating data, documented system operating data or defect in materials or workmanship upon which the claim is based. Operating data must include: permeate and brine flow, salt passage, operating pressure, pressure drop, feedwater temperature, pH, TDS, SDI, conversion, and elapsed time since start-up (hours). TriSep reserves the right to require additional data as necessary to validate the claims filed.

After receipt of the notice, TriSep will promptly undertake such investigations as, in TriSep's opinion, are necessary to verify whether a deficiency exists and to establish liability for remedy of any deficiency. The Customer may, in course of these investigations, be requested to return element(s) to TriSep for examination. TriSep may make reasonable tests and inspections on end-user's or on the Customer's premises.

TriSep will have the right to specify reasonable remedies other than replacement, repair or addition of element(s) to restore performance to TriSep specified levels.

TriSep's Returned Goods Authorization (RGA) Procedure must be followed for return of element(s). Element(s) shipped to TriSep for warranty examination must be shipped freight prepaid. Unless specifically agreed to in writing by TriSep prior to shipment, all collect and/or COD deliveries will be refused by TriSep. If the Customer desires replacement element(s) to replace those alleged to be defective or those returned to TriSep for warranty examination, Customer is responsible for providing any needed replacements until warranty examination is complete. Element(s) examined as part of a warranty claim which are found by TriSep to be performing as warranted will be returned to the Customer freight collect, with appropriate charges (minimum US\$100.00) made for TriSep handling, inspection, testing or analytical services, as described in TriSep's [RGA Procedure](#).

Replacement, by the Customer, of element(s) under Extended Element Performance warranties will be at the then current selling price, per TriSep's Standard Terms and Conditions, plus handling charge for each returned element. If in connection with any TriSep inspection and testing of products and/or system on the Customer's or end-user's premises a claim under the Extended

element performance warranty is determined by TriSep to be invalid, the Customer shall pay to TriSep a minimum fee of \$450 per day, plus all direct expenses incurred by TriSep employee(s) conducting such inspection/testing.

The [RGA Procedure](#) is part of TriSep's RGA (Return Goods Authorization procedure).

NO OTHER WARRANTIES, EXPRESS OR IMPLIED ARE MADE IN CONNECTION WITH THE SALE OF THESE PRODUCTS, INCLUDING NO WARRANTIES OF FITNESS FOR ANY PARTICULAR USE OR MERCHANTABILITY OF THESE PRODUCTS. THE REMEDY HEREBY PROVIDED SHALL BE THE EXCLUSIVE AND SOLE REMEDY OF CUSTOMER, AND IN NO EVENT SHALL TRISEP BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, WHETHER OR NOT CAUSED BY OR RESULTING FROM TriSep's NEGLIGENCE.

GUIDELINES FOR OPERATION

TriSep provides all data in good faith and believes the information and data contained herein to be accurate and useful. It is the user's responsibility to determine the appropriateness of TriSep's products for the user's specific end uses.

X-20TM, ACMTM, TS80TM, CA, XN40TM, UE50TM, AND TM10TM RO/NF/UF/MF Membrane Guidelines

SUSPENDED SOLIDS

- Turbidity of element RO feed must be <1.0 for all elements, except for X-20 turbidity must be less than 2.0, measured upstream of the micron filters, preferably <1.0. Operation at turbidities higher than 1.0 may require more frequent membrane cleanings and may reduce membrane life.
- The system array, recovery and instrumentation and the design parameters and components of the system in which the element(s) are employed shall be consistent with sound engineering practice. TriSep reserves the right to review system design.

BIOLOGICAL MATTERS

- Biological activity inside the element must be controlled during operation so that system water quality and quantity are not affected.

CHLORINE/BROMINE

- The total free chlorine and bromine content of all water entering the X-20TM, ACMTM, TS80TM, element(s) must be < 0.1 mg/l. The total free chlorine and bromine content of all water entering CA, XN40TM, UE50TM, and

TM10TM element(s) must be < 1.0 mg/l. Total free chlorine tolerance for the X-20 and ACM membranes are 1000 ppm-hrs, when exposed at concentrations less than 1 ppm in the absence of trivalent metals ions on the surface of the membrane. The presence of trivalent metal ions, such as ferric hydroxide, may reduce the oxidation tolerance substantially of all membranes.

MISCELLANEOUS CHEMICALS

- Chemicals which form a water-immisible phase in the RO feed or brine must not enter the element.
- Use of cationic polyelectrolytic compounds in elements is not permitted unless prior written approval is given by TriSep
- All water entering the element must be free of strong oxidants such as H₂O₂, O₃, KMnO₄, CH₃CO₃H.
- Impurities present in chemicals added to the RO feed water must not affect the element performance .
- Feedwater shall contain no colloidal sulfur.
- Membrane damage caused by chemical compounds (e.g. surfactants, solvents, soluble oils, free oils, lipids, and high molecular weight natural polymers) shall nullify and void the warranty.
- Failure to maintain the elements in a clean condition, unfouled by particulate matter, precipitates, suspended material, or biological growth shall nullify and void the warranty.

pH

- The pH in the element must be >4.0 for continuous operation. The maximum allowable exposure time during operation and cleaning for solutions with a pH between 2 to 4 is 150 hours over the life of the elements. Elements must not be exposed to pH <2.0.
- For continuous operation the pH in the elements must be < 11.0 up to 40°C and < 10.0 up to 45°C. The maximum total allowable exposure time during operation and cleaning is 500 hours over the life of the element for solutions with pH 11.0 to 11.9 up to 40°C and with pH 10.0 to 10.9 up to 45°C. Elements must not be exposed to pH >11.9.

SOLUBILITY LIMITS

- The Langelier Saturation Index (LSI) of the brackish water brine stream must be negative except where an approved Antiscalant is used. When an approved Antiscalant is used, the pressure vessels must be flushed within 15 minutes after shutdown to remove the supersaturated salt solutions. Recovery ratio shall be consistent with concentration of sparingly soluble salts. Membrane scaling caused by failure of the chemical dosing system (e.g. Ca, Ba, or Sr salts) shall nullify and void the warranty.
- $IP_b < K_{sp}$ for $CaSO_4$, $BaSO_4$, $SrSO_4$, and CaF_2 where IP_b is the ion product of brine stream, K_{sp} is the solubility product
- $IP_b CaSO_4 < 1.0 \times 10^{-3}$ or $2.5 \times (K_{sp})$ whichever is larger if TriPol 8510 or TriPol 9010 is used, where IP_b is the ion product of brine stream, K_{sp} is the solubility product.
- $IP_b BaSO_4 < 70 \times (K_{sp})$ if TriPol 8510 or TriPol 9010 is used, where IP_b is the ion product of brine stream, K_{sp} is the solubility product.
- $IP_b SrSO_4 < 8 (K_{sp})$ if TriPol 8510 or TriPol 9010 is used, where IP_b is the ion product of brine stream, K_{sp} is the solubility product.
- $IP_b CaF_2 < (K_{sp})$ if TriPol 8510 or TriPol 9010 is used, where IP_b is ion product of brine stream, K_{sp} is the solubility product.
- The brine silica shall be less than 150 mg/l at 25°C, unless an antiscalent approved by TriSep is used.

GUIDELINES FOR OPERATION

DESIGN

- Modifications of any TriSep element, and/or component supplied by TriSep are not permitted unless approved by TriSep in writing.
- In systems having 10 or more pressure vessels, provisions must be made to permit installation and operation of at least 10% additional pressure vessels calculated to meet design capacity.
- A thrust ring must be used on the last element in a pressure vessel.
- The pre-treatment system must be designed to prevent irreversible organic and/or inorganic fouling of the membrane.
- Cleaning shall be initiated at 10% to 15% normalized product flow decline, a 15% to 20% increase in normalized system delta P, or a 20% decline in normalized salt passage.

OPERATING CONDITIONS : TEMPERATURE AND PRESSURE

- The product pressure must never exceed the feed or brine pressure.
- The maximum temperature for operation of the element is 45°C. For operation outside this limit consult TriSep.
- In all stages the ratio of the brine flow to the product flow must be at least 5.0 per element.
- At all times e.g. operation, cleaning, flushing and post-treatment, the maximum pressure drop per pressure vessel is 60 psi or 15 psi per element, whichever is less as determined from routine monitoring on a representative sampling of pressure tubes per stage and per train.
- The elements shall not be exposed to pressure greater than 1000 psi for seawater elements, and 600 psi for brackish water elements.

OPERATING CONDITIONS- FLOW RATES

	Min. Brine	Max. Feed
Model No	l/min (gpm)	l/min (gpm)
4"	19.0 (5.0)	75.6 (20.0)
8"	57 (15.0)	303 (80.0)
8.5"	57 (15.0)	322 (85.0)

- The average gallons per square foot of membrane area per day (GFD) per element must not exceed 20 if the turbidity is less than 0.1, or 18 if the turbidity is equal to 0.1 but less than 0.3, or 15 if the turbidity is equal to 0.3 but less than or equal to 0.5, or 12 if the turbidity is equal to 0.5 but less than or equal to 1.0, or 10 if the turbidity is equal to 1.0 but less than or equal to 2.0. Operation at turbidities > 0.3 may result in increased cleaning frequencies. When the feedwater is RO permeate, elements may operate at flux rates up to 30 gfd. Turbidities may not be a good indicator of organic fouling potential.

FLUSHING

- Flush water must be of good quality (meeting Guidelines) and of low TDS (<2000 ppm).
- The product side must be open to atmosphere when flushing or adding water to the element.
- When scale inhibitor is used, the element must be flushed at shutdown within 15 minutes to remove the Antiscalant and the supersaturated salt solution.

SHIPPING, HANDLING AND STORAGE

- When not in operation the membrane must be kept saturated with good quality feedwater (meeting Guidelines) and having a low TDS (<2000 mg/l) at all times.
- The as-shipped elements must be kept sealed in its original double plastic bag, in a cool, dry place, out of direct sunlight, until required for installation.

STORAGE

Min. Storage Temp. without Glycerine	Min. Storage Temp. w/ 40 wt. % Glycerine	Maximum StorageTemp.
0°C (32°F)	15°C (5°F)	30°C (86°F)

- Only glycerin may be used as a freeze protection agent. If used, the concentration must be 20 wt %.
- 2 - 3 wt. % sodium metabisulfite or TriSep approved biocide must be used for storage, shipping or continuous element shutdowns in excess of 5 days to prevent biological growth



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