LIMITED WARRANTY
FOR TRISEP® SPIRAL-WOUND ELEMENTS
USED FOR WATER PURIFICATION

GENERAL
Microdyn-Nadir US, Inc. (MNUS) 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 MNUS 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, MNUS assumes no obligation or liability for such assistance and does not guarantee results from use of such products or other information herein. MNUS 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® products for the user's specific end uses.

The total system operation performance is out of the control of MNUS personnel and we are not "on-site" to monitor the proper operation of our products in the systems. The performance of TRISEP products are 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 November 1, 2016.

1.0 MODELS
TRISEP® X-20™, ACM, Cellulose Acetate (CA), XN45, TS40, TS80, UF10, UE50 and TM10 membrane elements.

1.1 Applications
The following warranty applies to TRISEP spiral-wound elements used in "water" purification applications. "Non-water" or "process" applications such as chemical processing, food processing, or wastewater treatment are not covered this by this limited warranty. Please see the limited warranty for TRISEP® process elements.

2.0 TYPE AND LENGTH OF WARRANTIES

	X-20, ACM, CA, XN45, TS40, TS80	UF10, UE50 TM10
A. Initial Performance	24 hours	24 hours
B. Materials and Workmanship	12 months	12 months
C. Extended Element Performance	36 months	Contact MNUS

3.0 WARRANTY START DATE
Warranties for extended element performance commence on the date of plant start-up or three (3) months after initial shipment date from MNUS' facility, whichever occurs first.

4.0 WARRANTIES AND LIABILITIES: SPIRAL-WOUND PRODUCTS

4.1: Materials and Workmanship:
MNUS warrants that its spiral element(s) will be free of mechanical defects, as determined by MNUS, 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 MNUS' 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 MNUS to analyze and process.

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

4.2: Initial Performance:
MNUS 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 MNUS 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: MNUS Liability:
MNUS reserves the right to repair or replace such element(s) as MNUS 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, TS40, XN45 Element Performance:
For a period of three (3) years the minimum product water flow for X-20, ACM, CA, TS80, TS40 and XN45 elements under Standard Test Conditions will be at least 70 percent of the MNUS specified initial minimum flow. The maximum overall salt passage X-20, ACM, CA, TS80, TS40 and XN45 element(s), under Standard Test Conditions and pressure required to give the initial specified flow, will not be more than 2 times the initial specified maximum level. Standard Test Conditions, and the specified product water flow and salt passage for X-20, ACM, CA, TS80, TS40 and XN45 element(s) are set forth in product specification sheets provided by MNUS.

4.3.2 Periodic Cleanings
Periodic cleanings of the membranes will be required to maintain this performance. MNUS will not be responsible for any costs associated with these element and/or system cleanings. Membrane cleaning protocols and determining compatibility of cleaning chemicals with TRISEP® membranes are the responsibility of the customer and/or

end-user of these products. Required frequency of cleaning will be determined during operation of the system, and may vary with time of year, feed water temperature, feed water contaminants, and microbial challenge level. Other variables not mentioned above may also affect the required cleaning frequency.

If MNUS determines that replacement is required under this warranty, MNUS 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® element(s) at the then current selling price set by MNUS.

5.0 CONDITIONS OF WARRANTIES

5.1: Limitation of Warranties:
5.1.1: Occurrence of any of the following as determined by MNUS 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 MNUS with element(s)

5.2: Standard Guidelines:
All element Warranties are conditioned upon MNUS' determination that shipping, storage, system design, installation, operation and maintenance of elements are in accordance with all Guidelines specified by MNUS in the attached Guidelines for Operation. Any reviews of system design or inspections of facilities made by MNUS 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:
MNUS 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 MNUS 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 (MNUS' 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). MNUS reserves the right to require additional data as necessary to validate the claims filed.

After receipt of the notice, MNUS will promptly undertake such investigations as, in MNUS' 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 MNUS for examination. MNUS may make reasonable tests and inspections on end-user's or on the Customer's premises.

MNUS will have the right to specify reasonable remedies other than replacement, repair or addition of element(s) to restore performance to MNUS specified levels.
MNUS' Returned Goods Authorization (RGA) Procedure must be followed for return of element(s). Element(s) shipped to MNUS for warranty examination must be shipped freight prepaid. Unless specifically agreed to in writing by MNUS prior to shipment, all collect and/or COD deliveries will be refused by MNUS. If the Customer desires replacement element(s) to replace those alleged to be defective or those returned to MNUS 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 MNUS to be performing as warranted will be returned to the Customer freight collect, with appropriate charges (minimum US$100.00) made for MNUS handling, inspection, testing or analytical services, as described in MNUS' RGA Procedure.

Replacement, by the Customer, of element(s) under Extended Element Performance warranties will be at the then current selling price, per MNUS' Standard Terms and Conditions, plus handling charge for each returned element. If in connection with any MNUS 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 MNUS to be invalid, the Customer shall pay to MNUS a minimum fee of $450 per day, plus all direct expenses incurred by MNUS employee(s) conducting such inspection/testing.

MICRODYN-NADIR US, Inc. · 93 S. La Patera Lane, Goleta, CA 93117
Phone: (805) 954-8003 · Fax: (805) 964-1235 · www.microdyn-nadir.com

LIMITED WARRANTY
FOR TRISEP® SPIRAL-WOUND ELEMENTS
USED FOR WATER PURIFICATION

The RGA Procedure is part of MNUS' 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 MNUS BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, WHETHER OR NOT CAUSED BY OR RESULTING FROM MNUS' NEGLIGENCE.

MICRODYN-NADIR US, Inc. · 93 S. La Patera Lane, Goleta, CA 93117
Phone: (805) 954-8003 · Fax: (805) 964-1235 · www.microdyn-nadir.com

LIMITED WARRANTY
FOR TRISEP® SPIRAL-WOUND ELEMENTS
USED FOR WATER PURIFICATION

GUIDELINES FOR OPERATION

MNUS 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® products for the user's specific end uses.

X-20™, ACM, TS40, TS80, CA, XN45, UF10, UE50, and TM10 Membrane Guidelines

SUSPENDED SOLIDS

- Turbidity of element RO feed must be <1.0 for all elements, measured upstream of the micron filters, preferably <0.1. 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 elements(s) are employed shall be consistent with sound engineering practice. MNUS 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-20™, ACM, TS80, TS40, XN45, element(s) must be <0.1 mg/l. The total free chlorine and bromine content of all water entering CA, UF10, UE50, and TM10 element(s) must be <1.0 mg/l. Total free chlorine tolerance for 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, anionic, or non-ionic polyelectrolytic compounds in elements is not permitted unless prior written approval is given by MNUS.
- All water entering the element must be free of strong oxidants such as H_20_2, 0_3, $KMn0_4$, CH_3CO_3H.
- Impurities present in chemicals added to the RO feed water must not affect the element performance.
- Fouling of the membrane elements by organic materials, suspended solids, or precipitated scales shall void the warranty.
- 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.

- The brine silica shall be less than 150 mg/l at 25°C, unless an antiscalant approved by MNUS is used.

MICRODYN-NADIR US, Inc. · 93 S. La Patera Lane, Goleta, CA 93117
Phone: (805) 954-8003 · Fax: (805) 964-1235 · www.microdyn-nadir.com

LIMITED WARRANTY
FOR TRISEP® SPIRAL-WOUND ELEMENTS
USED FOR WATER PURIFICATION

GUIDELINES FOR OPERATION

DESIGN

- Modifications of any TRISEP® element, and/or component supplied by MNUS are not permitted unless approved by MNUS 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 MNUS.
- 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

Model No.	Min. Brine l/min (gpm)	Max. Feed 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. Turbidity 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 Glycerin	Min. Storage Temp. w/ 40 wt. % Glycerin	Maximum Storage Temp.
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 40 wt %.
- 2 - 3 wt. % sodium metabisulfite or MNUS approved biocide must be used for storage, shipping or continuous element shutdowns in excess of 5 days to prevent biological growth

MICRODYN-NADIR US, Inc. · 93 S. La Patera Lane, Goleta, CA 93117
Phone: (805) 954-8003 · Fax: (805) 964-1235 · www.microdyn-nadir.com