

Membrane Module Operation

Tubular Ultrafiltration



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Membranes
Think outside the box

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1. General Use and Intent

The ultrafiltration membrane modules from Berghof Membranes are exclusively designed for solid and liquid separation as it relates to wastewater treatment. Any other use which is outside this scope is considered inappropriate and not covered under the product's warranty. Berghof Membranes will NOT be held liable for damages resulting from the misuse of its products.

“Appropriate use” is defined as:

- Adherence to all operating instructions and guidelines for the modules and system components
- Regular observation and monitoring of operating parameters
- Strict compliance to predefined inspection and maintenance schedules/guidelines



If there are any questions or concerns, especially during the first few weeks after the system's commissioning, please contact Berghof Membranes representatives via email (info@berghofmembranes.com) or telephone +31 58 81 00 110

Disclaimer

The information and data contained herein are deemed to be accurate and reliable and are offered in good faith, but without guarantee of performance. Berghof Membrane Technology GmbH assumes no liability for results obtained or damages incurred through the application of the information contained herein. Customer is responsible for determining whether the products and information presented herein are appropriate for the customer's use and for ensuring that customer's workplace and disposal practices are in compliance with applicable laws and other governmental enactments. Specifications subject to change without notice. Berghof Membrane Technology GmbH is a wholly owned company of Berghof GmbH. All rights reserved. © 2019 Berghof Membrane Technology GmbH

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2. New Module Handling

After receipt of your Berghof Membranes order, correct handling and storage precautions are necessary for ensuring that the membranes modules remain intact prior to installation and use.

Immediately upon receipt, conduct a visual inspection of the complete shipment to confirm that:

- Shipment arrived without damage to the packaging or its contents.
- All packages listed on the packing list were received in good order.
- If there is any damage or product shortage, please contact your carrier/freight forwarder and a Berghof Membranes customer support representative **immediately**.
- If any module parts are missing, please notify Berghof Membranes **immediately**.



To ensure the service life of your Berghof membrane modules, proper precautions should be taken to avoid damaging the modules or impeding their performance.

Additional requirements may be included in your performance warranty. If there is a conflict between the information provided in this manual and in your terms of warranty, the information provided in your warranty overwrite those outlined in this manual

2.1. New module storage

The modules are packaged and supplied with sealed connections. It is important to keep in mind the following considerations:

Protection against sunlight

Do not subject modules to long-term sunlight exposure. Store modules in a dark place. For storage of used modules, please refer to section 6.2 of this operation manual.

Protection against frost

Store and use the modules in a place that is not subject to frost. Freezing may damage the membranes.

Protection against solvents

Organic solvents, once in contact with the module housing, may increase the risk of damaging the paint and material. This could result in critical failure of the module's operation. To clean the module housing, use ONLY water and/or ethanol.

Careful transport

New membrane modules are heavy and special precautions must be taken when transporting or handling each module. If a module is dropped or knocked, this can result in fractures within and on the module and its connectors, thus rendering it non-functional. Contact Berghof Membranes if this occurs. Please remember to keep all ports closed.

3. Prior to Installation

3.1. Safety considerations

**Risk of injury from improper installation**

- Before use, inspect the product for any leaks or cracks.
- Installation **MUST ONLY** be carried out by qualified technicians or operators.
- Modules can weigh more than 20 kilograms (44 lbs) and **MUST** be handled using the proper tools/equipment and **ONLY** by qualified technicians. Large diameter (10-inch) modules, for example, can weigh 95 kg (210 lbs).

**Risk of injury from unintentional activation of the system and uncontrolled re-start**

- All precautions must be taken to secure the system from unintentional/unauthorized activation.
- Following installation of the modules, ensure a controlled (re)start according to the procedures outlined in section 4 of this operation manual.

**Risk of poisoning, chemical burns, or contamination from escaping medium**

- When handling hazardous substances, **ALWAYS** take appropriate precautionary measures and wear personal protective equipment in accordance with the requirements of the medium.
- Before disconnecting lines, the medium must first be **FLUSHED** from the entire system.

**Risk of injury from high pressure in the UF system/module**

- Before working on the system or product, make sure to release the pressure and vent/drain the lines to avoid serious injury.

3.2. Module and system preparation

- Remove the protective caps from the module(s) shortly before installation. Once the protective caps are removed, the module must be handled carefully with all necessary precautions.
- Clean the system and pipelines to ensure that solids and oily substances are removed from the UF system.

4. Installation and Start-Up

4.1. Precautions for module installation



Risk of material breaking

- Attach and connect the module in such a way that system vibrations do not compromise the stability and positioning of the module.
- The modules must be installed in a rack or similar.
- Module must be supported in several places along its entire length.
- Due to the weight of the module, it is not safe to attach the module only via the connectors. The module must be attached to the rack by using appropriate brackets or clamps.



When using brackets or clamps to attach modules to the system frame:

- Thoroughly inspect the sealing clamps,
- Ensure that the seals are not displaced when establishing the connections,
- Check that none of the connections are or could be subject to mechanical stress,
- Check that the seals are seated correctly,
- Tighten the clamp(s) only with appropriate force, making sure not to damage the module,
- Only use suitable, clean, quality clamps,
- Before disconnecting the lines, the medium must be flushed from the entire system.



DO NOT use excessive force to tighten the connections.

4.2. Start-Up

Rinsing Modules

Before the initial start-up with the process medium, the modules should first be rinsed with clean water, followed by the standard cleaning agent. The permeate flows from both the clean water (“clean water flux” or “CWF”) and cleaning agent rinse should be individually recorded.

Two weeks after start-up

A standard cleaning should be implemented no more than two weeks after the initial start-up. Once again, as previously outlined, the permeate flows from both the clean water and the cleaning agent rinse should be individually recorded and, after consultation with Berghof Membranes, evaluated as reference flows.

The success of subsequent cleaning procedures can be assessed by comparing the permeate fluxes, obtained after the cleaning agent or water rinse, against recorded reference values. It is important to ensure that identical conditions and parameters are set (pressure, crossflow velocity, temperature, detergent concentration, etc.) when recording permeate flow.

4.3. Important notices



Risk of damage to the UF system

Improper operation may result in injuries as well as damage to the UF system. Therefore, it is critical that the following conditions be observed:

- Before start-up, ensure that the operator(s) is qualified and trained to operate the UF system and thoroughly understands the instructions set forth in this operation manual,
- All health and safety regulations are strictly followed,
- Only qualified and trained personnel can operate the equipment, products, systems,
- Operator(s) should prevent water hammers, sudden increases in the feed's solid content, heavy pressure drops and temperature shocks.



Avoiding damage to the UF system/modules

Unlike pumps and pipelines, the membranes in a filtration system are relatively sensitive components. Therefore, every effort should be made during planning and operation to avoid pressure surges, sudden increases in the feed's solid content, heavy pressure drops, and temperature shocks. Pressure surges and vibrations, in particular, may damage the module and impair its performance.

- Please refer to the individual product data sheets when determining pH values, oxidants and other components.
- During filtration and backwashing, please adhere to the TMP pressure parameters stated on the individual module data sheet.
- NEVER exceed pressure and temperature parameters set forth in the module data sheets.
- Berghof Membranes recommends keeping the pressure level at the last positioned module to at least 0.5 bar (7.25 psi). The filtration system must be designed so that negative pressure does not occur in the feed chamber.
- Quick/rapid opening of the valves may cause water hammer, thus damaging the membrane modules and the UF system.

5. Module Operation

5.1. Data recording



To accurately monitor and maintain optimal membrane performance, Berghof Membranes recommends that the following operating values be recorded at least twice per day:

- Inlet and outlet pressure for each individual module
- Permeate flow, pressure and turbidity
- Operating temperature and pH
- Feed quality
- Circulated flow (crossflow velocity)

5.2. Decreased permeate flow

If the permeate flow decreases below the average value for an extended period of time, it is likely that the modules need to be cleaned. Instructions on how to clean your Berghof Membranes module(s) are outlined in section 5.5 of this manual.

In order to determine the effectiveness of the cleaning procedures, the post-cleaning permeate flow and pressure values should be logged and compared with the pre-cleaning permeate flow and pressure values.

5.3. Solids in the permeate

If solids are present in the permeate (check turbidity), it is likely that one or several tubular membranes in the system has or have been damaged. Individual sampling of the modules should be performed while the system is running so as to properly identify the source of the problem. If the color of the permeate has changed since the initial start-up and/or it has become darker and/or blurry, then a membrane inspection is recommended.



A module can be repaired if less than 15% of the membrane tubes inside the module are damaged. For questions on how to repair a module, please contact Berghof Membranes and a representative will assist you. If it is determined that a module needs to be returned to Berghof Membranes for repair, then the module should first be rinsed thoroughly and preserved. Detailed instructions for product returns are outlined in section 7 of this manual.

NOTE: Please make sure to complete and return the Health & Safety Declaration form indicating the module's use and any possible contamination with hazardous substances (see section 7). Any modules returned without prior approval and acceptance of the Health & Safety Declaration form from a Berghof Membranes representative will be shipped back to the customer.

5.4. Fouling

Increase in pressure / decrease in permeate flow

Increasing pressure drop across the module and/or decreasing permeate flow could indicate possible fouling. Usually, this is the result of inadequate pretreatment.

Fouling of the membrane module

Fouling in the membrane module can be removed. If the inlet of the individual membrane tubes is significantly hindered, it is likely due to the accumulation of solids, hairs, fibers, etc. Therefore, the membrane tubes should be checked individually for blockages.



Blocked membrane tubes can be identified visually by flushing each one with water to see if the water passes through to the other side of the tube. If clogs are present in the membrane tubes, please contact Berghof Membranes.



Do not attempt to manually unclog the tubes. Any mechanical attempt to unclog the membranes tubes can damage the membrane surface and will void the membrane module's warranty.

5.5. Cleaning

The following cleaning procedures explain how to manage fouling/scaling and maintain the optimal performance of the tubular UF membrane filtration system.

The degree of membrane fouling/scaling directly affects filtration performance. If the permeate flow decreases significantly and/or the permeate quality is not as defined by membrane manufacturer, and/or pressure drop increases above operational values, a chemical cleaning is necessary.

Commercially available membrane cleaners can be used only if they do not impair the function of the membrane and comply within the approved limits as regards pH values, temperature and chemical resistance. The limits are specified in Berghof modules and membranes data sheets.



Cleaning directions should always be followed, otherwise there may be unforeseen reactions between the cleaning solution and the medium to be filtered which might lead to both, the membrane modules and piping being damaged (for example, by heat generation).



Berghof advises to always use special ultrafiltration membrane cleaning chemicals. If this is not possible, the standard chemicals outlined in this document can be used.

5.5.1. Standard / enzymatic / acid cleaning

STANDARD CLEANING

Standard cleaning should be performed on a regular basis to prolong membrane life. To ensure effective cleaning, it is important to first flush the dirty water and/or process medium out of the system.

A water test should be performed after a cleaning. Therefore, it is important to record the clean water flux during start-up so as to have a reference point.

The RO permeate, deionized water or similar quality water must be used to prepare the cleaning solutions. Otherwise, use tap water that must be softened to less than 80 ppm CaCO₃.

Standard cleaning (A): Sodium Hydroxide and Sodium Hypochlorite mixture

- Add Sodium Hydroxide to reach pH 10 – 11
- Add Sodium Hypochlorite to reach 250 ppm (mg/L) concentration (The concentration depends on the installation and RO, deionized water or similar quality of water. Check pH with pH meter or pH indicator stripes)
- Gradually increase temperature during cleaning up to 40°C within 30 – 60 min, in order to avoid membrane module thermal shock
- Concentration of Sodium Hypochlorite can be recommended for specific application with max. value of 500 ppm
- Total membrane max. chlorine exposure 250.000 ppm·h at 25°C

ENZYMATIC CLEANING

Enzymatic cleaning can be applied if standard cleaning did not provide satisfactory results.

To avoid possible contamination of the membrane by the process media, it is recommended to carry out enzymatic cleaning immediately after standard cleaning.

Enzymatic cleaning (B): Enzymatic cleaning agent

- Please refer to the supplier information (datasheet etc.). (The concentration depends on the installation and RO permeate, deionized water or similar quality of water. Check pH with pH meter or pH indicator stripes)
- Gradually elevate temperature during cleaning up to 40°C within 30 – 60 min, in order to avoid membrane module thermal shock

Acid cleaning can be applied if enzymatic cleaning did not provide satisfactory results. Acid can remove inorganic fouling and/or scaling.

ACID CLEANING (C): CITRIC ACID

- Add Citric Acid to reach pH 2 – 3
(The concentration depends on the installation and RO, deionized water or similar quality of water. Check pH with pH meter or pH indicator stripes)
- Gradually elevate temperature during cleaning up to 40°C within 30 – 60 min, in order to avoid membrane module thermal shock

Standard / enzymatic / acid cleaning sequence					
Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Flush with water	Circulate A/B/C 60 – 120 min	Soak A/B/C 30 – 60 min	Flush 20% A/B/C (optional)	Circulate A/B/C 60 – 120 min	Flush with water

Legend: A=(Sodium Hydroxide + Sodium Hypochlorite), B=(Enzymatic cleaning agent) and C=(Citric Acid)

The first assessment can be made during step 2 by comparing the permeate flow with the corresponding reference value.

The effectiveness of cleaning can be judged after step 6 by comparing the permeate flow with clean water (clean water flux “CWF”) against the reference value. Alternatively or in addition, the filtration performance with process medium and the recorded reference performance can also be compared.

**IMPORTANT:**

1. If the cleaning solution shows heavy discoloration, discard the solution and prepare a new solution. Repeat this cleaning step. Flush out the membranes thoroughly with good quality, chlorine free water between each cleaning stage until pH is neutral.
2. Monitor pH and temperature during cleaning process, if it is still under the recommended levels. If not, adjust it again during circulation.
3. Times and values are approximate and depend on each installation and the degree of fouling/scaling.

5.5.2. Intensive Cleaning

Intensive cleaning is a combination of high and low pH. This combination is used to clean the deepest fouling/scaling that is in direct contact with the membrane surface. It can be applied if standard / enzymatic / acid cleaning did not provide satisfactory results.

A water test should be performed after a cleaning. Therefore, it is important to record the clean water flux during start-up so as to have a reference point.

The RO permeate, deionized water or similar quality of water must be used to prepare the cleaning solutions, otherwise use tap water that must be softened to less than 80 ppm CaCO₃.

Intensive cleaning sequence				
Step 1 Flush with water	Step 2 Circulate A 60 – 120 min	Step 3 Soak A 30 – 60 min	Step 4 Flush 20% of A (optional)	Step 5 Circulate A 60 – 120 min
Step 6 Flush with water	Step 7 Circulate C 60 – 120 min	Step 8 Soak C 30 – 60 min	Step 9 Flush 20% of C (optional)	Step 10 Circulate C 60 – 120 min
Step 11 Flush with water	Step 12 Circulate A 60 – 120 min	Step 13 Soak A 30 – 60 min	Step 14 Flush 20% of A (optional)	Step 15 Circulate A 60 – 120 min
Step 16 Flush with water				

Legend: A=(Sodium Hydroxide + Sodium Hypochlorite), B=(Enzymatic cleaning agent) and C=(Citric Acid)

The first assessment can be made during step 2 by comparing the permeate flow with the corresponding reference value.

The effectiveness of cleaning can be judged after step 16 by comparing the permeate flow with clean water (clean water flux “CWF”) against reference value. Alternatively or in addition, the filtration performance with process medium and the recorded reference performance can also be compared.



IMPORTANT:

1. If the cleaning solution shows heavy discoloration, discard the solution and prepare a new solution. Repeat this cleaning step. Flush out the membranes thoroughly with good quality, chlorine free water between each cleaning stage until pH is neutral.
2. Monitor pH and temperature during cleaning process, if it is still under the recommended levels. If not, adjust it again during circulation.
3. Times and values are approximate and depend on each installation and the degree of fouling/scaling.

5.5.3. Intensive Enzymatic Cleaning

Intensive cleaning is a combination of enzymatic and acid cleaning. Intensive enzymatic cleaning can be applied if intensive cleaning did not provide satisfactory results.

A water test should be performed after a cleaning. Therefore, it is important to record the clean water flux during start-up so as to have a reference point.

The RO permeate, deionized water or similar quality of water must be used to prepare the cleaning solutions, otherwise use tap water that must be softened to less than 80 ppm CaCO₃.

Intensive enzymatic cleaning sequence				
Step 1 Flush with water	Step 2 Circulate B 60 – 120 min	Step 3 Soak B 30 – 60 min	Step 4 Flush 20% of B (optional)	Step 5 Circulate B 60 – 120 min
Step 6 Flush with water	Step 7 Circulate C 60 – 120 min	Step 8 Soak C 30 – 60 min	Step 9 Flush 20% of C (optional)	Step 10 Circulate C 60 – 120 min
Step 11 Flush with water	Step 12 Circulate B 60 – 120 min	Step 13 Soak B 30 – 60 min	Step 14 Flush 20% of B (optional)	Step 15 Circulate B 60 – 120 min
Step 16 Flush with water				

Legend: A=(Sodium Hydroxide + Sodium Hypochlorite), B=(Enzymatic cleaning agent) and C=(Citric Acid)

The first assessment can be made during step 2 by comparing the permeate flow with the corresponding reference value.

The effectiveness of cleaning can be judged after step 16 by comparing the permeate flow with clean water (clean water flux “CWF”) against reference value. Alternatively or in addition, the filtration performance with process medium and the recorded reference performance can also be compared.



IMPORTANT:

1. If the cleaning solution shows heavy discoloration, discard the solution and prepare a new solution. Repeat this cleaning step. Flush out the membranes thoroughly with good quality, chlorine free water between each cleaning stage until pH is neutral.
2. Monitor pH and temperature during cleaning process, if it is still under the recommended levels. If not, adjust it again during circulation.
3. Times and values are approximate and depend on each installation and the degree of fouling/scaling.

6. Shut-down



Once the membranes become wet, do not allow them to dry out again. This may cause irreparable damage to the membranes.

- During a brief shut-down of up to 24 hours, flushing the modules with water or permeate is sufficient.
- In case of shut-downs lasting up to three days, standard cleaning must be implemented. The equipment then has to be filled with fresh water.
- In case the UF system shut-down lasts longer than three days, the membranes are to be kept in a cleaned and rinsed condition, filled with a 1.5% bisulfite solution. The preservation fluid must be replaced at least every two months.
- In the presence of wastewater which can aggressively contaminate the membrane, the membrane module should be cleaned prior to preservation

The instructions for module cleaning are outlined in section 5.5 of this manual. Instruction for the preservation of the modules are outlined in the following section.

6.1. Module Preservation

The sequence of steps in the preservation process is listed in following table. If flushing has already been performed, then operators can go directly to Step 2 in the preservation sequence. Membrane modules and piping should then be left filled with preservation fluid.

To avoid possible contamination of the membrane by the process media, it is recommended to carry out standard and intensive cleanings before preservation (see section 5.5.1 of this manual).

A water test should be performed after preservation. Therefore, it is important to record the clean water flux during start-up so as to have a reference point.

The RO permeate, deionized water or similar quality water must be used to prepare the cleaning solutions. Otherwise use tap water that must be softened to less than 80 ppm CaCO₃.

Preservation (D): Sodium Bisulfite

- Add 1.5% of Sodium Bisulfite (The concentration depends on the installation and RO permeate, deionized water or similar quality of water. Check pH levels using a pH meter or pH indicator stripes.)
- Gradually increase temperature during cleaning up to 30°C within 30 – 60 minutes in order to avoid membrane module thermal shock.

Preservation sequence					
Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Flush with water	Circulate D 60 – 120 min	Soak D 30 – 60 min	Circulate D 60 – 120 min	Flush 20% of D	Stop with D inside Max. 2 months

Legend: D=(Sodium Bisulfite)



IMPORTANT:

1. If the cleaning solution shows heavy discoloration, discard the solution and prepare a new solution. Repeat this cleaning step. Flush out the membranes thoroughly with good quality, chlorine free water between each cleaning stage until pH is neutral.
2. Monitor pH and temperature during cleaning process, if it is still under the recommended levels, if not, adjust it again during circulation.
3. Times and values are approximate and depend on each installation and the degree of fouling/scaling.

6.2. Used Module Storage

When used modules are in storage, there is a risk that the membranes would dry out. This may cause irreversible damage to the membranes so it is important that certain precautions to be taken in order to avoid this from happening.

Protection against frost

If there is a risk of freezing during transport, modules must be soaked in a 30-40% glycerine solution for several hours and fully drained afterwards.

Used module transport

Membrane modules, especially when wet, are heavy and special precautions must be taken when handling each module. Remember to close all ports. If a module is dropped or knocked, this can result in fractures within and on the module and its connectors, rendering it non-functional. If this happens, please contact Berghof Membranes.

7. Product Returns

7.1. Module cleaning prior to return

Before modules are returned, they **MUST** be cleaned as outlined in the following table. Please make sure that **ALL** materials are cleaned out from both the feed and permeate side. Operators should always comply with the standard cleaning sequence as outlined in the table below. This will not only ensure efficient cleaning, but it will also minimize undesirable reactions between cleaning chemicals and the process medium.

Standard / enzymatic / acid cleaning sequence					
Step 1 Flush with water	Step 2 Circulate A/B/C 60 – 120 min	Step 3 Soak A/B/C 30 – 60 min	Step 4 Flush 20% A/B/C (optional)	Step 5 Circulate A/B/C 60 – 120 min	Step 6 Flush with water

For detailed information on the cleaning sequences, refer to section 5.5 of this manual.

7.2. Module return procedure

Soaking of the module:

If there is a risk of freezing during transport, the *already cleaned and drained* membrane module **MUST** be soaked in a 30% (-9°C) to 40% (-15°C) glycerine solution for several hours then fully drained. No additional flushing will be required.

Handling and preparing for transport:

- After the modules have been soaked and drained, keep in mind that the weight of the module will increase.
- All ports **MUST** be drained well before closing them with end caps or plastic film to protect the membranes.
- To protect the module(s) from mechanical damage, please ensure that they are packed in a similar way as the original packaging.

Declaration form

BEFORE RETURNING the module(s), first complete the Health and Safety Declaration form (section 7.3 of this manual) and send it by email to: aftersales.membranes@berghof.com

Once the form has been received and accepted by Berghof Membranes, you will receive a case reference number specific to your product return.



IMPORTANT:

Please **DO NOT** return any module(s) to Berghof Membranes if you have not yet completed and returned the Health and Safety Declaration form, **AND** received a case reference number from a Berghof Membranes after sales representative.



ANY MODULES SHIPPED WITHOUT PRIOR APPROVAL AND ACCEPTANCE OF THE HEALTH AND SAFETY DECLARATION FORM BY A BERGHOF MEMBRANES REPRESENTATIVE WILL BE SHIPPED BACK TO THE CUSTOMER.

Shipping address:

Send the module to the address below and be sure to include the case reference number;

Berghof Membrane Technology GmbH
Case Number: XXX
Arbachtalstrasse 28
72800 Eningen
Germany

Please send an email to aftersales.membranes@berghof.com and provide the *estimated date of delivery*. Make sure to include the case reference number in ALL communications and correspondence.

**IMPORTANT:**

Berghof Membranes considers the health and safety of its employees as our top priority and we take all necessary precautions to protect them from contact or exposure with contaminated materials. Therefore, we will not accept any returned modules without a completed and approved declaration form, signed by an authorized specialist.

LEGAL STATUTES:

BGV A1 Principles of Prevention (01.01.2004)

(BGV = Employer's Liability Insurance Association)

§ 4 ArbSchG (Occupational Health and Safety Act) "General Principles"

§ 7 – 11 Ordinance on Hazardous Substances

7.3. Health and Safety Declaration Form

Product / Component: _____
 Serial Number: _____
 Year of Production: _____

With which process medium(s) did the product/component last come into contact? List all.

Designation of the process media and the constituents (if known). If necessary, attach an additional or separate sheet.

General material properties (check all that apply):

- Caustic Toxic Corrosive
 Explosive Biologically hazardous Caustic

Has the product/component been decontaminated?

- Yes No

How and with which substances was the product/component cleaned prior to dispatch?



IMPORTANT

Components contaminated by radioactivity **MUST** be decontaminated in compliance with the applicable radiation protection regulations prior to being repaired. We reserve the right to charge for additional costs of decontamination and cleansing of the module when necessary.

Legally-Binding Affidavit

I, the undersigned, hereby confirm that the information presented in this declaration is correct and complete.

Company / Organization _____
 Address 1: _____
 Address 2: _____
 Postal code/City/Country _____
 Telephone: _____
 Email address: _____

Printed name of authorized personnel: _____

Signature _____

Place/Date: _____