

TECHNICAL DOCUMENTATION

Installation, Operation & Maintenance Manual

Multistage Restriction Orifice Assemblies

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IMPORTANT NOTICES

⚠ CRITICAL SAFETY NOTICE

This manual must be read in its entirety before installing, operating, or performing maintenance on any Globe United FZE Multistage Restriction Orifice (MSRO) assembly. Failure to comply with the instructions contained herein may result in personal injury, death, or significant equipment damage. Globe United FZE accepts no liability for damage or injury resulting from improper installation, operation, or maintenance.

Disclaimer

The information contained in this document is provided in good faith and is believed to be accurate at the time of publication. Globe United FZE reserves the right to modify the content of this document, including specifications and procedures, at any time without prior notice. The operator bears full responsibility for the suitability of the device for the specific application. Incorrect installation or operation will void the product warranty.

Warranty

Globe United FZE warrants its Multistage Restriction Orifice assemblies to be free from defects in materials and workmanship for a period of **twelve (12) months** from the date of delivery, subject to the conditions that the product has been installed, operated, and maintained in strict accordance with this manual and the applicable engineering data sheet. This warranty does not cover damage resulting from misuse, unauthorized modification, or operation outside the specified design conditions.

Revision History

Rev.	Date	Description	Prepared By	Approved By
1.0	April 2023	Initial Issue	Engineering Dept.	Technical Director

Applicable Standards

This product is designed and manufactured in accordance with the following internationally recognized standards:

Standard	Description
ASME B31.3	Process Piping – Design and Construction
ASME B16.5	Pipe Flanges and Flanged Fittings
ISO 5167	Measurement of Fluid Flow – Differential Pressure Devices
ASME VIII Div. 1	Boiler and Pressure Vessel Code (where applicable)
NACE MR0175 / ISO 15156	Materials for H ₂ S Service (where specified)

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1. INTRODUCTION & PRODUCT DESCRIPTION

1.1 Scope of this Manual

This Installation, Operation, and Maintenance (IOM) Manual provides comprehensive guidance for the safe and effective use of Globe United FZE Multistage Restriction Orifice (MSRO) assemblies. It covers all aspects of the product lifecycle from receipt and storage through to installation, commissioning, routine operation, maintenance, and troubleshooting. This document must be retained for the operational life of the equipment and made available to all personnel involved in its installation and maintenance.

1.2 Product Identification

Each Globe United FZE MSRO assembly is supplied with a stainless steel nameplate permanently affixed to the body. The nameplate contains the following critical information:

Nameplate Field	Description
Tag Number	Unique identifier linking the unit to the project data sheet and P&ID
Serial Number	Globe United FZE manufacturing serial number for traceability
Line Size / Schedule	Nominal pipe size (NPS) and pipe schedule the unit is designed for
Pressure Rating	Maximum allowable working pressure (MAWP) in bar(g) or psi(g)
Design Temperature	Maximum and minimum design temperature range
Material	Body and plate material of construction
Flow Direction	Arrow indicating the required fluid flow direction
Number of Stages	Total number of orifice plates in the assembly

⚠ CRITICAL

Before installation, verify that ALL nameplate data matches the installation location data sheet. Do NOT install the unit if any discrepancy is found. Contact Globe United FZE immediately.

1.3 Operating Principle

The Globe United FZE MSRO assembly achieves controlled pressure reduction by distributing the total required pressure drop across multiple orifice plates arranged in series within a single spool piece. Each plate creates a partial pressure drop, and the flow recovers partially between each stage before encountering the next restriction. This staged approach ensures that the pressure drop at any single stage remains below the fluid's vapour pressure (for liquids), thereby preventing cavitation and the associated erosion, noise, and vibration. For gas service, the multistage design prevents choked (sonic) flow at any individual stage, which would otherwise cause severe noise and potential structural damage.

The spacing between plates (typically one pipe diameter) allows the turbulent jet from the upstream orifice to dissipate and the velocity profile to partially recover before the next stage, further reducing the risk of damage. The assembly operates entirely without moving parts, requiring no external power, control signals, or routine adjustment.

2. SAFETY INSTRUCTIONS

2.1 Intended Use

Globe United FZE MSRO assemblies are designed exclusively for the process service conditions (fluid type, pressure, temperature, and flow rate) specified on the approved engineering data sheet supplied at the time of order. Any use outside these specified conditions constitutes misuse and will void the product warranty. It is strictly prohibited to install or operate the unit in any service condition for which it was not specifically designed without prior written approval from Globe United FZE engineering.

2.2 Safety Symbols Used in this Manual

Symbol	Meaning
 WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
 CAUTION	Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury or equipment damage.
 NOTE	Indicates important information that, if not followed, may result in suboptimal performance or damage to the equipment.
 CRITICAL	Indicates a mandatory action or prohibition that must be strictly followed to prevent catastrophic failure.

2.3 General Safety Precautions

⚠ WARNING – HIGH PRESSURE HAZARD

The MSRO assembly is a pressure-containing device. Always ensure the pipeline is fully depressurized, drained, and isolated (using lockout/tagout procedures) before performing any installation or maintenance work. Never attempt to loosen or remove bolting while the system is under pressure.

2.4 Personal Protective Equipment (PPE)

The following minimum PPE must be worn at all times during installation and maintenance activities:

PPE Item	Requirement
Safety Glasses / Face Shield	Mandatory during all installation and maintenance activities
Chemical-Resistant Gloves	Required when handling process fluids or cleaning agents
Safety Footwear (Steel-Toed)	Mandatory at all times on site
Hard Hat	Required in areas with overhead hazards
Hearing Protection	Required during initial pressurization and start-up checks
Flame-Resistant (FR) Clothing	Required for hydrocarbon service applications

3. RECEIVING, HANDLING & STORAGE

3.1 Receiving Inspection

Upon receipt of the MSRO assembly, the following inspection procedure must be carried out immediately and before the unit is moved to its storage or installation location:

- 1** **Inspect the outer packaging** for any signs of damage during transit (crushed corners, punctures, water damage). Photograph any damage found.
- 2** **Check the packing list** against the contents of the shipment. Verify that all items listed (assembly, documentation package, spare gaskets) are present.
- 3** **Inspect the assembly** for physical damage (dents, scratches on flange faces, damaged nameplate). Verify that the protective flange covers are intact and in place.
- 4** **Verify the nameplate data** (Tag Number, Serial Number, Pressure Rating, Material) against the purchase order and engineering data sheet.
- 5** **Report any discrepancies or damage** to Globe United FZE after-sales service within 48 hours of receipt, providing the serial number and photographs.

3.2 Handling

⚠ WARNING – LIFTING HAZARD

Large MSRO spool assemblies can be extremely heavy. Always use appropriate rated lifting equipment (cranes, hoists, slings). Never lift the assembly by the nameplate, instrument connections, or drain/vent taps. Ensure all personnel are clear of the suspended load.

- Use lifting lugs (if provided) or appropriately rated slings around the spool body for lifting.
- Avoid impact shocks and do not drop the assembly under any circumstances.
- Keep the protective flange covers in place until the moment of installation to protect the flange faces and internal plates from damage and contamination.

3.3 Storage

If the assembly is to be stored prior to installation, the following conditions must be maintained:

Parameter	Requirement
Environment	Indoors, clean, and dry. Free from rain, water ingress, and excessive humidity.
Temperature	Between -10°C and +50°C (14°F to 122°F), with minimal variation.
Vibration	Free from vibration and mechanical shock.
Flange Covers	Protective covers must remain in place throughout storage.
Orientation	Store horizontally on a clean, level surface or on suitable dunnage.
Long-Term Storage (>6 months)	Contact Globe United FZE for specific long-term preservation requirements, which may include internal preservation fluids and external protective coatings.

4. INSTALLATION

4.1 Pre-Installation Checks

Before commencing installation, the following checks must be completed and documented:

- Confirm that the design pressure and temperature of the installation location are within the MAWP and design temperature range stated on the nameplate.
- Confirm that the pipeline material and the MSRO body material are compatible with the process fluid from a corrosion resistance standpoint.
- Confirm that the pipe bore (internal diameter) of the connecting pipework matches the design bore for which the orifice plates were sized.
- Confirm that the mating flanges are of the correct rating (ASME Class) and facing type (e.g., Raised Face, Ring-Type Joint) to match the MSRO assembly flanges.
- Ensure that the correct gaskets for the service (material, pressure rating, and facing type) are available on site.

4.2 Required Tools & Materials

Item	Specification / Notes
Gaskets (x2 per flanged connection)	Material and rating per project specification (client supply)
Stud Bolts, Nuts & Washers	Grade and quantity per flange rating and size (client supply)
Calibrated Torque Wrench	Range appropriate for bolt size and specified torque values
Wrenches & Sockets	Sized for the stud bolt/nut specification
Flange Alignment Pins / Bars	For safe alignment of heavy flanges

Item	Specification / Notes
Lifting Equipment	Crane, hoist, or chain block rated for assembly weight
Pipe Supports / Stanchions	To support pipework adjacent to the MSRO spool
Lockout/Tagout (LOTO) Equipment	Per site safety procedures
Pressure Gauges	For post-installation leak testing and commissioning

4.3 Piping Requirements & Orientation

⚠ CRITICAL – FLOW DIRECTION

The MSRO assembly is directional. The flow direction arrow on the nameplate **MUST** align with the actual direction of fluid flow in the pipeline. Installing the unit in the reverse direction will result in incorrect pressure reduction performance and may cause damage to the assembly.

The MSRO assembly may be installed in any pipeline orientation (horizontal, vertical upward flow, or vertical downward flow) unless otherwise specified on the engineering data sheet. For liquid service in vertical pipelines, **upward flow is strongly preferred** to ensure the assembly remains fully flooded and to prevent gas pockets from forming upstream of the first orifice plate. Pipe supports must be installed on both the upstream and downstream sides of the MSRO spool to prevent excessive pipe loads (bending moments, shear forces) from being transmitted to the assembly flanges.

4.4 Installation Procedure – Flanged Spool Assembly

- 1 System Isolation & Lockout/Tagout:** Follow the site-approved lockout/tagout procedure. Isolate the pipeline section using the upstream and downstream isolation valves. Verify zero energy state using a calibrated pressure gauge.
- 2 Depressurize & Drain:** Gradually depressurize the pipeline through the appropriate vent or drain point. For liquid service, drain the line completely. Ensure any hazardous fluids are disposed of safely and in accordance with environmental regulations.
- 3 Prepare Mating Flanges:** Clean the flange faces of the mating pipeline flanges. Inspect for scratches, pitting, or damage. Minor surface imperfections may be dressed with a fine file; significant damage requires flange replacement.
- 4 Remove Protective Covers:** Remove the protective flange covers from the MSRO assembly. Inspect the MSRO flange faces and verify the internal orifice plates are undamaged.
- 5 Position the Assembly:** Using appropriate lifting equipment, hoist the MSRO spool into position. Verify the flow direction arrow is correctly oriented. Use flange alignment pins to align the bolt holes.
- 6 Install Gaskets:** Place new gaskets between the MSRO flange faces and the mating pipe flanges. Ensure gaskets are perfectly centred and are not protruding into the bore.
- 7 Install Bolting:** Insert stud bolts and hand-tighten the nuts. Ensure all bolts are engaged before applying torque.
- 8 Torque the Bolts:** Using a calibrated torque wrench, tighten the nuts in a **crisscross (star) pattern** in at least three incremental passes (e.g., 30%, 70%, 100% of final torque). Refer to the gasket manufacturer's recommended torque values.

4.5 Installation Procedure – Butt-Weld Spool Assembly

Butt-weld (BW) MSRO assemblies must be installed by **qualified and certified welders** in accordance with an approved Welding Procedure Specification (WPS) that is compatible with both the MSRO body material and the pipeline material. The following precautions apply:

- Protect the internal orifice plates from weld spatter by covering the bore with a suitable heat-resistant material prior to welding.

- Do not use the MSRO assembly to align or pull misaligned pipes.
- Post-weld heat treatment (PWHT), if required by the applicable piping code, must be performed in accordance with the approved WPS.
- Radiographic or ultrasonic examination of the welds must be performed as required by the piping specification.

4.6 Post-Installation Checks

- Visually inspect all flange joints for correct gasket seating and uniform bolt engagement.
- Verify that all bolts are tightened to the specified torque values and that no bolts are missing.
- Confirm that the assembly is correctly supported and that no excessive loads are applied to the flanges.
- Ensure all drain and vent connections are plugged or valved as required.

5. COMMISSIONING & OPERATION

5.1 Pre-Commissioning Verification

Before introducing process fluid, the following must be confirmed:

- All installation checks from Section 4.6 have been completed and signed off.
- All temporary blinds, construction debris, and foreign objects have been removed from the pipeline upstream of the MSRO assembly. A pipeline flushing/cleaning procedure should be completed prior to commissioning.
- All pressure gauges and instrumentation connected to the pipeline are functional and calibrated.
- All personnel are clear of the immediate area around the MSRO assembly.

5.2 Start-up Procedure

⚠ WARNING – PRESSURE SHOCK (WATER HAMMER)

Rapid opening of isolation valves can cause severe pressure transients (water hammer) that may damage the MSRO assembly and associated pipework. Always open isolation valves slowly and gradually.

- 1** Slowly open the upstream isolation valve to approximately 10% to allow the pipeline to pressurize gradually. Monitor the upstream pressure gauge.
- 2** Once the upstream pressure has stabilized, slowly open the downstream isolation valve to allow flow through the MSRO assembly.
- 3** Monitor both the upstream and downstream pressure gauges. Verify that the downstream pressure is within the expected range as per the design data sheet.
- 4** Inspect all flange joints and connections for leaks. If any leak is detected, immediately close the isolation valves, depressurize the system, and address the leak before re-pressurizing.
- 5** Gradually open the isolation valves to their fully open position. Monitor for any abnormal noise or vibration.

5.3 Normal Operation

Under normal operating conditions, the MSRO assembly requires no operator intervention. The assembly operates passively and continuously. Operators should periodically monitor the upstream and downstream pressures to verify that the pressure drop across the assembly remains consistent with the design value. A significant increase in pressure drop may indicate partial blockage; a significant decrease may indicate plate erosion.

5.4 Shutdown Procedure

- 1** Slowly close the downstream isolation valve to reduce flow through the assembly.
- 2** Slowly close the upstream isolation valve.
- 3** Vent and drain the pipeline section containing the MSRO assembly if required for maintenance. Follow all applicable safety procedures for the process fluid.
- 4** Apply lockout/tagout as required before commencing any maintenance work.

6. MAINTENANCE & INSPECTION

6.1 Maintenance Philosophy

Globe United FZE MSRO assemblies are designed to be essentially maintenance-free during their operational life when used within the specified design conditions with clean process fluids. The primary maintenance activities are periodic external inspection and gasket replacement when the assembly is removed from the pipeline for any reason. Maintenance frequency should be increased for services with high particulate content, corrosive fluids, or operating conditions close to the design limits.

6.2 Routine External Inspection

The following external inspection should be performed at regular intervals (see Section 6.5):

- Inspect all flange joints for signs of leakage (staining, crystalline deposits, wet surfaces).
- Inspect the external surface of the spool body for signs of corrosion, pitting, or mechanical damage.
- Inspect the nameplate to ensure it remains legible and securely attached.
- Monitor and record the upstream and downstream pressures. Compare against the baseline readings taken at commissioning.

6.3 Internal Inspection & Plate Removal

Internal inspection is required if: (a) a significant deviation from the design pressure drop is observed; (b) the process fluid contains high levels of particulates or is known to be erosive; or (c) the assembly is removed from the pipeline for any reason. The procedure is as follows:

- 1** Isolate, depressurize, drain, and apply LOTO as per the shutdown procedure in Section 5.4.
- 2** Remove the MSRO spool from the pipeline. Cap or blind the mating pipeline flanges immediately.
- 3** Visually inspect the internal bore and each orifice plate for signs of erosion (enlarged bore holes), pitting (cavitation damage), cracking, or blockage by debris.

- 4** Measure the bore diameter of each orifice plate using calibrated instruments. Compare against the original design dimensions on the data sheet. If any bore has increased by more than 5% of its original diameter, the assembly must be replaced.
- 5** Clean the internal surfaces of the spool body and orifice plates using a suitable cleaning agent compatible with the body material and process fluid residue.

6.4 Gasket Replacement

① NOTE

Gaskets must NEVER be reused. Always install new gaskets of the correct specification whenever the MSRO assembly is removed from the pipeline and reinstalled.

6.5 Recommended Maintenance Schedule

Activity	Frequency	Responsible Party
Pressure drop monitoring	Daily (during normal operation)	Operations
External visual inspection & leak check	Monthly	Operations / Maintenance
Bolt torque verification	Annually or after any thermal cycle	Maintenance
Internal inspection (clean service)	Every 3–5 years or during planned shutdown	Maintenance / Inspection
Internal inspection (erosive/dirty service)	Annually or as dictated by process conditions	Maintenance / Inspection

7. TROUBLESHOOTING

The following table provides guidance for diagnosing and resolving the most common operational issues encountered with MSRO assemblies. If the issue cannot be resolved using this guide, contact Globe United FZE after-sales engineering support.

Symptom	Potential Cause(s)	Recommended Corrective Action
Leakage at Flange Joint	Loose bolting; damaged or incorrectly specified gasket; misaligned flanges; flange face damage.	Depressurize and isolate the system. Inspect flange faces and gasket. Retorque bolts in a crisscross pattern. If leak persists, replace gasket. If flange faces are damaged, dress or replace the flange.
Pressure Drop Higher Than Design	Partial or full blockage of orifice bores by debris, hydrates, wax, or scale deposits.	Remove the assembly and inspect internal bores. Clean as required. Review upstream filtration and pipeline pigging schedule to prevent recurrence.
Pressure Drop Lower Than Design	Erosion of orifice bores enlarging the effective flow area; incorrect assembly installed (wrong tag number).	Remove the assembly and measure orifice bore diameters. If erosion is confirmed, replace the assembly. Verify tag number against data sheet. Review process conditions for erosive service (high velocity, solids content).
Excessive Noise / Vibration	Actual flow rate or pressure drop significantly exceeds design values; cavitation occurring in liquid service; choked flow in gas service; loose internal components.	Verify actual process conditions (flow rate, inlet pressure, temperature) against the design data sheet. If conditions have changed, contact Globe United FZE engineering for a re-evaluation. Check for loose pipe supports.

Symptom	Potential Cause(s)	Recommended Corrective Action
Cavitation Damage (Pitting on Plates)	Insufficient number of stages for the actual pressure drop; actual fluid vapour pressure higher than design; operating at off-design conditions.	Contact Globe United FZE engineering to review the design. An assembly with more stages or a different plate configuration may be required. Replace the damaged assembly.
External Corrosion on Spool Body	Inadequate external coating or insulation; exposure to corrosive environment (marine, chemical).	Clean the affected area, apply a suitable corrosion-inhibiting coating. Review insulation system. Monitor wall thickness using ultrasonic testing (UT).
Incorrect Downstream Pressure (No Blockage or Erosion)	Actual process conditions (flow rate, inlet pressure, fluid properties) differ from the design data sheet values used for sizing.	Verify all actual process conditions. Contact Globe United FZE engineering with the actual conditions for a performance check and re-sizing if necessary.

8. SPARE PARTS & ORDERING

Globe United FZE recommends maintaining the following spare parts on site to minimize downtime in the event of maintenance requirements:

Spare Part	Recommended Quantity	Notes
Full-face / Spiral-wound Gaskets	2 sets per MSRO assembly	Must match the flange rating, size, and facing type. Specify material compatible with process fluid.
Stud Bolts & Nuts (full set)	1 set per MSRO assembly	Grade as per original specification (e.g., ASTM A193 B7 / A194 2H).
Replacement Orifice Plate Assembly	1 complete assembly (for critical services)	Must be ordered with the original serial number for correct sizing. Contact Globe United FZE.

When ordering spare parts or a replacement assembly, please provide the following information to Globe United FZE:

- Globe United FZE Serial Number (from the nameplate)
- Tag Number
- Project Name / Purchase Order Number
- Description of the required part

9. Technical Specifications

The following table summarizes the standard design envelope for Globe United FZE MSRO assemblies. Specific values for each unit are defined on the individual engineering data sheet.

Parameter	Standard Range	Notes
Line Size (NPS)	½" to 24" (DN 15 to DN 600)	Larger sizes available on request
Pressure Rating	ASME Class 150 to Class 2500	Per ASME B16.5 / B16.47
Design Temperature	-196°C to +650°C (-320°F to +1200°F)	Material-dependent
Number of Stages	2 to 20+	Determined by pressure ratio and fluid properties
End Connection	Flanged (RF, RTJ) or Butt-Weld	Per project specification
Body Material	CS, SS 316/316L, Duplex, Super Duplex, Alloy 625, Alloy 825	Per fluid service requirements
Plate Material	SS 316/316L, Duplex, Hastelloy C276, Titanium	Per fluid service requirements
Fluid Service	Liquids, Gases, Steam, Two-Phase	Including hydrocarbons, water, acids
Design Code	ASME B31.3, ISO 5167	Other codes available on request
Testing	Hydrostatic shell test at 1.5x MAWP	Per ASME B16.5 / client specification

10. CONTACT & AFTER-SALES SUPPORT

Globe United FZE is committed to providing comprehensive after-sales technical support throughout the operational life of our products. Our engineering team is available to assist with technical queries, spare parts, and field service requirements.

10.1 Technical Support

For technical inquiries, troubleshooting assistance, or to request a site visit from a Globe United FZE field service engineer, please contact our engineering support team using the details below. When contacting us, please have the following information available: the unit Serial Number, Tag Number, and a description of the issue.

10.2 Contact Details

Contact Method	Details
Company	Globe United FZE
Location	United Arab Emirates
Email	info@globeunitedae.com
Phone	+971 50 330 1384
Website	www.globeunitedae.com

10.3 Information Required When Contacting Support

To enable our team to provide the most efficient and accurate support, please have the following information ready when contacting Globe United FZE:

- Globe United FZE Serial Number (from the unit nameplate)
- Tag Number and Project Name

- Current operating conditions (inlet pressure, outlet pressure, flow rate, fluid, temperature)
- Design conditions from the original data sheet
- A clear description of the symptom or issue observed
- Any recent changes to the process or operating conditions

① **NOTE – DOCUMENT CONTROL**

This document is controlled by Globe United FZE Engineering. The latest revision is available upon request. Please verify that you are using the current revision before commencing any work. Document Number: **GU-IOM-MSRO-001** | Revision: **1.0** | Issue Date: **April 2023**.