

Bettis Multiport Actuator

Valve Actuator



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Introduction

This section lays down the outline for an overall “Integrated skid mounted well test manifold” by Emerson. Important components in a well test manifold will be:

- Bettis Multiport Flow Selector – Valve Automation
- Multiphase Flow Meter - Roxar
- Remote Transmission Unit – Remote Automation Solutions

Developing a oil field successfully inherently carries with itself a host of challenges. Owing to the large amount of investment committed for field development there is need to maximize profits, and at the same time minimize risk and cost.

In Country work – Projects are increasingly looking for ways to do as much as possible as “Plug and Play” modules.

Remote Operations Capability – There is concern around being able to deal with day to day operational needs remotely and efficiently.

Efficient Spares Management – Standardization on equipment ensures that there is an efficient spares strategy and management.

Training Considerations – There is need to administer training in a systematic and efficient manner to local operational staff.

Service Support – A Support Structure is required for Mega Projects with facilities, and headcount.

Project On time Delivery – Time to Oil is a major Consideration for Upstream Project and affects Return on Investment negatively.

Safety Concerns – The Volatile Security Situation warrants a solution, where there is minimum human involvement

In a bid to address these concerns, there is a need to develop efficient, and cost effective solutions, that can be modular and easy to install. This minimizes manpower, effort, and risk on the field, and can optimize resources in the right direction.

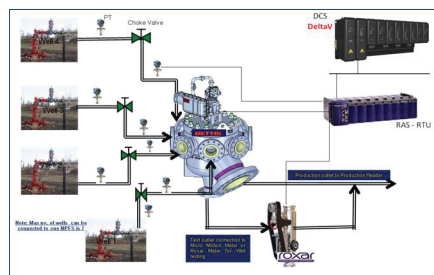
Vision – The “Solution”

This technical solution is employing the Bettis™ Multiport Flow Selector, which is a unique pressure vessel, which is designed to manifold up to 8 well flow lines. These flows are combined together, and it is possible to single out a particular well flow, and conduct well testing on the same.

The actual well fluid test is done via the Roxar™ Multiphase meter, which measures 3 distinct phases that could be present in the crude output from the wells; i.e. water, gas, and oil.

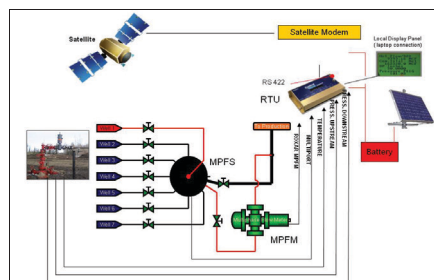
Test data, and a host of other parameters, taken from the actuator, pressure and temperature readings from the wellheads, and the multiport actuator position and control, is fed back into the RAS – Remote Transmission Unit. This device enables to then feed data back into the SCADA system via radio or satellite communication. Made for remote locations, these RTU's report by exception, with time stamps, therefore giving the user a real feel of the changes that occur on critical parameters – This contributes to decisive control on the upstream scope of the project, and is the cornerstone of the “Digital Oilfield”.

As illustrated, below is a brief outline of the solution proposed above:



Various parameters from wellhead, multiport and multiphase meter are fed back to the DCS system (Delta V shown in the example above), via radio or satellite communication.

From each well, there are a host of parameters which are detailed in below layout/diagram. This elucidates the overall function of solution. Pressure, temperature at well site enables the user to monitor for any pressure losses or spikes which, in turn give an accurate vision of the condition of the infrastructure far upstream. The multiport manifold allows the well fluid to be singled out and tested with the Multiphase meter. This will provide the user with complete and comprehensive information on each well in terms of flow, the composition of the crude fluid that each well produces – enabling pro-active and decisive reservoir and field management throughout the entire lifecycle of the project. Below image that outlines the different parameters measured per well flow line.



Technical Specification

Battery Limit And Scope Of Supply For Integrated Skid Mounted Well Test Manifold

- The proposed option should be best for production and testing of oil wells without interruption. It should include Multiport Flow Selector units (MPFS) for normal operation of manifold.
- The basic scope of supply shall be design, manufacturing, testing, delivery, documentation, of a complete operational multiport Flow selector skid. Supervision of erection and commissioning at site. Skid will be comprises of following items.

Table 1.

Sr. No.	Description	Notes	Manufacturer Name / Brand name	Qty.
1	Multiport Flow Selector (MPFS)		Emerson - Bettis Make	One No
2	Electrical actuator to be mounted on Multiport Flow Selector		Emerson – EIM make	One No
3	Multiphase flow meter		Emerson – Roxar Make	One No
4	RTU		Emerson Make	One No
5	Isolation Valves (Ball Type Valves)	On the Upstream and downstream side of MPFS.	To be advised	As per P&ID.
6	Check Valves	Upstream and downstream of MPFS. As shown in the attached P&I Diagram.	To be advised	As per P&ID.
7	Skid		To be advised	1 No. Duly mounted with piping and fabricated
8	Any other items required for completion of skid.	Any other items required to complete the skid scope like Nuts, bolts, flanges, gaskets, pipes, fittings, structural steel, cable supports/ trays, etc.	As per the availability in the market and suppliers preference.	

Overall skid limit will be as shown in the P&I Diagram.

Mechanical Limits

- All Well inlet connections (Seven Nos.) to be terminated at the inlet flange of skid piping by others.
- Skid outlet connections will be outlet flange of main production (bulk) header pipe.

Power Supply limits

- Client will supply power supply at one point of skid. Cable connections within the skid will be taken care by Emerson.

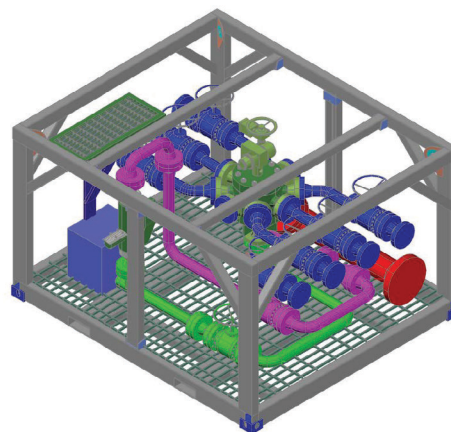
Communication limits

- Communication of Multiport Flow Selector and Multi-phase Flow Meter is limited to RTU mounted on the skid.
- Communication between RTU and User system will be in the scope of contractor.

Civil limits

- Any Civil work is excluded from the scope of the supplier.

Typical Skid Arrangement



NOTES:

The below arrangement of skid is only for illustrative purpose only actual dimensions and arrangement may change as per the plot lay-out and contractors / end user requirement.

Multiport and Actuator Technical Details

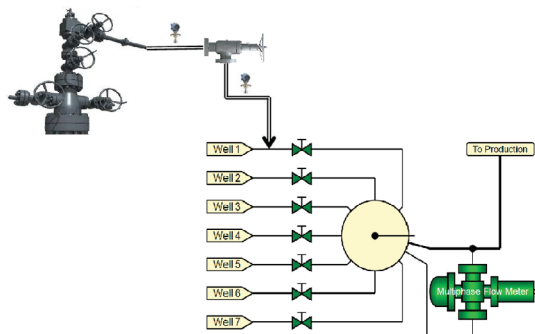
General Description

Crude oil well test manifold to be provide as Multiport Flow Selector (MPFS) technology. It provides a cost effective method for selecting and diverting well fluids from an individual well to a single test outlet or loop. MPFS should be able to operate in a variety of oil and gas or process applications.

Multiport Flow selector is advanced concept for oil Well test and Production Manifold. This is preferred choice of manifold due to economical and more compact than conventional designs. Multiport valve is a cluster of connecting more than one well and grouping together before the production.

The maximum number of wells inlets to a single MPFS is 8 (Eight), however for engineering excellence operation it is recommended to connect maximum 7 (Seven) nos. of wells. The maximum number of wells that can be connected to a single MPFS in a specific application is determined by the media type and flow rate.

Arrangement and Working of Multiport Flow Selector Valve in Production Manifold:



The well lines can easily be diverted to production and Test separator from MPFS. The seven inlets of the multiport flow selector are connected to wells along with isolation valve. The remaining one port is kept free which is home port. During service the home port can be used for seal adjustment.

1. Scope Of Supply

The basic scope of supply shall be design, sizing, selection, manufacturing, testing, delivery, documentation, of a complete operational multiport Flow selector along with controller.

Typical arrangement is shown in the attached P&I Diagram.

The VENDOR's scope for the Multiport Flow Selector shall be as described in this specification and associated documents including but not limited to:

- Multiport Flow Selector controller, i.e. Electrical Actuator
- Sizing calculations
- Data and Documentation as per Material Requisition, including maintenance manuals, export crating and transportation details
- Inspection and Testing
- Commissioning and Start-up Spares
- Two (2) years operations and maintenance spares list inclusive of sub-vendor
- Itemized special tools required for installation, start-up and maintenance
- Field service rates for technical support and on-site pre-commissioning
- Training
 - One session of in house training in vendor's facility
 - One session of on the site training.
- Project Management of the complete order and scope of supply
- Storage, preservation packing and suitable for land, sea or air shipment as per the delivery terms

2. Technical Requirements

a. General Technical Requirements

The MPFS shall be used to divert the flow from up to seven well strings (or as mentioned in datasheets) to a single multiphase flow meter for well testing purposes. An eighth position shall be provided to "park" the selector. The MPFS shall be equipped with remote and local position control facilities.

The following sub-sections shall constitute common technical requirements for the MPFS.

b. Hazardous Area Classification and Certification

All electrical / electronic field instrumentation items such as motor, transmitters, switches, controller etc shall be of EEx'd' type suitable for installation in Zone 1, Gas Groups IIB, Temperature Class T3, as a minimum irrespective of the area classification.

All electrical / electronic Instrumentation items shall be certified by an internationally recognised organisation (statutory body) such as BASEEFA, PTB, FM, CSA, UL etc for operation in hazardous area classification.

All electrical / electronic Instrumentation items to be installed in a hazardous area shall conform to CENELEC / IEC as per EU Directive ATEX 94/9/EC and shall also carry the marking as per ATEX directive.

c. Ingress Protection

All MPFS components shall have ingress protection of IP-65 in accordance with IEC-60529 as a minimum. All field instruments installed under / exposed to direct sun light shall be provided with a UV resistant, GRP canopy.

d. Sour Service Requirements

In sour service application as identified in applicable project pipe material class specification / instrument datasheet all process wetted parts materials including accessories of the corresponding instrument must conform to the requirements of NACE Standards MR-0175/ISO15156.

e. Power Supply

To Specify

f. Connections

All Threaded end connections shall be NPT (Taper) as per ASME B 1.20.1. Threaded process connection shall be seal welded. All Flanged end connections shall be as per ASME B 16.5. / NORSOK / SPO Compact TYPE. Flange Rating, Facing and finish shall be as specified in data sheet.

Electrical field cable connection shall be of Metric Thread (Eg: M20, M25 etc) and sizes shall be as specified in datasheet. Separate entries shall be provided for input, output and power supply, as specified in datasheet.

g. Design Life

MPFS and its actuator assembly, control circuit and associated accessories within the VENDOR scope of supply shall be designed for a life expectancy of thirty (30) years, as a minimum. VENDOR shall warrant the availability of spares and services for all parts for a minimum of 10 years.

h. Low Power Consumption

All electrical / electronic items shall be of low power consumption type. Vendor must provide power consumption of individual component along with the bid.

i. Specific Technical Requirements

The following sub-sections shall constitute specific technical requirements for the MPFS.

3. General

The MPFS shall be designed and constructed in accordance with the requirements of this specification, data sheets and other specifications referred in the requisition with the requirements of the referenced codes and standards. The MPFS shall be supplied as fully assembled and tested units, complete with all necessary accessories.

The MPFS shall be vertical type with all inlets horizontal around the valve body and the main production outlet and test outlet shall be at the bottom. The valve ports shall be sized as per the process conditions mentioned in the data sheets. MPFS shall have 8 inlets, as a minimum; one of which shall be in parking position.

The MPFS shall be with the flanged connections for the Process inlet and outlet flanges. The design shall be constructed such that maintenance, cleaning and testing can be performed easily.

MPFS should be provided with vent connections. MPFS plug sealing design should allow performing temporary maintenance in-situ condition. Plug seal should be field adjustable type. VENDOR to provide suitable plug-seal assembly adjustable tool.

The MPFS shall be provided with a motorised actuator and position indications. Position feedback mechanism to be specified by the supplier. The Electronic controller shall be integral part of electrical actuator. EC shall have the following functionalities as a minimum:

- Control of the MPFS selector position
- Remote well switching and testing as a part of well test programme; i.e., allow the operator to remotely communicate from the DCS / ICSS through the respective station via RTU system.
- Local selector switches and display unit for the field operator to take control of the MPFS.
- Serial link to select and confirm valve position and any system diagnostics to the MPFS.
- Local interface through the selector switch for the field operator to take control of the MPFS.
- Actuator shall have inbuilt local control station. It shall be provided with a Three (3) – position selector switch for REMOTE/ JOG / STEP functions.
- REMOTE position shall disable all the local push buttons operations.

- JOG/STEP position shall allow the local operation by the field Operator.
- JOG enables continued plug rotation whilst push button is depressed. JOG function shall be disabled in normal working condition. It should be password protected and shall be accessed only by authorized person.
- STEP rotates plug to next well inlet port
- In REMOTE mode operation, the control command will be issued from the USSC control room to the Multiport Actuator, and multiport actuator in turn shall position the MPFS port to the well inlet which is to be tested. Only one well at a time will be selected for the test.
- The signals from multiport actuator unit to the control room shall include:
 - Indication of well under the test
 - Indication of Local / Remote mode position
 - System status common alarm

4. MPFS Body Construction

The MPFS shall be manufactured in accordance with ASME B 16.34 and ASME Sec VIII. When selecting MPFS ports, factors taken into consideration shall include, process properties, capacity requirements, normal and shutoff pressure, etc.

The MPFS shall offer a compact manifold design combining production and test manifold in one single unit. The MPFS shall consist of 8 inlets, one test outlet, one main production outlet and a selector (moving part). In a MPFS, maximum 7 inlets shall be connected to the flow lines and the 8th inlet shall be left with blind flange which shall be used as an inspection port called as inspection and parking port. It shall be possible to divert the flow from any of the 7 inlets to the test outlet by operating the selector. All other flows shall combine and exit via the common production outlet port.

The MPFS main production outlet shall be sized to cater total flow from 7 different wells whose flow profile has been given in the Process Data Sheet (PDS). Also, inlet size shall be sized suitability to handle the flow profile given in the PDS. The MPFS trim shall be completely replaceable through the bonnet.

5. Piping Requirements

The MPFS shall be provided with flanged connections for the process inlet and outlet flanges. Nozzle (inlets, main production outlet and test outlet) size shall be based on the VENDOR sizing calculation.

The flange dimension, rating, facing and surface finish shall be in accordance with the Piping Material Specification (PMS).

6. MPFS Trim and Leakage Class

The MPFS trim consist of the manifold assembly that are in contact with the process medium, which include selector (plug), guide bushing and seat ring.

The seat ring shall be easy / quick replaceable type. It should also allow temporary maintenance in-situ condition. The MPFS seat leakage class shall be as per process requirement and as specified in the data sheets. All MPFS shall be sized to provide different flow from different wells and sizing calculation as per API 14E shall be submitted for approval.

7. Materials

The material of the MPFS shall be as per the PMS and as mentioned the data sheet. Seal and gasket materials shall be selected for long term operation under the specified site conditions. VENDOR shall highlight clearly, in case other materials offered which shall be superior to the material indicated in the PMS.

Materials for sour service shall conform to the requirements of NACE Standard MR-0175 / ISO15156. Asbestos or any other locally and/or internationally prohibited materials shall not be used in any forms.

Materials of construction of the actuator shall be electrochemically compatible with the valve body. Materials of construction of the MPFS and actuator shall be suitable for prolonged service in the specified environment.

Castings shall be in the normalized or quenched and tempered condition. Welds or weld repairs shall be subject to a stress relief heat treatment and shall be certified. Austenitic stainless steel and Inconel 625 material shall be in the annealed condition. Forgings in CS shall be in the normalized condition.

■ BODY, TRIM:

The MPFS shall be constructed from material as per data sheet.

■ ACTUATOR:

Motor enclosure material shall be in Carbon Steel or Marine grade Aluminum with low copper content.

MPFS shall be electrically actuated by a motor. Motor shall be provided with integral starter with associated microprocessor based controller to position the selector (moving part) to the required position.

The controller shall provide the position feedback, diagnostic data etc to platform PCS system. VENDOR shall provide the power consumption details along with the bid.

Actuator shall be provided with Hand wheel for manual operation. It shall be designed by the VENDOR to suit the offered MPFM.

■ MOTOR

Actuator motor shall operate on 24 V DC, $\pm 10\%$ (-ve earthed) Power Supply from solar power system. The minimum class of insulation shall be Class F and temperature rise shall be limited to Class B insulation.

The motor housing shall be certified EEx'd' type suitable for Zone 1, Gas Group IIB, and Temperature Class T3 hazardous area classification.

8. Control Features

Actuator shall have following control and diagnostic features.

- Control of the MPFS selector position
- Modbus over RS-485 or Modbus over TCP/IP serial communication module for remote communication
- Remote well switching and testing as a part of well test program i.e., allow the operator to remotely communicate
- Local selector switches and local display unit for the field operator to take control of the MPFS.

■ Modbus RTU RS485

■ I/O and alarm monitoring include

- Integral circuit breaker/disconnect
- Motor overload and motor thermal
- Loss of control voltage
- Encoder failure
- Stall detection and alarming (detects mechanical faults)
- 3-Phase monitoring and phase correction to insure correct motor rotation
- Monitor relay for hardwired relay contact status on fault



ACTUATOR TECHNICAL DETAILS

Multiport Actuator (MPA) Features

- Based on EIM's heavy duty 3000 Series gearbox with a capacity of 3000 ft-lb
- Configurable for multiport flow selectors from 3 to 8 ports
 - Any port may be selected as home port and any port(s) may be skipped
 - Actuator calibrated at factory for exact match to flow selector port positions
 - Calibration parameters stored in non-volatile memory and available to DCS
- 12-bit magnetic encoder coupled directly to valve stem for position feedback
 - Provides position measurement resolution of 0.088 degrees
- EIM's exclusive solid state motor starter and control software provides precise positioning of flow selector within ± 1 degree of selected port
- High performance microcontroller updates motor control output every 1mS for precision motor control
- 12-bit magnetic encoder coupled directly to torque pinion for torque feedback
 - Provides torque measurement resolution of 0.146% of full torque

MPA includes local display module (LDM) standard

- Uses rugged LED display for port number, torque, and alarms
- (also displays setup menus and setup parameters)
- Multiple colour LEDs display
 - Port position within 1o of port
 - Motor running
 - Alarm
 - Over torque
 - Local mode
 - Off mode
 - Remote mode
- Includes Local Off Remote selector switch
- Local control knob for Port selection and Jog control
- Configuration and test may also be performed with EIM's MPA CONFIG software, a Microsoft Windows XP application
 - Laptop with RS485 converter and MPA CONFIG may be connected to the RDM communication port for easy configuration and test for factory and field applications.



ENVIRONMENTAL SPECIFICATIONS

- ATEX - II 2 GD, EEx d IIB T4 or EEx d IIB 120 °C (T4), IP66, Explosionproof
- Ambient Temperature rating of -40 °C to + 60 °C
 - Enclosures include thermostatically controlled space heaters to keep dry and
 - Stable clock frequency over entire temperature range
- Operating humidity, 5 - 100% RH

9. Sizing of the Multiport Selector Manifold

- MPFS shall be sized and selected accordingly based on the process data sheet and Instrument datasheet.
- VENDOR shall submit the sizing calculation along with the bid. Sizing calculation shall be approved by EPC CONTRACTOR / COMPANY.

10. Tagging and Identification

Each MPFS and its accessories shall be provided with a permanently fastened SS316L nameplate. Name plate shall be permanently fixed to the body of the instrument using SS316L screws. Adhesive labels shall be forbidden. In order to prevent corrosion, name plates in SS316L shall be covered by a transparent protective film.

The name plate shall indicate the following information as a minimum:

- Tag number
- Manufacturer's name and trade mark
- Serial number and model number
- Material
- Size and rating
- Voltage, watts and frequency for electrical instruments
- IP rating/Hazardous area classification

The VENDOR shall submit a label schedule with nameplate details to the EPCC / CONTRACTOR for approval.

11. Painting and Coating

The protective coatings for the MPFS unit including the parts in SS316L shall be as per "Painting Manual of the COMPANY. Protective coating shall not obscure equipment tag plate etc. It shall be suitable for offshore environment.

VENDOR's standard painting specification may be acceptable if the same conforms to the above COMPANY Specification or exceeds the specification requirements subject to COMPANY's approval.

12. Inspection and Testing

■ GENERAL

The inspection and testing requirement shall be in accordance with Inspection and Test Plan attached with the Material requisition and Purchase Order. The Inspection and Testing shall be witnessed by EPCC CONTRACTOR /COMPANY/ COMPANY's representatives.

It shall cover in-house inspection and testing by the VENDOR, Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT).

VENDOR shall be responsible for preparing test procedures, co-ordination with third party system vendors and the testing of interface to third party equipment.

It shall be VENDOR's responsibility to modify and/or replace any hardware and modify the software if the specified functions are not completely achieved satisfactorily during testing and factory acceptance.

■ FACTORY ACCEPTANCE TEST (FAT)

A detailed Factory Acceptance Test (FAT) procedure shall be prepared by VENDOR and submitted for EPCC CONTRACTOR / COMPANY approval.

FAT procedure shall provide the following details, as a minimum:

- Description of each test, purpose of test and expected result.
- The tests shall be conducted in accordance with approved procedure.
- VENDOR shall record all test results, issues and shall take action on all issues till the successful completion of the tests.

All records shall be verified and signed by the personnel witnessing the tests. One full set of documentation shall be made available during 'FAT' for reference and use, which shall be used to record 'FAT' changes and observations. All 'FAT' punch lists shall be cleared by VENDOR prior to the shipment.

13. Training

VENDOR shall provide necessary training to the COMPANY engineers. VENDOR shall indicate the optimum number of attendees per training session and the pre-requisites for attending these courses.

The course and the documentation shall be in English, and tailored for the application and site concerned. VENDOR shall provide training materials for all the participants which shall adequately cover every aspect of the MPFS including site calibration.

Training shall include the theoretical, practical, number of attendees and required sessions.

VENDOR offer shall cover the following options in terms of location of training:

- Training to be held in COMPANY's offices
- Training to be held at VENDOR's office

14. Spare Parts And Consumables

PRE-COMMISSIONING, COMMISSIONING SPARE PARTS:

VENDOR shall provide spares for:

- Pre-commissioning
- Commissioning and Start-up

OPERATIONAL SPARE PARTS

VENDOR shall compile a S.P.I.R. list based on 2 years continuous operation of the MPFS. This list should be based on VENDOR's recommendations.

VENDOR shall provide a separate price for all recommended spare parts, repair /replacement policy, including which spares are currently stocked and where.

CONSUMABLES

VENDOR shall provide all the consumables required during pre-commissioning, commissioning and SAT's (If applicable).

15. Packing, Marking and Shipping

MPFS and its associated accessories shall be packed, marked and shipped as per the EPCC CONTRACTOR purchase document.

All openings of MPFS must be positively sealed for storage and shipping by proper backing plates or other methods to ensure against ingress of dirt and transportation hazard. The use of adhesive tape alone is prohibited.

Easily damageable parts such as machined faces shall be fitted with caps / plates for proper protection. Machined or threaded surfaces exposed to the atmosphere in shipment or storage shall be coated with rust preventive.

After the successful test, all the components especially body cavities are to be thoroughly dried prior to preparation for packing and shipping.

Table 2. MPFS - Recommended Material of Construction for Option 1

Multiport Flow Selector	6" X 16" ----- 1500# (QTY 1 NO.)
Notes	■ 8 Nos. of inlet connections of 6" Size each. ■ One no of Test outlet connection of 6" size ■ One no of Production outlet of 16" size.
MAJOR COMPONENT DESCRIPTION	MATERIAL
Design Code	ANSI B 16.34 / ASME Sec VIII Div. 1
Body	A216-WCB + Inc 625 cladding (Min. 3 mm)
Flange	A216-WCB / A 105 + Inc 625 cladding (Min. 3 mm)
Bonnet	A216-WCB + Inc 625 cladding (Min. 3 mm)
Bonnet Stud	ASTM A 193 GRB7M
Bonnet Nut	ASTM A 194 GR2HM
Plug	Inc 625 (ASTM A 494 CW6MC)
Trim (Back up plat/Scraper/ Adjustment Nut)	Inconel 718
Seat Insert	25% Carbon Teflon
O-Rings	AFLAS
Painting	Std. 3 coat painting.
Quality Certification	3.1 Certificate for Major Raw Material
Quality Certificate	2.1 compliance certificate for small components like seal, seat, o-ring etc.

Multiphase Flow Meter Technical Details

PURPOSE OF MPFM

MPFMs are in-line flow meters wherein all the measurements of the individual phase fractions and individual phase flow rates are performed directly in the multi-phase flow line without any separation and/or sampling of the fluids. The MPFM shall serve the following purpose in the facility:

1. Well Testing
2. Real time Well Surveillance or Monitoring for Production optimization and Flow assurance.

PRE-QUALIFICATION CRITERIA

1. The Supplier shall have previous experience of supplying MPFMs for the similar applications and the MPFM model shall have proven track record of delivering satisfactory performance under the conditions similar to the Project.
2. Reference List: Supplier shall submit reference list of installations wherein the offered MPFM model is in use currently. For the purpose of Reference list of installations only installations of reputed Oil and Gas Companies, or equal, would be considered.
3. Experience: Supplier shall submit documentation indicating their experience in all the activities related to the supply of MPFM in their previous projects. References shall be considered only from the reputed Oil and Gas Companies.
4. MPFM evaluation in Third party Laboratory: Offered model of MPFM shall have undergone performance evaluation in third party laboratory, preferably TUV-NEL, Scotland, UK. Performance evaluation report of the MPFM from third party laboratory shall be submitted in the offer for review.
5. MPFM proven track record: Offered model of MPFM shall have at least 2 years of proven track record of providing satisfactory performance under the operating conditions.

SCOPE OF WORK

1. Supplier shall supply all aspects of MPFMs including design, engineering, materials, fabrication, procurement, project management, configuration, programming, integration, inspection, testing, marking, shipment, training, assistance in installation/commissioning/operation and maintenance/ Nucleonic gauge equipment licensing, documentation.
2. Supplier shall provide all the necessary Project management, engineering, consultation and programming services to fulfil the requirements of this specification.
3. Supplier shall supply all hardware and software required to build complete functioning MPFMs as per this specification and other referenced project specifications and standards.
4. All hardware, firmware, software and system components necessary for the proper functionality of the MPFMs shall be identified and provided by the Supplier as part of his scope.
5. Supplier shall support the complete configuration of the MPFM inclusive of the configuration of the interfaces between MPFM and DCS. As the part of MPFM engineering the Supplier shall provide complete configuration details of all the components of the MPFM.
6. Supplier shall special tools and test equipment (including pricing, model numbers, etc) required to properly install, start-up, commission, operate and maintain the MPFMs.
7. Supplier shall provide Priced list of recommended spares for two years of operation.
8. Supplier shall make available an experienced Start-up and Commissioning Engineer to assist and provide direction during Commissioning of the MPFMs.
9. Supplier shall provide, when necessary, factory trained MPFM troubleshooting assistance.
10. Supplier offer shall include statements of availability and locations of service personnel for the MPFMs.
11. Supplier shall provide priced options along with the offer for the following:
 - a. Conducting Training courses for Engineering, Operations and Technicians.
 - b. Installation, Site-integration, Start-up, Commissioning support.
 - c. Post Commissioning support related to Operations and Maintenance.

TECHNICAL REQUIREMENTS**MPFM shall consist of:**

- a. In-line, Multi-Phase Flow Meter. The equipment shall strive to make no attempts at separation, but shall directly measure physical characteristics of the fluids and their flow through the pipe to determine the phase flow rates and phase fraction.
- b. Other Process Instruments inclusive of Multivariable transmitter for Pressure, Temperature and differential pressure measurement and shall be fitted as integral part of the MPFM.
- c. Flow Computer part performing calculations of quantities, reporting functions. This Flow Computer shall be installed in the field near MPFM and shall have interfaces for DCS.
- d. A compact design is encouraged to reduce space requirements and weight.
- e. The measurement principle shall use Gamma ray for mixture density measurement and impedance electrodes for phase fraction measurement.

MPFM DESIGN CONSIDERATIONS**Proven Design**

- The MPFM shall use proven components, utilize techniques that minimize the need for maintenance and implement an overall system design that enhances the integrity of the installation.

In-Line Construction with Low Pressure Loss

- The MPFM shall have an in-line construction that exhibits a low permanent pressure drop and no moving parts. Furthermore, the meter shall not be dependent on any mixer/flow conditioner or require a phase separator device. Use of upstream mixers strainers and sampling ports is not recommended due to extra pressure loss and costs.

Independent of Flow Regime

- The MPFM shall have a measurement technique that is independent of flow regime and insensitive to fluid flow phase changes.

Pressure and Temperature Design Rating

- The MPFM system shall be pressure rated to withstand wellhead design conditions. Design Pressure shall be 5000 psi and design temperature shall be -20 °C to +130 °C.

Material of Construction

- The MPFM materials and construction shall be compatible with the process fluids and the environmental conditions that it will be exposed to. Further, the MPFM materials and construction shall comply with the associated piping codes.

Field Transmitters

- The Pressure, Temperature and differential pressure transmitters shall be a single Multivariable transmitter.

Gamma-Ray Sensor

- If MPFM has Gamma-ray source then the isotope source shall have a minimum half-life of 30 years and with as low an activity as is reasonably practicable for the application. Surface radiation on the Gamma source must be less than 7,5 microsievert per hour. Source strength shall be less than 5 milli Curie (mCi). The isotope used for gamma ray shall be Cesium 137 with half life of 30 years.

Phase Fraction Measurement

- The vendor shall state the technique used by the MPFM for determining phase fractions. Techniques proposed shall be based on the process conditions and other functional requirements as enumerated in clause no. 5 of this document.

(Phase) Slip

- MPFM designs shall be capable to measure interphase slips directly by using cross correlation methods.

Sampling

- The MPFM technology shall be independent of any process sampling requirement at site. Flow calculation shall be done using the hydro carbon composition input.

Interface with DCS

- Interface can either be RS 485 or Industrial Ethernet with protocol MODBUS / RTU or TCP / IP. Interface should allow remote access to MPFM for remote diagnostics and set-up. The flow computer shall have 01 no RS 232 port for service console communication and 01 no RS 485 port for DCS communication.

Flow Computation

- The vendor shall describe the flow computation software package used for the calculation of flow rates in Standard conditions and in mass units. The software package shall be part of the supply.

UNCERTAINTY

The performance specification should be tuned to expected flow conditions.

Given the flow data this meter operating in multiphase mode the uncertainty shall be:

Absolute watercut: 2.5% - 3.5%

Relative gas volume flow rate: 6%

Relative liquid volume flow rate: typically 3.5% - 5%

Also the meter should be able to work in both Multiphase and wetgas modes, if process data requires.

Uncertainty calculations shall be in line with ISO/ IEC Guide 98-1, Uncertainty of Measurement- Part 1: Introduction to the expression of uncertainty in measurement and NFOGM's Handbook of Uncertainty Calculations, Rev 2. Confidence level of the specified measurement uncertainties shall be 95% ($k=2$), where, k is the coverage factor.

Measurement uncertainties for MPFMs shall be specified by the Supplier as per the following table.

Table 3.

Multiphase MPFM 2600				
Confidence level:	95%	($k=1.96$)	Combined expanded uncertainties	
Sub range	GVF range	Gas	Liquid	WLR
A	0 – 25 %	8 ⁽¹⁾	3,0	2,0
B	25 – 85%	6	3,5	2,5
C	85 – 96 %		5,0	3,5
D	96 – 98 %		8,0 ⁽²⁾	4,5 ⁽²⁾
E	98– 100%		Wetgas	Wetgas
Repeatability:		1/4 of %	1/4 of %	1/4 of %

In addition to the expression of MPFM measurement uncertainties in tabular form above, the Supplier shall also present uncertainties in graphical plots including, the two phase flow map, the composition map, and the cumulative performance plot. Refer NFOGM's "Handbook of Multiphase Flow Metering" for guidance on these plots.

MPFM SIZING / CAPACITY

- The measurement system shall be capable of measuring the full range of planned quantities of multiphase well fluid through the MPFM as specified in data sheets by using a field replaceable insert venturi solution.
- MPFM shall be designed to measure the flowing conditions as specified in the data sheet.
- MPFM shall be designed to measure Wet gas flow and shall have a wet gas mode to handle the high GVF range (ie. GVF between 95- 100%).
The MPFM shall have its own inside mini thermoelement for temperature measurement as integral part of meter construction. It shall be part of the meter like other sensors.

ENGINEERING / CONFIGURATION, USER INTERFACE SOFTWARE and LAPTOPS

SUPPLIER shall also supply Engineering / Configuration, User Interface Software along with Industrial Laptops.

Engineering / Configuration, User Interface Software shall be loaded on the supplied Industrial laptops.

LAYOUT REQUIREMENTS

Any specific layout requirements for the MPFM inclusive of vertical installation, straight lengths, etc shall be advised by the Supplier during offer stage.

SPECIFICATION OF OUTPUT DATA

Outputs from MPFM shall be typically in actual conditions; however, MPFMs shall also have provision of giving outputs at standard conditions.

ENGINEERING / CONFIGURATION, USER INTERFACE SOFTWARE and LAPTOPS

SUPPLIER shall also supply Engineering / Configuration, User Interface Software along with Industrial Laptops.

Engineering / Configuration, User Interface Software shall be loaded on the supplied Industrial Laptops.

POWER SUPPLY

Power supply for the MPFM shall be 24 V DC / 230 V AC. The power consumption shall be less than 24 Watts.

OPERATIONAL REQUIREMENTS

MPFM shall not require any operational actions for it to be operated.

MAINTENANCE REQUIREMENTS

MPFM along with other instrumentation shall be selected to reduce need for maintenance and calibration activities. There should be easy access to all instruments for maintenance.

It shall be possible to calibrate transmitters without moving them from their permanent installations, without disconnecting any cables.

INSTALLATION / COMMISSIONING REQUIREMENTS

1. MPFM shall be inline type and mounted in vertical up-flow direction.
2. Vendor shall provide the minimum straight length requirements for various piping configurations to meet the specified installed accuracy.
3. Vendor shall provide clear commissioning instructions for each model offered.
4. Vendor shall provide the recommended start-up procedures and warm-up time (shall not exceed 30 minutes) required.
5. Vendor shall provide eye-let hoisting facilities for large meters.

HAZARDOUS AREA CERTIFICATION and IP RATING

1. All filed instrumentation items inclusive of JB's, etc of MPFM shall be suitable for Zone 1, Gas Group IIB, Temp. Class T3.
2. Ingress protection rating of the complete MPFM unit shall be IP 66 to IEC 60529.
3. Supplier shall have all the necessary documents inclusive of Hazardous area certificates / ATEX certificates detailing the protection technique(s) used from the accredited notified body / certification body.

RADIOLOGICAL SAFETY

For MPFMs utilizing radioactive materials following shall be ensured by the Supplier:

1. The offered MPFM with Radioactive material shall be type tested for Radiological safety. This type test will verify the radiation dose at the surface of the housing of the Radioactive material. Test shall be performed by a testing laboratory accredited by a Statutory body on Radiological safety. Supplier shall submit the Type test certificate/report, covering Radiological safety aspect, to the COMPANY for review.
2. Supplier shall ensure that the proper QA/QC is in place to replicate the performance as per the results of type testing of the MPFM in respect of Radiological safety.
3. Supplier shall be responsible for the safe disposal of the Radioactive material in the event de-commissioning of the MPFMs. An undertaking shall be submitted by the Supplier taking the responsibility for the safe disposal of the Radioactive material.

MPFM OUTPUTS SPECIFICATION

The units in which measurement data are displayed may be changed by the user.

The following units shall be available:

- Liquid flowrate m³/hr, m³/d, kl/d, kT/d, BPD, GPM (US)
- Gas flowrate m³/hr, CFM, CFD, km³/d, MMCFD, MCFD, m³/d, kT/d
- Liquid volume m³, BBL, Gal (US), kl, kT
- Gas volume m³, CFT, km³, MCFT, MMCFT, kT
- Flow pressure (Pflow), bar (g), Bar (a), kPa (g), kPa (a), psi (g), psi (a)
- Flow temperature (Tflow) deg C, deg F
- Diff. Pressure (dP) mbar, psi, kPa, Inches H₂O
- Density kg/m³, g/ml
- Mass Flowrate kg/hr, kg/d, kT/d
- Mass Volume kg, kT

INSTRUMENT CONFIGURATION SUMMARY

The below information is for general information only and does not describe all alternative designs available. The specifications for the actual configuration offered are found in the attached Instrument Data Sheet (IDS).

Table 4.

Product	Details
Model	Multiphase meter 2600
Manufacturer	Roxar
Country of origin	Norway

Meter size	Specifications
Body	To Be advised
ID mm	To Be advised

Measurement Principles	Function
Field replaceable insert venture	Measures differential pressure and calculates the speed of the flow going through the meter
Electric impedance electronics	Measures the fraction of oil, water and gas flowing through the meter
Multivariable transmitter	Compact, integrated measurement solution for pressure, differential pressure and temperature
Cross-correlation	Calculates the speed of the mixture flowing through the meter by utilizing time series analysis
Compact gamma system	Measures total density of the mixture flowing in the meter pipe
Roxar Zector™ technology	Advanced signal processing, new field electronics and electrode geometry provides accurate characterization of flow
Combined	The Roxar Multiphase meter 2600 is based on electrical impedance, single gamma, cross correlation and venturi based measurement principles. The new Roxar Zector™ technology operates seamlessly in both oil- and water-continuous flow which results in rapid detection of regime changes, and provides multiple flow velocities and near wall measurements.



Quality of Material	Specifications
Body and flange material	Super Duplex UNS S32760/A479 - To be advised

Meter Connection	Specifications
Interface Flanges	Grayloc® hub with welded neck

Electrical Certification	Type of approval
Ex i-a	CENELEC / ATEX

MMI	Details
Flow Computer	SS316 enclosure including display
I/O	RS-232 and RS 485
Software	Roxar Service Console SW

Utility Consumption	Details
Power Supply	10 - 36 V DC
Power Consumption	20 W

RTU SCADA Unit Technical Details

Introduction

The core components of the proposed solutions shall be:

- One Control Wave Micro based Remote terminal unit with required number of I/O interface.

The Primary function of Control Wave Micro RTU will be,

- Scheduled and Controllable Moving from one port to the other (Scheduled testing + Manual Testing)
- Continuous logging of the data from Multiphase Meter.
- Collect conventional Analog input signals from two pressure transmitters and one temperature transmitter.
- And transfer these data's to main control room.

Communication interface between the field and control room is taken care by third party. The ControlWave RTU with serial and Ethernet port are proposed and hence the same can be interfaced to the Modem provided by the third party.

Control Wave Micro

This RTU equipment is ideally suited to wide area telemetry applications and we have a wealth of experience with this product for the Oil and Gas, and water distribution and transmission markets. The unit provides an RTU capability in terms of communications capability together with the flexibility of a fully featured PLC platform with a full implementation of the IEC 61-1131 programming language. The wide area telemetry market has dictated the evolution of our products and we recognise and emphasise the RTU capabilities such as large local storage capacity, time synchronisation, and serial interface to field equipment, communication media and protocol support, and low power consumption as the key features for this application.



The Control Wave Micro is a highly programmable controller that combines the unique capabilities of a programmable logic controller (PLC) and a remote terminal unit (RTU) into a single hybrid controller.

Hardware Features

- ARM processor provides exceptional performance and low power consumption
- Up to two 10/100 Mbps Ethernet ports
- Up to 11 serial communication ports with built-in modem option
- Three, four, and eight slot base unit with two, four, and eight slot I/O expansion base
- Mixed I/O cards for cost effective small RTU applications
- Optional isolated I/O modules
- IEC 61131-3 programming with ACCOL III process control function block library
- Open standards for programming, network configuration, and communication
- Security key-lock to prevent unauthorized access
- Wide temperature range (–40 °C to 70 °C)
- Class I, Div. 2 hazardous location approval

Isolation Valves Ball Type Technical Details

- Isolation valves will be used for isolation of flow line during maintenance of Multiport Flow Selector, and Multiphase flow meter.
- Isolation valves will also be used in the drain lines. Drain lines will be tapped from test header and production header in the skid limit.
- Isolation valves location details and quantity of isolation valves is indicated in the attached P&I Diagrams.

Table 5.

	Description	Technical Details
1	Type of Valve	Ball Valve (Two Piece or Three Piece design)
2	Operator	Manual / Gear Operated
3	Size	Based on the location of valve in the skid limit. Please refer P&I Diagram for more details
4	Pressure rating	To Be Decided
5	Service	Crude Oil, Water and Gas
6	Design Temp	To Be Decided
7	Construction	As per API 6D. Trunnion Mounted / Floating for 4" size and below
8	End Connection	Flanged RF
9	Body Material	Carbon Steel / ASTM A 105 / ASTM A 216 Gr WCB + NACE compliant - To Be Decided
10	Trim	SS 316 / ASTM A 351 Gr. CF8M / NACE compliant To Be Decided
11	Stem	SS / ASTM A 479 Gr 316 NACE compliant
12	Seat	Devlon / RPTFE
13	Seals	Viton , PTFE, Graphite
14	Bolting	ASTM A 193Gr B7M / A 194 Gr. 2HM
15	Leakage class	FCI 70-2 Class VI
16	Operation	Manual (Through gear operation or manual wrench) as per the torque requirement.
17	Material Certificates	For Major raw material as per EN 10204. 3.1

Check Valves Technical Details

- Check valves are proposed upstream of MPFS. This is ensure no back flow through the flow lines during normal operation of well test manifold.
- Check valves are also used downstream of Multiphase flow meter. This is to ensure no back flow form production header test line.
- Check valves are also used downstream of Multiport Flow selector. This is to ensure no back flow from production header to MPFS and through bypass lines.

Table 6.

	Description	Technical Details
1	Type of Valve	Swing TYPE Check Valve (Lug Type or Two Piece or Three Piece design)
2	Operator	Not Applicable
3	Size	Based on the location of valve in the skid limit. Please refer P&I Diagram for more details
4	Pressure rating	ANSI 600#
5	Service	Crude Oil, Water and Gas
6	Design Temp	To Be Decided
7	Construction code	As per API 594
8	End Connection	Flanged or lug type based on the size of the valve.
9	Body Material	Carbon Steel / ASTM A 105 / ASTM A 216 Gr WCB + NACE compliant - To Be Decided
10	Trim	SS 316 / ASTM A 351 Gr. CF8M / NACE compliant - To Be Decided
11	Seat	EPDM
12	Spring	Inconel X 750
13	Hing Stop Pin and Other	SS 316
14	Material Certificates	For Major raw material as per EN 10204. 3.1

Skid Technical Details

Scope of Work

The vendor shall design and construct a structural steel frame to accommodate the entire unit and it shall have following features as minimum:

General

- All components shall be properly supported on the skid considering piping loads due to thermal expansion.
- Anchoring of piping and other equipments on the skid shall be done to avoid vibrations due to possible hammering effect of flow lines.
- Lifting eyes to permit the entire package to be lifted by a crane for transportation and installation. All lifting eye welds shall be full penetration welds and shall be ultrasonically tested.

Fabrication and Assembly

- All welding assembly testing and erection within the skid shall comply with the requirements of ASME B 31.3
- Welding shall be carried out only by qualified welders.
- Structural welding shall be in accordance with BS 5135 or AWS D1.1. All welding shall be performed according to shop drawings produced by the vendor.

Skid Arrangement

- All components shall be mounted on skid ready for use.
- The steel frame of sledge-type runner shall be of welded design. It shall be capable of withstanding the total weight of all units and its accessories for lifting.
- The skid shall be sufficiently rigid such that it does not deflect during lifting. Lifting lugs shall be attached to the skid frame by certified full penetration welds and painted as per painting specification. The lifting lugs shall be designed to lift the total weight of the skid. Lifting calculation to be furnished.
- Two earthing bosses shall be welded on opposite side of the skid. The metal work of the structure shall be bonded to the skid and all the equipment shall be bonded to the skid to ensure that a conducting path to the main earthing grid is established.
- The equipment shall be cleaned of all debris and all flanged openings covered with wooden discs.

- Any special lifting accessory such as spreader beams shall be supplied as part of the order along with calculations.
- The skid layout shall allow for removal of the Multiport flow selector and Multiphase Flow meter without having to drain the connected flow lines i.e. the downstream side of the flow lines from the block valves shall drain towards the Multiport Flow Selector.
- The vendor shall attach a stainless steel nameplate.
- Material of construction will be as below:
 - Skid Design - API RP 2A / En 12079
 - Pipes - A 106 Gr. B + NACE MR 0175
 - Flanges - A 105 + NACE MR -0175
 - Fittings - A 234 WPB + NACE MR 0175
 - Structural steel - A36 / S 275 / S 355 / Equivalent
 - Pipe Support frame - As per the design requirement

Inspection and Testing

NDT :

All Butt Welds: 100% visual

Pad eye Attachment weld: 100% MPI

RT: 100% as per B 31.3

Codes and Standards

- Piping shall be in accordance with ASME / ANSI B 31.3
- Welding to be in accordance with the requirement of ASME VIII, ASME / ANSI B 31.3 and AWS D 1.1
- Welding procedure/performance qualification shall be in accordance with ASME IX and AWS D 1.1

Major Sub Vendor List

Table 7.

Sr. No.	Description	Location
A	Multiport Flow Selector	Emerson FZE. UAE
B	Electrical Actuator	EIM Controls USA
C	Multi Phase Flow Meter	Roxar Make / Norway
D	RTU	Emerson Global (UAE, Asian countries)
E	Ball Valve (Isolation Valves)	To Be Decided
F	Check Valve	To Be Decided
G	SKID	To Be Decided
H	Other	
	Any other items required to complete the skid scope like Nuts, bolts, flanges, gaskets, pipes, fittings, structural steel, cable supports/trays, junction box / etc.	From reputed Stockist.

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NORTH & SOUTH AMERICA

19200 Northwest Freeway
Houston TX 77065
USA
T +1 281 477 4100

Av. Hollingsworth
325 Iporanga Sorocaba
SP 18087-105
Brazil
T +55 15 3413 8888

ASIA PACIFIC

No. 9 Gul Road
#01-02 Singapore 629361
T +65 6777 8211

No. 1 Lai Yuan Road
Wuqing Development Area
Tianjin 301700
P. R. China
T +86 22 8212 3300

MIDDLE EAST & AFRICA

P. O. Box 17033
Jebel Ali Free Zone
Dubai
T +971 4 811 8100

P. O. Box 10305
Jubail 31961
Saudi Arabia
T +966 3 340 8650

24 Angus Crescent
Longmeadow Business Estate East
P.O. Box 6908 Greenstone
1616 Modderfontein Extension 5
South Africa
T +27 11 451 3700

EUROPE

Holland Fásor 6
Székesfehérvár 8000
Hungary
T +36 22 53 09 50

Strada Biffi 165
29017 Fiorenzuola d'Arda (PC)
Italy
T +39 0523 944 411

For complete list of sales and manufacturing sites, please visit
www.emerson.com/actuationtechnologieslocations or contact us at
info.actuationtechnologies@emerson.com

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