

GENERAL SPECIFICATION

INSTRUMENTATION

GS EP INS 111

**Design and supply of liquid custody transfer
metering units**

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1. Scope

This document defines the minimum requirements for the design of liquid metering units intended for installation at custody transfer points for sales, ownership determination or allocation purposes.

This specification describes requirements applicable for continuous transfer (pipeline metering) or for batch transfer (typically off loading...).

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Metering design and supply shall also be in accordance with principles and operational metering requirements described in the project metering philosophy.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
API MPMS	Manual of Petroleum Measurement Standards
IEC 60079	Parts related to the Electrical apparatus for explosive gas atmospheres
ISO 17025	General requirements for the competence of testing and calibration laboratories
ISO 3171	Petroleum Liquids - Automatic Pipeline Sampling
ISO 4124	Liquid hydrocarbons - Dynamic measurement - Statistical control of volumetric metering systems
ISO 5168	Measurement of fluid flow - Evaluation of uncertainties
ISO 6551	Petroleum Liquids and Gases - Fidelity and Security of Dynamic Measurement - Cabled Transmission of Electric and/or Electronic Pulsed Data
ISO/CEI GUIDE 98-1	Uncertainty of measurement - Part 1: Introduction to the expression of uncertainty in measurement
OIML R117-1	Dynamic measuring systems for liquids other than water - Part 1: Metrological and technical requirements

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Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP ELE 079	Electrical apparatus for potentially explosive gas atmospheres
GS EP INS 101	Instrumentation engineering, supply and construction general requirements
GS EP INS 110	Instrumentation for package units
GS EP PVV 112	Piping material classes
GS EP PVV 142	Valves
GS EP PVV 211	Design and fabrication of pressure vessels according to ASME VIII
GS EP PVV 771	Thermal insulation (hot service)

3. Basis for metering system design

Design of liquid custody transfer metering systems shall be performed in compliance with:

- Local regulations
- Contracts and lifting agreement
- Uncertainty target
- Custody transfer mode: continuous transfer (pipeline metering) or batch transfer (typically off loading)
- Process conditions (pressure, temperature, flow rate ranges), pressure drop in the custody transfer metering system
- Fluid properties and analysis (viscosity, water content, BSW, vapor pressure, solids contents or slurries and erosion or deposition risks, etc.)
- Location
- Installation constraints.

4. Standards

API MPMS or ISO shall be used.

5. Units & base conditions

At minimum, the metered volumes shall be STANDARD GROSS & STANDARD NET expressed in US barrels at 60°F/14.696 psi a and in m³ at 15°C/1.01325 bar a.

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6. Metering system uncertainty for measured quantities

The degree of uncertainty on the determination of the delivered STANDARD GROSS quantity shall be less than $\pm 0.1\%$ relative.

On a case by case basis, higher uncertainties may be specified and accepted by Company (reference shall be made to project metering philosophy) to comply with economical conditions and financial risks.

The uncertainty shall never exceed $\pm 0.25\%$.

Uncertainty calculation shall be developed to demonstrate system uncertainty matches with targets.

Recommendations of [ISO 5168](#), [ISO/CEI GUIDE 98-1:2009 \(GUM\)](#) and [API MPMS](#) shall be followed.

Overall uncertainty calculation includes the uncertainties related to:

- Real sensors: flow meter and gross volume, temperature and pressure measuring instruments, on line analyzer like density meter, and water cut meter, and viscosity meter (if any)
- Parameter inputs used in thermal dilatation or compressibility calculation, like density for liquid
- Signal conversion instruments and calculation algorithms
- Calibration system e.g. Volume of the pipe prover loop
- Variations in flow and consistency of the crude (density and viscosity) between two calibrations: meter factor linearization curve
- Characteristics of the flow measurement device.

7. Flow measurement technology

Metering technologies acceptable for custody transfer are:

- Turbine meter
- Positive displacement meter
- Coriolis mass flow meter
- Ultrasonic flow meter.

Recommended flow measurement principle(s) will be defined in the project metering philosophy.

7.1 Measurement of gross volumes

7.1.1 Turbine meter

Turbine flow meter shall be selected for any application until the fluid viscosity and its changes (oil and emulsion) remain compliant to the meter performances and area availability (filters, flow straightener and straight lengths).

Where turbines are selected, they shall be with helical blades.

Each flow metering element shall have two (2) detectors, one for metering and the other one for checking the measurements of the first one.

Limitations on turbine meter are mainly fluid viscosity and change on fluid properties, turn down ratio for pipe export application and global bulk (filters and straight lengths).

7.1.2 Positive displacement meter

Positive displacement meter shall be selected when fluid could have **high viscosity** and when Coriolis mass flow meter cannot apply.

Limitations shall be suspended solids and filtering, maintainability (moving part) and pressure drop through the custody transfer unit.

7.1.3 Coriolis mass flow meter

Coriolis mass flow meter shall be selected when flow rate turndown ratio is high (turn down ratio > 1:10), or when large changes in viscosity or variable water content (typically in case of pipeline transfer) are expected or when available area to install custody transfer metering does not allow straight lengths.

Coriolis mass flow meter shall also be selected for light hydrocarbons.

Flag installation shall be preferred to limit the impact of slurries.

All useful measurements from Coriolis mass flow meter (frequency, pressure, temperature, flowing density, mass flow rate and volume flow rate) shall be made available to user.

Limitations like high flow rate, pressure drop due to the Coriolis itself, requirements in back pressure and installation constraints shall be considered on a case by case basis.

7.1.4 Ultrasonic flow meter

Ultrasonic meter (transit time measurements) shall be selected in case of steady fluid properties (density, water content) to minimize the pressure drop in the metering unit, typically for high flow rate and to increase the turn down ratio.

Ultra-sonic devices shall be minimum **four paths** and shall be reserved to very specific uses where other techniques are not practical.

Ultrasonic flow meters shall not be used for water content higher than 1%.

A careful study shall be made and an extensive qualification and test program shall be run for acceptance.

Limitations are the stability of fluid properties, required straight lengths and size of proving system.

7.2 Use of "Universal performance curve"

The "Universal performance curve" (also known as "Q/V" curve or meter factor versus Reynolds number) specified by [ISO 4124](#) can be applied in case of fluctuations of the flow-rate and/or the viscosity at operating conditions, typically for turbine meter and ultrasonic meters.

The Contractor shall indicate the acceptable range of flow-rates and acceptable range of viscosity within which the meter factor remains valid. The calculation of acceptable ranges of

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flow rates shall be performed around the nominal flow-rate of the unit and the calculation for viscosity shall be performed around the nominal viscosity of each crude oil to be measured.

Contractor shall propose the implementation of performance curve (and its historian) in the flow computer to on line correct the meter linearity when meter response versus Reynolds number or “Q/v” changes is higher than the required uncertainty.

An alarm shall be activated every time the actual flow rate, or viscosity, or Reynolds number is out of the ranges for which the meter factor is valid.

8. Temperature & pressure measurement

8.1 Deviation from of the [API MPMS 7](#) & [API MPMS 21](#)

Temperatures shall be measured to within $\pm 0.1^{\circ}\text{C}$. The piping shall be heat insulated 50 cm either side of the thermowell and the head of measuring device shall be included in the heat insulation.

Thermowell shall be preferably installed downstream the meter in such position where flow profile is not disturbed and temperature measurement remains representative (between 5 and 8 pipe diameter).

The calibration loop shall be fitted with one thermowell at the inlet and another at the outlet of the proving system.

Additional thermowells are strongly recommended for in situ verification at the working point, based on certified portable temperature reference.

8.2 Pressure and temperature measurements for pipeline metering

For custody transfer applications on continuous pipe export mode, each temperature and pressure used to calculate the quantities shall be measured by two separate devices.

One device shall supply the measurement required for the calculation and the other shall check the measurement. The difference between the two measurements shall be monitored and, if it exceeds a pre-set value, shall generate an alarm at the Operator interface.

System shall offer the possibility to used “Check” sensors in case of proven failure of “Pay” one.

If this “Pay and Check” system is not economically justified, a validation of the measurements may be done by software comparison between the measurements of devices that should give the same readings (for instance the TT’s that are on the meter runs).

For batch export if regulations or if metering philosophy do not require “Pay and Check” system, dual instrumentation is not mandatory.

9. Fluid property & quality measurements

9.1 Use of on line analyzers

Measurements shall be as specified in the regulations, contract and/or [API MPMS](#).

Depending on the variability of fluid properties and sensitivity of the metering system to these fluid properties during custody transfer, and custody transfer mode (continuous or batch),

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interest of on line analyzers (density meter, water cut monitor, viscosity meter, etc.) shall be evaluated versus metering technology.

Any on line analyzer used for quantity or quality determination shall be certified by Authorities or recognized organization or at least demonstrated by Supplier.

“Virtual” analyzer could be used when qualified, e.g.: viscosity corrector versus temperature or water content.

9.2 Case of systems dedicated to batches

Quality of fluid to be exported shall be controlled prior batch, or during batch based on representative sample (automatic or back up sample from tank storage) and laboratory analysis. The specification does not systematically require on line analyzers.

The analysis reports shall be generated from the laboratory certified measurements. It shall be possible to include the laboratory measurement results (water content, crude density, viscosity) to recalculate official corrected volumes from the metering system in order to issue the final measurement ticket.

When on line analyzers are not installed, flow computation system shall be able to deliver an intermediate batch report prior an update for fluid property parameters, then a final report from metering system for quantity corrected by the last fluid property update (typically density and water content) and quality shall be issued.

9.3 Case of systems dedicated to continuous measurements

The water shall be measured with an online analyzer, preferably installed directly on the main stream line (header).

An online density measurement will be considered also as case basis. Rules for representative sampling ([API MPMS chapter 8](#)) apply for the installation of on line analyzer.

An automatic sampling flow proportional shall also be used as check measurement of on line analyzers and as a back-up solution.

The Metering system shall propose user configurable inputs as fallbacks values for any required fluid properties typically when on line analyzers fail.

10. Automatic sampling

The metering unit must have an automatic flow proportional sampling system in compliance with [ISO 3171](#) or [API MPMS chapter 8](#) in the full range of metering system.

The calculations used to determine the location of the sampling probe shall be approved by an independent authority.

Calculations shall include the representativity of the final sample and the representativity of diverted flow in case of fast loop sampling, if any.

Efficiency of static or dynamic mixer, if required, shall be demonstrated.

The sample receptacle shall have a minimum capacity of 20 liters. It shall protect the sample from the atmosphere to reduce sample degassing.

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A sample homogenizer shall be supplied. It shall produce sample partitions, which are identical in composition.

The sampling unit shall be designed to calculate sampler performance factor and to print values with the measurement ticket.

Every precaution shall be taken to ensure that there is no risk of paraffin deposit in the sample receptacle or in the sampler lines (trace heating and insulation).

11. Flow meter calibration systems

The standard practice for custody transfer installation shall include at least flow diversion fittings and valves to connect permanent proving system as per defined in the [API MPMS](#) chapter 4.

The pipe prover loop shall be bi-directional. Pulse interpolation shall be implemented and shall be demonstrated during FAT typically in case of use of helical turbine meter (low pulse numbers < 10,000 during proving).

If it is not practical to install & operate a conventional pipe prover loop, other flow meter calibration principles may have been defined in the project metering philosophy and may be applied in metering system design.

In any case, such methods like master meter method or piston prover method shall be submitted to Company metering specialist.

The "Universal performance curve" may also be used.

11.1 Initial calibration of the calibration system

Pipe prover or compact prover calibration shall be done using the "water draw" method specified in the MPMS during FAT under the approval of third company and witnessed by Company.

Depending on local regulation a recalibration could be required once the metering installation is on site, prior use as official and shall be planned by Contractor.

Master meter shall be delivered with calibration certificate issued by recognized and agreed calibration company.

The uncertainty of the prover system shall be calculated.

11.2 Construction & installation of the calibration system/tools

If, during a meter proof, the climatic conditions are likely to alter the fluid temperature by more than $\pm 0.1^{\circ}\text{C}$ as it passes through the loop, the calibration system and connection lines or/and fitting for sensors shall be insulated.

Note that $\pm 0.1^{\circ}\text{C}$ is a value that is calculated based on expected atmospheric and process conditions. Therefore thermal protection is hardly recommended to avoid heating from process installation, and / or metering installation shall not be installed close to flaring system.

All precautions shall be taken to ensure that no paraffin deposit can build up in the metering calibration system (insulation and, if necessary, electrical trace heating). A way of cleaning the loop by flushing with a non waxy fluid shall be applied.

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For pipe prover, the launching chambers of the sphere shall be vertical with fast opening door on each side.

Pipe prover concentricity check shall be performed.

The pipe prover loop shall include a double set of sphere detectors defining at least two different volumes; Flange between detectors shall be avoided or at least minimized.

The pipe prover loop shall be fitted with necessary tackle assembly and tools to take the sphere out of the launching chamber.

The supply of pipe prover shall include a sizing ring designed to fit the diameter of the inflated sphere, a spare sphere and a net to store it. Sizing ring shall be adjusted with the require sphere diameter during pipe prover calibration.

A high quality 4-way diverter valve of lift, turn & sealed type shall be provided with pressure monitoring for check of seal integrity. Depending on project specification, the prover runs might be canceled if the seal condition is not acceptable.

The calibration system shall be fitted with all the taps needed to measure, on site, its internal volume using the "water draw" method or equivalent.

Calibration system sizing calculation including pre run, if any, shall be compliant to [API MPMS](#) chapter 4 and submitted to Company approval.

Calibration system based on serial/parallel master meter shall be submitted to metering specialist of the Company for approval.

Location of calibration system shall allow easy inspection (internal and external) and maintenance typically for recalibration, and easy and reliable degassing of the proving system. The skid shall include all fitting equipment required for maintenance.

11.3 Operation of the prover system

It shall be possible to prove the meters at any flow-rate commonly encountered during normal operations.

In case of serial parallel meter run installation, the configuration serial or parallel shall be clearly identified.

12. General arrangement of the unit

The metering system shall be designed and installed to insure easy degassing, so higher elevation would be avoided or / and degassing system would be implemented.

To help in easy venting, to avoid depressurization due to elevation then oil degassing, the calibration system and sampling system would be accepted out of the metering skid.

A minimum back pressure downstream metering system, including sampling shall apply in compliance with metering standards and oil equilibrium pressure typically in case of tandem offloading.

The flow being measured shall be equally divided between the meter runs in use.

It shall be possible to measure the nominal flow rate with one line stopped (kept available as a backup, ready to be brought into service at any time).

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Any measurement fault on a line (failure of flow computer, of meter including security level as per [API MPMS](#) or [ISO 6551](#), of sensor and its back up impacting the volume determination (e.g.: on line analyzer, pressure or temperature transmitter, etc.) shall cause the line to be automatically isolated. In cases where isolation could cause technical problems or damages, only an alarm shall be raised.

All isolation valves downstream each meter (outlet meter run to export and outlet meter to proving system) shall be double block and bleed (DB&B).

Ball valves are not authorized due to internal damage linked potential deposit (typically sand) and therefore leakage.

A leakage monitoring system on DB&B (drain valve + pressure indicator/transmitter) shall be installed.

Maximum acceptable leakage rates of the isolating valves shall be defined during Basic Engineering in order to select the valve type as per [GS EP PVV 142](#).

All piping (by-passes, drains, etc.) not shown on the typical API diagram and likely to divert the oil after it has been metered must be fitted with a "double block and bleed" system (combinations of valves and blind flanges are acceptable depending on the practicality of the operations).

The piping shall be designed and arranged to ensure that the pressure relief valves are upstream of the turbines.

Metering systems shall be designed and supplied to take into account all aspects related to safety, space, location and operation or maintenance constraints. They can be delivered in separate modules provided performances are guaranteed.

Environmental and external conditions like sun, flare, etc., which can generate failure, errors or generate difficulties in operation shall be considered.

Systems shall be designed, installed and operated in accordance with safety & environmental rules. Special care shall be paid for instance to sampling, venting, degassing, draining, over pressures due to quick closure of valves on the take off tanker, etc.

13. Heat tracing & insulation

In particular cases where location of metering installation is exposed to thermal severe constraints (such as flare proximity or extreme cold), full insulation / heat tracing of metering units and analysers systems shall be investigated as per project metering philosophy.

Insulation and heat tracing shall be also evaluated to face to potential fluid properties when able to generate plugging of fittings to sensors (impulse lines of pressure devices, density meter loop, etc.) or when waxy coating would be suspected.

That shall apply both for metering and proving systems.

14. Arrangement of the computing system

14.1 Flow computers

Base case would be one flow computer per meter run.

Each flow computer shall be able to:

- Collect all metering raw data from meter run: pulses, actual gross volume if any, pressure, temperature, analyzer if any (e.g.: density from Coriolis meter)
- Collect all useful information from header(s): analyzer like density meter, on line water cut, viscosity meter...
- Manage prover system and performance curve (K-factor table or meter linearization) when required
- Manage sampling system when only one line (+spare) is required
- Calculate net oil standard volumes from raw measurement and parameter inputs (meter K-factor, API tables, fluid properties, etc.)
- Generate the measurement ticket and the proving report from the data issued by this computer (fallback solution if there is a failure of the higher level computer)
- Generate technical alarms like faulty transmitter, over/under range instrument, communication alarms...
- Store the proving data and export data at least for 2 months.

Each flow computer shall be fully configurable by authorized people defined throughout a clear access policy (login & password for each level: "operator", "maintenance", administrator).

Each flow computer shall propose non resettable totalizers for each meter run.

Depending on regulations and stakes and on export mode, flow computation redundancy and "Pay & check" system shall be evaluated.

Depending on regulations and contract, it is acceptable to install only one unique master flow computer if it is fully demonstrated it can manage full metering system: inlet/outlet headers, all meter runs and proving system. When unique flow computer is selected, a slave flow computer shall be installed for hot full redundancy.

14.2 Higher level computer

When the metering system has several meter runs and depending on the flow computer capabilities, a supervision of the metering system shall be installed.

A higher level computer shall:

- Centralize measurements and calculations from the flow computers
- Control the flow computers (e.g.: configuration from supervisor)
- Control the meter run closing / opening and adjust the control valves to optimize the flow rate into the meters during export and proving
- Display the metering station unit in real time
- Communicate with the plant systems:
 - Integrated Control and Safety systems (ICSS) for remote monitoring and control with view of unit, diagram with actual flow, valve positions, sampling status, accumulated volume and instantaneous flow rates, proving command & status, alarms...

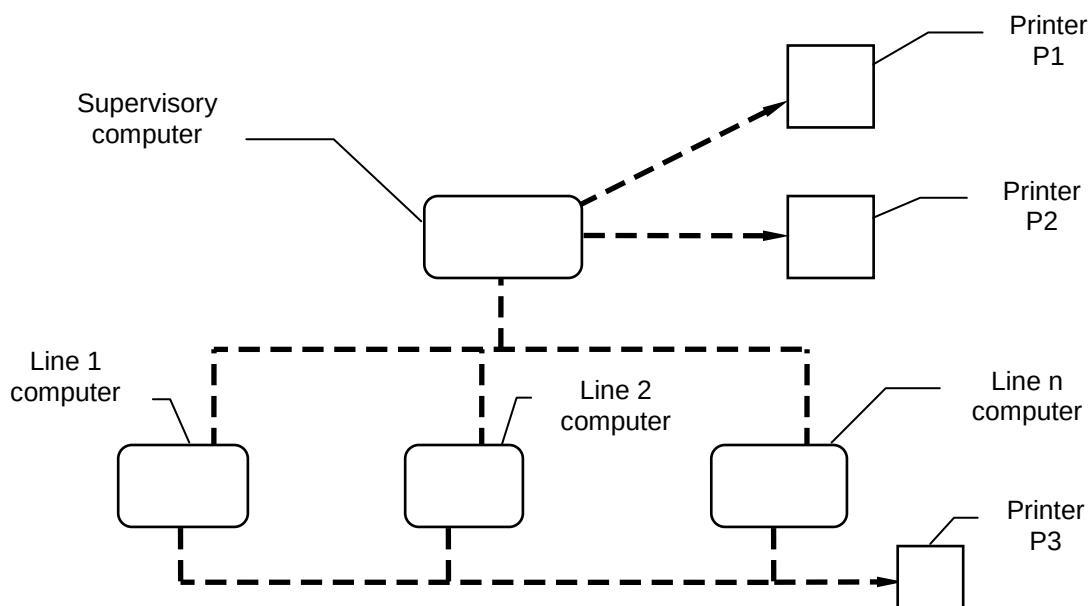
- Process Data Server (PDS) for local and / or remote metering data analysis and correlation.

Refer to **GS EP INS 110** for detailed requirements.

- Control the sampling units
- Manage the "Pay & Check" or redundancy systems, if any
- Print out the reports (the measurement ticket, the proving report and the sampling report) according to MPMS format and to asset /affiliate requirements
- Print out the intermediate reports (systematically and at the Operator's request), the alarms and the configuration of the flow computers
- Store all meter factors of each meter and elaborate follow-up charts as described in MPMS. Store all performance factors of the sampling unit and elaborate similar charts as for meter factors
- Allow for the control of the metering unit by an Operator
- Be protected by a clear access policy.

Installation of high level computer is not mandatory when flow computers are able to manage all the supervision functions of high level computer (especially communication with the PDS) or when metering system is simple enough (single export line + spare line).

14.3 Bloc diagram for a regular availability system

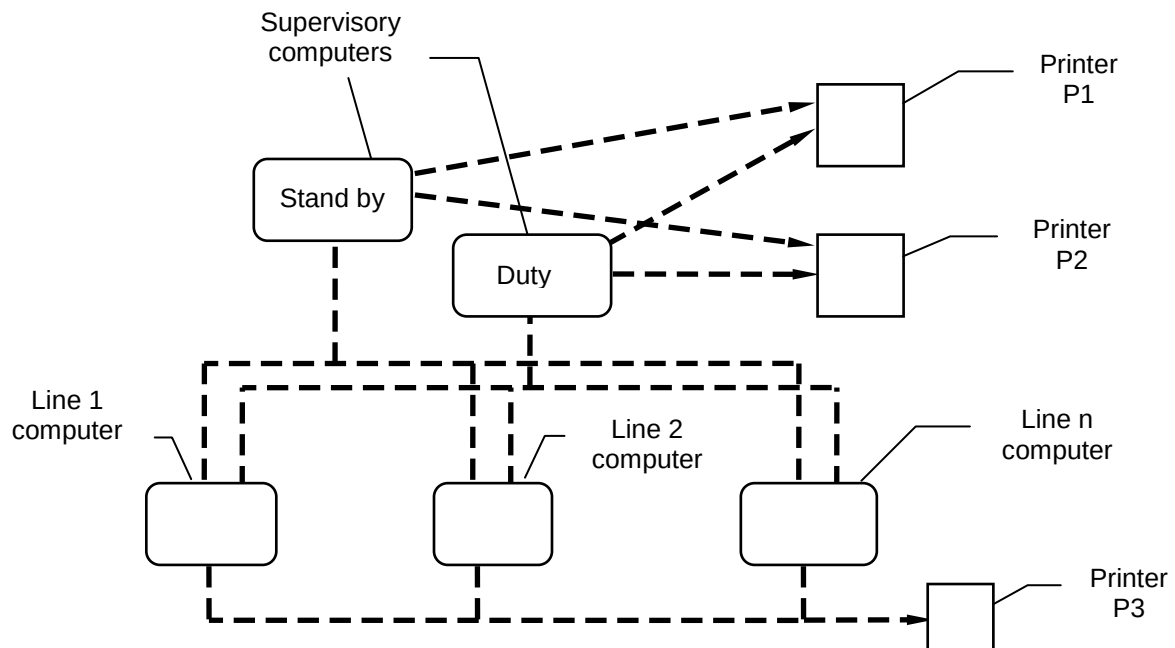


14.4 Enhanced availability

Dual redundancy at the supervisory system level can be applied if extreme availability is requested by regulations, contract, project metering philosophy, or continuous pipe export mode of high quantities (> 100 kbpd).

The robustness of the supervisory system shall withstand spurious power shut downs and communication failures applied randomly at any device of the network.

Recommended Bloc diagram for an enhanced availability computing system:



Dual redundancy shall be applied to the communication network too.

15. Particular points

The metering unit shall have all branch points and clearances needed to carry out profile tests as per [MPMS Chapter 8 section 2](#).

Every precaution shall be taken to avoid a wax build-up in the measurement runs and the instruments impulse lines (insulation, electrical trace heating, etc.).

The supply shall include fine mesh filters (3 mm) which can temporarily be fitted into the filters during the flushing operations when turbine or positive displacement meters are selected.

During start-up or after heavy maintenance operations of the upstream piping, the flow shall not be routed through the unit to avoid damages to the measuring devices.

The differential pressure meter monitoring the pressure drop caused by the filter, as required by the MPMS, must be fitted with an alarm that is relayed to the Operator interface.

Beneath the metering unit, there shall be a pan to collect drips. The slope of the drip pan shall be 5%. The low point shall have a 2 inch drain equipped with a liquid trap (gooseneck).

The measurement lines shall be fitted with lifting tackle to lift out the filters and handle the turbines.

Housing of electronic equipment exposed to the weather shall be minimum AISI 316.

Each device or item of equipment shall be identified by a firmly attached, stamped stainless steel plate.

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16. Additional specifications

The statements and requirements of this specification shall be completed by relevant Company's General Specifications [GS EP COR 350](#), [GS EP ELE 079](#), [GS EP INS 101](#), [GS EP INS 110](#), [GS EP PVV 112](#), [GS EP PVV 211](#) and [GS EP PVV 771](#).

Recommendations and prescriptions of [IEC 60079](#) shall also be followed.

17. Safety

Metering systems shall be designed and supplied to take into account all aspects related to safety, space, location and operation constraints.

Environmental and external conditions like sun, flare, etc., which can generate failure, errors or generate difficulties in operation shall be considered.

Systems shall be designed, installed and operated in accordance with safety & environmental rules. Special care shall be paid for instance to sampling, venting, degassing, draining, etc.

18. Tests

Testing activity shall comply with the requirements of the [GS EP INS 110](#) - Appendix 5.

The testing shall include the following:

18.1 Factory acceptance tests of the meters

The meter tests at the factory shall include proving at a viscosity as close as possible to the most viscous crude to be measured across the specified flow rate range of the meter.

Flow calibration facility shall be compliant with [ISO 17025](#).

If different viscosities are specified in the project, each meter shall be tested at different flow rate for each viscosity in order to control the effect of Reynolds number and so initiate the original Performance Curve. In such a case, the test procedure shall be approved and test results shall be agreed by the Company.

18.2 Prover system calibration

It shall be done at the factory and witnessed by Company.

18.3 Factory tests of the unit

The tests of the unit at the factory shall include:

- A test of water flow rate, at the rated nominal flow of a measurement run. During this test, the unit head loss shall be measured with a DP cell and all the instruments and the sampling unit shall be checked for correct operation
- Each meter run shall be tested in terms of flow measurement & calculation, based on live sensors
- Each meter shall be proven through the calibration system, demonstration the functionality of the flow diversion and proving system
- The repeatability of the meter factor shall comply with the [MPMS](#)

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- A profile test if the mixing energy is close to the minimum acceptable value
- Flow calculations formulae and Operator interface test, including configuration access & checks up to report print out (proving ticket, intermediate and final export tickets, alarm ticket, etc.).

18.4 Site acceptance tests

Tests on site shall include:

- Different connections and communication between different components up to ICSS and printers
- Software configurations: flow computers, high level flow computer, analyzers, PLC, etc.; especially versus fluid be used for test or crude to be later exported
- Venting & degassing system, if required
- Proving test on all meters and check of the repeatability of the meter factors (on crude)
- A check of the temperature change throughout the calibration loop during a proving operation
- Print out reports.

19. Certification

In case of Fiscal application subject to approval from National regulation Authorities, necessary approvals shall be obtained for the supply of Metering System.

Those approvals shall be obtained through one or several¹ third Party Certifying Agency.

The Third Party Certifying Agency shall certify that the FISCAL Metering system is compliant with relevant standards and [OIML R117-1](#), in the following domains:

- Metering skid construction:
 - Piping
 - Equipments
 - General architecture.
- Flow Meters
- Instrumentation:
 - Instrumentation that takes part in the fiscal figures is designed and will be operated according to the relevant standards.

For each project and details on typical approval, reference shall be the project metering philosophy.

¹ Depending on their own domain of certification.

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20. Documentation

In addition to documents required by the table 2.4 of Appendix 2 of the **GS EP INS 110**, documentation shall be provided as follows:

- A dossier containing all information needed for the approval of the authorities of the country where the unit is to be installed
- The unit documentation, including the operating and maintenance manuals in the language appropriate to the site of use
- The certificates issued by the Manufacturer or his Subcontractors stating that the equipment complies with the specified standards
- The certified calculations of an independent, professionally recognized authority showing that the equipment and procedures used by the Manufacturer are capable of measuring to the degree of uncertainty specified in the section entitled "Uncertainty on quantities measured", including prover loop calculation and its pre run if any. (as per [ISO 5168](#) or equivalent)
- The calculations of the accuracy of the measurement of the base volume of the prover system, if any
- The calculations of the temperature variations in the fluid passing through the prover loop during a proving of a turbine
- The dispersion calculations as per [ISO 3171](#) justifying the position of the sampling probe and the approval of those calculations by an independent authority
- The calculations of the acceptable variations in flow rates and viscosity
- Process calculation including pressure drop calculation, back pressure calculations, sampling flow loops calculations, etc.
- The report of the initial calibration of the meters, produced by an independent authority
- The report of the initial prover system calibration with uncertainty on prover volume produced by an independent authority
- The unit factory test report
- Availability calculations
- Operating parameters calculations like filling and degassing time when required
- A first version of Metering unit handbook.



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