

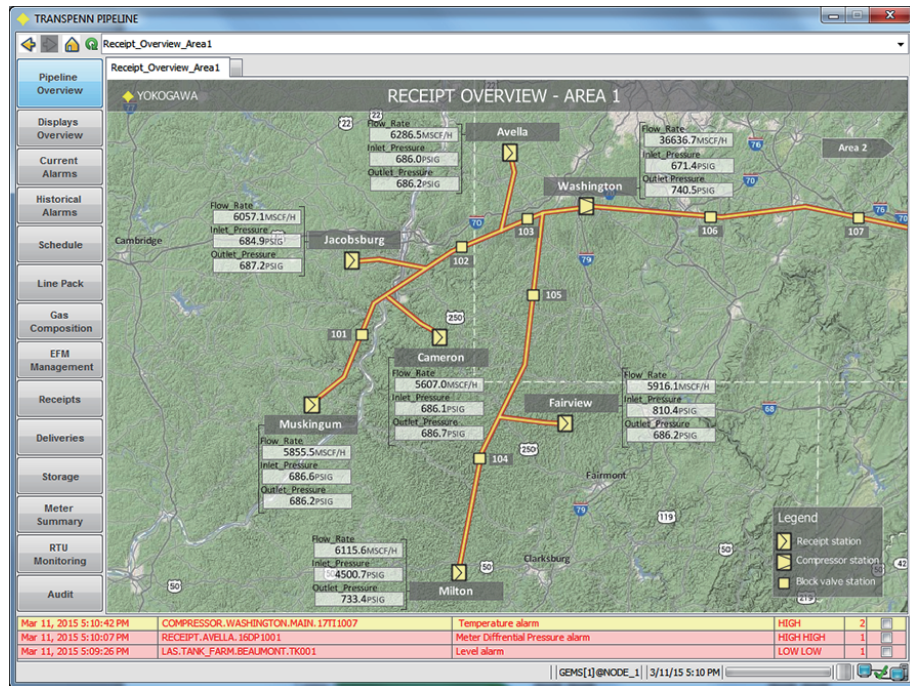
General Specifications

Enterprise Pipeline Management Solution (EPMS) for gas and liquids

GS 50A01B10-01EN

■ OVERVIEW

The Enterprise Pipeline Management Solution (EPMS) provides a collection of standard applications which can be seamlessly plugged into the FAST/TOOLS real-time system platform similar to SCADA monitoring and control applications to facilitate the management and operations of gas/liquids pipeline systems. EPMS consist of Gas Enterprise Management Suite (GEMS) and Liquid Enterprise Management Suite (LEMS).



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Figure Sample Pipeline Operations Image

The utilization of the EPMS package brings the following benefits to the pipeline/grid operators based on 20 years of experience in engineering medium to large complex pipeline automation jobs around the world:

- Pipeline management system implementation
 - Better, faster implementation
 - Dedicated consultants and product support
 - Knowledge centralization, retention and documentation
 - Enhanced lifecycle management
 - Reliable systems using proved functions
- Cost of integration
 - Prevent application vendor and integration technology lock-in
 - Establish a standards-based and IT/Security compliant application platform
- Reduced cost of ownership
 - Standard technology
 - Scalable, flexible, reusable
 - Lifecycle management
- Support of industry standards
 - Implement best practices from pipeline industry standards
 - Provide foundation for regulatory support and compliance
- Future proof
 - IT architecture hedges against disruptive technologies and trends
 - Increased process and data variety, volume, and velocity

■ FEATURES

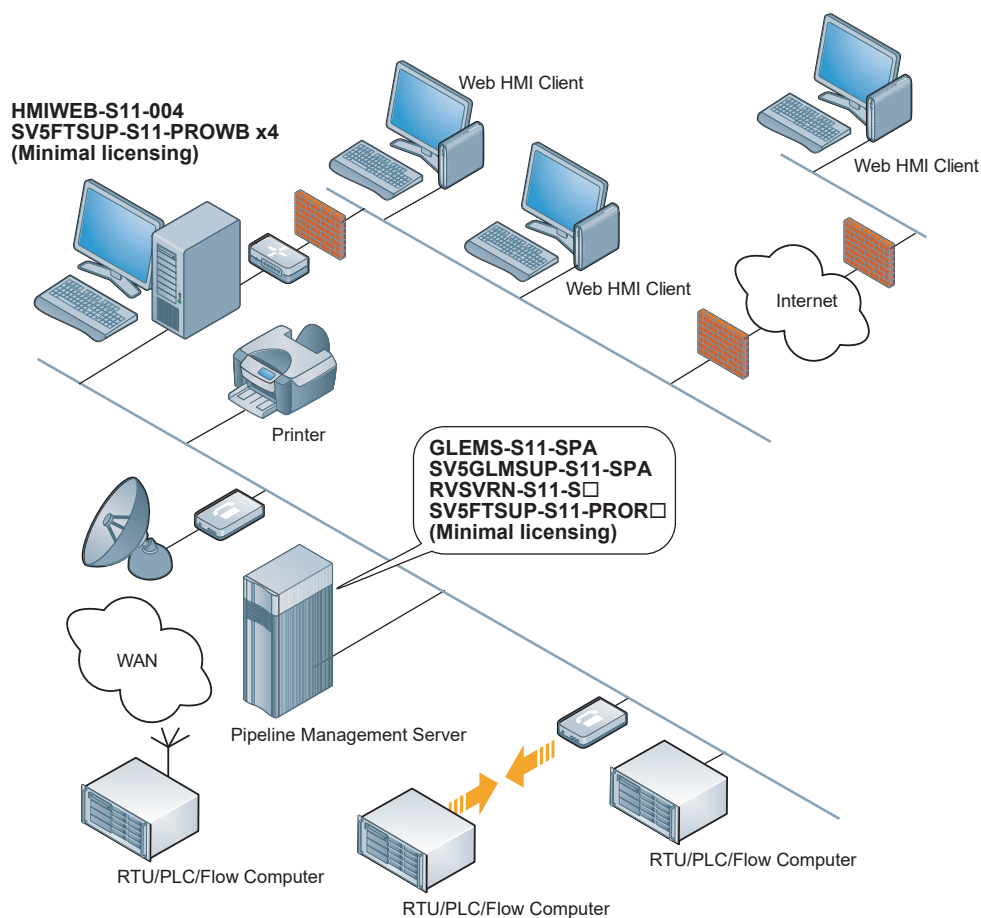
Gas Enterprise Management Suite (GEMS)

- Flexible sourcing of gas composition data from local GC (Gas Chromatograph) or via the EPMS host system from other area's or manually entered from laboratory GC's
- Support manual adjustments of gas composition data and forced upload to the flow computer
- Scheduling of gas composition and AGA parameters data exchange per flow computer
- Authorized pipeline operators can make some adjustments to key measurements which are trailed and signed as history for auditing purposes while daily, weekly and monthly volumes are automatically recalculated.
- Fast application deployment due to standard display, symbol templates and functions
- Embedded alarm functions on deviation from nomination/delivery targets for gas delivery and receipt stations
- Embedded alarm functions on safe operation violation with respect to the Maximum Allowable Operating Pressure (MAOP) per station and segment
- Indication of changes in line pack change over various time periods result in a drafting, packing or stable statuses per segment and pipeline
- Storing of EFM logs in the EFM log database for long term retention and exporting the EFM logs to a cfx file to be used by other business applications
- Update nominations within defined time limits over the course of the gas day

Liquid Enterprise Management Suite (LEMS)

- Automatic aggregation and storage all flows into hourly, daily and monthly figures.
- Indicated flow estimation in case of lost field communication and recalculation on recovery
- Support for remotely initiated and/or automatic meter proving with temperature and pressure compensation
- Batch scheduling and Batch tracking
- Ticketing
- Product compatibility checking
- Continuous real-time updating of Estimated Time of Arrival (ETA)
- Volume corrections
- Embedded alarm functions on safe operation violation with respect to the Maximum Allowable Operating Pressure (MAOP) per station and segment
- Tank management
- Path/Manifold management

■ SYSTEM CONFIGURATIONS



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Figure Sample System Configuration

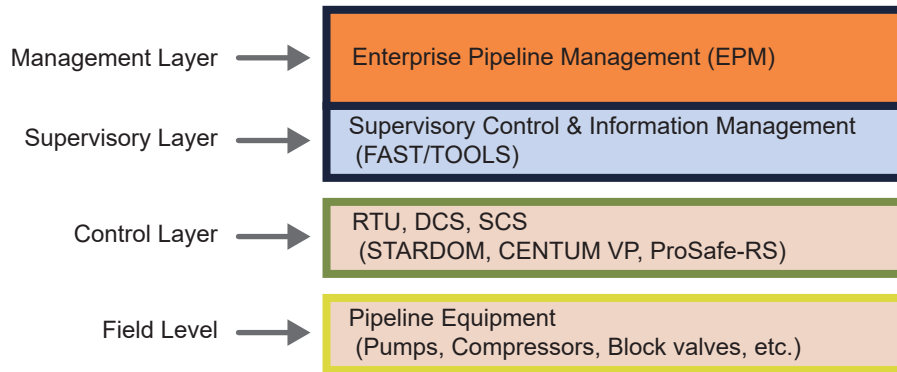
Item	Model	Quantity
Enterprise Pipeline Management Server (*1)	GLEMS-S11-SPA	1
FAST/TOOLS Server Package	RVSVRN-S11-S□	1
Web HMI Server/Client	HMIWEB-S11-004	1
Support Contract for GLEMS	SV5GLMSUP-S11-SPA	1
Support Contract for RVSVRN	SV5FTSUP-S11-PROR□	1
Support Contract for HMIWEB	SV5FTSUP-S11-PROWB	4

*1: Enterprise Pipeline Management Solution (EPMS) Server contains Gas Enterprise Management Suite (GEMS) and Liquid Enterprise Management Suite (LEMS).

- EPMS requires one (optionally redundant) FAST/TOOLS Server Package (RVSVRN-S11-S□). Multi-level systems are not supported. The size of FAST/TOOLS license depends on the system size.
- EPMS licenses require agreement between Yokogawa and customer.
- EPMS is an enterprise pipeline management solution at level 3. Level 2 control and monitoring/alarming of a pipeline is out of EPMS scope as this is provided at SCADA and (field) controller level

■ SYSTEM ARCHITECTURE

EPMS is positioned on Management Layer

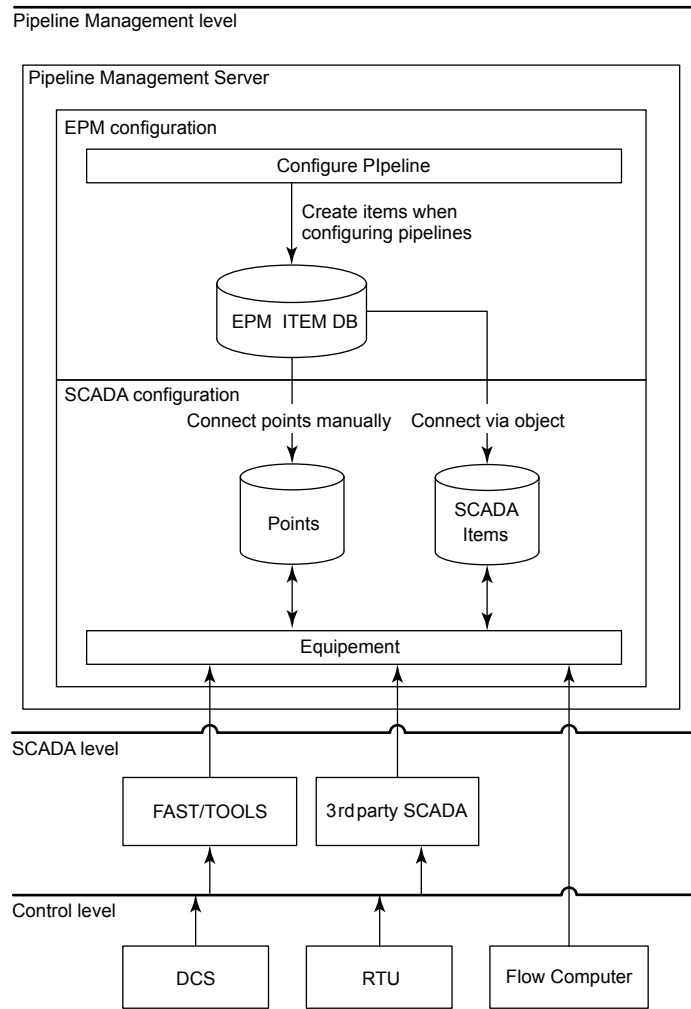


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Figure System Architecture

EPMS plugs into the same platform with FAST/TOOLS Advantages of use with FAST/TOOLS are:

- One system/user management and configuration environment
- Same layout of pipeline displays can be used for process displays
- Same user authorization can be used within the whole application
- Standard features like reporting, history and configuration are available in the same environment.



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Figure System Architecture

When utilizing FAST/TOOLS for the pipeline SCADA functions, the configuration is done in the same engineering environment. Items created by EPMS are linked to the field information. Item linking can be done by configuring the points or by linking them to other items via objects.

■ FUNCTIONAL SPECIFICATION

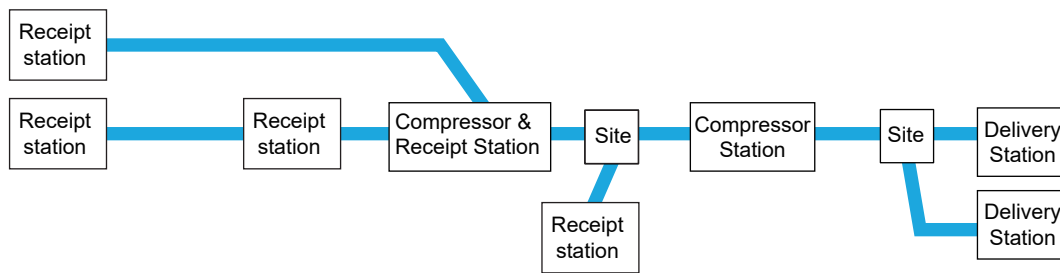
EPMS delivers the following interrelated and integrated functions:

- Processing of meter inputs for accurate measurement and flow calculations
- Management of gas data with the device scheduler and EFM log up-loader
- Schedule and monitor gas nominations
- Monitor the line-pack along the pipelines and segments
- MAOP (Maximum Allowable Operating Pressure) monitoring
- Pipeline balance, storage and inventory calculations
- Schedule and track batches for efficient transportation of liquid products.
- Monitor liquid pipelines for leaks, inventory and hydraulic profiling
- Drag reducing agent management and power management on compressors and pumps.
- Controlling a manifold with the flow path manager
- Tracking and management of anomalies like pigs/scrapers, merge/hot spots and interfaces

EPMS is segregated into a suite with specific application functions and features for gas pipelines GEMS (Gas Enterprise Management Suite) and a suite providing the application functions that are specific to the management of liquid pipelines LEMS (Liquids Enterprise Management Suite).

■ PRODUCT LINEUP

● GAS Enterprise Management suite (GEMS)



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Figure Samples of gas pipeline topology

● Key functionality provided by GEMS (Gas Enterprise Management Suite)

Main functionality	Sub functionality
Metering processing	Gas Flow Measurement (GFM)
	Flow Processing (gas calculations)
	Flow Estimation
	Flow Aggregation
	Station Totals
Gas Measurement Data Management	Device Scheduler
	EFM Log
	EFM Log uploader
	EFM Exporter
Gas Nominations	Nomination Monitoring
	Nomination Projection
Pipeline Monitoring	Pipeline Balance
	Maximum Allowable Operating Pressure (MAOP)
	Survival Time
	Line Pack variations
Pipeline Optimization	Compressor performance
	Compressor operations business rules

Metering processing

Depending on the measurement methodology and the level of intelligence of intermediate devices like flow computers, RTU's and instruments correctly processes the available inputs into normalized flow, volume and energy values.

Gas measurement data management

Ensure that each flow calculation is done with the correct gas composition. This calculation can be done by GEMS or a flow computer. Gas data management also makes Electronic Flow Measurement (EFM) log data available in GEMS. The primary function of EFM is the scheduled or on demand upload of measurement data from Flow Computers or EFM log capable RTU's.

Gas nominations

Monitor the received and delivered volumes at the receipt and delivery station along the pipeline throughout the gas day. The received and delivered volumes are compared with the projected nominated volumes for each station to timely identify any nomination imbalances.

Pipeline monitoring

Provide the operator with the following insights on the real-time operational conditions to make timely and right decisions:

- Pipeline balance - to track the gas stock figures the pipeline balance function calculates the volume and energy balance for the total pipeline/grid and storage buffers
- Line pack - calculated per segment by actual pressure and temperature as well as over the total pipeline with volume corrections in accordance with AGA 8
- Maximum allowable operating pressure (MAOP) - provides the minimum, maximum and actual pressures of each segment of the pipeline
- Leak Detection (3rd party)

Pipeline optimization

Calculate the efficiency and manage the overall statistics of compressors:

- Compressor Performance
 - Start/stop
 - Peak hour statistics
 - Volume or period statistics
- Compressor operations business rules

● Liquids Enterprise Management Suite (LEMS)

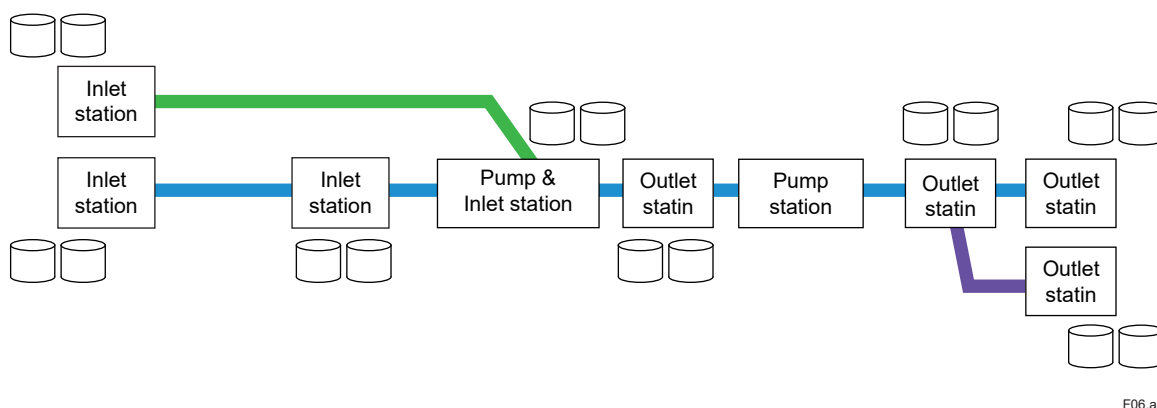


Figure Samples of liquid pipeline topology

● Key functionality provided by LEMS (Liquid Enterprise Management Suite)

Main functionality	Sub functionality
Meter Processing	Liquid Flow Measurement
	Flow Processing
	Flow Correction
	Flow Estimation
	Flow Aggregation
	Site Totals
	Inlet Totals
	Outlet Totals
	Meter proving
Batch Management	Scheduling
	Tracking
	Tracking Line Fill
	Splitting and Merging
	Anomaly/Scraper Tracking
	Interface management
	Side stream injection and stripping
	Ticketing
Pipeline Monitoring	Leak Detection
	Pipeline Balance
	Hydraulic Profiles
Tank Monitoring	Level/Volume Processing
	Inventory forecasting
Pipeline Optimization	Pump Performance
	Power Management
	Drag Reducing Agent Manager
Manifold Management	Flow Path Manager
	Tank Manager

Meter processing

Depending on the measurement methodology and the level of intelligence of intermediate devices like flow computers, RTU's and instruments correctly process the available inputs into Gross Observed Volume (GOV) and Gross Standard Volume (GSV).

Batch management

Manage transportation of multiple liquid products to multiple customers in a single pipeline. Within LEMS a batch has always only one origination and one destination. Batch management includes the following sub functions:

- Scheduling: allows pipeline operators to schedule batches by adding them manually or by importing prepared schedule.
- Batch tracking: monitoring the position of the batches in the pipeline
- Ticketing: create tickets for the delivered batches containing the following information; type of product, actual amount delivered, transportation origination, destination point and batch owner.
- Anomaly tracking: provides the operator with a visual representation of one or more (non-)product entities moving through the pipeline like (inspection) pigs, scrapers, interfaces, hot spots and merge spots.
- Interface management: calculates the amount of transfer mix generated by different adjacent product batches and how the trans mix should be managed; as a separate batch (to be reprocessed) or as product to be added to the upstream or downstream batch.

Pipeline monitoring

LEMS includes the following modules for pipeline monitoring:

- Leak detection - employs the Compensated Volume Balancing (CVB) methodology to detect leaks on a pipeline per segment.
- Pipeline Inventory - calculates the total inventory for the whole pipeline and intermediate tank storage depots.
- Hydraulic profiling - monitor all times that the pipeline operates safe and efficient within the Maximum Allowable Operating Pressure (MAOP) boundaries. When the actual pressure at any point along the pipeline is out of range an alarm is generated. The maximum and minimum pressures per pipeline station and segment can be in the LEMS pipeline topology database.

Tank Monitoring

Monitors Tank Level and converts it to volumes based on a strapping table (capacity table) or a linear equation. The temperature, pressure, density and other parameters are used for the volume correction and other tank specific calculations.

Pipeline optimization

Calculate the real-time pump performance based on the pump performance tables from the pump suppliers. The operating point is shown in the pump performance graphical component. The following power management statistics are recorded:

- Start/stop data
- Peak hour statistics
- Efficiency at different head and flow levels
- Volume or period statistics
- Pump actions or business Rules

Business rules can be defined for instance by setting limitations on requested commands.

An additional function to optimize power consumption in the LEMS suite is the Drag Reducing Agent Management (DRAM) that optimizes fluency to reduce the energy required to pump the products through the pipeline. The amounts are optimized per product and for the specific pipelines.

Manifold Management

Manages flow path alignments for station manifolds at storage depots. Each Batch in the LEMS has an origin and sub origin as well as a destination and sub destination. The origin/sub origin is used to assign the lot id of the tank in the tank farm station or warehouse the product is taken from. The destination/sub destination is used to transport the product to the correct tank farm station or warehouse and tank.

■ LIMITATIONS

- Liquids batch tracking operates on a per pipeline route basis in one direction.
- Gas nominations are scheduled and assigned on a gas day basis though can be adjusted during operations.

EPMS applications operate on the (optionally redundant) host system server.

■ APPLICABLE STANDARDS

The EPMS suite follows the following standards to the extent of relevance for the delivered functionality:

Standard	Description	Remark
API RP 1165	Recommended Practice for Pipeline SCADA Displays	1st Edition, January 2007
API RP 1167	Pipeline SCADA Alarm Management	1st edition December 2010
API STD 1164	Pipeline SCADA Security	2nd Edition, June 1, 2009
ANSI/ISA-18.2	Management of Alarm Systems for the Process Industries	2016
ANSI/ISA 101.01	Human Machine Interfaces for Process Automation Systems	

Specifically for GEMS

Standard	Description	Remark
AGA Report No. 3 PART 4	Orifice Metering of Natural Gas Part 3: Natural Gas Applications	3rd Edition, 1992
AGA Report No. 5	Calculation of gross heating value and compressibility factor for natural gas mixtures	
AGA Report No. 7	Measurement of Natural Gas by Turbine Meters	1996
AGA Report No. 8	Compressibility factors of natural gas and related hydrocarbon gases	1992
GPA 2172	Calculation of gross heating value, relative density and compressibility factor for natural gas mixtures from Compositional Analysis	1996, Dry only

Note: Other (regional specific) standards can be made available on request

Specifically for LEMS

Standard	Description	Remark
API MPMS 11.1	Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils	May 2004/September 2007
API MPMS 12.1.1	Calculation of Static Petroleum Quantities- Upright Cylindrical Tanks and Marine Vessels	
API MPMS 12.2.1	Calculation of petroleum quantities using dynamic measurement methods and volumetric correction factor. Part 1 -Introduction	2nd edition, May 1995, reaffirmed February 2009
API MPMS 12.2.2	Calculation of petroleum quantities using dynamic measurement methods and volumetric correction factor. Part 2 - Measurement Tickets	3rd edition, June 2003
API MPMS 14.3.1	Orifice Metering of Natural Gas and other related hydrocarbon fluids- Concentric, Square-edged Orifice Meters Part 1: General Equations and Uncertainty Guidelines	4th edition, September 2012, Errata July 2013
API MPMS 21.2	Flow Measurement Using Electronic Metering Systems Section 2 - Electronic Liquid Volume Measurement Using Positive Displacement and Turbine Meters	1st Edition June 1998, reaffirmed August 2011

Note: Other (regional specific) standards can be made available on request

■ OPERATING ENVIRONMENT

The pipeline management package is supported on the server platforms as defined below. For each platform, the required operating system is specified.

Platform	Operating System
Microsoft	Microsoft Windows 10 X64 Microsoft Windows 8.1 Update 2, Professional Edition Microsoft Windows 2016 Server Microsoft Windows 2012 R2
LINUX	Red Hat Linux x86 6.4 (contact GSC)
HP	HP-UX11i v3 (contact GSC)

■ SYSTEM REQUIREMENTS

The specified hardware is a minimum recommendation for optimal software performance when installing EPMS on a SCADA host system running FAST/TOOLS. Furthermore, it should be taken into account that additional non EPMS applications may require additional resources.

Application/Host Server

Items	Specifications	
CPU	Microsoft Windows 10	X64 Intel Core i5 3 GHz or better
	Microsoft Windows 8.1	X64 Intel Core i5 3 GHz or better
	Microsoft Windows 2016	X64 Intel Xeon E-series 3 MHz or better
	Microsoft Windows 2012	X64 Intel Xeon E-series 3 GHz or better
	Red Hat Linux x86 6.4	X64 Intel Core i5 3 GHz or better (contact GSC)
	HP-UX 11i v3	HP Integrity LX3600 (contact GSC)
RAM	Minimum 8 GB	
Hard Disk	250GB SSD disk At least 300 Mbytes of free space is required for the software. Additional disk space is required to store configuration and historical data: add on average 2150 byte per item definition, 100 byte per history sample, 550 byte per event sample, 18 Kb per class, 2 Kb per object, 2 Kb per report and 30 Kb per display symbol	
Ethernet adapter	An Ethernet adapter that is supported by the operating system is required at installation. Please note that for HAC (High Availability Computing) a dedicated network adapter is preferred.	
DVD-ROM Drive	A DVD-ROM drive that is supported by the operating system is required.	

■ RELATED DOCUMENTS

GS 50A01A10-01EN FAST/TOOLS

■ MODELS AND SUFFIX CODES

Application Suite

		Description
Model	GLEMS	Gas and Liquid Enterprise Management Suite
Suffix Codes	-S	Software license
	1	Always 1
	1	Always 1
	-SPA	Single products / Single pipeline
	-SPB	Multi products / Single pipeline
	-MPA	Single products / Multiple pipelines
	-MPB	Multi products / Multiple pipelines

Annual Support Fee

		Description
Model	SV5GLMSUP	Gas and Liquid Management Support Contract (Annually)
Suffix Codes	-S	Support License
	1	Always 1
	1	Always 1
	-SPA	Single products / Single pipeline
	-SPB	Multi products / Single pipeline
	-MPA	Single products / Multiple pipelines
	-MPB	Multi products / Multiple pipelines

Note: This support includes; Free version upgrade to latest version of the Pipeline Application Suites, Bug solving, Telephone/email support, Availability of consultant.

■ TRADEMARKS

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