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<div> <div>TECHNICAL SPECIFICATION FOR</div> <div>ULTRASONIC FLOW METERING SYSTEM</div> </div>						
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1. APPLICATION

This specification describes the minimum requirements for the design, materials, manufacture, testing and inspection of ultrasonic flow meters for installation and supply of a natural gas metering system for custody transfer.

2. APPLICABLE CODES AND STANDARDS

The following relevant codes and standard of the latest edition shall be applied. If there is any item inconsistent with this specification, the contractor should be approved by the purchaser prior to manufacturing the metering system.

- . The Model Approval and The Inspection Pass in Korea
 - Metering Law in Korea (NO.8486)
 - “ Chapter.3 Formal Approval of Gas Meter”
 - “ Chapter.4 Inspection of Gas Meter”
 - Enforcement Ordinances for Metering Law in Korea(Presidential Decree No.19669)
 - “Article.17 (Meters to be approved and Expiration Period : Attachment.9)”
 - Enforcement Regulations for Metering Law in Korea
(The Ministry of Commerce, Industry and Energy Decree NO.362)
- . International Standardization Organization(ISO)
 - 17089-1 Measurement of fluid flow in closed conduits-Ultrasonic meters for gas-part 1:Meters for custody transfer and allocation measurement
 - 12213 Natural gas - Calculation of compression factor - part 2 : Calculation using molar-Composition analysis
- . AGA (American Gas Association)
 - AGA Report No 8 Compressibility Factors of Natural Gas and Related Hydrocarbon Gases. (API MPMS 14.2)
 - AGA(American Gas Association) Report No. 9
Measurement of Gas by Multipath Ultrasonic Meters
- . Korean Industrial Standards(KS)
 - KS M ISO 6974-5 Natural gas-Determination of composition with defined uncertainty by gas chromatography-Part 5: Determination of nitrogen, carbon dioxide and C1 to C5 and C6+ hydrocarbons for a laboratory and on-line process application using three columns
 - KS M ISO 6976 Natural gas-Calculation of calorific values, density, relative density and Wobbe index from composition
 - KS M ISO 10715 Natural gas-Sampling guidelines

- KS M ISO 12213
 - Natural gas - Calculation of compression factor - part 1 : Introduction and guidelines
 - Natural gas - Calculation of compression factor - part 2 : Calculation using molar-Composition analysis
 - Natural gas - Calculation of compression factor - part 3 : Calculation using physical properties
- . National Electrical Manufacturers Association(NEMA)
 - SP 250 Enclosures for electrical equipment
- . American Petroleum Institute (API)
 - 500 - Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 1 and Zone 2
 - 5L Line Piping
- . American Society for Testing and Materials (ASTM)
 - A48/A48M Standard Specification for Gray Iron Castings
 - A105/A105M Standard Specification for Forgings, Carbon Steel for Piping Components
 - A106B Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
 - A182/A182M Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fitting and Valves and Parts for High-Temperature Service
 - A193/A193M Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
 - D1945 Standard Test Method for Analysis of Natural Gas by Gas Chromatography
- . American Society of Mechanical Engineers(ASME), Boiler and Pressure Vessel Code
 - Sec. V Nondestructive Examination
 - Sec. VIII Pressure Vessels
 - Sec IX Welding and Brazing Qualifications
 - ASME B 31.8 Gas Transmission and Distribution Piping Systems
 - ASME B16.5 Steel Pipe Flanges and Flanged Fittings
 - ASME B16.9 Factory-Made Wrought Steel Butt welding Fittings for fitting
 - ASME B16.11 Forged Fittings, Socket-weld and Threaded
 - ASME B16.25 Butt-welding ends
 - ASME B16.47 Large Diameter Steel Flange
- . Instrument Society of American(ISA)
 - S5.1 Instrumentation Symbols and Identification

- S5.4 Instrument Loop diagram
- . Electrical Industries Association, Inc.(EIA)
 - RS-232C "Interface between data terminal equipment & data Communication equipment employing serial binary data interchange" for communication
- . International Electro-technical Commission(IEC)
 - 60529 Degrees of Protection Provided by Enclosures (IP Code)
Institute of Electrical and Electronics Engineers
 - 60751 Industrial Platinum Resistance Thermometer Sensors
 - 60079-10 Electrical Apparatus for Explosive Gas Atmospheres
 - 60079-14 Electrical Installations Design, Selection And Erection
- . National Electrical Code(NEC)
 - Article 500 "Hazardous(Classified) Locations"
 - Article 501 "Class 1 Locations" for field instrument
- . International Organization of Legal Metrology(OIML)
 - R-137-1 Gas meters
- . Institute of Electrical and Electronics Engineers(IEEE)
 - IEEE Standard 142 Grounding of Industrial and Commercial Power Systems,
 - IEEE Standard 242 Protection and coordination of industrial and Commercial Power systems.
- . The metering system uncertainty
 - International Standardization Organization(ISO) 5168
"Estimation of uncertainty of a flow-rate measurement"
- . Federal Communication Commission (FCC)
 - Part 15 Class A&B, Part 68 : for EMI test

3. SYSTEM OUTLINES

Ultrasonic measuring system shall consist of 'field metering equipments' , flow computer panel' and 'HMI system' .

3.1) Field metering equipments

Field metering equipments are composed of ultrasonic flow meter, Temperature element & transmitter, Pressure Transmitter, gas chromatograph other accessories.

3.2) Flow Computer Panel

- a) The flow computer panel has a self-supporting panel incorporating a power supply system which supplies power to the incorporated flow computer, gas chromatograph controller and field facilities and terminals for the cable connections with field facilities, and auxiliary facilities

- b) The flow computer panel incorporates flow computers and gas chromatograph controller which receive signals transmitted from the field facilities, calculates instantaneous values, totalized metering values and unit energy, activates the alarm for abnormal situations and makes the report, prepares the report program for abnormal situations.

3.3) HMI System(for Flow computer & gas chromatograph)

a) PC for Flow computer

The PC communicates with the flow computer, monitors various supply data, checks whether there is any abnormal condition in the flow computer panel, and outputs and stores hourly, daily and monthly data.

b) PC for Gas chromatograph

The PC communicates with the gas chromatograph controller and outputs and stores the analysis results of the gas chromatograph.

4. PROCESS AND ENVIRONMENTAL CONDITIONS

4.1 Environmental Conditions

Classification	Ambient temp.	Relative humidity	Remarks
Indoor	0 °C ~ 40 °C	10% ~ 90%	Flow computer and GC controller
Outdoor	-20 °C ~ 40 °C	10% ~ 90%	Ultra Sonic Meters, Field instruments and GC with cabinet: Hazardous Area

4.2 Power Source

- 220VAC $\pm 10\%$, 60Hz, 1 ϕ , UPS : for flow computer panel and GC controller
- 24VDC : for field instruments

4.3 Process Conditions

• SK Ulsan Metering Station

Item	Description	Remarks
Fluid	Natural gas	
Maximum pressure	7.85 MPa(g)	
Operating pressure	3.53 MPa(g)	
Operating temperature	Above 0 °C	
Flowrate	Refer to the table 1	

4.4 Hazardous area classification for field instrument ;

- Class I , DIV 1, GR.D

4.5 General characteristics of the natural gas

Presumable natural gas composition								
Item	Light		heavy		Typical			Present
	max.	min.	max.	min.	1	2	3	4
CH ₄	95.74	89.40	85.12	86.231	90.75	86.11	85.12	91.082
C ₂ H ₆	1.89	5.04	8.63	8.50	4.94	8.60	9.32	5.656
C ₃ H ₈	0.68	3.34	4.14	4.23	2.92	3.85	4.58	2.194
i-C ₄ H ₁₀	0.34	0.91	1.10	0.55	0.62	0.69	0.58	0.440
n-C ₄ H ₁₀	0.34	0.97	0.90	0.43	0.69	0.65	0.42	0.457
i-C ₅ H ₁₂	0.01	0.10	0.10	0.023	0.06	0.05	-	0.030
n-C ₅ H ₁₂	-	-	-	0.013	0.01	0.02	-	0.030
CO ₂	-	-	-	-	-	-	-	-
N ₂	1.00	0.24	0.01	0.023	0.01	0.03	0.01	0.202
Total	100	100	100	100	100	100	100	100

Table 1. Estimated flowrate

Station Name	Flowrate (Nm ³ /h)			Customer	Remarks
	Size	Minimum*	Maximum**		
SK ULSAN METERING STATION	12"	5,664	188,795	SK ENERGY	
	12"	5,664	188,795		

* Calculated Flowrate when velocity is 0.6m/s.

** Calculated Flowrate when velocity is 20m/s.

5. UNITS

The units to be used are as follows.

Item	Units	Remarks
Volume flowrate	Nm ³ /h, m ³ /h	N : normal (at 101.325kPa, 0℃)
Mass flowrate	t/h	t : ton
Energy flowrate	GJ/h, kcal/sec	
Pressure	MPa(a), kg/cm ²	
Differential pressure	hPa	
Temperature	℃	
Gas density	kg/m ³	
Calorific value	MJ/Nm ³	At 15℃
Totalized volume	Nm ³	
Totalized mass	T	
Totalized energy	GJ, kcal	
Velocity	m/s, mm/s	

6. SCOPE OF WORK INCLUDED

The contractor shall provide the following items in accordance with the requirements of this specification.

6.1. Design service

Design service furnished by contractor shall include all functions necessary to provide completely engineered and debugged system drawings, calculation sheets, data books, operating and maintenance manuals, meter run switching flowchart, program description, etc.

6.2. Equipment (att. #2)

- Communication cable & connector between flow computer panel and HMI PC for flow computer and GC controller, Ultrasonic Flow Meters etc.
- Isolators required on flow computer panel for all incoming field instruments wiring
- Communication device, protocols & interface

6.3. Special tool, consumables

6.4. Supervision service and training

Supervisor's duty include following items as a minimum

- Loop check and correction between Ultrasonic meter including field instruments and flow computer
- Check and correction for software and hardware(flow computer panel & field instruments)
- Flow computer accuracy acceptance test accuracy verification for all parts supplied
- Recommend the installation method for all parts supplied

6.5. Other subsidiary works

- Packing and shipping
- Inspection and test
- QA/QC
- Document Submittal shown in att. #4

6.6. Submitting certificate for explosion proof type for electric equipment (KOSHA, KGS, KTL) & standard gas issued by a traceable agency (KRISS).

7. Technical Specification

The Ultrasonic flow measuring system shall be designed for the custody transfer measurement with the following accuracy.

Overall accuracy : within $\pm 1.0\%$

7.1 Flow computer panel

Flow computer panel shall be of a free-standing type and it shall be possible to interface with other systems such as HMI PC, Gas chromatograph controller etc.

a) Flow Computer

- CPU : 32bit or better, Redundant
- Non-volatile memory
- Communication equipment : RS-232, 422/485, Ethernet
- Hart Communication shall be applied for PT, TT signal

b) Programmable Logic Controller

- Redundant PLC shall be installed to monitor field instrument, valve status & control the electric actuated valves. Also it should output and display the information (such as field instrument monitoring, valve control and alarm activating) on Flow computer HMI which is supplied by the contractor.

c) Redundant Power supply unit(220 VAC/24 VDC)

d) Redundant UPS(Uninterruptible Power Supply) for Flow computer (24Vdc, 3~5 hours long)

e) Surge arrester (Capacity : 40KA or over for line to ground or line to neutral, neutral to ground) before the AC power supply on the flow computer panel

f) Isolators required on flow computer panel for all incoming field instruments wiring

g) General alarm light and buzzer with reset button and buzzer stop button

h) Power on/off switch

i) Ventilating fans with filters (bottom) and discharge grilles (top) of the rear access door

j) Interior fluorescent lighting fixture with door switch

- k) Safety covers and labels for all wiring terminations
- l) 2.15 m height, 0.83 m depth and manufacturer's standard width
- m) Munsell No. N 7.5 or RAL 7038 finishing color
- n) Accessories (Terminal block, Earth lugs, Relay, cable, etc.)
- o) An override ON/OFF switch in software function on the LCD display shall be provided to manually override the automatically transferred caloric values from G/C controller, when any malfunction such as measuring and/or communication error is occurred on the G/C controller. When the user selects the override ON button, the flow computer shall use the manually entered value (or average values in stored data) instead of the received values from G/C controller.
- p) The flow computer panel shall be composed of 2 kinds [each line each computer or dual redundant(Hot/stand-by) computers type] of system and the flow computer shall be capable of measuring the flows with two meter runs.
- r) Communication devices necessary
Contractor shall supply suitable communication device such as FO switch hub, Frame Distribution Frame (FDF) etc., for both Flow computer panel and DCS panel for redundant communication interface with DCS

7.2 Ultrasonic flow meter(USM)

7.2.1 Meter Performance Requirement

Ultrasonic meter shall meet the following specification.

a) Performance requirement

The general flow-measurement performance of all USMs shall meet the following requirements, prior to making any calibration-factor adjustment.

Division		Before adjustment of Calibration-factor	After adjustment of Calibration-factor
Repeatability		0.2% for $q_{v,t} \leq q_v \leq q_{v,max}$. 0.4% for $q_{v,min} \leq q_v \leq q_{v,t}$	0.2% for $q_{v,t} \leq q_v \leq q_{v,max}$. 0.4% for $q_{v,min} \leq q_v \leq q_{v,t}$
Resolution		0.001 m/s	0.001 m/s
Velocity Sampling Interval		≤ 1 second	≤ 1 second
Zero-Flow Reading	$\geq 12"$	$< 6\text{mm/s}$ for each acoustic path	$< 6\text{mm/s}$ for each acoustic path
	$< 12"$	$< 12\text{mm/s}$ for each acoustic path	$< 6\text{mm/s}$ for each acoustic path
Here, q_v : Instantaneous flowrate, $q_{v,t}$: Instantaneous flowrate of transition			

- Large Meter Accuracy

USMs of 12" (nominal) diameter size and larger shall meet the following flow-measurement accuracy requirements, prior to making any calibration-factor adjustment.

Division		Before adjustment of Calibration-factor	After adjustment of Calibration-factor
Maximum Error		$\pm 0.7\%$ for $q_{v,t} \leq q_v \leq q_{v,max}$. $\pm 1.4\%$ for $q_{v,min} \leq q_v \leq q_{v,t}$	$\pm 0.35\%$ for $q_{v,t} \leq q_v \leq q_{v,max}$. $\pm 0.7\%$ for $q_{v,min} \leq q_v \leq q_{v,t}$
Maximum Peak-to-Peak Error		0.7% for $q_v \geq q_{v,t}$	0.7% for $q_v \geq q_{v,t}$
$Q_{v,t}$ for meter $\geq 12"$		$Q_{v,t}$ at $v=1.5\text{m/s}$ ($q_{v,min}$ at $v=0.6\text{m/s}$)	$Q_{v,t}$ at $v=1.5\text{m/s}$ ($q_{v,min}$ at $v=0.6\text{m/s}$)
Here, q_v : Instantaneous flowrate, $q_{v,t}$: Instantaneous flowrate of transition			

- Small Meter Accuracy

USMs less than 12" (nominal) diameter shall meet the following flow-measurement accuracy requirements, prior to making any calibration-factor adjustment.

Division	Before adjustment of Calibration-factor	After adjustment of Calibration-factor
Maximum Error	$\pm 1.0\%$ for $q_{v,t} \leq q_{v,max}$. $\pm 1.4\%$ for $q_{v,min} < q_{v,t} < q_{v,max}$	$\pm 0.5\%$ for $q_{v,t} \leq q_{v,max}$. $\pm 0.7\%$ for $q_{v,min} < q_{v,t} < q_{v,max}$
Maximum Peak-to-Peak Error	1.0% for $q_{v,t} \geq q_{v,t}$	0.7% for $q_{v,t} \geq q_{v,t}$
$Q_{v,t}$ for meter $\leq 12''$	$Q_{v,t}$ at $v=3.0m/s$ ($q_{v,min}$ at $v=0.6m/s$)	$Q_{v,t}$ at $v=3.0m/s$ ($q_{v,min}$ at $v=0.6m/s$)
Here, q_v : Instantaneous flowrate, $q_{v,t}$: Instantaneous flowrate of transition		

b) Effect of pressure, temperature and gas composition influences

- The USM shall meet the above accuracy requirements over the full operating pressure, temperature, and gas composition ranges, with inputs and/or a correction algorithm if necessary.
- The necessary correction algorithm and inputs shall be specified. If a correction algorithm is not necessary, an Additional uncertainty due to pressure, temperature and composition changes shall be specified.

c) Noise immunity of USM

For SK Ulsan metering station, the USM meters are positioned after the regulating valve.

Therefore, manufacturer should submit the documents to improve noise immunity of USMs as below.

- Signal strength P_s of a USM
- The minimum required S/N parameter, $\delta_{s/n,min}$ of a meter
- Signal processing techniques for signal detection

cf.) the documents should be calculated in accordance with ISO-17089-1 and issued by an authenticated agency.

7.2.2 Meter Body

- a) The meter body and the internal mechanism shall be manufactured of materials suited for the service conditions and resistant to attack by the fluid which the meter is to handle. Exterior surfaces of the meter shall be protected as necessary against corrosion

b) Maximum operating pressure and connections

Meters and inlet/outlet connection of the meter should be manufactured to meet ANSI CLASS 600

c) Corrosion Resistance

All wetted parts of the meter shall be manufactured of materials compatible with natural gas and related fluids.

d) Meter Body Length and Bores

- The overall face to face length of the meter body with flanges shall be below 5DN
- The meter inside diameter in the measurement section shall be of constant diameter to within 0.5% of the average internal diameter of the measurement section. The measurement section average internal diameter shall be determined by a minimum of four equally-spaced individual internal diameter measurements made in a plane at the meter measurement section entry, middle, and exit.

e) Ultrasonic Transducer Ports

- Transducer ports shall be designed in a way which reduces the possibility of liquids or solids accumulating in the transducer ports
- The USM may be equipped with valves or necessary additional devices, mounted on the transducer ports in order to make it possible to replace the ultrasonic transducers without depressurizing the meter run.

f) Pressure Tapping

At least one metering-pressure tapping shall be provided on the meter or on the piping adjacent to the meter to enable direct measurement of the static pressure at the metering conditions. The diameter of the pressure tapping shall have a minimum bore diameter of 3mm and a maximum bore of 12mm.

g) Marking

A nameplate containing the following information should be affixed to the meter body.

- the manufacturer, model number, serial number and month and year manufactured
- meter size, flange class and total weight
- meter body design code and material, and flange design code and material
- maximum operating pressure, operating temperature range
- maximum and minimum actual volumetric flow rate per hour
- direction of positive or forward flow

h) Anti roll provision

- The meter should be designed in such a way that the body will not roll when resting on a smooth surface with a slope of up to 10%.
- The meter should be designed to permit easy and safe handling of the meter during transportation and installation. Hoisting eyes or clearance for lifting straps should be provided.

7.2.3 Meter Tube

a) Specifications

- USM shall be supplied with more than 20D of straight pipe length at the upstream and 5D of straight pipe length at the downstream. They should be connected with USM by using flanges(600lb RF).
- Inlet upstream/Outlet downstream pipes shall be connected to WN flanges type. (600lb RF)
- Flange type : ASTM A 105 ANSI B 16.5 forged #600 RF
- Contractor should submit the certificate of perturbation test. Test shall be performed that meter is located within 20D of upstream pipe (without flow conditioner).
- Thickness of the upstream & downstream pipe shall be determined after technical meeting

b) Protrusions and Misalignments

- The USM flanges and adjacent upstream pipe, should all have the same inside diameter, to within 1%, and be carefully aligned to minimize flow disturbances, especially at the upstream flange section. The adjacent upstream flange internal welds should be ground to a smooth transition with the pipe wall. No part of the upstream gasket of flange face edge should protrude into the flow stream by more than 1% of the internal diameter.

c) Thermowells

- The distance from the downstream flange face to the thermowell should be between 2ND and 5ND
- Conical thermowells shall be installed and the insertion length for thermowells shall be between D/2 and D/3.

7.2.4 Ultrasonic Transducers

a) Specifications

- The manufacturers shall state the general specifications of their ultrasonic transducers, including critical dimensions, maximum allowable operating

pressure, operating pressure range, operating temperature range and gas composition limitations.

- The manufacturer shall specify the minimum operating pressure based on the ultrasonic transducer model, USM size and expected operating conditions. This minimum pressure shall be marked or tagged on the USM.
- Ultrasonic transducer ports shall be greater than or equal to 4-path / 8 transducer. In the event of a path failure, it shall be met 7.2.1 a) accuracy requirement.

b) Rate of Pressure Change

Clear instructions should be provided by the manufacturer for depressurization and pressurization of the meter and transducers during installation, start-up, maintenance and operation.

c) Exchange

- Ultrasonic transducers shall be removable and replaceable without the need to depressurize the meter run. If an extraction/insertion tool or any other specialized tools and consumable parts are required, those shall be provided as part of the USM package.
- Replacement or relocating of transducers shall not affect the 7.2.1 a) performance requirement without recalibration.

d) Transducer Tests

- Each transducer or pair of transducers should be tested by the manufacturer and the result document shall be submitted.
- Each transducer should be marked with a permanent serial number and be provided with the general transducer data listed in Section a) Specifications. If the SPU requires specific transducer characterization parameters, each transducer should be provided with test documentation that contains the specific calibration test data, calibration method and characterization parameters.

7.2.5 Electronics(SPU)

a) General Requirements

- The USM' s electronic system may be housed in one or more enclosure and mounted on or next to the meter body
- It shall also be possible to replace the entire SPU or change any field replacement module without a significant change in meter performance
- The system should contain a watch-dog-timer function to ensure automatic restart of the SPU in the event of a program fault or lock-up.

- The meter should operate from a power supply of nominal 220V AC at 60Hz or from 24V DC power supply.

b) Output Signal Specifications

- The SPU should be equipped with the following outputs.
 - serial data interface : Over 2 Points (RS-422/RS-485)
 - ethernet : 1 Point (can be replaced by RS-422/RS-485)
(Flow Computer, Diagnostic program Notebook)
 - frequency(Pulse output) : Over 3 Points
 - analog(4-20mA, DC) output : 1 Point (Flow Rate and other configurable)
 - digital output : 2 Points
- Flow-rate signal should be scaleable up to 120% of the meter's maximum flow rate, q_{max} . (V_{max} . 30m/s)
- A low-flow cutoff function should be provided that sets flow-rate output to zero when the indicated flow rate is below a minimum value.

c) Electrical Safety Design Requirements

- The USM, including the electronics (SPU), should be designed by appropriate explosion proof
 - explosion proof type : Class I , Zone 1 hazardous
Locations (KOSHA, KGS, KTL Certificate)
- Cable jackets, rubber, plastic and other exposed parts shall be Resistant to ultraviolet light, heat, oil and grease.

d) Component Replacement

- The ability to replace or relocate cables, electronic parts and software without a significant change in the meter performance is a requirement. The manufacturer shall provide proven procedures and sufficient data for Component Replacement.

7.2.6 Software

a) Firmware

- Computer codes responsible for the control and operation of the meter should be stored in a nonvolatile memory. All flow-calculation constants and the operator-entered parameters should also be stored in nonvolatile memory.
- For auditing purposes, it should be possible to verify all flow-calculation constants and parameters while the meter is in operation.
- The manufacturer should provide a record of all firmware revisions, including revision serial number, date of revision, applicable meter models, circuit board revisions and a description of changes to the firmware.

b) Configuration and Maintenance Software

The meter shall be supplied with a capability for local or remote configuring the SPU and for monitoring the meter operation. The software should be able to display and record the following measurements:

- Flow rate at line conditions
- Mean velocity.
- Average speed of sound.
- Speed of sound along each acoustic path
- Acoustic signal quality received by each transducer

c) Inspection and Auditing Functions

- It should be possible for the auditor or the inspector to view and print the flow measurement configuration parameters used by the SPU: e.g., calibration constants, meter dimensions, time averaging period and sampling rate.
- Provisions shall be made to prevent an alteration of those parameters that affect the performance of the meter.

d) Alarms

The following alarm-status output shall be provided:

- output invalid: when the indicated flow rate at line conditions is invalid
- trouble: when any of several monitored parameters fall outside of normal operation for a significant period of time
- partial failure: when one or more of the multiple ultrasonic path results is not usable

e) Diagnostic Measurements

Through serial interface, following diagnostic measurement method should be provided.

- average axial flow velocity through the meter
- flow velocity for each acoustic path (or equivalent for evaluation of the flowing velocity profile).
- speed of sound along each acoustic path.
- average speed of sound.
- velocity sampling interval.
- averaging time interval.
- percentage of accepted pulses for each acoustic path.
- signal to noise ratio
- status and measurement quality indicators.
- alarm and failure indicator.

f) Exchange of components

Replacement of software shall not affect the 7.2.1 a) accuracy requirement without recalibration.

7.3 HMI PC, Printer & Peripherals

a) HMI computer(Workstation class PC) and monitor (color, LED 24" or larger)

b) HMI software(MFR. ST'D, I/O server)

c) Industrial printer(s) for Report & Alarm printing

* Peripherals shall be supplied with the FCC compliance statement and notating the FCC I.D. No.

7.4 Instruments

a) Absolute Pressure Transmitter

- Function : indication and transmission (LCD indicator with Engineering unit included)
- Range : Refer to the data sheet. (att. 3)
- Accuracy : better than $\pm 0.1\%$ of full scale
- Output : 4~20mA
- Explosion proof enclosure
- SMART TYPE (HART PROTOCOL)
- Others : 2-way valve, cable gland, and necessary accessories
1/2" instrument valves

b) Temperature element

- Sensor element : platinum 100 Ω at 0°C, 4 wire
- Accuracy : $\pm 0.15^\circ\text{C}$ at 0°C or better
- Immersion length : Refer to the data sheet. (att. 3)
- 1½" RF flanged thermowell, gasket, bolts and nuts
- Light alloy explosion proof head
- Flange : ANSI B 16.5 CLASS 600 1b, ASTM A105 R6
- Others : explosion proof type cable gland
- Location : A thermowell Shall be installed at the downstream location of 2D~ 5D from the ultrasonic meter

c) Temperature Transmitter

- Function : indication and transmission (LCD indicator with Engineering unit included)
- Range : Refer to the data sheet. (att. 3)

- Accuracy : Better than $\pm 0.1\%$ of full scale
- Output : 4~20mA
- Explosion proof enclosure
- SMART TYPE (HART PROTOCOL)
- Others : explosion proof type cable gland and accessories
(The manufacturer of the temperature transmitter shall be the same as that of the pressure transmitter so that the purchaser may use the same calibrator.)

d) Transmitter Sunshade

The transmitters shall be assembled and equipped with sunshade (304 SS) at the contractor's factory according to the following requirements.

One set of pressure transmitter and one set of temperature transmitter shall be installed in the sunshade with the following accessories.

- Process tubings and 2-way valve(1/2")
- Cable glands (explosion proof type), conduits and fittings required for installation in a Class 1, Zone 1 hazardous area Following Conduit and process tubing are connected to the bottom side of the sunshade.
- Conduit
 - * 1/2" NPT F x 2 ea : temperature transmitter
 - * 1/2" NPT F x 1 ea : pressure transmitter
 - * 1/2" NPT F x 1 ea : temperature element (RTD)
- Process tubing
 - * 1/2" OD tubing connection x 1 EA pressure transmitter
 - * Tube material : Seamless SS Tube (ASTM A269 TP316/316L), 0.065 Thick.
- 2" pipe stanchion shall be provided with the sunshade and accessories as one completed assembly.
- Refer to Attachment #13 for the transmitter sunshade



7.5 Gas Chromatograph

a) General

- Gas analyzer sends the result to flow computer in control room after analyzing natural gas that is extracted from measuring pipe. Flow computer uses the result that is analyzed for measuring.
- Can use the gas analyzer controller that is compatible with flow computer and data to process the data of the gas analyzer.
- The contractor should supply hardware communication facility and software for swapping data between gas analyzer, controller, flow computer.

- As soon as the communication error between the gas chromatograph and the flow computer occurs, it should be informed to the operator with the alarm.
- A printer shall be provided for the data logging.
- The contractor should install filter to remove humidity, oxygen, organic matter in the entrance of natural gas and carrier gas.
- Sample injection device shall consist of injection valve and loop for sampling that can connect gas sample to on-line and do injection.
- Should have function that can sense and control velocity of flow and pressure of natural gas and Carrier gas.
- Ingredient of standard gas should be made to be similar to ingredient of analysis target gas. But, micro ingredient (more than C5+) of standard gas should be made more than 100 ppm (0.01%) because of the feature of gas analyzer.
- Should have function that apply the default or last values(each components) to the calculation, if the G/C fails to meet the criteria(each components' mole percent)

b) Gas Analyzer

- Detector : microthermal conductivity detector
- Carrier gas : Pure helium (99.999%)
- Valve actuation gas : Pure helium or nitrogen
- Sample gas : vapor
- Repeatability Accuracy
 - Calorie standard : ± 0.5 BTU / 1000 BTU (± 0.05 % CV)
-18~55°C Temperature range
 - Ingredient standard

Component mol%	Repeatability
0.0 ~ 0.1	0.01
0.1 ~ 1.0	0.04
1.0 ~ 5.0	0.07
5.0 ~ 10	0.08
10 or more	0.10

- Reproducibility
 - Calories standard : within ± 0.3 %
(For standard gas calculation calorie value)
- Analysis time : within 5 minute or less per stream(adjustable)
- Sample conditioning system : multi streams with automatic calibration
- Columns : micropacked or capillary column(5 year warranty)
- Oven : airless heat sink oven
- Safety classification : approved for Class 1, Zone 1
- Power requirement : 220VAC $\pm 10\%$, 60 Hz, 1 ϕ

- Operating temp. : 0~40℃
- Humidity : 10~90% non-condensing

c) Controller

- Alarm inputs : 1 analyzer alarm, voltage free dry contact
- Communication mode : MODBUS, TCP/IP
- Serial output : for printer and Flow computer
- Automatic calibration : programmable timing or on demand
- Battery backup : 10 years volatile memory protection
- Reports : analysis report, calibration report, communication fault alarm
- Power requirement : 220VAC $\pm 10\%$, 60 Hz, 1 ϕ
- Operating temp. : 0~40℃
- Humidity : 0~95% non-condensing

d) Sample probe with regulator

- Max. inlet pressure : 140.6 kg/cm² (13.79 MPa)
- Outlet pressure: 0~2.03 kg/cm² (0~0.2 MPa)
- Flange : 600# RTJ(determined after the isometric drawing has been issued)
 ※ Flange shall be stamped with the probe tag number and flow direction.
- Gasket (2" OVAL RING JOINT TYPE SOFT IRON), Bolt & Nut (Stud Bolt A193 Gr B7/ Heavy Hex. A 194 Gr. 2H Galvanized) to be provided by vendor
- Probe length (Refer to P&ID): the sample probe shall be installed so as to Withdraw gas from the Center of the pipeline diameter (Min. 30mm to Max 0.5D+10mm) and maximum insertion length shall not exceed 8 inches.
 The probe insertion length shall be calculated in accordance with IEC TR61831 Annex B "Determination of sample probe lengths calculation"
- Outlet connection size: 1/4"NPT
- Material: 316stainless steel
- Sampling Tube Length & Type : 30M(Adjustable), Pre-Insulation Tubing(Electric heat Tracing)
- Adjustable regulated pressure-setting
- Accessory: SS (stainless steel) relief valve and SS pressure gauge.
- Type: Fixed type.



e) Gas Chromatograph cabinet

Gas Chromatograph(analyzer), sampling system, space heater and accessories shall be installed inside a cabinet and two standard gas cylinders, two carrier gas cylinders shall be installed outside the cabinet.

(refer to att. #11 and below specification)

- Dimension : 1400(W) x 900(D) x 2100(H) mm (Reference only)
- Material : Stainless Steel (2.0t or better)
- Double doors on the front & rear
- Stainless Steel Hinges

- SS Base
- Ventilation Louver
- Double Wall Insulation w/concerned Internal Accessories
- Gas Cylinder Rack for 4 Cylinders
- Explosion-proof Electrical J/B W/fuses
- Combined Trap for Gas Cylinders
- Hand Valves, Tubing, Supports and Flame arrester etc.
- Explosion-proof Heater
- Rigid Type Insulation, Lightings, Lifting Lugs,
- Tumbler Switchs, Receptacles
- Space heater with explosion proof type electrical power junction box
- Cabinet w/Ventilation
- Insulation plate & fitting(Under G/C cabinet, Valve) : Refer to ATT #11 &12.
- If necessary, standard gas cylinder shall be heat insulated to prevent Condensation

f) Sample Tube Line (Refer to Attachment #12)

- Electrically traced tubing 30M(Adjustable) and Power Kits
(Explosion proof certification shall be provided)
- Valves
- Tube fittings
- The above materials to be supplied in loose items.

g) Standard gas

The calibration gas accompanied by an authenticated certificate, having for each specified quantity value, measurement uncertainty and stated metrological traceability chain.

The quality of calibration gas is primary reference material (PRM) and it shall have the following specification:

For every component, the expanded uncertainty($k=2/95\%$) of the components shall be stated and the range of uncertainty shall be satisfied with following limit.

Methane: $\pm 0.5\%$, Ethane: $\pm 0.7\%$, Propane: $\pm 0.8\%$, other components: $\pm 1\%$ within the limit.

Analytical quality is guaranteed for more than 2 years. Supplier shall submit documentation for demonstrating the international traceability. Standard gas should be heat-insulated to prevent condensation.(e.g. blankets)

The procedure how the standard gas is prepared shall be specified.

h) Pressure transmitter for carrier gas

- Mount a Measuring Point upstream of the regulator for helium gas
- function : indication and transmission(LCD indicator included)
- Range : Refer to the data sheet.(see attachment)
- Accuracy : $\pm 0.1\%$ of full span or better
- Output : 4~20mA DC
- Explosion-proof enclosure, smart type with a certificate issued by KOSHA,

KGS, KTL

- Others : gauge pressure transmitter, 2-way valves, explosion-proof type glands with flexible cable etc.

※ It is acceptable to transmit the helium gas pressure and alarms via Communication method

7.6 Double Modulation System

In order to communicate between Ulsan metering station and KOGAS G/S, Double modulation system shall be supplied by contractor. The Double modulation system shall support protocols (DNP3.0, Modbus) with redundant communication.

The signal lists from Ulsan metering station to KOGAS G/S are as below.

- Instantaneous volume flow(Nm3)
- Instantaneous mass flow(Ton)
- Instantaneous energy flow(GJ)
- Totalized volume flow(Nm3)
- Totalized volume flow(Ton)
- Totalized energy flow(GJ)
- Calorific value(MJ)

The valve status signal also shall be monitored in KOGAS G/S with above listed signal.

8. FUNCTIONAL DESCRIPTION

8.1 Flow rate measurement

The metering system shall measure gas flows in the range of minimum to maximum shown in the table 1. The flow computer shall be programmed to have the following functions.

- a) The computer acquires data from various sensors, converts the data into physical values, calculates flowrate from the values and generates alarms.
- b) The computer should display and print operating condition of metering station and should be able to receive the data from USMs and G/C controller.
- c) The maximum flow shall be measured with one meter run. However, the flow computer shall be capable of measuring the flows with two meter runs.
- d) Calculation Formulas

The flow computer shall utilize the following calculation formulas.

- Volume flowrate : ISO-17089-1
- Mass flowrate : ISO-17089-1

- Gas density : ISO-12213-2
- Uncertainty : ISO 5168

e) Linearization

The flow computer should have the function of linearizing the ultrasonic meter inputs at various measuring points.

f) Calculation accuracy

The flow computer should perform the flow calculation with the accuracy for each meter flow and totalized flow according to the specification.

- i) The flow computer shall have the function to generate alarm and print out the status when the flow rate of each meter run exceed the maximum flowrate and less than minimum flowrate. The flow limit of each meter run shall be declared by operator.

8.2 Operator/Flow computer Interface

The following operator entry and supervisory data display functions shall be provided utilizing the system monitor display, keyboard, and monitor pointing devices.

- a) Entry and display of metering parameters such as scales, alarm thresholds, base pressure, base temperature, viscosity, base density, gas property, meter tube switching hysteresis and others. Operator shall be accessible for entry of the parameter with a password.
- b) Display and print out of process values, flowrate, totalized flow, etc. on the monitor and printer.
- c) Blinking alarm display and acknowledgment
- d) Designation of meter tubes for automatic meter run switching
(Flow computer should not control the meter run not designated.)
- e) Graphic display shall be designed according to att. #7
- f) The application software for the monitor display function shall be operated on Windows 10 or similar operating system with latest version.



- g) Time synchronizing between flow computer and HMI PC with a GPS Device (Network type)

8.3 Linkage with DCS

The flow computer shall send the data related to the flow but not to be limited the following.

- instantaneous gas flowrate (Nm^3/h)
- ongoing totalized flow (Nm^3)
- ongoing totalized energy (GJ)
- instantaneous gas calorific value (MJ/Nm^3)
- etc.

The communication protocol (Hardware/Software) between the DCS in SK energy CLX and the flow computer will be Modbus TCP/IP (to be confirmed later).

The contractor shall support/co-operate for the data communication between flow computer and DCS.

Following detail requirements of data communication shall be defined by DCS supplier and Purchaser after contract.

- Protocol mode
- Baud rate
- Parity
- Stop/Data/Start bit
- Comm. type, Set type
- Start address
- Register point, bit for flow rate, totalized flow

The contractor shall discuss all the requirements above of communication with DCS supplier and modify software and hardware of metering system to meet the requirements.

Data address of flow rate, totalized flow and totalized energy flow shall be defined by metering system contractor.

The contractor shall submit the MODBUS software protocol to the Purchaser so that the Purchaser and DCS manufacturer can make it possible to communicate between the flow computer and DCS.

In addition to above, the contractor shall supply double modulation device which will be installed in KOGAS G/S.

8.5 Printing Function

Each report shall be printed or not by setup of function key such as PRINT ON/OFF on monitor. Also, print function for hardcopy for the whole screens

which are displayed on flow computer and supervision computer shall be included.

a) Flow computer shall provide the following functions.

- Hourly report showing following data of each meter and station total
 - * totalized volume flow for an hour and day
 - * totalized mass flow for an hour and day
 - * totalized energy flow for an hour and day
 - * process data(instantaneous)
 - . pressure
 - . temperature
 - . corrected normal volume flow rate
 - . corrected mass flow rate
 - . energy flow rate
- Hourly report shall be printed out every hour automatically.
- Daily report showing following data of each meter and station total
 - * data described in the hourly report every hour
 - * maximum, minimum and total flowrate of the day with its time of occurrence
 - * totalized flow of a current day or a previous day
 - * weighted mean values(volume, energy, mass)
- Daily report shall be printed out at the end of the day automatically.
- Monthly report showing following data of each meter and station total
 - * totalized volume flow for a day and month
 - * totalized mass flow for a day and month
 - * totalized energy flow for a day and month
 - * maximum/minimum day flowrate and date of the month
 - * maximum/minimum hour flowrate and hour of the month
 - * flow weighted average calorific value
- Monthly report shall be printed out at the end of the month automatically.
- Alarm and event reports with its time of occurrence and recovery
 - * failure of sensors (FT, PT, TT)
 - * High and Low alarm over range limit of each sensor(FT, PT, TT)
 - * Output invalid: when the indicated flow rate at line conditions is Invalid
 - * trouble: when any of several monitored parameters fall outside of normal operation for a significant period of time
 - * partial failure: when one or more of the multiple ultrasonic path results is not usable
 - * High and Low alarm over range limit volume, mass, energy, density, flow rate per stream.
 - * event status (Open, close, fault, running, stop command, line switching

- stage, stream status, auto & manual mode) changes for MOVs.
 - * Alarm & status (failure, total reset, warm start, cold start, communication, duty and standby mode etc) internal defect of Flow computer
 - * FC communication error
 - * others
 - Metering parameter list
 - Historical report
 - Process report
 - The report of the specific hour or day selected by operator can be printed out.
 - Instant hardcopy of any screen on monitor
- b) Supervision computer(HMI) shall store the data of ongoing hourly, daily, and monthly totalized flow. The stored data shall be available for operator's review and print out for at least one month after they stored.
- c) The flow computer should be able to be connected directly to the Alarm & Event Printer.
- d) The attachment #9 shows minimum items to be printed out. The contractor shall make print format including all items of att. #9 and submit the format to the Purchaser for approval

8.7 Printers

Three(3) printers station shall be provided and roles of each printer are as follows:

- a) Report printer for display computer
 - Hourly report
 - Daily report
 - Monthly report
 - Historical report
 - Instant screen copy
 - Etc.
- b) Alarm & Event printer for display computer
 - Failure of sensors
 - Status changes of MOVs
 - Internal defect of computer
 - Communication error
 - Etc.
- c) Printer for gas chromatograph
 - heating value

- specific gravity
- each components Mole%
- Ref. density
- Etc.

9. QA/QC

The contractor shall use his QA/QC program for the design and manufacturing of the metering system. The contractor shall submit a quality assurance and quality control plan for the Purchaser's approval in accordance with the att. #4 "Submittal Documents"

At least the following procedures shall be submitted to Purchaser for approval.

- manufacturer's written material specifications for pressure-containing parts
- welding procedures
- NDT procedures
- final testing procedures
- painting procedures
- marking procedures
- shipping procedures

The Purchaser shall have a right to monitor the contractor's QA/QC activities.

9.1 Inspection and Test

9.1.1 Factory Test

All equipment shall pass the standards of tests and inspections specified in the applicable codes and standards.

The contractor shall submit the test reports when required

Among the FAT tests, 3rd party inspection parts should be performed by one of the authorized independent inspection agencies listed below and should submit proof of permanent full-time employment about 3rd party inspector.

- ABS, DNV, HSB, KR, LR, SGS, TUV SUD, TUV Rheinland

The cost for all tests as well as the third party inspection fee shall be included in the bid price.

However, Traveling expenses (including Round-air travel cost, Living allowance, sundry expenses and so on) for inspectors of purchaser shall be borne by the purchaser. Nevertheless, if the test is rejected by inspector, further test costs shall be borne by the Contractor and inspector's inspection costs (including Round-air fare, Living allowance) shall be deducted from the Contract price.

Contractor shall notify Purchaser before the beginning date of the factory acceptance test at least fourteen (14) days in advance.

The Purchaser shall have a right to witness all the tests to verify whether the test is performed properly or not.

All inspection documentation (3rd party inspection parts) shall be signed and certified by the contractor and the third party inspector. The certificate of inspection shall be issued by the third party inspection agency.

The certificate of inspection shall be sent to the purchaser by the 3rd party inspector directly. In case the schedule for the factory inspection is fixed, the certificate of 3rd party inspection shall be submitted at least 5 working days prior to starting date of the factory inspection.

Factory functional test under the witness of inspectors of purchaser shall be signed and certified by the contractor and inspectors of purchaser.

All certificates of inspection, test reports shall be submitted to the Purchaser at least 7 days prior to shipment for approval. The contractor shall not ship any goods unless the Purchaser approves the test reports.

The contractor shall submit the FAT procedure for approval to the purchaser 2 months prior to FAT.

After the test has been completed with satisfaction of purchaser, the contractor shall not change or modify any passed items without the written consent of the purchaser.

Scope of Test and Inspection is as follows

Table 2. Scope of Inspection

Test Item	Contractor	3rd party inspector	inspectors of purchaser	Remark
NDT	W	R	R	
Pressure & leakage test	W	W	R	
Dry calibration	W	—	W	Enforcement before calibration test under flowing condition
Calibration under flowing condition	W	R	R	Review of the certificate issued by an authorized agency
Type test	R	R	R	Review of the certificate issued by an authorized agency
Dimensional test	W	W	R	USM
	W	—	W	Flow computer panel
Path failure test	W	W	R	
Accuracy test of flow rate and Totalized flow quantity	W	—	R,W	R : Submittal of manufacturer's test report of 24hour integrated value W : Review 1 hour or more integrated value (1 lot/ 1 set)
Simulation test for meter run switching	W	—	W	
Electrical check & Loop test	W	—	W	
Gas Chromatograph performance test	W	W(—)	R(W)	
Test of monitor graphic Configuration and printer function	W	—	W	
Material test	R	R	R	
Certificates of Explosion proof	R	—	R	

Note)

- W : witness
- R : review(check by document)
- NDT shall be performed by a qualified person who has an appropriate license like ASNT level certificate.
- Test methods and test items specified by the purchaser(Refer to ATT#5.)
- Instantaneous totalized flow accuracy range of flow computer(When used the fixed value) : $\pm 0.02\%$
- W(-) : if the Test of the items(witness points) performed by Purchaser's inspector, the 3rd party inspectors don't perform the Test
- W(R) : if the shop test for the items(witness points) performed by 3rd party inspectors, Purchaser's inspectors only review the results

10. Supervision Service and Training

After shipment, the contractor shall submit the resume of his several supervisor to the Purchaser for approval and dispatch competent, experienced, English speaking supervisor who will perform duties as required to assure a proper installation and successful operation of the system. In case the Purchaser disapproval of the supervisor, the contractor shall submit the resume of other supervisors for re-approval. The Contractor shall dispatch his engineer to site on time when the Purchaser request. The Purchaser shall request the supervisor before 15 calendar days from start date of supervision service. The supervisor shall perform the start-up service which includes inspection of equipment delivered to job site, inspection of installation, calibration, placing into operation and training the Purchaser's personnel.

The supervisor shall prepare all tools, test equipments, spare parts and consumables necessary for the start-up of the systems.

The supervisor shall submit 1(one) copy of his daily work sheet(including time work sheet) which is signed by Purchaser's personnel at site to the Purchaser for approval of supervision service. Supervision services period shall be 8 days as actual working days(8 hours/day, 5 days/week). The period of supervision services may be adjusted within the days according to the Purchaser's circumstances.

The supervision shall perform the Field test, Site Acceptance Test, Training etc, as follows

10.1 Field Test

After installation at the project site, the system and all accessories furnished shall be thoroughly tested by the contractor to verify its proper performance under actual operating conditions.

In compliance with all requirements of this specification, the contractor's guarantee for all applicable standards will be appraised at this time.

A list of proposed tests including detailed description of system test procedure shall be submitted to purchaser for approval prior to tests.

The contractor shall perform a point-to-point checkout of all systems to verify input/output values and/or functions specified using actual inputs.

All equipment and system functions that fail to meet the requirements of this specification shall be promptly modified, repaired, or replaced at the contractor's own expense. Any system malfunctions or troubleshooting shall be noted on the contractor's daily work sheet. The format of the daily work sheet shall be approved by the Purchaser prior to the commencement of the testing period.

10.2 Site Acceptance Test

After all field tests for the site are completed, a site acceptance test shall be performed by the Purchaser and the Purchaser's customer, under witness of the contractor. This site acceptance test shall be completed to the satisfaction of the Purchaser.

Acceptance tests may include additional point-to-point checkout of all systems so that the installed systems perform all functions specified in this specification.

This acceptance test shall be performed within the period of supervision service.

10.3 Training

Training the Purchaser's personnel for the operation and maintenance of the metering system shall be included in the supervision service.

Service costs related to correcting design and manufacturing deficiencies of the equipment supplied shall not be chargeable to the Purchaser

11. TRAINING SERVICES

11.1 The contractor shall provide comprehensive formal training course and instruction program for the purchaser's site supervisor and design engineer as follows. The entire cost of the training program shall be borne by Contractor. Certificates shall be provided by manufacturer to the trainees on successful completion of the course

Training Course	Number of Persons	Training Period	Training Place
1. Installation & Test run Training for Metering System	3 Men	5 days	Training center of main contractor or original manufacture
2. Operation & Maintenance	5 Men	3 days	Site

11.2 The contractor shall be responsible for furnishing detailed course outline, manuals of training, equipment necessary to conduct the training exercises and to evaluate trainees' progress

1) Course contents

The outline of each course shall give the subject matter, a short resume of the pre-requisite subjects(if applicable), the position of the course in the training program, the aim and yardsticks for evaluation and other topics which will added the usefulness of the program.

The detailed training schedule and training course outline shall be submitted 2 months prior to the start of training for review. The training exercises shall be designed to be objective in nature and shall include trouble shooting exercises on similar equipment.

2) Training Manuals

All training manuals shall be prepared by the contractor and submitted for review 2 months prior to the commencement of the course. After completion of the course, these manuals shall be the property of the purchaser. Any changes in equipment, manuals and other material shall be informed to the purchaser during the guarantee period.

In addition to contractor documentation, the following minimum requirements shall be adhered to for the training manuals;

- Functional flow-charts, descriptive materials, program source listings applicable to all operating and application software and diagnostics programs.
- schematic drawings of each assembly of the hardware for the course on installation & test run.
- All manuals pertaining to procedures, specification and operation for each equipments.

Contractor shall be responsible for any other requirements necessary to train the engineers designated by purchaser within a time limit so that they can acquire the necessary expertise to install and test the programs and the supplied equipments.

11.3 For the purpose of efficient and appropriate training, experienced project engineers and/or managers who should have at least five years experience in related field and also who have participated in engineering, manufacturing of metering system in the same or similar project shall be assigned to the training program.

The contractor shall submit, for approval, the trainer's personal history record for acceptance at least 1 month prior to the start of the training

11.4 The contractor shall provide the trainees with the followings during the whole training period without additional costs.

- Reasonably required office space and related services including communication (local), stationaries, copy machines, word processor, papers and furniture required for the training (excluded in case of site training)
- Training aids, materials and instructions required for the training.
- Necessary approvals and permissions from third parties and transportation service to allow access of the trainees to selected other companies, plants and facilities required in connection with the training.
- Transportation service between lodging place and training site for the trainees (excluded in case of site training)
- The training languages shall be ENGLISH or KOREAN

12. Technical coordination meeting

After the Purchase order is awarded, the technical coordination meeting shall be held between the both parties to facilitate communication on technical matters and to check the manufacturing process at purchase's office. The meeting shall be held for Five(5) working days within 4 week after first vendor print submission at bidder's cost.

13. Document Submittal

All drawings shall be drawn up according to the Purchaser's Drawing Standard. After contract, the contractor shall request the Drawing Standard to Purchaser.

The contractor shall submit the Purchaser 4 copies of all manufacturing specification, installation drawings and wiring diagrams according to the att. #4 for approval.

The Purchaser will send the document and drawing to contractor either noticed with "Approved" or noticed with "Approved as Noted".

The Purchaser shall have the right to require the contractor to make any changes to the drawing which may necessary to make the equipment conformable to the intent of the specification.

Reviewing the contractor's drawings by the Purchaser shall not be held to relieve any part of the contractor's responsibilities for the correction of such drawings.

The Purchaser will not be liable for any material purchased or work done prior to the final approval of the document.

All drawings and documents should be submitted as CD-ROM type using AUTO-CAD(2002), MS-WORD program with replica and also all of original certificates and inspection records should be submitted as the CD-ROM type with PDF files with replica in addition to

printed material.

The original document shall be retained by the manufacturer for a minimum of ten years from the date of manufacture.

Each drawing shall carry a title block as shown as below.

TITLE BLOCK

REV.	DATE	DESCRIPTION	DGN	CHK	APP.	CL/APP.
 SK E&S						
공급배관(계량설비) 설계용역						
SCALE	DRAWING NO.					REV.

14. Consumables and spare parts

14.1 The contractor shall submit the list of miscellaneous consumables. (for 2 years operating)

14.2 When bidding, contractor shall submit spare parts list and unit cost. And have warranty period and responsibility such as main equipment about all spare parts except consumables.

14.3 The contractor shall possess consumables and spare parts to be cost for 10 years so that there is no problem to supply consumables and spare parts during 10 years.

15. Maintenance tools

The contractor shall provide with the following hardware and software tools for Maintenance

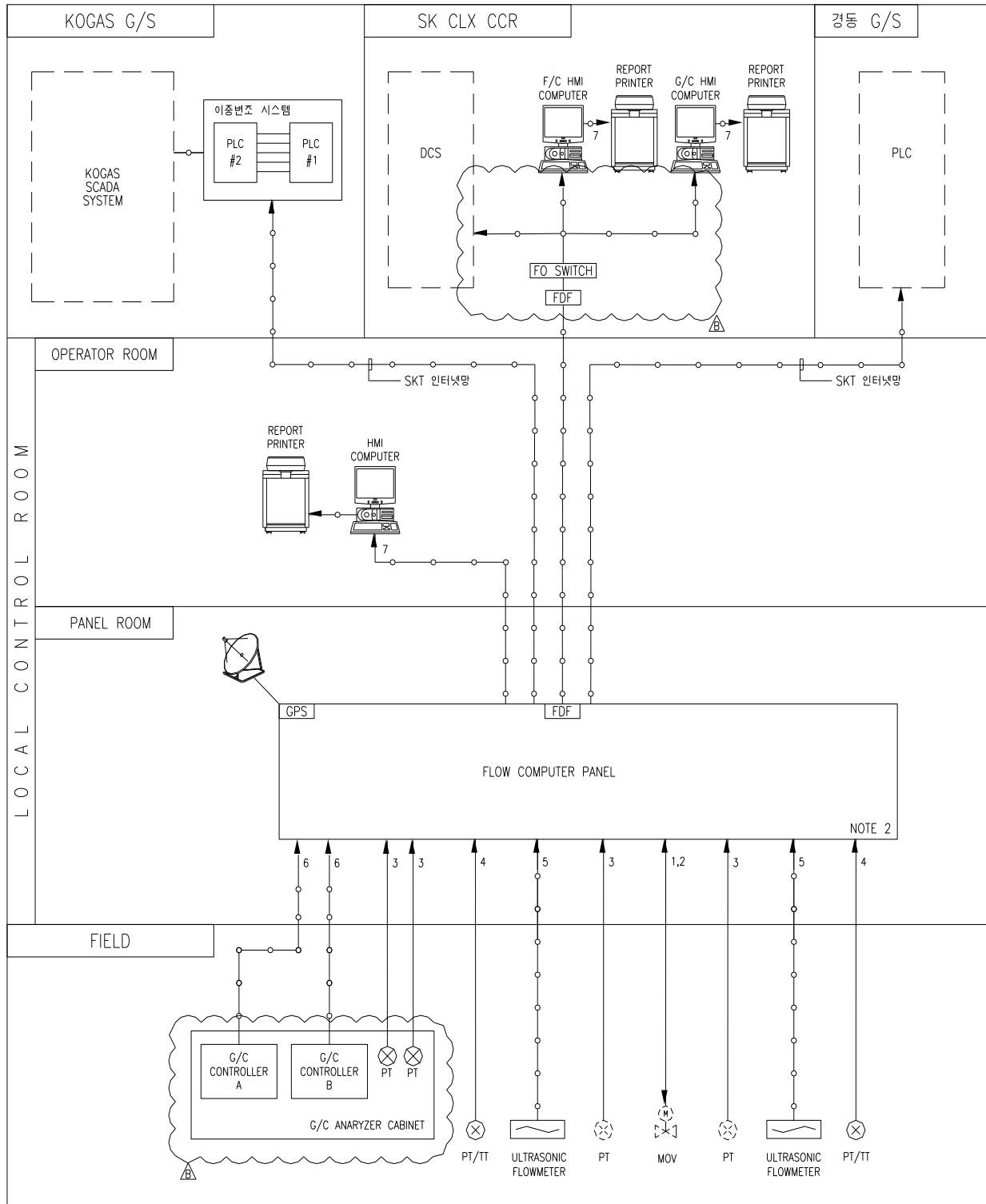
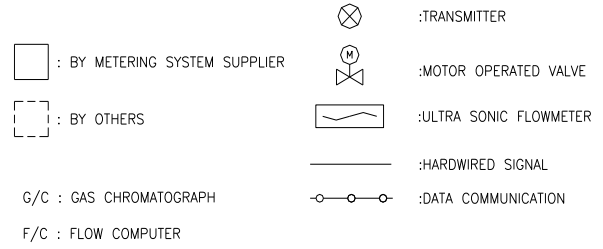
15.1 Software tools

15.2 Application program and configuration tools for HMI PC (including all software license)

15.3 Tools for replacement or removal of transducer

ATT. #1. SYSTEM BLOCK DIAGRAM (SK Ulsan Metering Station)

SYSTEM BLOCK DIAGRAM



NOTE

1. CABLES & CONNECTORS FOR COMMUNICATION (NO. 5, 6, 7) SHOULD BE SUPPLIED BY METERING SYSTEM SUPPLIER.
2. EACH LINE, EACH FLOW COMPUTER OR DUAL REDUNDANT TYPE FLOW COMPUTER SHALL BE PROVIDED IN ONE(1) F/C PANEL.

SIGNAL DESCRIPTION

NO.	FROM	TO	DESCRIPTION	SIGNAL SPEC.	REMARKS
1	FLOW COMPUTER PANEL	MOV	MOV OPEN/ CLOSE/ STOP COMMAND	MOMENTARY, VOLTAGE FREE, NORMALLY OPEN CONTACT -OPEN : 1P/MOV -CLOSE : 1P/MOV -STOP : 1P/MOV	
2	MOV	FLOW COMPUTER PANEL	MOV OPENED / CLOSED / FAULT / RUNNING STATUS	CONTINUOUS, VOLTAGE FREE, NORMALLY OPEN CONTACT - OPENED : 1P/MOV - CLOSED : 1P/MOV - FAULT : 1P/MOV - OPEN RUNNING : 1P/MOV - CLOSE RUNNING: 1P/MOV	
3	PT	FLOW COMPUTER PANEL	PRESSURE OF CARRIER GAS	ANALOG 4~20mA	
4	PT, TT	FLOW COMPUTER PANEL	PRESSURE TEMPERATURE	ANALOG 4~20mA	
5	ULTRASONIC METER	FLOW COMPUTER PANEL	FLOWRATE	DATA COMMUNICATION (RS-485/PULSE/4~20mA)	
6	GAS CHRO. ANALYZER	FLOW COMPUTER PANEL	MANUFACTURER STANDARD	DATA COMMUNICATION (RS-485/ETHERNET)	
7	FLOW COMPUTER PANEL	DISPLAY COMPUTER SYSTEM(G/C, F/C) PRINTER(ALARM, REPORT)	FLOWRATE	DATA COMMUNICATION (RS-232C/RS-485)	

ATT. #2. ITEMS TO BE SUPPLIED

Items to be Supplied

Item no.	Description	Quantity	Remarks
		SK ULSAN CLX METERING STATION	
1	Flow computer panel for 2 meter runs and G/C controller w/cables & connectors for G/C Controller	1 set	- Each line each flow computer or dual redundant type - PLC for Field Instrument & Valves
2	Three(3) Display computer system w/three(3) printers (Two display computers are for F/C and another Computer for GC)	1 set	
3	12" USM's meter w/meter tube[API 5L Gr .X65 (14.3mm)]	4 sets	#600
4	Transmitter sunshade w/ PT&TT, and Accessories (including tubing, instrument valves(1/2"), stanchion and so on)	4 sets	
5	Resistance temperature detector W/thermowell	4 sets	#600
6	Two (2) Gas chromatograph w/ two (2) sample probe in (1) cabinet including accessories (Pre-heated tube, Power kit, etc.)	1 sets	Sample probe shall be <u>IRA-4SS or Equiv.</u>
7	The Standard gas cylinder for Calibration. filled 29L (Pre charged Pressure : 10.7MpaG or above)	4 sets	
8	The carrier gas cylinder. filled 47L (Pre charged Pressure : 15MpaG or above)	4 sets	Purity : 99.999%
9	Transducers	1 set	- 12" : 2 Pair
10	Transducers Retraction Tool	1 set	MFR. SPECIFY
11	Double Modulation System Panel	1 set	
12	GPS System	1 set	

Remarks for the table

1. The minimum length of meter tubes shall be Min. 20D of upstream and Min. 5D of downstream of each ultrasonic meter. The meter tube shall be supplied with bolts, nuts, and gaskets for being assembled at site
2. Pressure transmitter and temperature transmitter shall be supplied explosion proof type with cable gland. Pressure and temperature transmitter shall be made by the same manufacturer so that the Purchaser may use the same calibration and supplied with a factory calibration report certified by the transmitter manufacturer.
3. Temperature element shall be of Pt-100 Ω at 0°C, 4-wire. Explosion proof head and thermowell with cable gland (explosion proof type) shall be included. A thermowell shall be installed at the downstream location of 2D~ 5D from the ultrasonic meter.
4. Transmitter sunshade shall be manufactured to contain a pressure transmitter and a temperature transmitter.
5. Data link cables and connectors to connect equipment(G/C controller \leftrightarrow G/C HMI PC, F/C \leftrightarrow HMI PC, HMI PC \leftrightarrow printers) shall be supplied by contractor.
6. Ultrasonic meters with Electronics(SPU) shall be linked to flow computer by RS-485/422 , ETHERNET or signal cable(manufacture standards). And the cables(SPU \leftrightarrow F/C) shall be supplied by contractor.
7. In order to communicate between G/C and F/C, G/C controller and PC for G/C, Communication cable such as RS-485/422, RS-232 etc. shall be supplied by contractor.
8. If there is any intrinsic safety type equipment in the flow meter, the contractor shall supply the barrier to be installed in flow computer panel and special cable which can be used for intrinsic safety equipment between the equipment and flow computer panel. The length will be about 200 meter, however it will be fixed by the Purchaser after contract.
9. Each transducer port on the meter body shall be uniquely marked for easy reference. Each ultrasonic transducer shall be marked with a unique serial number and with the minimum operating pressure.

10. To protect the ultrasonic meter against rolling, one of the body flanges shall be provided with two screwed supporting pins.
11. The ultrasonic meter shall be supplied with at least two thread hole to accommodate suitable eyebolts for lifting the meter.
12. The meter calibration data sheet should be plotted as a function of the actual flowrate, baseline flowrate or pipe Reynolds number.
13. The sample probe for gas chromatograph shall be sized for insertion near the center of a 16" nominal diameter pipe. The probe shall be constructed of 316SS and include a temperature compensated pressure regulator, integral relief valve and output pressure gauge.
14. Provided Transducer Retraction Tool shall be used to replace any sizes of transducers which is supplied by the contractor. If necessary, it shall be provided for each size transducers

ATT. #3. INSTRUMENT DATA SHEETS

ULTRASONIC FLOW METERS				DATA SHEET			
1	JOB NO.			ITEM NO.			
2	CLIENT	SK ENERGY		NO. REQ'D			
3	LOCATION	SK ULSAN CLX METERING STATION		REQ. NO.			
4	SERVICE			P.O. NO.			
GENERAL	1.	Tag Number	FT-21A		FT-21B		
	2.	Service	1'ST METER RUN		2'ST METER RUN		
	3.	Meter Location	HORIZONTAL		HORIZONTAL		
	4.	Line Size / Spec.(mm)	12" / API 5L Gr. X42 (14.3mm)		12" / API 5L Gr. X42 (14.3mm)		
METER	5.	End Connections (ANSI)	12", # 600 RF (Flange type : ANSI B16.5)		12", # 600 RF (Flange type : ANSI B16.5)		
	6.	Body Rating	# 600		# 600		
	7.	Nominal Flow Range (ton/h)	MFR. SPECIFY		MFR. SPECIFY		
	8.	Flow Calibrated Accuracy	(Note 1)		(Note 1)		
	9.	Rangeability	MFR. ST'D		MFR. ST'D		
	10.	Linearity	-		-		
	11.	Repeatability	(Note 3)		(Note 3)		
	12.	Materials : Body	ASTM A352 Gr LCC		ASTM A352 Gr LCC		
	13.	Materials : Flange	ASTM A352 Gr LCC		ASTM A352 Gr LCC		
	14.	Transducer holder Material	MFR. ST'D		MFR. ST'D		
	15.	Transducer Mount Material	MFR. ST'D		MFR. ST'D		
	16.	Transducer Cable Material	MFR. ST'D		MFR. ST'D		
	17.	Meter Body Paint Specification	MFR. ST'D		MFR. ST'D		
	18.	Transducer Paths	Greater than or equal to 4 Multi Path / 8 Transducers		Greater than or equal to 4 Multi Path / 8 Transducers		
	19.	Max. Speed (Note 5)	30 m/s		30 m/s		
	20.	Min. Output Voltage	MFR. ST'D		MFR. ST'D		
	21.	Enclosure Class	CLASS I, DIV 1. GR D., IP65		CLASS I, DIV 1. GR D., IP65		
FLUID DATA	22.	Fluid	NATURAL GAS		NATURAL GAS		
	23.	Flow Rate: Min. Max. (Nm ³ /h) (Note 4)	5,664	188,795	5,664	188,795	
	24.	Normal Flow (Nm ³ /h)	72,000		72,000		
	25.	Operating Pressure MPa(g)	3.53		3.53		
	26.	Operating Temp. (°C)	0		0		
	27.	Operating Specific Gravity	0.614		0.614		
	28.	Viscosity (cP)	0.01136		0.01136		
METER TUBE	29.	Percent Solids & Type	-		-		
	30.	Meter Tube(Upstream)	20D(#600 RTJ X #600 RF)		20D(#600 RTJ X #600 RF)		
	31.	Meter Tube(Downstream)	5D(#600 RF X #600 RTJ)		5D(#600 RF X #600 RTJ)		
	32.	Thermowell	Welled at downstream		Welled at downstream		
	33.	Pipe Material	API 5L Gr. X42		API 5L Gr. X42		
	34.	Pipe Schedule(Thickness)	14.3mm		14.3mm		
ULTRASONIC TRANSMITTER & CONTROLLER	35.	Secondary Instr. Tag No.	FQY-21A		FQY-21A		
	36.	Function	Transmitter and Flow Computer		Transmitter and Flow Computer		
	37.	Mounting	INTEGRAL		INTEGRAL		
	38.	Power Supply	MFR. ST'D		MFR. ST'D		
	39.	Output Signal – Pulses Output(frequency)	3 Points		3 Points		
		- Analog Output	1 Point		1 Point		
		- Digital Output	2 Points		2 Points		
		Serial & Ethernet Comm. Port (RS-485, TCP/IP)	3 Points (FC, Notebook)		3 Points (FC, Notebook)		
OPTIONS		Enclosure Class	CLASS I, DIV 1. GR D., IP65		CLASS I, DIV 1. GR D., IP65		
	40.	Archive Data	Audit/Alarm/History retrieval in Excel® or CSV files		Audit/Alarm/History retrieval in Excel® or CSV files		
	41.	Flow Compensation	-		-		
	42.	Display	-		-		
	43.	AGA 10 SOS Calculator	Yes		Yes		
	44.	Manufacturer					
	45.	Meter Model No.					

Notes : 1) Flow calibrated accuracy (qv,t at v=3.0m/s (qv, min. At v=0.6m/s))
 - prior to making any calibration-factor adjustment : $\pm 1.0\%$ for qv, t \leq qv \leq qv, max, $\pm 1.4\%$ for qv, min \leq qv \leq qv, t
 - after making calibration-factor adjustment : $\pm 0.5\%$ for qv, t \leq qv \leq qv, max, $\pm 0.7\%$ for qv, min \leq qv \leq qv, t
 2) Flow calibrated accuracy (qv,t at v=1.5m/s (qv, min. At v=0.6m/s))
 - prior to making any calibration-factor adjustment : $\pm 0.7\%$ for qv, t \leq qv \leq qv, max, $\pm 1.4\%$ for qv, min \leq qv \leq qv, t
 - after making calibration-factor adjustment : $\pm 0.35\%$ for qv, t \leq qv \leq qv, max, $\pm 0.7\%$ for qv, min \leq qv \leq qv, t
 3) Repeatability
 - prior to making any calibration-factor adjustment : $\pm 0.2\%$ for qv, t \leq qv \leq qv, max, $\pm 0.4\%$ for qv, min \leq qv \leq qv, t
 - after making calibration-factor adjustment : $\pm 0.1\%$ for qv, t \leq qv \leq qv, max, $\pm 0.2\%$ for qv, min \leq qv \leq qv, t
 4) Qmin. At v : 0.6m/s, Qmax. At v : 20m/s
 5) Max speed should be guaranteed by 30m/s because of a possibility of increased demand and calibration.

ULTRASONIC FLOW METERS				DATA SHEET			
1	JOB NO.			ITEM NO.			
2	CLIENT	SK ENERGY		NO. REQ'D			
3	LOCATION	SK ULSAN CLX METERING STATION		REQ. NO.			
4	SERVICE			P.O. NO.			
GENERAL	1.	Tag Number	FT-22A		FT-22B		
	2.	Service	1'ST METER RUN		2'ND METER RUN		
	3.	Meter Location	HORIZONTAL		HORIZONTAL		
	4.	Line Size / Spec.(mm)	12" / API 5L Gr. X42 (14.3mm)		12" / API 5L Gr. X42 (14.3mm)		
METER	5.	End Connections (ANSI)	12", # 600 RF (Flange type : ANSI B16.5)		12", # 600 RF (Flange type : ANSI B16.5)		
	6.	Body Rating	# 600		# 600		
	7.	Nominal Flow Range (ton/h)	MFR. SPECIFY		MFR. SPECIFY		
	8.	Flow Calibrated Accuracy	(Note 1)		(Note 1)		
	9.	Rangeability	MFR. ST'D		MFR. ST'D		
	10.	Linearity	-		-		
	11.	Repeatability	(Note 3)		(Note 3)		
	12.	Materials : Body	ASTM A352 Gr LCC		ASTM A352 Gr LCC		
	13.	Materials : Flange	ASTM A352 Gr LCC		ASTM A352 Gr LCC		
	14.	Transducer holder Material	MFR. ST'D		MFR. ST'D		
	15.	Transducer Mount Material	MFR. ST'D		MFR. ST'D		
	16.	Transducer Cable Material	MFR. ST'D		MFR. ST'D		
	17.	Meter Body Paint Specification	MFR. ST'D		MFR. ST'D		
	18.	Transducer Paths	Greater than or equal to 4 Multi Path / 8 Transducers		Greater than or equal to 4 Multi Path / 8 Transducers		
19.	Max. Speed (Note 5)	30 m/s		30 m/s			
20.	Min. Output Voltage	MFR. ST'D		MFR. ST'D			
21.	Enclosure Class	CLASS I, DIV 1. GR D., IP65		CLASS I, DIV 1. GR D., IP65			
FLUID DATA	22.	Fluid	NATURAL GAS		NATURAL GAS		
	23.	Flow Rate: Min. Max. (Nm ³ /h) (Note 4)	5,664	188,795	5,664	188,795	
	24.	Normal Flow (ton/h)	72,000		72,000		
	25.	Operating Pressure (MPa(g)) ,(kg/cm ² g)	3.53		3.53		
	26.	Operating Temp. (°C)	0		0		
	27.	Operating Specific Gravity	0.614		0.614		
	28.	Viscosity (cP)	0.01136		0.01136		
29.	Percent Solids & Type	-		-			
METER TUBE	30.	Meter Tube(Upstream)	20D(#600 RTJ X #600 RF)		20D(#600 RTJ X #600 RF)		
	31.	Meter Tube(Downstream)	5D(#600 RF X #600 RTJ)		5D(#600 RF X #600 RTJ)		
	32.	Thermowell	Welled at downstream		Welled at downstream		
	33.	Pipe Material	API 5L Gr. X42		API 5L Gr. X42		
	34.	Pipe Schedule(Thickness)	14.3mm		14.3mm		
ULTRASONIC TRANSMITTER & CONTROLLER	35.	Secondary Instr. Tag No.	FQY-22A		FQY-22A		
	36.	Function	Transmitter and Flow Computer		Transmitter and Flow Computer		
	37.	Mounting	INTEGRAL		INTEGRAL		
	38.	Power Supply	MFR. ST'D		MFR. ST'D		
	39.	Output Signal – Pulses Output(frequency)	3 Points		3 Points		
		- Analog Output	1 Point		1 Point		
		- Digital Output	2 Points		2 Points		
		Serial & Ethernet Comm. Port (RS-485, TCP/IP)	3 Points (FC, Notebook)		3 Points (FC, Notebook)		
OPTIONS		Enclosure Class	CLASS I, DIV 1. GR D., IP65		CLASS I, DIV 1. GR D., IP65		
	40.	Archive Data	Audit/Alarm/History retrieval in Excel® or CSV files		Audit/Alarm/History retrieval in Excel® or CSV files		
	41.	Flow Compensation	-		-		
	42.	Display	-		-		
	43.	AGA 10 SOS Calculator	Yes		Yes		
	44.	Manufacturer					
	45.	Meter Model No.					

Notes : 1) Flow calibrated accuracy (qv,t at v=3.0m/s (qv, min. At v=0.6m/s))
 - prior to making any calibration-factor adjustment : $\pm 1.0\%$ for qv, t \leq qv \leq qv, max, $\pm 1.4\%$ for qv, min \leq qv \leq qv, t
 - after making calibration-factor adjustment : $\pm 0.5\%$ for qv, t \leq qv \leq qv, max, $\pm 0.7\%$ for qv, min \leq qv \leq qv, t
 2) Flow calibrated accuracy (qv,t at v=1.5m/s (qv, min. At v=0.6m/s))
 - prior to making any calibration-factor adjustment : $\pm 0.7\%$ for qv, t \leq qv \leq qv, max, $\pm 1.4\%$ for qv, min \leq qv \leq qv, t
 - after making calibration-factor adjustment : $\pm 0.35\%$ for qv, t \leq qv \leq qv, max, $\pm 0.7\%$ for qv, min \leq qv \leq qv, t
 3) Repeatability
 - prior to making any calibration-factor adjustment : $\pm 0.2\%$ for qv, t \leq qv \leq qv, max, $\pm 0.4\%$ for qv, min \leq qv \leq qv, t
 - after making calibration-factor adjustment : $\pm 0.1\%$ for qv, t \leq qv \leq qv, max, $\pm 0.2\%$ for qv, min \leq qv \leq qv, t
 4) Qmin. At v : 0.6m/s, Qmax. At v : 20m/s
 5) Max speed should be guaranteed by 30m/s because of a possibility of increased demand and calibration.

PRESSURE TRANSMITTERS			DATA SHEET
1	JOB NO.	ITEM NO.	
2	CLIENT SK ENERGY	NO. REQ'D	
3	LOCATION SK ULSAN CLX METERING STATION	REQ. NO.	
4	SERVICE	P.O. NO.	
GENERAL	1.	Tag No. SEE NEXT SHEET Service SEE NEXT SHEET	
	2.	Function	Record <input type="checkbox"/> Indicate <input checked="" type="checkbox"/> Control <input type="checkbox"/> Blind <input type="checkbox"/> Trans <input checked="" type="checkbox"/> Other _____
	3.	Case	MFR STD <input checked="" type="checkbox"/> Nom Size _____ Color : MFR STD <input checked="" type="checkbox"/> Other _____
	4.	Mounting	Flush <input type="checkbox"/> Surface <input type="checkbox"/> Yoke <input checked="" type="checkbox"/> 2" Pipe Stanchion Type with U-Bolt & Nuts
	5.	Enclosure Class	General Purpose <input type="checkbox"/> Weather proof <input checked="" type="checkbox"/> Explosion proof <input checked="" type="checkbox"/> CLASS I, DIV 1, GR.D, IP65
	6.	Power Supply	For Use In Intrin. Safe System <input type="checkbox"/> Other _____
	7.	Chart	117V 60Hz <input type="checkbox"/> Other ac _____ dc 24 Volts
	8.	Chart Drive	Strip <input type="checkbox"/> Roll <input type="checkbox"/> Fold <input type="checkbox"/> Circular _____ Time Marks _____
	9.	Scales	Range _____ Number _____ Speed _____ Power _____ Type _____ Range 1 _____ 2 _____ 3 _____ 4 _____
XMTR	10.	Transmitter Output (Note 4)	4-20 mA <input checked="" type="checkbox"/> 10-50 Ma <input type="checkbox"/> 21-103 kPa (3-15 psig) <input type="checkbox"/> Other _____ For Receiver See Spec. Sheet _____
CONTROLLER	11.	Control Modes	 P = Prop (Gain) I = Integral (Auto-Reset) D = Derivative (Rate) Sub : s=Slow I=Fast P <input type="checkbox"/> PI <input type="checkbox"/> PD <input type="checkbox"/> PID <input type="checkbox"/> If <input type="checkbox"/> Df <input type="checkbox"/> Is <input type="checkbox"/> Ds <input type="checkbox"/> Other _____ On Meas. Increase Output : Increases <input type="checkbox"/> Decreases <input type="checkbox"/> None <input type="checkbox"/> MFR STD <input type="checkbox"/> Other _____ Manual <input type="checkbox"/> External <input type="checkbox"/> Remote <input type="checkbox"/> Other _____ None <input type="checkbox"/> MFR STD <input type="checkbox"/> Other _____ 4-20 mA <input type="checkbox"/> 10-50 mA <input type="checkbox"/> 21-103 kPa (3-15 psig) <input type="checkbox"/> Other _____
	12.	Action	
	13.	Auto-Man Switch	
	14.	Set Point Adj.	
	15.	Manual Reg.	
	16.	Output	
ELEMENT	17.	Service	Gage Press <input type="checkbox"/> Vacuum <input type="checkbox"/> Absolute <input checked="" type="checkbox"/> Compound <input type="checkbox"/>
	18.	Element Type	Diaphragm <input checked="" type="checkbox"/> Helix <input type="checkbox"/> Bourdon <input type="checkbox"/> Bellows <input type="checkbox"/> Other _____
	19.	Material	316 SS <input checked="" type="checkbox"/> Ber. Copper <input type="checkbox"/> Other _____
	20.	Range	Fixed <input type="checkbox"/> Adj. Range MFR STD Set at 0-10 MPa(a) Overrange Protection to 200% F.S.
	21.	Process Data	Press : Normal 3.63 MPa(a) Max 7.95 MPa(a) Element Range _____
	22.	Process Conn.	¼ in. NPT <input type="checkbox"/> ½ in. NPT <input checked="" type="checkbox"/> Other _____ Location : Bottom <input checked="" type="checkbox"/> Back <input type="checkbox"/> Other _____
ALARM	23.	Alarm Switches	Quantity _____ Form _____ Rating _____
	24.	Function	Press <input type="checkbox"/> Deviation <input type="checkbox"/> Contracts To _____ on Inc. Press
OPTIONS	25.	Options	Filt-Reg. <input type="checkbox"/> Sup. Gage <input type="checkbox"/> Output Gage <input checked="" type="checkbox"/> LCD DISPLAY W/ENG'G UNIT _____ Charts Diaph Seal <input type="checkbox"/> Type _____ Diaph _____ Bot Bowl _____ Conn _____ Capillary : Length _____ Mat'l _____ Other PACKING TYPE CABLE GLAND (EXPLOSION PROOF) : 1/2" NPT
	26.	MFR & Model No.	ROSEMOUNT 3051 CA OR EQUIVALENT
Notes : 1. ACCURACY : ±0.1% OF SPAN OR BETTER 2. SUPPLIER SHALL PROVIDE PERMANENT S.S TAG PLATE WITH STAMPED TAG NO. 3. CONVENTIONAL ZERO & SPAN ADJUSTMENT SHALL BE INCLUDED 4. SMART TYPE TRANSMITTER (HART PROTOCOL)			

[illegible]

PRESSURE TRANSMITTERS		DATA SHEET
1	JOB NO.	ITEM NO.
2	CLIENT SK ENERGY	NO. REQ'D
3	LOCATION SK ULSAN CLX METERING STATION	REQ. NO.
4	SERVICE	P.O. NO.
GENERAL	1. Tag No. SEE NEXT SHEET Service SEE NEXT SHEET	
	2. Function	Record <input type="checkbox"/> Indicate <input checked="" type="checkbox"/> Control <input type="checkbox"/> Blind <input type="checkbox"/> Trans <input checked="" type="checkbox"/> Other _____
	3. Case	MFR STD <input checked="" type="checkbox"/> Nom Size _____ Color : MFR STD <input checked="" type="checkbox"/> Other _____
	4. Mounting	Flush <input type="checkbox"/> Surface <input type="checkbox"/> Yoke <input checked="" type="checkbox"/> Other _____
	5. Enclosure Class	General Purpose <input type="checkbox"/> Weather proof <input checked="" type="checkbox"/> Explosion proof <input checked="" type="checkbox"/> CLASS I, DIV 1, GR.D, IP65
	6. Power Supply	For Use In Intrin. Safe System <input type="checkbox"/> Other _____
	7. Chart	117V 60Hz <input type="checkbox"/> Other ac _____ dc 24 Volts Strip <input type="checkbox"/> Roll <input type="checkbox"/> Fold <input type="checkbox"/> Circular _____ Time Marks _____
	8. Chart Drive	Range _____ Number _____
	9. Scales	Speed _____ Power _____ Type _____ Range 1 _____ 2 _____ 3 _____ 4 _____
XMTR	10. Transmitter Output	4-20 mA <input checked="" type="checkbox"/> 10-50 Ma <input type="checkbox"/> 21-103 kPa (3-15 psig) <input type="checkbox"/> Other _____ For Receiver See Spec. Sheet _____
CONTROLLER	11. Control Modes	 P = Prop (Gain) I = Integral (Auto-Reset) D = Derivative (Rate) Sub : s=Slow f=Fast P <input type="checkbox"/> PI <input type="checkbox"/> PD <input type="checkbox"/> PID <input type="checkbox"/> If <input type="checkbox"/> Df <input type="checkbox"/> Is <input type="checkbox"/> Ds <input type="checkbox"/> Other _____ On Meas. Increase Output : Increases <input type="checkbox"/> Decreases <input type="checkbox"/> None <input type="checkbox"/> MFR STD <input type="checkbox"/> Other _____ Manual <input type="checkbox"/> External <input type="checkbox"/> Remote <input type="checkbox"/> Other _____ None <input type="checkbox"/> MFR STD <input type="checkbox"/> Other _____ 4-20 mA <input type="checkbox"/> 10-50 mA <input type="checkbox"/> 21-103 kPa (3-15 psig) <input type="checkbox"/> Other _____
	12. Action	
	13. Auto-Man Switch	
	14. Set Point Adj.	
	15. Manual Reg. Output	
	16. Output	
ELEMENT	17. Service	Gage Press <input checked="" type="checkbox"/> Vacuum <input type="checkbox"/> Absolute <input type="checkbox"/> Compound <input type="checkbox"/>
	18. Element Type	Diaphragm <input checked="" type="checkbox"/> Helix <input type="checkbox"/> Bourdon <input type="checkbox"/> Bellows <input type="checkbox"/> Other _____
	19. Material	316 SS <input checked="" type="checkbox"/> Ber. Copper <input type="checkbox"/> Other _____
	20. Range	Fixed <input type="checkbox"/> Adj. Range <u>MFR STD</u> Set at <u>0-15Mpa</u> Overrange Protection to <u>200% F.S</u>
	21. Process Data	Press : Normal <u>12 MPa(g)</u> Max <u>KPa(G)</u> Element Range _____
22. Process Conn.	<u>1/4</u> in. NPT <input type="checkbox"/> <u>1/2</u> in. NPT <input checked="" type="checkbox"/> Other _____ Location : Bottom <input checked="" type="checkbox"/> Back <input type="checkbox"/> Other _____	
ALARM	23. Alarm Switches	 Quantity _____ Form _____ Rating _____ Press <input type="checkbox"/> Deviation <input type="checkbox"/> Contracts To _____ on Inc. Press
	24. Function	
OPTIONS	25. Options	Filt-Reg. <input type="checkbox"/> Sup. Gage <input type="checkbox"/> Output Gage <input checked="" type="checkbox"/> LCD DISPLAY W/ENG'G UNIT Charts Diaph Seal <input type="checkbox"/> Type _____ Diaph _____ Bot Bowl _____ Conn _____ Capillary : Length _____ Mat'l _____ Other <u>PACKING TYPE CABLE GLAND (EXPLOSION PROOF) : 1/2" NPT</u>
	26. MFR & Model No.	<u>ROSEMOUNT 3051 CG OR EQUIVALENT</u>
Notes : 1. ACCURACY : $\pm 0.1\%$ OF SPAN OR BETTER 2. SUPPLIER SHALL PROVIDE PERMANENT S.S TAG PLATE WITH STAMPED TAG NO. 3. CONVENTIONAL ZERO & SPAN ADJUSTMENT SHALL BE INCLUDED 4. SMART TYPE TRANSMITTER (HART PROTOCOL)		

[illegible]

RESISTANCE TEMPERATURE SENSORS

DATA SHEET

1	JOB NO.	ITEM NO.
2	CLIENT SK ENERGY	NO. REQ'D
3	LOCATION SK ULSAN CLX METERING STATION	REQ. NO.
4	SERVICE	P.O. NO.

1. Complete Assembly ☒ Other

HEAD

2. Screwed Cover ☒ Other3. Explosion Proof ☒ Class I, Div 1 Gr D, IP65

4. Material AL DIECAST Cond. Conn. 1/2" NPT(F)

5. Nipple Size 1/2" NPT Dim. "N" 200mm Union ☒

ELEMENT

6. Platinum ☒ Nickel ☐ Other7. Ice Point Resistance 100 Ω , 0°C $\pm 0.15\Omega$

8. Temperature Range -30°C ~ +70 °C

9. Leads : STD ☒ Potted ☐ Harm. Sealed ☐10. Sheath Material 316 SS O.D. 6.4 Φ

11. Mounting Thread 1/2" NPT

12. Connection : 2-Wire ☐ 3-Wire ☐ 4-Wire ☒Lead Wires ☐ Receptacle ☐ Bayonet Lock ☐

Other

WELL OR TUBE

13. Material 304SS

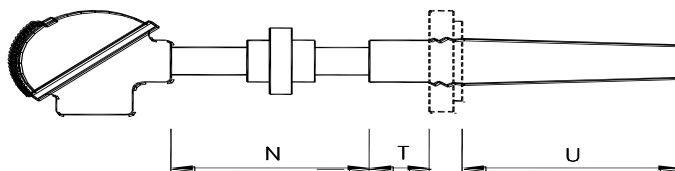
14. Construction : Tapered ☒ Straight ☐Drilled ☒ Built - Up ☐ Closed - End ☐

Tube

15. Dim. : MFR STD ☐ O.D. I.D.

16. Internal Thread 1/2" NPT

17. Process Connection 1-1/2" ANSI 600 # RTJ



Rev.	Tag No.	Process Conn. (ANSI)	Well Dim.		Element Length (mm)	Single or Dual	Service	Oper. Temp. (°C)	Notes
			" U " (mm)	" T " (mm)					
B	TE-21A	1-1/2" 600#RTJ	350 (Note 6)	MFR. STD	MFR. STD	SINGLE	FT-21A LINE TEMP.	0	
B	TE-21B	1-1/2" 600#RTJ	350 (Note 6)	MFR. STD	MFR. STD	SINGLE	FT-21B LINE TEMP.	0	
B	TE-22A	1-1/2" 600#RTJ	350 (Note 6)	MFR. STD	MFR. STD	SINGLE	FT-22A LINE TEMP.	0	
B	TE-22B	1-1/2" 600#RTJ	350 (Note 6)	MFR. STD	MFR. STD	SINGLE	FT-22A LINE TEMP.	0	

Notes :

1. ACCURACY : $\pm 0.15^{\circ}\text{C}$ AT 0°C OR BETTER
2. SUPPLIER SHALL PROVIDE PERMANENT S.S TAG PLATE WITH STAMPED TAG NO.
3. PACKING TYPE CABLE GLAND FOR CONDUIT CONNECTION SHALL BE SUPPLIED
4. MFR. AND MODEL NO. : ROSEMOUNT 0078 OR EQUIVALENT
5. VENDOR TO CLCULATE THE SAFE THERMOWELL LENGTHS IN ACCORDANCE WITH ASME VOLUME 81(PTC 19.3)
6. U-LENGTH IS CONSIDERED ONLY WHEN LENGTH BETWEEN FLANGE AND PIPE IS 200mm. THE INSERTION LENGTH SHALL BE BETWEEN D/2 AND D/3 OF PIPE.

TEMPERATURE TRANSMITTERS			DATA SHEET
1	JOB NO.	ITEM NO.	
2	CLIENT SK ENERGY	NO. REQ'D	
3	LOCATION SK ULSAN CLX METERING STATION	REQ. NO.	
4	SERVICE	P.O. NO.	
GENERAL	1.	Tag No. SEE NEXT SHEET Service SEE NEXT SHEET	
	2.	Function	Record <input type="checkbox"/> Indicate <input checked="" type="checkbox"/> Control <input type="checkbox"/> Blind <input type="checkbox"/> Trans <input checked="" type="checkbox"/> Other _____
	3.	Case	MFR STD <input checked="" type="checkbox"/> Nom Size _____ Color : MFR STD <input checked="" type="checkbox"/> Other _____
	4.	Mounting	Flush <input type="checkbox"/> Surface <input type="checkbox"/> Yoke <input checked="" type="checkbox"/> <u>2" Pipe Stanchion Type with U-Bult & Nuts</u>
	5.	Enclosure Class	General Purpose <input type="checkbox"/> Weather proof <input checked="" type="checkbox"/> Explosion proof <input checked="" type="checkbox"/> <u>CLASS I, DIV 1, GR.D, IP65</u>
	6.	Power Supply	For Use In Intrin. Safe System <input type="checkbox"/> Other _____
	7.	Chart	117V 60Hz <input type="checkbox"/> Other ac _____ dc <u>24</u> Volts _____ Strip <input type="checkbox"/> _____ Roll <input type="checkbox"/> _____ Fold <input type="checkbox"/> Circular _____ Time Marks _____
	8.	Chart Drive	Range _____ Number _____
	9.	Scales	Speed _____ Power _____ Type _____ Range 1 _____ 2 _____ 3 _____ 4 _____
XMTR	10.	Transmitter Output (Note 4)	4-20 mA <input checked="" type="checkbox"/> 10-50 mA <input type="checkbox"/> 21-103 kPa (3-15 psig) <input type="checkbox"/> Other _____ For Receiver See Spec. Sheet _____
CONTROLLER	11.	Control Modes	P = Prop (Gain) I = Integral (Auto-Reset) D = Derivative (Rate) Sub : s=Slow f=Fast P <input type="checkbox"/> PI <input type="checkbox"/> PD <input type="checkbox"/> PID <input type="checkbox"/> If <input type="checkbox"/> Df <input type="checkbox"/> Is <input type="checkbox"/> Ds <input type="checkbox"/> Other _____ On Meas. Increase Output : Increases <input type="checkbox"/> Decreases <input type="checkbox"/> None <input type="checkbox"/> MFR STD <input type="checkbox"/> Other _____ Manual <input type="checkbox"/> External <input type="checkbox"/> Remote <input type="checkbox"/> Other _____ None <input type="checkbox"/> MFR STD <input type="checkbox"/> Other _____ 4-20 mA <input type="checkbox"/> 10-50 mA <input type="checkbox"/> 21-103 kPa (3-15 psig) <input type="checkbox"/> Other _____
	12.	Action	
	13.	Auto-Man Switch	
	14.	Set Point Adj.	
	15.	Manual Reg.	
	16.	Output	
ELEMENT	17.	Service	Gage Press <input type="checkbox"/> Vacuum <input type="checkbox"/> Absolute <input type="checkbox"/> Compound <input type="checkbox"/> Temperature <input checked="" type="checkbox"/>
	18.	Element Type	Diaphragm <input type="checkbox"/> Helix <input type="checkbox"/> Bourdon <input type="checkbox"/> Bellows <input type="checkbox"/> Other <u>RTD (SEE SHEET. NO.7)</u>
	19.	Material	316 SS <input type="checkbox"/> Ber. Copper <input type="checkbox"/> Other _____
	20.	Range	Fixed <input type="checkbox"/> Adj. Range _____ Set at _____
	21.	Process Data	Overrange Protection to _____ Press : Normal _____ Max _____ Element Range _____
	22.	Process Conn.	$\frac{1}{4}$ in. NPT <input type="checkbox"/> $\frac{1}{2}$ in. NPT <input type="checkbox"/> Other _____ Location : Bottom <input type="checkbox"/> Back <input type="checkbox"/> Other _____
ALARM	23.	Alarm Switches	Quantity _____ Form _____ Rating _____ Press <input type="checkbox"/> Deviation <input type="checkbox"/> Contracts To _____ on Inc. Press
	24.	Function	
OPTIONS	25.	Options	Filt-Reg. <input type="checkbox"/> Sup. Gage <input type="checkbox"/> Output Gage <input checked="" type="checkbox"/> <u>LCD DISPLAY W/ENG'G UNIT</u> Charts Diaph Seal <input type="checkbox"/> Type _____ Diaph _____ Bot Bowl _____ Conn _____ Capillary : Length _____ Mat'l _____ Other <u>PACKING TYPE CABLE GLAND (EXPLOSION PROOF) : 1/2" NPT x 2 EA</u>
	26.	MFR & Model No.	<u>ROSEMOUNT 3144 D OR EQUIVALENT</u>
Notes : 1. ACCURACY : $\pm 0.12^{\circ}\text{C}$ OR BETTER AT BETWEEN -20°C AND 40°C (AMBIENT TEMP.) 2. TEMPERATURE TRANSMITTER SHALL BE CONNECTED TO RESISTANCE TEMPERATURE DETECTOR (4-WIRE) 3. CONVENTIONAL ZERO & SPAN ADJUSTMENT SHALL BE INCLUDED 4. SMART TYPE TRANSMITTER (HART PROTOCOL)			

[illegible]

ATT. #4. DOCUMENT SUBMITTALS

DOCUMENT	Q'TY	FOR BIDDING	FOR APPROVAL		FOR FINAL	
			Q'TY	DUE DATE	Q'TY	DUE DATE
1. MAJOR ITEMS OF TECHNICAL BID EVALUATION		2 C	-	-	-	-
2. BILL OF MATERIAL FOR ALL EQUIPMENT		2 C	4 C	WITHIN ONE MONTH AFTER CONTRACT	10 C	WITHIN ONE MONTH AFTER APPROVAL
3. MANUFACTURING SPECIFICATION FOR ALL EQUIPMENT		2 C	4 C	"	10 C	"
3.1 DOCUMENT OF IMPROVING NOISE IMMUNITY OF USMs		2 C	4 C	"	10 C	"
3.2 PERTURBATION TESTs CERTIFICATE		2 C	4 C	"	10 C	"
4. FLOW COMPUTER PANEL ARRANGEMENT DRAWING		-	4 C	"	10 C	"
5. LOG FORMAT AND CRT DISPLAY FORMAT		-	4 C	"	10 C	"
6. ULTRASONIC FLOW METER DATASHEET		2 C	4 C	"	10 C	"
7. METER RUN		-	4 C	"	10 C	"
8. SOFTWARE DESCRIPTION		-	4 C	"	10 C	"
9. FLOWRATE CALCULATION SHEET		2 C	4 C	"	10 C	"
10. UNCERTAINTY EVALUATION REPORT		-	4 C	"	10 C	"
11. INTERFACE SPECIFICATION WITH OTHER EQUIPMENT		-	4 C	"	10 C	"
12. HOOK-UP DRAWING OF TRANSMITTER CABINETS		-	4 C	"	10 C	"
13. WIRING DIAGRAM		-	4 C	"	10 C	"
14. INSTRUMENT DATA SHEET & SPECIFICATION		2 C	4 C	"	10 C	"
15. SYSTEM BLOCK DIAGRAM		-	4 C	"	10 C	"
16. FLOWRATE CALCULATION PROCEDURE		-	4 C	"	10 C	"

Q'TY DOCUMENT	FOR BIDDING	FOR APPROVAL		FOR FINAL	
		Q'TY	DUE DATE	Q'TY	DUE DATE
17. DETAIL DESCRIPTION OF OPERATION PRINCIPLE FOR ALL SYSTEMS	-	4 C	WITHIN ONE MONTH AFTER CONTRACT	10 C	WITHIN ONE MONTH AFTER APPROVAL
18. QUALITY ASSURANCE AND QUALITY CONTROL PROGRAM	2 C	4 C	"	10 C	"
19. FACTORY TEST AND INSPECTION PROCEDURE	-	4 C	"	4 C	TWO MONTH PRIOR TO FAT
20. FACTORY TEST REPORT	-	-	-	4 C	PRIOR TO SHIPMENT
21. TEST CERTIFICATE CONTAINING - ULTRASONIC METER (CALIBRATION REPORT) - METER TUBE (DIMENSION TEST) - CRT, PRINTER, VIDEO BOARD (EMI TEST) - TRANSMITTER (CALIBRATION)	-	-	-	10 C	WITHIN ONE MONTH AFTER APPROVAL
22. OPERATION AND MAINTENANCE MANUALS	-	-	-	10 C	WITHIN ONE MONTH AFTER GOODS DELIVERED
23. SPARE PARTS LIST FOR 2 YEAR'S OPERATION	2 C	-	-	10 C	-
24. CATALOG AND OTHER RELATIVE MATERIAL	2 C	4 C	-	10 C	-
25. EXPLOSION PROOF CERTIFICATE	2 C	4 C	-	10 C	-

GENERAL NOTES

- Document "For Final" shall be submitted with 2CD
- Document shall be submitted per station.
- The Purchaser will send the document and drawing to contractor either noticed with "Approved" or noticed with "Approved as Noted".
- The Purchaser shall have the right to require the contractor to make any changes to the drawing which may necessary to make the equipment conformable to the intent of the specification.
- Manufacturer should submit the type approval certificates of USM(without flow Conditioner) under same conditions with ISO-17089-1 6.4.4, OIML R137, AGA 9 to verify minimum required upstream pipe lengths(within 20D).The certificate shall be issued by the Authorized agency.

ATT. #5. INSPECTION & TEST

1) NDT

- All part around the welded edge of the pressure wet equipment shall be examined by ultrasonic test or magnetic particle test to confirm that they have no lamination.
- Radiographic test shall be carried out around the welded edge of fittings and flanges to confirm they have no defects such as shrinkage crack, porosity and others.
- Acceptance criteria : ASME Sec. VIII

2) Pressure test

- Any pressure test point or tapping connection on the ultrasonic meter shall be provided with a suitable means of closure, e.g. a plug, and shall be capable of being sealing against unauthorized interference.
- Ultrasonic meter shall not be painted or otherwise coated with materials capable of sealing against leakage before leakage tests are completed. Chemical corrosion protection treatments and internal linings are permitted.

2-1) Hydrostatic pressure test

- Hydrostatic pressure test for the USM & Meter run pipes shall be performed at 1.5 times the maximum allowable operating pressure at 20°C(nominal) with water or kerosene.
- The test duration shall be 30 minutes with pressure and temperature Charts supplied upon the conclusion of each test.
- The test shall be performed by applying pressure inside all the pressure retaining walls of the assembled meter with the connection closed.

2-2) Leakage test

- Every USM, complete with transducers and transducer isolation valves(if used), shall be leak-tested by the manufacturer after final assembly and prior to flow-calibration. The test medium should be an inert gas, such as nitrogen. The leak test pressure shall be a minimum of 1.1 times of maximum operating pressure, maintained for a minimum of 15 minutes, with no leaks detectable with a non-corrosive liquid solution or an ultrasonic leak detector.

3) Dry calibration

Dry calibration comprises the measurement of the meter body dimensions and of time delays of electronics as well as a zero flow verification test

a) Geometrical parameters

The manufacturer shall document:

- the average internal diameter of the meter
- the cross-sectional area of the meter
- the length of each acoustic path between transducer faces
- the inclination angle of each acoustic path or the axial(meter body axis) distance between transducer pairs
- the uncertainty of these measurements shall be specified
- the meter body material
- the meter body pressure and temperature expansion coefficients
- the wall thickness
- the wall roughness
 - The meter body temperature shall be measured at the time these measurements are made.
 - All instruments used to perform these measurements shall have validcalibrations traceable to internationally recognized standards.

b) Timing and time delays

The manufacturer shall measure and document the time delay(s) of electronics and transducers. All calibration instruments used to perform these measurements shall have calibration certificates traceable to internally recognized standards.

c) Zero Flow Verification Test

Test procedure shall include the following elements

- after blind flanges are attached to the ends of the meter body, the meter shall be purged of all air and pressurized with a pure test gas or gas mixture.
- gas pressure and temperature shall be allowed to stabilize. Gas velocities for each acoustic path shall be recorded for at least 300s. The mean gas velocity and standard deviation for each acoustic path shall be calculated
- if the measured SOS values are compared with theoretical values, the theoretically determined values shall be computed using a complete compositional analysis of the test gas. The uncertainty of the test gas pressure measurement shall be than $\pm 0.1\%$ and the uncertainty of the test gas temperature measurement shall be better than $\pm 0.2K$.
- The speed of sound shall be within 0.1% of the theoretical value of the standard used

4) Calibration under flowing conditions

Contractor shall perform the calibration under flowing conditions about all flow meter and should submit the test results.

Calibration shall be carried out under the condition that USM(Ultrasonic meter)is connected to meter' s upstream pipe(20D) by using flange(CLASS #600).

Calibration should be performed two(2) times : 1' st calibration should be performed prior to making any calibration-factor adjustment and 2' nd one should be performed after making calibration-factor adjustment to enhance the flow measurement accuracyFlow calibration is as follows.

- For Ulsan Metering Station: 100%, 70%, 40%, 25%, 10%, 5% of the Q_{max} .(30 m/s), Q_{min} (0.6m/s):7 Points
- It should meet 7.2.1 a) accuracy requirement prior to making any calibration-factor adjustment.
- For the 7 points shall meet 7.2.1 accuracy requirement prior to making any calibration-factor adjustment.

During the calibration, meter log data will be accumulated at each flow rate. at least 120 seconds of log data at each flow rate are required.

a) Calibration Adjustment factors

Calibration Adjustment factor shall be applied in accordance with ISO-17089-1

b) Calibration test Report

The result of calibration shall be provided to the purchaser and the content of the report should be documented in accordance with ISO-17089-1

- ※ At least 3 tests shall be done per each points and the test results shall be provided in the calibration certificates for judging the repeatability of a meter.

5) Type test

Manufacturer should perform the type test of USM(without flow Conditioner) to verify minimum required upstream pipe lengths(within 20D).

- Accuracy and installation conditions shall be applied in accordance with ISO-17089-1 6.4.4 or equivalent installation conditions.
- Manufacturer shall submit the certificate of the type test issued by the Authorized approval agency.

- ※ It is acceptable to submit the type approval certificates under same conditions with ISO-17089-1 6.4.4, OIML R137, AGA 9

6) Dimensional test

- The manufacturer shall measure and document the average internal diameter of the meter, flanges & meter tube, the length of each acoustic path between transducer faces and the axial (meter body axis) distance between transducer pairs
- The average internal diameter should be calculated from a total of 12 inside diameter measurements. For internal diameter measurements (one in the vertical plane, another in the horizontal plane and two in planes approximately 45° from the vertical plane) shall be made to at three meter cross-sections: 1) near the set of upstream ultrasonic transducers, 2) near the set of downstream transducers and 3) half way between the two transducer sets (see ATT. #15)
- All instruments used to perform these measurements shall have valid calibrations traceable to national standards

7) Path failure simulation and exchange of components

7-1) Path failure test

- Meter shall remain in-service in the event of a path failure, the effect of the failure must be determined at the meter's flow calibration by simulating the failure of one or more paths. The test should be carried out at or around the mid-point of the meter's expected operating range. During the test the flow rate should be varied by 20% of the flow rate to ensure that the meter responds appropriately. In the event of a path failure, it shall meet the 7.2.1 a) accuracy Requirement

7-2) Exchange of component

- The manufacturer shall demonstrate the meter's capability to replace or relocate transducers, electronic parts and software without a significant change in meter performance.

This has to be demonstrated for:

- the electronics
- transducers of different path types
- When components are exchanged, the accuracy shall meet the 7.2.1.a) accuracy requirement
- ※ It is acceptable to submit the type approval certificates or the report witnessed by 3rd party inspector.

8) Flow computer accuracy test

Accuracy test of flow computer shall perform instantaneous flow and totalized flow test. These test performed with connection of signals that are the inputs from flow computer panel terminal

8-1) Instantaneous Test

- While the signals of pressure and temperature are fixed at the values of actual gas supply condition, the flow rate values displayed on the flow computer by dummy signals shall be compared against the flow rate values calculated by flow rate calculation program(FRCPT) to check on the accuracy of the flow computer(within $\pm 0.02\%$)

8-2) Totalized flow Test

- In the case of accuracy test for integrated flow rates, the accuracy shall be checked by comparing the flow integrated by the flow computer For a minimum 1 hour against the flow by flow rate calculation program(FRCPT) with 50% of maximum flow to check on the integrated accuracy (within $\pm 0.02\%$)

9) Simulation test for meter run switching

10) Electrical check and Loop test (including point-to-point continuity check, instrument calibration and analog I/O board calibration)

11) G/C Performance test

11-1) Accuracy test

- The analysis capability of a gas chromatograph shall be tested in the reference standard gas which has the certificate issued by a national standard institute or a traceable authorized agency, the analysis results(heating value, relative density, standard compression property coefficient, etc.) obtained from the gas chromatograph controller shall be checked against the results obtained by the physical property calculation program(NGP)(to be within $\pm 0.02\%$) to assure that the calculation has been performed in accordance with the values of the physical properties of ISO 6976

11-2) Repeatability test

- The difference between two successive results obtained by the same operator with the same apparatus under constant operating conditions on identical test materials should be considered. Repeat **twenty(20)** times on the calibration gas. The system should repeat within Report Repeatability (or By ASTM1945).



11-3) Temperature Cycling Test

- Gas analyzer placed in the temperature chamber will be calibrated using a reference standard gas which has the certificate issued by a national standard institute or a traceable authorized agency. Once calibrated the

analyzer will run the 24 hour TCT(Temperature Cycling Test) on stream 1 using a $\pm 1\%$ certified blend gas. During 24 hours TCT test each analyzer cycle results are stored in Archive Data Files. Upon completion of testing, archive data are collected and cyclic data for each analyzer cycle is recorded in an excel data spread sheet. The spreadsheet will log a summary that lists the “Minimum” and “Maximum” component values. The difference of these values is noted in the “Difference” column which is the repeatability for each measured component. The results in the summary area should be equal to or below “Criteria Repeatability %” in order to pass TCT tests.

Component mol%	Repeatability
0.0 ~ 0.1	0.01
0.1 ~ 1.0	0.04
1.0 ~ 5.0	0.07
5.0 ~ 10	0.08
10 or more	0.10

12) All enclosure test certificates for electric component shall be reviewed to confirm that they meet the relative safety regulations for use in the hazardous locations.

13) Certificate of explosion proof

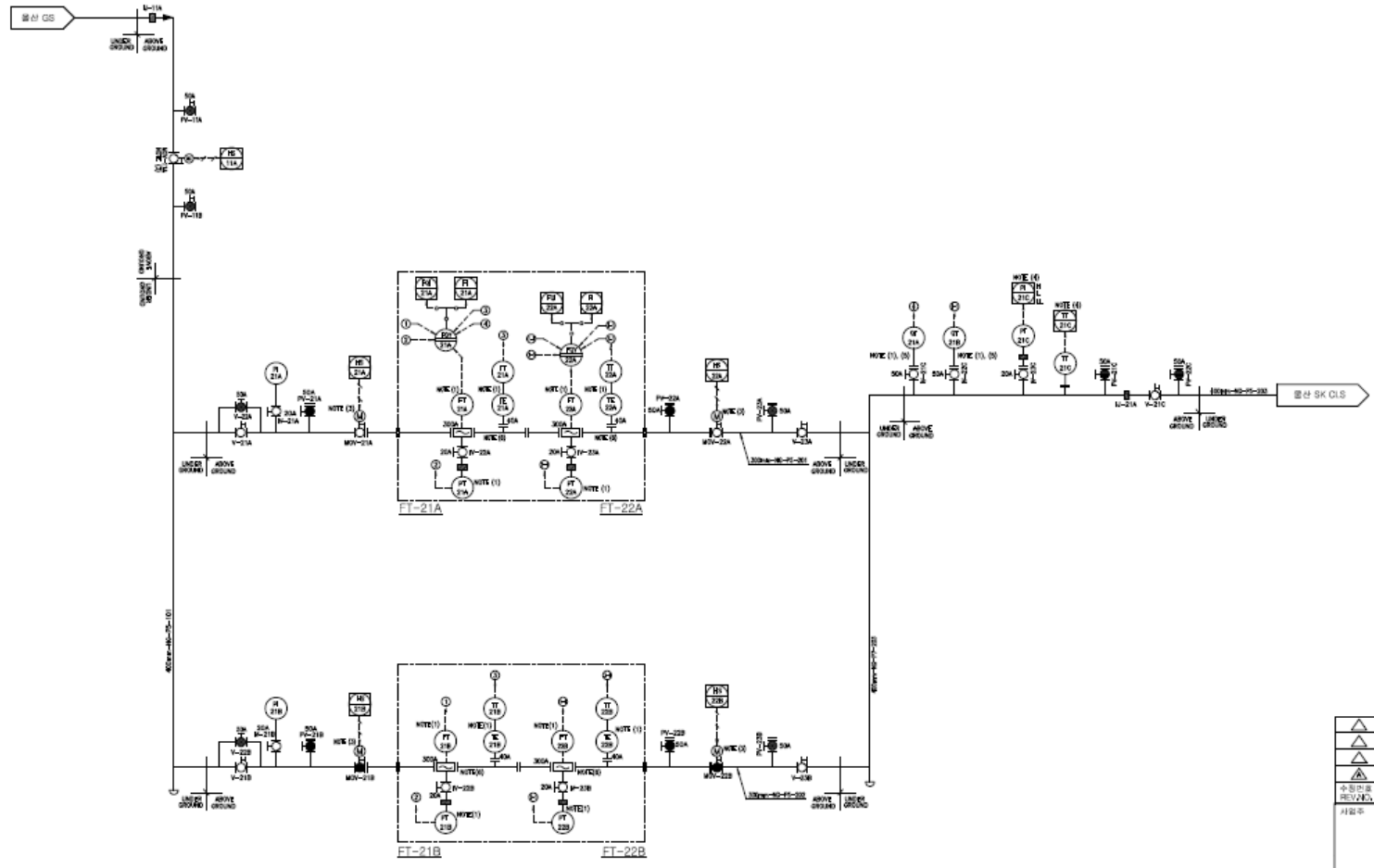
The contractor must submit the certification of enclosure which shall be issued by the authorized approval agency in Korea on all equipment using in hazardous area during field test even if it has approved by authorized approval agency in manufacturer's country as appropriate. If they were tested already by a Korean test agency and their effective date is not expired, the test can be replaced with submission of their certificates.

ATT. #6. PIPING & INSTRUMENT DIAGRAM

8 7 6 5 4 3 2 1

F
E
D
C
B
A

- NOTE**
- (1) F/P, T/E, ST AND ULTRASONIC FLOW METER SHOULD BE SUPPLIED BY METERING SYSTEM VENDOR.
 - (2) INSTANTANEOUS (IN/TON, G/G), INTEGRATION VALUE (WH/TON, G/G), CALORIFIC VALUE SHALL BE SENT TO KOGAS AREA CONTROL CENTER.
 - (3) MWK-11A, 21A/B, 22A/B POSITION SHALL BE SENT TO KOGAS AREA CONTROL CENTER.
 - (4) H-21C, T1-21C SIGNAL SHALL BE TRANSMITTED TO KOGAS.
 - (5) THE SAMPLING GAS SHALL BE TRANSMITTED TO 21(W) GAS CHROMATOGRAPH.
 - (6) THE STRAIGHT LENGTH OF A METER TUBE MORE THAN 300 AT FLOW METER UPSTREAM AND MINIMUM 50 AT DOWN STREAM.
 - (7) FOR PURGING TO SAFETY AREA, VENT PIPE (V") SHALL BE INSTALLED IN METERING STATION BUILDING.



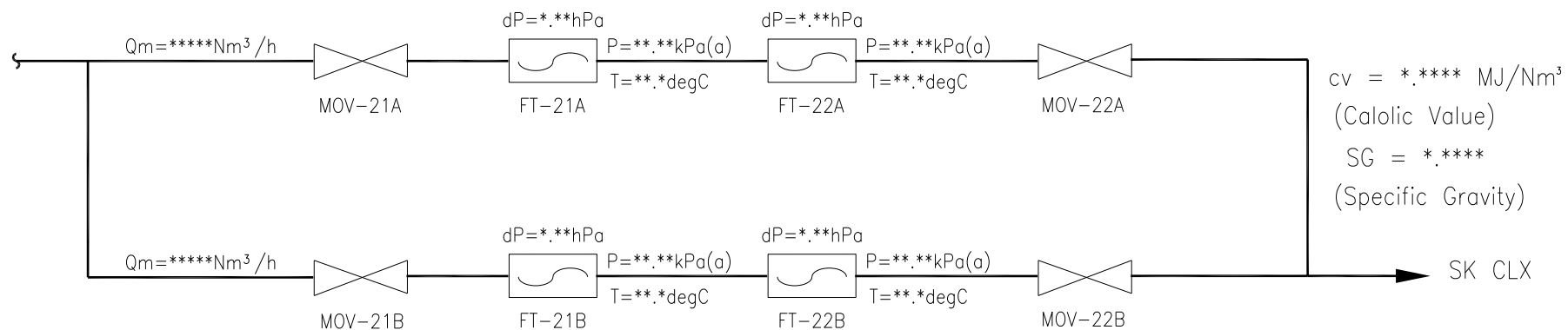
TAG	FT-21A/22A	TAG	FT-21B/22B
NAME	ULTRASONIC FLOWMETER	NAME	ULTRASONIC FLOWMETER
QUANTITY	100% X 2EA	QUANTITY	100% X 2EA
CAPACITY	120 TON/HR	CAPACITY	120 TON/HR

FOR APPROVAL

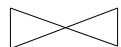
수정번호 REV. NO.	날짜 DATE	내용 DESCRIPTION	수정 CHK	확인 CHK	승인 APP
18.04.15	FOR APPROVAL		JHL	JHM	JUC
<p>SK E&S 물산 공급배관 (계량설비) 설계용역</p> <p>한국가스기술공사 KOGAS GAS TECHNOLOGY CORPORATION</p> <p>도면명 TITLE: PIPING & INSTRUMENT DIAGRAM</p> <p>제치자 도면번호 CONC. DWG. NO.: NONE</p> <p>프로젝트 번호 PROJECT NO.: PEX001</p> <p>도면종류 DWG. TYPE: A</p> <p>시트 번호 SHEET NO.: 1</p> <p>도면크기 A1(841mm x 594mm)</p>					

ATT. #7. GRAPHIC CONFIGURATION

SK ULSAN METERING STATION



cv = *.**** MJ/Nm³
(Caloric Value)
SG = *.****
(Specific Gravity)



: VALVE SYMBOL

OPEN : RED
CLOSED : GREEN
TRAVELING : FLICKERING YELLOW
FAULT : STEADY YELLOW

FOR REFERENCE

METER-RUN	FLOW UNIT	INSTANT FLOW RATE			DAILY TOTAL FLOW RATE		
		VOLUME (Nm ³ /h)	MASS (Ton/h)	ENERGY(MJ)-NOTE	VOLUME (Nm ³ /h)	MASS (Ton/h)	ENERGY(MJ)-NOTE
FT-21A		*****	*****	*****	*****	*****	*****
FT-21B		*****	*****	*****	*****	*****	*****
FT-22A		*****	*****	*****	*****	*****	*****
FT-22B		*****	*****	*****	*****	*****	*****
TOTAL		*****	*****	*****	*****	*****	*****

ATT. #8. TEST SHEET FOR FLOW COMPUTER

FACTORY TEST SHEET FOR METERING SYSTEM

(SUPPLIER'S NAME)

CUSTOMER :
CONTRACT NO. :
FLOW CALCULATOR MODEL :
SERIAL NUMBER :
STATION NAME :

INSPECTED BY DATE SIGNATURE

WITNESSED BY DATE SIGNATURE

QUALITY CONTROL DEPARTMENT
(SUPPLIER’S NAME)

TEST CONDITION OF FLOW COMPUTER

TYPE OF FLUID	:
RANGE OF TRANSMITTER	:
RANGE	:
PRESSURE TAPPING	:
STATIC PRESSURE RANGE	:
TEMPERATURE RANGE	:
BASE PRESSURE	:
BASE TEMPERATURE	:
ISENTROPIC EXPONENT	:
DYNAMIC VISCOSITY	:
FLOW CALCULATION STANDARD	:
DISCHARGE COEFFICIENT STANDARD	:

FLOW ACCUMULATION ACCURACY TEST

STATION NAME				METER RUN NUMBER			
STATIC PRESSURE				PIPE SIZE			
TEMPERRATURE				SPECIFIC GRAVITY			
BASE DENSITY							
% N ₂		% CO ₂		CPV			
% C ₁		% C ₂		% C ₃			
% i-C ₄		% n-C ₄		% i-C ₅			
% n-C ₅		% n-C ₆		% H ₂ O			
START		TIME		COUNTER READING			
END		TIME		COUNTER READING			
THEORETICAL FLOWRATE(Nm ³ /H)							
THEORETICAL ACCUMULATED FLOW(Nm ³)							
ACCUMULATED FLOW (Nm ³) ON COUNTER							
ERROR RATE(%)							

INSPECTED BY

DATE

SIGNATURE

WITNESSED BY

DATE

SIGNATURE

VOS ACCURACY TEST FOR ULTRASONIC METER

STATION NAME				METER RUN NUMBER			
STATIC PRESSURE				PIPE SIZE			
TEMPERRATURE							
BASE DENSITY				SPECIFIC GRAVITY			
% N ₂		% CO ₂		CPV			
% C ₁		% C ₂		% C ₃			
% i-C ₄		% n-C ₄		% i-C ₅			
% n-C ₅		% n-C ₆		% H ₂ O			
VELOCITY OF SOUND (VoS)			(m/s)				
			THEORETICAL VALUE	METER READING	ERROR RATE(%)		

INSPECTED BY <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/> WITNESSED BY <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/>	DATE <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/> DATE <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/>	SIGNATURE <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/> SIGNATURE <hr style="border: 0; border-top: 1px solid black; margin: 5px 0;"/>
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ATT. #9. SAMPLE OF REPORT FORM

Hourly Report

Line	Mass (Ton)	Volume (Nm ³)	Energy (GJ)	Average Calorific Value
1				
2				
3				
4				
5				
Total				

Daily Report(Station Total)

Hour	Mass (ton)	Volume (Nm³)	Energy (GJ)	Average Calorific Value (MJ/Nm³)	Accumulated		
					Mass	Volume	Energy
01:00							
02:00							
03:00							
04:00							
05:00							
06:00							
07:00							
08:00							
09:00							
10:00							
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							
19:00							
20:00							
21:00							
22:00							
23:00							
24:00							
Total				Average value			

Monthly Report (Station Total)

Date	Mass (Ton)	Volume (Nm ³)	Energy (GJ)	Average (MJ/Nm ³)	Accumulated		
					Mass	Volume	Energy
1 . 31							
Total				Average value			

Process Report

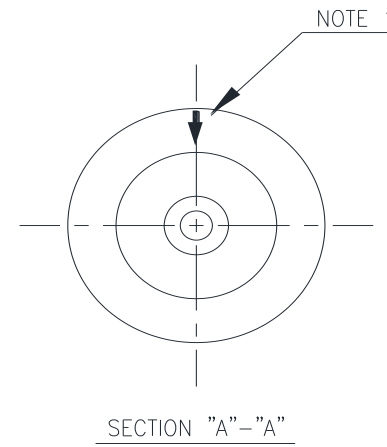
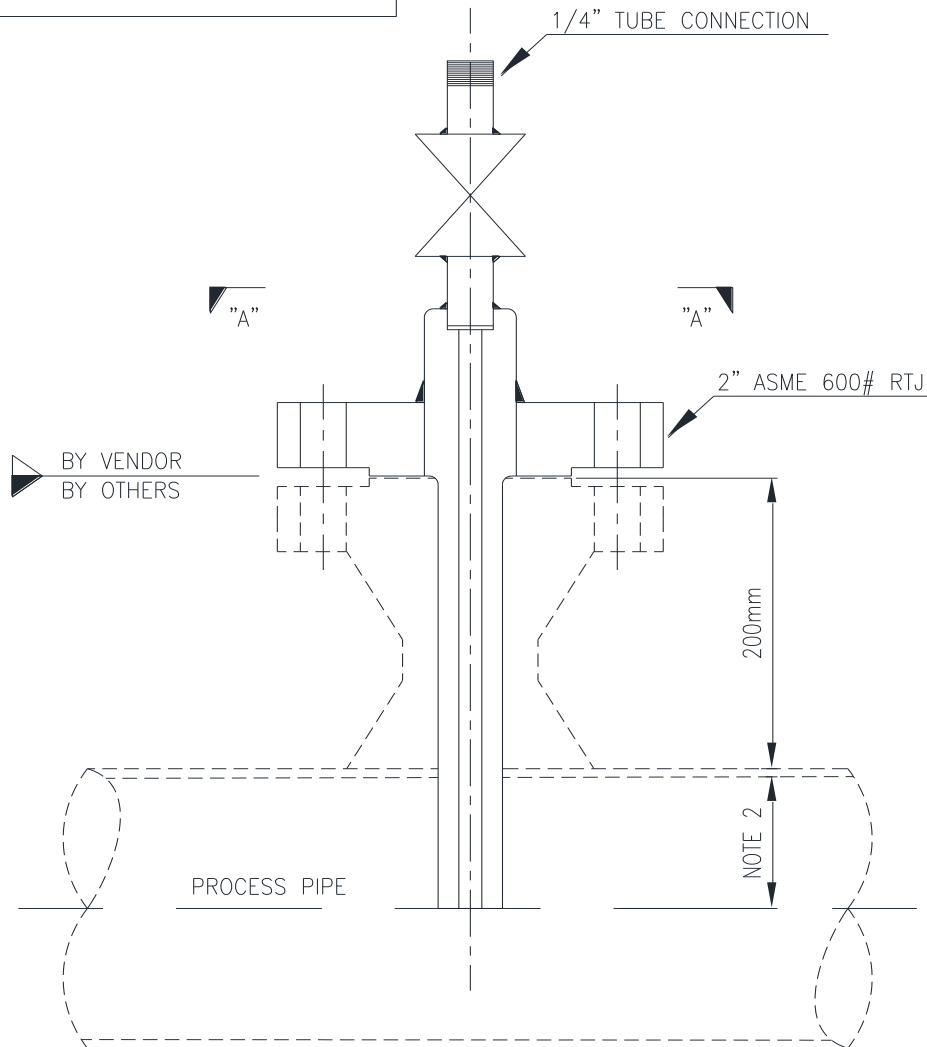
Date :

	Tube #1	Tube #2	Tube XX	Tube XX	Total
Diff. Press. A						
Diff. Press. B						
Static Press.						
Line Temp.						
Line Density						
Mass Flow						
Volume Flow						
Energy Flow						
Heating Value						
Spec. Gravity						
% N ₂		% CO ₂		CPV		
% C ₁		% C ₂		% C ₃		
% i-C ₄		% n-C ₄		% i-C ₅		
% n-C ₅		% n-C ₆		% H ₂ O		
Ref. Density						

ATT. #10. Sampling Probe [FOR REFERENCE]



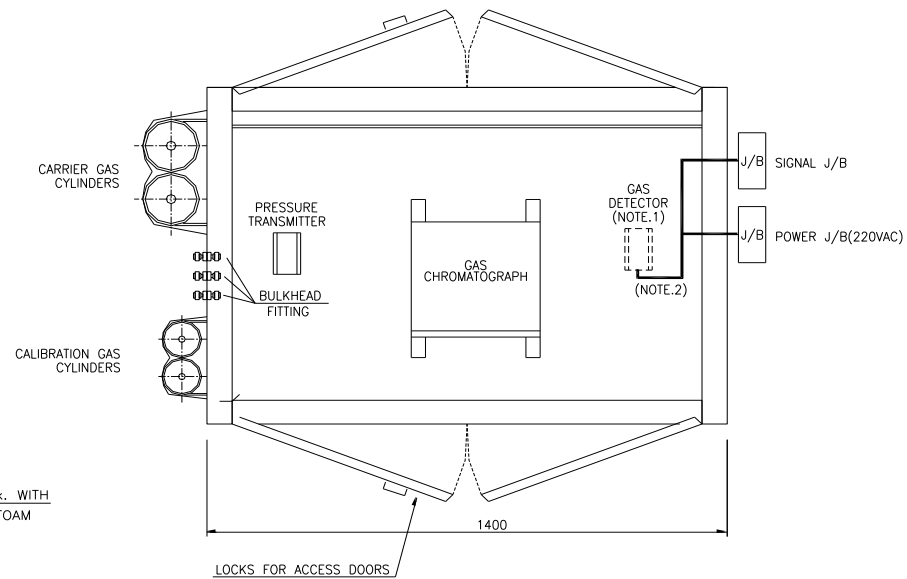
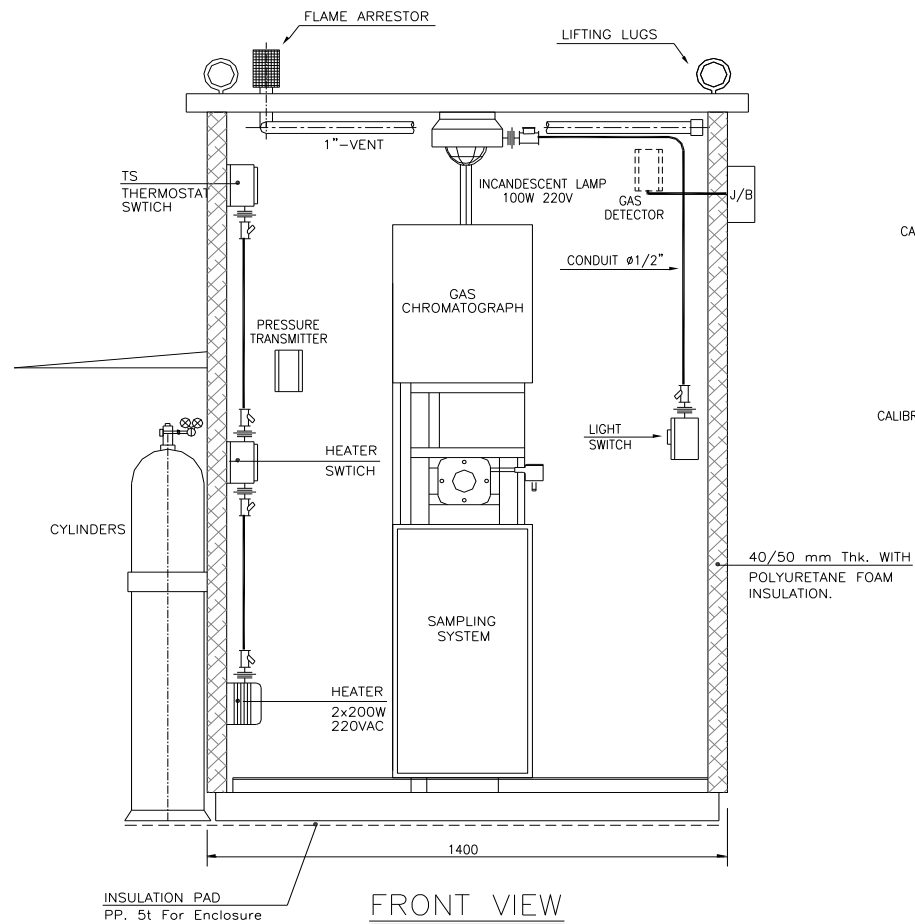
SAMPLE PROBE TYPICAL DRAWING



NOTES

1. THE FLANGE SHOULD BE STAMPED WITH THE PROBE TAG NUMBER AND FLOW DIRECTION.
2. THE PROBE INSERTION LENGTH SHALL NOT EXCEED MAX. PROBE LENGTH CALCULATED IN ACCORDANCE WITH IEC TR 61831 ANNEX. DETERMINATION OF SAMPLE PROBE LENGTHS CALCULATION. THE INSERTION LENGTH SHALL BE CONTENT OF PIPE LINE DIAMETER (MIN. 300MM TO MAX. $0.5D + 10\text{MM}$) AND MAX. INSERTION LENGTH SHALL NOT EXCEED 8 INCHES.

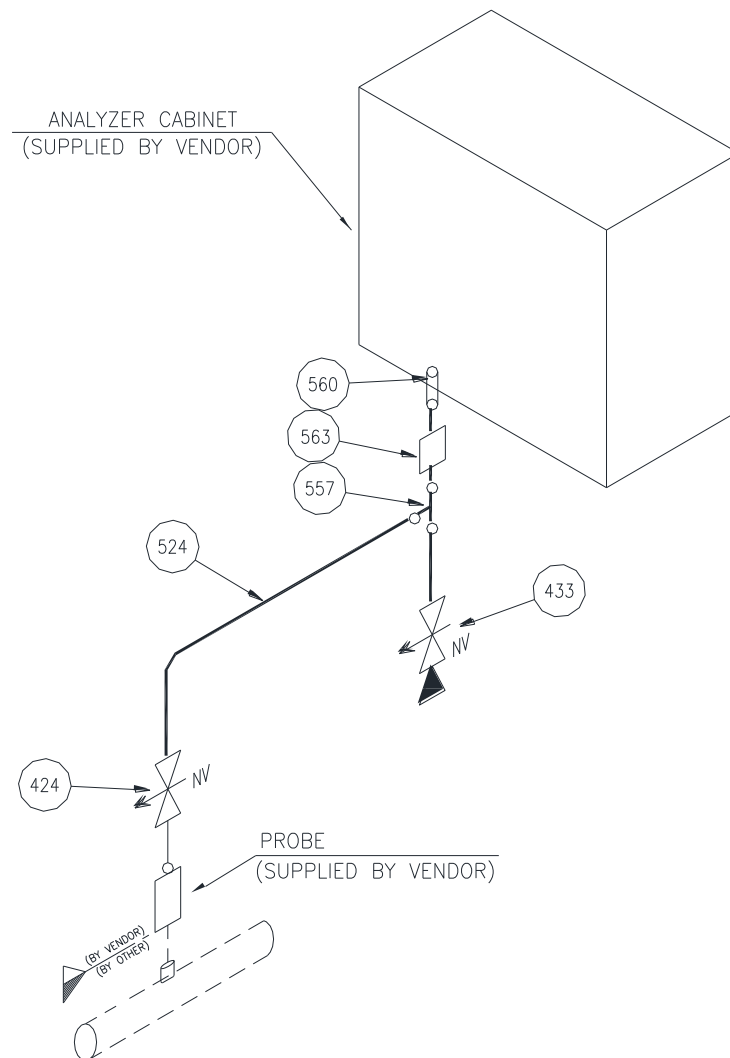
ATT. #11. GAS CHROMATOGRAPH CABINET DRAWING [FOR REFERENCE]



NOTE.

1. GAS DETECTOR : SUPPLIED BY PURCHASER.
2. CABLING BETWEEN GAS DETECTOR AND JUNCTION BOX IS CONTRACTOR'S SCOPE.

ATT. #12. SAMPLE TRANSPORT LINE HOOK-UP [FOR REFERENCE]

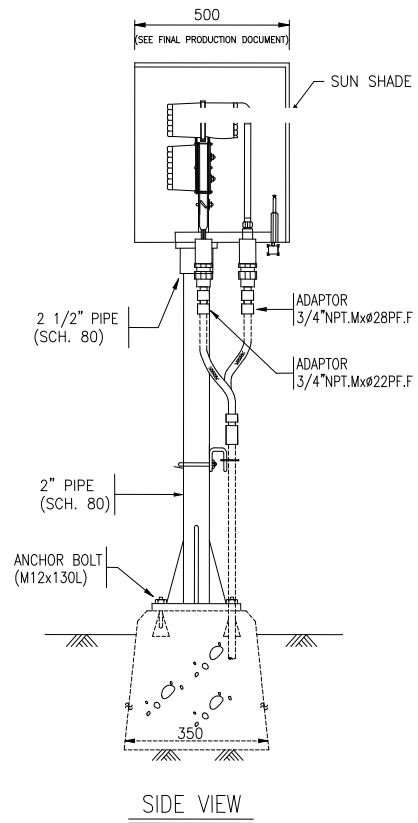
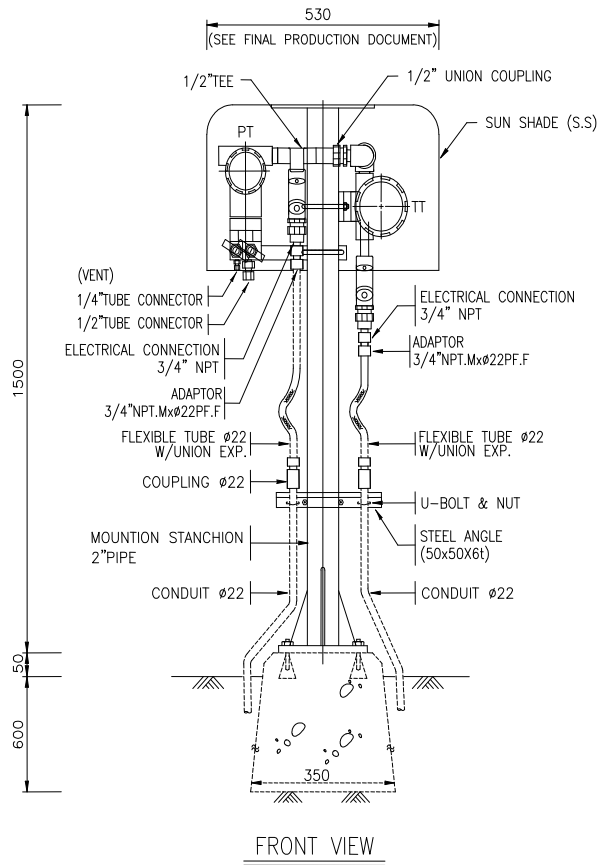


563	INSULATION FITTING	1/4"	(1)	EA	316SS (SUPPLIED BY VENDOR)
560	BULK-HEAD UNION (COMPRESSION)	1/4"	(1)	EA	316SS (SUPPLIED BY VENDOR)
557	TUBE TEE (COMPRESSION)	1/4"	(1)	EA	316SS (SUPPLIED BY VENDOR)
524	HEAT TRACING TUBE	1/4" O.D.	(14)	M	316SS (SUPPLIED BY VENDOR)
433	NEEDLE VALVE (COMPRESSION) W/PLUG	1/4"	(1)	EA	316SS (SUPPLIED BY VENDOR)
424	NEEDLE VALVE (COMPRESSION)	1/4" O.D.	(1)	EA	316SS (SUPPLIED BY VENDOR)
CODE	DESCRIPTION	SIZE	Q'TY	REMARKS	

NOTE

ATT. #13. TRANSMITTER SUNSHADE [FOR REFERENCE]

- SUPPLIED BY VENDOR
- SUPPLIED BY OTHERS



PRESSURE & TEMP. TRANSMITTER W/SUNSHADE

ATT. #14. G/C PERFORMANCE TEST SHEET

REPEATABILITY TEST FOR GAS CHROMATOGRAPH

Model No.					
Serial No.					
Components	Test Result (mol %)		Error (A-B)	Repeatability(%) (ASTM-1945)	Judgement
	1st(A)	2nd(B)			
N ₂				0.04	
CO ²				0.01	
CH ₄				0.1	
C ₂ H ₆				0.08	
C ₃ H ₈				0.07	
i-C ₄ H ₁₀				0.04	
n-C ₄ H ₁₀				0.04	
i-C ₅ H ₁₂				0.01	
n-C ₅ H ₁₂				0.01	
C ₆ ⁺				0.01	

INSPECTED BY

DATE

SIGNATURE

WITNESSED BY

DATE

SIGNATURE

GAS CHROMATOGRAPH ACCURACY TEST

Item	Test Result	Analysis Result		Remark	
Gas Analysis	CH ₄				
	C ₂ H ₆				
	C ₃ H ₈				
	i-C ₄ H ₁₀				
	n-C ₄ H ₁₀				
	i-C ₅ H ₁₂				
	n-C ₅ H ₁₂				
	CO ₂				
	N ₂				
	C ₆ ⁺				
Data Calculation	Item	GC	Calculation	Error(%)	Judgement
	CPV				
	Specific Gravity				
	1/Z				
	WOBBE				

INSPECTED BY

DATE

SIGNATURE

WITNESSED BY

DATE

SIGNATURE

GAS CHROMATOGRAPH REPEATABILITY TEST(TCT)

Model No.					
Serial No.					
Components	Test Result (mol %)		Error (A-B)	Repeatability(%) (ASTM-1945)	Judgement
	1st(A=Max)	2nd(B=Min)			
N ₂				0.04	
CO ²				0.01	
CH ₄				0.1	
C ₂ H ₆				0.08	
C ₃ H ₈				0.07	
i-C ₄ H ₁₀				0.04	
n-C ₄ H ₁₀				0.04	
i-C ₅ H ₁₂				0.01	
n-C ₅ H ₁₂				0.01	
C ₆ ⁺				0.01	

INSPECTED BY

DATE

SIGNATURE

WITNESSED BY

DATE

SIGNATURE

ATT. #15. USM DIMENSIONAL TEST SHEET

USM DIMENSIONAL TEST

CONTRACT NO.

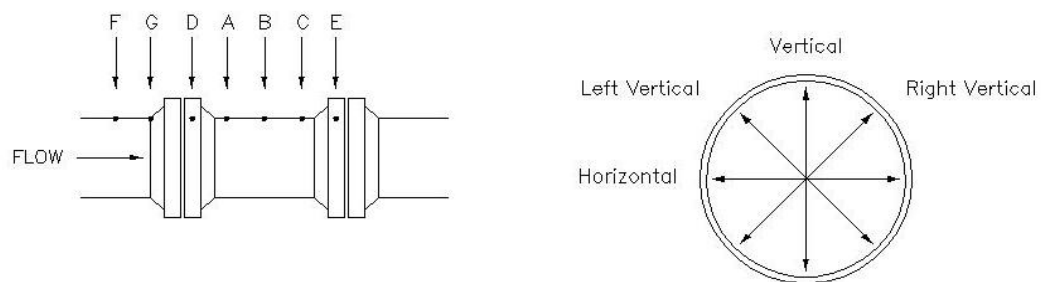
TAG NO.

SERIAL NO.

AVERAGE INTERNAL DIAMETER

PIPE SCHEDULE

NOTE : Letters A, B, C, D, E, F, G mean the location from the USM top hole.



Case 1) USM Meter (Accuracy $\pm 0.5\%$) – Measurement Zone

Location	A	B	C
Vertical			
Left Vertical			
Right Vertical			
Horizontal			
Average			

Case 2) Meter Tube (Accuracy $\pm 1.0\%$)

Location	D	E	F	G
Vertical				
Left Vertical				
Right Vertical				
Horizontal				
Average				

We certify that the above values are within the criteria of ISO 17089–1 specification

Inspected by

Date

Signature

Witnessed by

Date

Signature

ATT. #16. I/O LIST

I/O POINT 수량

(단위 POINT)

[illegible]

비고 : 1. I/O CARD 는 실수량(POINTS)에 30%이상의 예비 POINT 를 추가한 수량을 기준으로 공급해야 함.



SK 울산 공급배관[계량설비] ANALOG INPUT LIST

[illegible]

SK 울산 공급배관[계량설비] DISCRETE INPUT LIST

SK 울산 공급배관[계량설비] DISCRETE OUTPUT LIST

[illegible]

ATT. #17. TECHNICAL BID EVALUATION SHHET

TECHNICAL BID EVALUATION SHEET

PROJECT : 울산 공급배관 (계량설비) 용역

ITEM : ULTRASONIC FLOW METERING SYSTEM

RFQ NUMBER : IN-SPC-001

DISCIPLINE : INSTRUMENT

REV : B

DATE :

NO	DESCRIPTION	REQUIREMENT	BIDDER : TO BE FILLED BY BIDDER			REMARK
				BIDDER PROPOSAL	PURCHASER'S COMMENT	
ABBREVIATION - V : Acceptable (Confirmed), N/A : Not Applicable, X : Not Acceptable, ? : Not Specified, * : To be clarified						
1	GENERAL					
1.1	Quotation Number	By Bidder				
1.2	Quotation Date	By Bidder				
1.3	Explosion Proof Certificates	by KOSHA, KTL, or KGS				
2	SCOPE OF WORK					
2.1	Consumables and Spare parts	1 Lot (As per Sec. #14 on RFQ)				
2.3	Supervision service & Training	1 Lot (As per Sec. #10 and #11 on RFQ)				
	- Loop check and crrection between field instruments and F/C					
	- Check & Correction for software and hardware					
	- F/C accuracy acceptance test, accuracy verification for all parts					
	- Recommended installation mehpd for all parts					
2.3	Documents and Drawings	1 Lot As per Sec. #13 and Attach #4 on RFQ				
2.4	Inspection & Test	1 Lot (As per Sec. #9.1 and Attach #5 on RFQ)				
2.5	Pakcking and Shipping	1 Lot				
3	SCOPE OF SUPPLY					
3.1	Flow Computer for 2 meter runs with Panel	1 Set				
3.2	G/C controller with cables & connector for G/C controller	2 Sets				
3.3	Display computer with printers	3 Sets				
	- 2 (two) for F/C and 1 (one) for G/C					
3.4	12" Ultrasonic Flow meter with meter tube [API 5L Gr. X65 (14.3mm)]	4 Sets				
3.5	Pressure Transmitter & Temperature Transmitter with sunshade	4 Sets				

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	(Including tubing, instrument valves (1/2"), stanchion etc)					
3.6	Resistance Temperature Detector (RTD) with Thermowell	4 Sets				
3.7	2 (two) Gas Chromatograph with 2 (two) sample probe and 1 cabinet	1 Sets				
	including PT & accessories (Pre-heated tube, Power kt, etc.)					
3.8	Standard Gas Cylinder for Calibration filled 29L	4 Sets				
	(Pre charged pressure : 10.7MPa.g or Above)					
3.9	Carrier Gas Cylinder filled 47L	4 Sets				
	(Pre charged pressure : 15MPa.g or Above)					
3.10	Transducer (12" : 2 Pair)	1 Set				
3.11	Transducer Retraction Tool	1 Set				
3.12	Double Modulation System with Panel	1 Set				
3.13	GPS System	1 Set				
3.14	Maintenace Tools	1 lot				
1)	Software tools					
2)	Application program and configuration tools for HMI PC					
	(including all software license)					
	※ Application software shall be operated in Windows 10 or similar operating system with latest version					
3)	Tools for replacement or removal of transducer					
3.15	All cables and connectors described in attachment #1	1 lot				
3.16	Communication devices necessary (FO switch, FDF etc)	1 lot				
4	TECHNICAL REQUIREMENT					
4.1	Flow computer panel					
	- Type	Self standing type				

TECHNICAL BID EVALUATION SHEET

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				BIDDER PROPOSAL	PURCHASER'S COMMENT	
ABBREVIATION - V : Acceptable (Confirmed), N/A : Not Applicable, X : Not Acceptable, ? : Not Specified, * : To be clarified						
	- Dimension	2150(H) x 830(D) and MFR.STD Width				
	※ Size is only for reference and will be informed later in detail engineering stage					
	- Redundant Power Supply Unit (220VAC / 24VDC)	Required				
	- Redundant UPS for Flow computer (24VDC, 3~5 hours long)	Required				
	- Surge arrester (Capacity : 40KA or above)	Required				
	- Isolators	Required				
	- Color	Munsell No. N7.5 or RAL 7038				
	※ Color is only for reference and will be informed later in detail engineering stage					
4.2	Flow Computer with PLC					
	- CPU	32 bit or better, Redundant				
	- Memory	Non-volatile memory				
	- Communication equipment	RS-232, 422/485, Ethernet				
4.3	HMI PC, Printer					
	- HMI computer	Workstation Class PC				
	- Monitor	24" LED or larger				
	- Printer	Laser color printer				
4.4	Ultrasonic Flowmeter					
	- Tag No.	FT-21A/ 21B/ 22A/ 22B				
	- Size and Connections	12", 600# RF				
	- Material (Body & Flange)	ASTM A352 Gr LCC				
	- Transducer Paths	4 Multi path / 8 Transducers				

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				BIDDER PROPOSAL	PURCHASER'S COMMENT	
ABBREVIATION - V : Acceptable (Confirmed), N/A : Not Applicable, X : Not Acceptable, ? : Not Specified, * : To be clarified						
	- Enclosure Class	CLASS I, ZONE 1				
	- Meter tube					
	a) Upstream	20D (#600RTJ x #600RF)				
	b) Downstream	5D (#600RF x #600RTJ)				
	c) Meterial & Thickness	API 5L Gr. X42 (14.3mm)				
	- Accuracy	As sec. #7.2 on RFQ				
4.5	Absolute Pressure Transmitter					
	- Tag No.	PT-21A/ 21B/ 22A/ 22B				
	- Signal Output	4-20mA with HART				
	- Range	0~10 Mpa.a				
	- Accuracy	± 0.1% of F.S				
	- Explosion Proof	Class I, Div 1, Gr.D				
	- LCD Display	Required				
	- Electrical connection	1/2" NPT.F				
	- Accessories					
	a) 2" Pipe Stanchion type with U-Bolt & Nuts	Required				
	b) Packing type Cable gland (explosion proof type)	Required				
	c) 2" Pipe Stanchion	Required				
	d) 2-Way Manifold valve and 1/2" Instrument valve	Required				
	e) Sunshade	Required				
	f) Tubing	Required				
4.6	Gauge Pressure Transmitter					

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				BIDDER PROPOSAL	PURCHASER'S COMMENT	
ABBREVIATION - V : Acceptable (Confirmed), N/A : Not Applicable, X : Not Acceptable, ? : Not Specified, * : To be clarified						
	- Tag No.	PT-31A/ 31B				
	- Signal Output	4-20mA with HART				
	- Range	0~15 Mpa.g				
	- Accuracy	± 0.1% of F.S				
	- Explosion Proof	Class I, Div 1, Gr.D				
	- LCD Display	Required				
	- Electrical connection	1/2" NPT.F				
	- Accessories					
	a) 2" Pipe Stanchion type with U-Bolt & Nuts	Required				
	b) Packing type Cable gland (explosion proof type)	Required				
	c) 2-Way Manifold valve and 1/2" Instrument valve	Required				
4.7	Resistance Temperature Detector (RTD) with Thermowell					
	- Tag No.	TE-21A/21B/22A/22B				
	- Type	PT 100Ω at 0°C, 4-wires				
	- Accuracy	± 0.15% at 0°C				
	- Sheath	316SS, 6.4Φ				
	- Explosion Proof	Class I, Div 1, Gr.D				
	- Packing type Cable gland (explosion proof type)	Required				
	- Thermowell					
	a) Material	304SS				
	b) Construction	Drilled & Tapered				
	c) Size & Connection	1-1/2", 600# RTJ				
	d) Insertion Length (U-Lenth)	350 mm				

TECHNICAL BID EVALUATION SHEET

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ITEM : ULTRASONIC FLOW METERING SYSTEM

RFQ NUMBER : IN-SPC-001

DISCIPLINE : INSTRUMENT

REV : B

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				BIDDER PROPOSAL	PURCHASER'S COMMENT	
ABBREVIATION - V : Acceptable (Confirmed), N/A : Not Applicable, X : Not Acceptable, ? : Not Specified, * : To be clarified						
	※ U-LENGTH IS CONSIDERED ONLY WHEN LENGTH BETWEEN FLANGE AND PIPE IS 200mm. THE INSERTION LENGTH SHALL BE BETWEEN D/2 AND D/3 OF PIPE					
4.8	Temperature Transmitter					
	- Tag No.	TT-21A/21B/22A/22B				
	- Signal Output	4-20mA with HART				
	- Range	-30 ~ 50°C				
	- Accuracy	± 0.1% of F.S				
	- Explosion Proof	Class I, Div 1, Gr.D				
	- LCD Display	Required				
	- Electrical connection	1/2" NPT.F				
	- Accessories					
	a) 2" Pipe Stanchion type with U-Bolt & Nuts	Required				
	b) Packing type Cable gland (explosion proof type)	Required				
	c) 2" Pipe Stanchion	Required				
	d) Sunshade	Required				
4.9	Gas Chromatograph					
1)	Gas Analyzer					
	- Detector type	Microthermal Conductivity Detector				
	- Carrier Gas	Pure Helium (99.999%)				
	- Repeataibility Accuracy	± 0.5 BTU / 1000 BTU (± 0.05% CV)				
	- Analysis Time	Within 5 minute				
2)	Sample probe with regulator					
	- Type	Fixed type				

TECHNICAL BID EVALUATION SHEET

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				BIDDER PROPOSAL	PURCHASER'S COMMENT	
ABBREVIATION - V : Acceptable (Confirmed), N/A : Not Applicable, X : Not Acceptable, ? : Not Specified, * : To be clarified						
	- Connection	2", 600# RTJ				
	- Gasket	2", Oval Ring Joint Type Soft Iron				
	- Bolt & Nuts	Stud Bolt A193 Gr B7/ Heavy Hex. A 194 Gr. 2H Galvanized				
	- Material	316SS				
	- Tube length & type	30m, Pre-insulated tubing (Electric heatracing)				
	- Tube Material	Seamless Tube (ASTM A269 TP316/316L), 0.065 Thk.				
	- Stainless Steel Relief valve & Pressure Gauge	Required				
3)	Gas Chromatograph Cabinet					
	- Dimension	1400(W) x 900(D) x 2100(H)mm				
	- Material	Stainless Steel (2.0t or better)				
	- Double doors on the front & rear	Required				
	- Stainless Hinges, Base	Required				
	- Ventilation Louver	Required				
	- Explosion proof Electrical J/B	Required				
	- Hand valves, tuning supports and flame arrester etc.	Required				
	- Explosion proof heater	Required				
	- Space Heater with explosion proof type electrical power J/B	Required				
4.10	Double Modulation System					
	- Type	Free standing type				
	- Dimension	2150(H) x 830(D) and MFR.STD Width				
	※ Size is only for reference and will be informed later in detail engineering stage					
	- Communication	DNP3.0, Modbus				
	- Signal List	As per Sec #7.6 on RFQ				