6 Instrumentation and Control Systems

6.1 Scope and Base of Study

6.1.1 Scope of Study

Scope of the FSR is PetroChina-Costa Rica MOIN Refinery Revamp and Expansion Project.

Grass root units in the FSR mainly include:

Atmospheric and Vacuum Distillation Unit, Naphtha Hydrotreating Unit, Continuous Catalytic Reforming Unit, Delayed Coking Unit, Diesel Hydrofining Unit, VGO Hydrogenation Unit, H_2 Production Unit, Sulfur Recovery Unit, Isomerization Unit and Dry Gas / LPG treatment Unit.

New utility and auxiliary units in the Project mainly include:

Logistics system, steam system, flare system, water supply and drainage system, power supply and distribution system, and air separation and compression system.

Instruments and automatic systems mainly include field instruments, control systems and safe instrumented (emergency shut down) systems for new production units, logistics system, steam system, waste water treatment system, water supply and drainage system, power supply and distribution system, and air separation and compression system.

6.1.2 Base of Study

(1) Information from field investigation

(2) Design conditions and design requirements for all units.

(3) Correspondence and minutes of meetings during feasibility study.

6.2 Status of existing Plant Wide Automatic Controls

Existing units in the Project include an Atmospheric and Vacuum Distillation Unit, an Kerosene Hydrofining Unit, a Reforming Unit, a Visbreaking Unit, a Light Ends Recovery Unit as well as supporting water supply and drainage system, waste water treatment plant, air compression station, and steam system.

The Project consists of the following existing systems:

(1) Existing DCS

Existing DCS

System model: Honeywell TDC3000

Location of installation: Existing CCR

Time of startup: 1967.

Modifications to be conducted: RECOPE is going to revamp the system within 4 years, solution to which is implementing.

(2) Existing SIS

Existing SIS control system

Location of installation: Existing CCR

(3) Conditions of existing instruments:

Pressure, flow and level gauges: Under revamping by RECOPE

Metering gauges for crudes and oil from units: Under revamping by RECOPE

Control valves: Under revamping by RECOPE

6.3 Selection of Plant Wide Control Systems and Instruments

6.3.1 General

Because it is required to revamp the existing units without production halts, design principle for automatic engineering is to incorporate control system configuration plan to install a new control system in a new building without any influence on existing production according to the construction plan of the grassroot unit.

The new control system is furnished with communication interfaces linking up with the existing control system, to complete monitoring and alarm displays of existing control system.

For each productin unit, basic automatic process control will be conducted via DCS.

The control systems in the center control room shall be furnished with communication interfaces linking up with the Plantwide Management Net to provide necessary data and network structure foundation for Management Information System (MIS).

Plant Wide Control system architecture see the attached drawing 1.

6.3.2 General Level of Plant Wide Controls

(1) A plant wide CCR with a DCS will be built in the revamping project to achieve central operation, control and management of new production units, logistics system and utility systems with level of control reaching advanced level among similar international plants. Grass root units and supporting production units after expansion will be equipped with DCS, SIS, CCS, PLC, FAS, and FGDS.

(2) Control, management and operation of all production units and supporting systems (unit) in the Project will be integrated. Automatic control of all production units, logistics system and utilities will reach advanced level of similar plants in the world.

(3) Process control, monitoring and operation management of all production units, logistics system and utility facilities will be conducted via DCS in CCR.

All production information for process units, security information is sent through the network interface OPC to Management Information System to monitor dynamic monitoring the whole plant.

(4) For the oil tank farms, install in-line oil prduct quality analyzers, in-line oil product harmonic control system and in-line harmonic model software, to achieve the automation of oil to reconcile.

(5) According to the process requirements and feasibility of the process units, may consider Atmospheric and Vacuum Distillation Unit, Continuous Catalytic Reforming Unit adoption and implementation of advanced process control.

(6) The process plant shall be implemented simultaneously asset management system.

(7) Being the center and base of plant wide operation, monitoring and control, control systems of the Project are capable of real time monitoring on complete process from production, oil logistics, utilities, feed stock and product inflow/outflow to product quality control.

(8) The project on the production facilities, production operations and control layer mainly including:

- Distributed Control System (DCS)
- Safty Instrumentation System (SIS)
- Fire Alarm System (FAS)
- Flammable/Toxic Gas Detection System (FGDS)
- Asset Management System(AMS)
- Preliminary Analyzer System (PAS)
- Advanced Process Control (APC)
- Control System for Package (PLC)
- Compressor Control System (CCS)
- Management Information System（MIS）

(9) Control and monitoring of logistics tank farms will be conducted via DCS. All data

display, control, logging and alarms for the operation and monitoring of tank farms in logistics area will be executed in CCR.

(10) Other integrated automation solutions for process units.

Other integrated automation solutions for process units shall also include:

MCC (to be implemented by electrical discipline)

Closed-circuit Video System (CCTV).

6.3.3 General Principle of Selection

All instrument equipment or systems applied in the Project shall be advanced in technology and reliable in performance, applicable for the Project and commercially proven products widely used in similar units in the world in recent years, and proven to be dependable products or systems.

(1) The control systems shall meet both functional requirements and the requirements for safety, reliability, real time response, maintainability, expandability, and costs. Operation tested system of proven technology and high performance/price efficiency and software and hardware easy to use and maintain shall be selected.

(2) Measurement and control instruments selected shall be advanced in technology, reliable in operation, safe and durable, superior in dynamic performance, high in precision, good in reproducibility, easy to operate and maintain, economical, and in line with monitoring and control requirements.

6.3.4 Selection of Control System

(1) DCS

DCS is a comprehensive, integrated, configurable and standardized process control system, selection principle of which is as following:

1) Technical level: Up to date technology and system developed and improved in recent years with open and expandable infrastructure and advanced and reliable hardware shall be applied.

2) System redundancy: The system shall be equipped with perfect redundant technology, including equipment redundancy and performance redundancy. Control stations or controllers, network communication equipment and components at all levels, mainframe power supply and channel power supply devices, I/O cards in control loops shall be 1:1 redundant.

3) System expandability: All I/O channels and slots for I/O cards shall have 15% spares.

In addition, the systems shall have online expandability.

4) System openness: The systems shall communicate with systems compatible with ISO/OSI communication standards. It shall be possible to add simple or standard interfaces to connect with Ethernet.

5) System reliability: System MTBF and MTTR level shall be advanced.

6) System maintenance and faults diagnostic: Systems shall be equipped with perfect software and hardware fault diagnostic and self diagnostic functions and automatically record fault alarms and prompt maintenance operators to maintain. All cards of the systems shall be capable of online plug-in/out and changing.

(2) SIS

In order to ensure safety of all units, critical process equipment and large machineries as well as operators, a highly reliable safety instrumented system (SIS) shall be equipped to execute emergency shutdown and safety interlock protection of all units and critical equipment.

Major technical performance requirements for SIS:

The system shall be of failsafe models based on PLC and of redundant and fault tolerant structure. Its safety level shall be configured according to the requirements for SIL analysis for units. It shall be capable of fault self-diagnostic, SOE and communication with DCS.

In order to ensure high reliability of SIS, the following principles shall be considered:

Independent from DCS

Failsafe model (actuation on blackout)

Safety level of system is compatible with that of units.

Logic structure applies connection method of subsystem blocks.

Reasonable redundant configuration for I/O cards and primary field operation elements

Sufficient operator interfaces.

Flexible automatic/semi-automatic operation means.

Sufficient bypass maintenance switches.

Equipped with fault diagnostic technology, millisecond resolution for first event and alarm printers

Capable of communication with DCS

Strong expandability and capacibility of online plug-in/out and changing of cards.

(3) FGDS

Sufficient flammable gas and toxic gas detection sensors shall be installed in the unit areas according to the distribution of leakage sources from units. Data from the sensors shall be connected with an independent flammable gas and toxic gas detection and alarm system (FGDS) for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

The system will be configured as a redundant control and monitoring system based on PES (Programmable Electronics System). FGDS shall be capable of communication with DCS.

(4) Other Control Systems

1) AMS

In order to ensure effective, long term and stable operation of the units, an AMS is installed.

AMS is mainly to conduct management functions including maintenance, calibration and fault diagnostic for field instruments and regulating valves in the units.

AMS servers will be installed in CCR and connect with corresponding DCS LAN.

2) CCS

Compressors will be equipped with their own control system applying MODBUS RTU protocol to communicate with DCS for load control, process control and interlock protection. Local display panels of explosion proof and weather proof models are installed for local monitoring, startup and shutdown debugging, polling, and maintenance.

CCS is redundant and fault tolerant system equipped with application software capable of SOE. Machinery specific monitoring and control system shall be supplied by machinery package supplier.

3) FAS

Manual fire alarm push buttons will be installed in units and along the perimeters of tank farm according to the properties of units in the plant. The 50,000 m^3 external floating roof crude tank will be equipped with temperature detecting cable type automatic fire detection and alarm system. Critical buildings, e.g., area control centers, substations and power distribution stations and instrument cabinet rooms will be equipped with FAS. Main fire alarm control panel will be installed in CCR and auxiliary fire alarm panels will be installed in fire station of the plant. Local fire alarm display of the FAS will monitor and control all fire alarm signals and fire fighting interlocks within unit areas.

4) CCTV

CCTV system of the Project is a safety protection system capable of strict monitoring

and management of all process units of the Project as well as central management in CCR.

5) Control System for the Package (PLC)

Specific packages must have a proprietary control system, the system should communicate with the DCS through the interface unit, the DCS to complete monitoring.

6) PAS

For complex in-line analyzer (such as: Process Gas Chromatograph), the communication interface with the network to form a separate analysis instrumentation systems for the analyzer repair, maintenance and management.

7) APC

By advanced process control methods, solve such process control problems as process time-varying, strong coupling, nonlinearity and long time delay, improve control quality, optimize production operations, improve units processing, product quality and product yield, reduce energy consumption, so as to achieve the facilities' maximum economic efficiency and obtain satisfactory results.

Advanced Process Control is based on conventional control of DCS, which uses a variety of DCS hardware and software functions, and in-line analyzers' analysis results to make process calculation and establish a multi-variable predictive controller to achieve smooth operation of the production process and the card edge operation and improve the yield of desired product.

In the project design, the advanced control platform and interface are reserved.

On this project, it is recommended that priority of using Advanced Process Control be given to: atmospheric and vacuum distillation unit and continuous catalytic reforming unit.

Based on the completion and implementation of advanced process control, further execute real-time optimal control. Optimization of the whole plant process shall be further worked on at a later, proper time.

6.3.5 Instrument Selection

Field instruments and control valves shall be applicable to local environment and fluid conditions. Instruments and their enclosures, instrument tubing and installation materials shall be resistant to fluid and environment corrosion.

Electricals of instruments shall meet the requirements for explosion proof and protection grading of the installation location. Field instruments for explosion hazard areas shall be of intrinsic safety models while some of them may be of explosion proof types according to the requirements. Protection level shall not be lower than IP65 for outdoor instruments and IP55 for indoor products.

Advanced, reliable, maintenance free or easy to maintain instruments shall be selected. Instrument models shall be as identical with existing ones as possible to cut down instrument varieties.

Remote instruments shall be of electric types normally with smart transmitters.

Regulating valves shall select reliable imported products.

Diaphragms shall be used in pressure and differential pressure measurement for viscous, corrosive and prone to crystallization fluids. Material of diaphragm shall be selected according to fluid. Under special circumstance, isolation fluid or flush oil may be used.

Transmitters with diagnostic functions are preferred. When necessary, switch type instruments shall be used.

Calibration instruments: Except for special calibration instruments and maintenance tools for units, general calibration instruments and devices shall be considered on plant wide base. Proper addition according to practical needs based on existing equipment shall be made to meet the needs in repair and maintenance.

6.4 Automatic Control Plan for Process Unit

6.4.1 Main Automatic Control Plan for Process Unit

Automatic control system mainly executes data acquisition, monitoring, control, and safety interlock protection on processes of all units and implements computer data processing and production management to facilitate long term, safe, stable and effective operation of units so as to ensure product quality.

Automatic control system monitors and controls major process parameters of the units and transmits them to CCR for central display and recording. Normal parameters will be equipped with monitoring instruments for local display. Critical parameters will be equipped with acoustic and visual alarms in CCR. Critical units will be equipped with SIS to ensure safe production, cut down accident rate, avoid personnel and equipment damage, and mitigate economic loss.

Concentration sensors with alarms in unit control room and CCR will be installed at locations possible of flammable or toxic gas leakage.

6.4.2 Main Control Plan for Process Units

(1) 2,000KTPA ADU and 1,500KTPA VDU

1) Description of Control System

The 2,000KTPA ADU and 1,500KTPA VDU constitute a complex with flammable and explosive fluids requiring rigorous operation safety. Therefore, automatic control system shall not only have perfect control capabilities but also possess high reliability and high safety for

safe, reliable and long term operation of the units so as to improve reliability of the automatic control system, ensure safe production, promote operation management level and yield better economic returns from unit operation. According to the properties of the units and requirements for safe production, the following systems will be installed:

DCS

SIS

FGDS

AMS

A WRS will be installed to improve staff management.

a) The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 5 sets. Each operation station shall be equipped with separate electronic unit, display and key board.

- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

b) Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe and long term operation of the unit.

c) According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

2) Major control loops of the unit are as following:

- Cascade control of level in primary distiller bottom with crude flow rate through heat exchanger before desalting

- Cascade control of ADU top temperature with ADU overhead reflux

- Outlet temperature control of the heater will be in cascade with furnace chamber temperature to regulate fuel flow.

- Oxygen content control and furnace chamber vacuum control will be applied for ADU to improve heat efficiency of the heater.

3) Major interlock protection systems of the unit are as following:

- ADU interlock.

- VDU interlock.

Size of control points in the unit:

- DCS detection points about 800 and control loops about 150.

- SIS detection points about 160 and control loops about 40.

- FGDS detection points about 40.

(2) 700 KTPA Delayed Coking Unit

1) Description of the control system

Automatic control of 700KTPA Delayed Coking Unit consists of coking section, fractionation section and absorption and stabilization section. (Control design for compressor, HP water pump and hydraulic decoding system will be provided by the suppliers). Feed to the unit is VGO. Major products include gasoline, diesel, wax oil, coke, LPG, and dry gas. The unit features in high operation temperature and viscous, flammable, explosive, corrosive, and toxic process fluids with strict requirements for operation stability, safety, reliability, and product quality. Therefore, both software and hardware of the automatic control system must have high reliability, high safety and high tech. According to the properties of the unit and the requirements for safe production, the following control systems will be installed:

DCS

SIS

CCS

FGDS

AMS

A WRS will be installed to improve staff management.

The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 3 sets. Each operation station shall be equipped with separate electronic unit, display and key board.

- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe and long term operation of the unit.

According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

2) Major control loops of the unit are as following:

- Heater control

Outlet temperature of heater radiation section constitutes cascade control with furnace chamber temperature to control fuel gas to each section.

Flow controls will be installed on all 4 feeding streams to heater radiation section.

The heater will be equipped with zirconia oxygen analyzer to analyze and monitor oxygen content in flue gas as well as control air flow.

- A flow control will be installed on each steam injection for heater tubes.

Furnace chamber vacuum controls flue gas duct damper.

- Coke tower control

Temperature control of coke tower is conducted via a specific amount of quench oil

injected under control to stabilize temperature and pressure in coke tower.

In order to protect radiation furnace tubes from burning out due to local superheating and coking, surface thermocouples will be installed on tube walls to monitor tube temperature.

Armored thermocouples will be installed in the upper, middle and lower part of the coke tower to monitors surface temperature of the tower so as to indirectly reflect level in it.

Neutron level gauges will be installed in the upper, middle and lower part of the coke tower to measure level in it.

- Fractionator control

Fractionator top temperature constitutes cascade control with its overhead reflux flow. Refluxes of each section will be equipped with flow and temperature controls. Each oil collector will be equipped with a level control and double jacket level gauges.

Fractionator bottom level constitutes cascade control with inlet flow to convection section of the heater.

Fractionator top KO drum level constitutes cascade control with gasoline outlet flow from the unit.

3) Major interlock protection systems of the unit are as following:

- Upon low-low feed flow to heater and low-low pilot gas pressure, the interlock will open heater tube for steam purging, cut off heater feed, pilot gas supply and fuel gas feed, open heater chimney baffle, open heater bottom air duct, shut down flue gas draught fan, and shut down air blower.

- Upon fuel gas pressure low-low, cut fuel gas feed, open heater chimney baffle, open heater bottom air duct, shut down flue gas draught fan, shut down air blower, and manually switch bypass hater fuel feed.

- Upon flue gas preheater temperature high-high, draught fan inlet flue gas temperature high-high, draught fan inlet flue gas pressure high-high, open heater chimney baffle and shut down flue gas draught fan.

- Upon air blower outlet pressure low-low, open heater chimney baffle, open heater bottom air duct, shut down flue gas draught fan, and shut down air blower.

4) Hydraulic decoking unit will be equipped with a programmable control system as the automatic control system for the unit.

5) Compressor control system

6) Size of control points in the unit

DCS detection points about 600 and control loops about 100.

(3) 500 KTA Continuous Catalytic Reforming Unit

1) Description of the control system

Because the unit features in high temperature operating with hydrogen and catalyst regeneration must be converted from a hydrogen and nitrogen environment to an oxygen environment, the control system shall be advanced, proven and reliable. A distributed control system (DCS) will be used in the design to conduct central monitoring, control and management of the unit so as to ensure long term, safe production and stable operation and achieve the objective of reduce cost and improve benefits. According to the properties of the unit and the requirements for safe production, the following control systems will be installed:

DCS

SIS

CCS and RDAS

FGDS

AMS

Catalyst and regeneration unit will be equipped with dedicated control system provided by reformer licensor.

A WRS will be installed to improve staff management.

The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 4 sets. Each operation station shall be equipped with separate electronic unit, display and key board.

- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe

and long term operation of the unit.

According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

2) Major control loops of the unit are as following:

- Pressure control of reaction system

Pressure of the reaction system is a critical parameter in connection with stable unit operation, reaction performance and safety of people and equipment. Reaction system pressure (i.e., pressure in reforming product separation drum) will be set as a criterion of control, which will be combined with compressor anti-surge control system and venting control system into an advanced control system.

- Heater control

The heater will be equipped with oxygen analyzers to detect oxygen content in flue gas so as to improve heat efficiency.

The heater will be equipped with air fuel ratio control and air-fuel switch sequence logic control during heater turn-up and turndown to ensure complete combustion to minimize air pollution. In addition, a valve-down flameout control on fuel adjustment will be configured.

3) Major interlock protection systems of the unit are as following:

- Upon circulation hydrogen flow low-low, shut down all reforming reaction heaters and cut off reforming feed.
- Upon depentanizer reboiler feed flow low-low, shut down reboiler.
- Upon heater pilot fuel gas pressure low-low, shut down heater.

4) Control system for catalyst and regeneration unit

Catalyst and regeneration process is critical to the operation of high vacuum and high severity continuous catalytic reforming process. It applies a catalyst regeneration control system. Its control and interlock protection belongs to patent technology of licensor, which will be strictly followed during implementation.

5) Size of control points in the unit

DCS detection points about 650 and control loops about 80.

SIS detection points about 85 and control loops about 24.

FGDS detection points about 120.

CCS detection points about 330 and control loops about 10.

(4) 1,300 KTPA Diesel Hydrofining Unit

1) Description of the control system

Besides continuous operation and flammable, explosive, corrosive and hazard fluids common in petrochemical units, reaction section of the unit also features in high temperature, medium pressure and hydrogen presence. Selection and installation of instruments and electrical shall be in line with the process properties of the unit to ensure uninterruptable, safe and reliable operation so as to achieve safe production, promote operation management and better improve unit operation benefits. According to the properties of the unit and the requirements for safe production, the following control systems will be installed:

DCS

SIS

CCS and RDAS

FGDS

AMS

A WRS will be installed to improve staff management.

a) The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 3 sets. Each operation station shall be equipped with separate electronic unit, display and key board.

- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

b) Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic

operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe and long term operation of the unit.

c) According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

d) CCS

According to the practical needs of diesel section of the unit, circulation hydrogen compressor package will be equipped with a special compressor control system (CCS) to execute load control, process control and interlock protection functions. The system is capable of communication with DCS. CCS will apply TMR or DMR redundant and fault tolerant system and use special application software with event sequence recording function. CCS will be supplied by compressor package supplier.

CCS shall communicate with DCS. CCS operation shall be monitored on DCS displays. Signal transmission between CCS and DCS will use RS485, Modbus RTU communication protocol.

2) Major control loops of the unit are as following:

- Feed stock buffer drum will be equipped with level – flow rate cascade control. Nitrogen purging system will use pressure split range control.

- Hydrogenation feed heater outlet temperature cascades with fuel gas pressure.

- Hydrogenator will be equipped with multiple thermocouples to detect reactor bed temperature. Hydrogenation feed heater will be equipped with furnace tube surface temperature detection thermocouples.

- Heater will be equipped with chamber vacuum control and zircornia oxygen analyzer for flue gas to control heater combustion efficiency.

- Fractionator will be equipped with pressure control, overhead temperature cascading with reflux flow and bottom level cascading with product flow at the outlet of the unit to ensure product quality and stable fractionators operation.

- Pressure control of hydrogenation system will use low value selection through the adjustment of reflux to fresh hydrogen compressor.

- Where flammable gas and H2S leakage or accumulation is possible, flammable gas and H2S content detection transmitters shall be installed with central display and alarm in CCR.

3) Major interlock protection systems of the unit are as following:

- Heater fuel gas pressure low-low and heater chamber pressure extra high interlocks.
- Circulation hydrogen compressor inlet KO drum high-high interlock.
- Compressor package safety interlock protection system.

4) Size of control points in the unit

DCS detection points about 500 and control loops about 60.

SIS detection points about 200.

FGDS detection points about 50.

(5) 550 KTA Naphtha Hydrotreating Unit

1) Description of the control system

Besides continuous operation and flammable, explosive, corrosive and hazard fluids common in petrochemical units, reaction section of the unit also features in high temperature, medium pressure and hydrogen presence. Selection and installation of instruments and electrical shall take this into consideration to ensure long term and safe operation, minimize process operators and instrument maintenance staff so as to improve system reliability, achieve safe production, promote operation management and better improve unit operation benefits. According to the properties of the unit and the requirements for safe production, the following control systems will be installed:

DCS

SIS

CCS

FGDS

AMS

WRS

a) The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 2 sets. Each operation station shall be equipped with separate electronic unit, display and key board.
- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

b) Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe and long term operation of the unit.

c) According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

2) Major control loops of the unit are as following:

- Feed stock buffer tank fuel sealing system uses pressure split range control.

- Hydrogenation feed heater outlet temperature cascades with fuel gas pressure.

- Hydrogenator will be equipped with multiple thermometers to detect reactor bed temperature. Hydrogenation feed heater will be equipped with furnace tube surface temperature detection thermocouples.

- Heater will be equipped with chamber vacuum control and zircornia oxygen analyzer for flue gas to improve heater combustion efficiency.

- Fractionator will be equipped with pressure control, overhead temperature cascading with reflux flow and bottom level cascading with partial naphtha product flow at the outlet of the unit to ensure product quality and stable fractionators operation.

- Where flammable gas and H2S leakage or accumulation is possible, flammable gas and H2S content detection transmitters shall be installed with central display and alarm in CCR.

3) Major interlock protection systems of the unit are as following:

- Heater fuel gas pressure low-low and heater chamber pressure extra high interlocks.

- Circulation hydrogen compressor inlet KO drum high-high interlock.

- Circulation hydrogen compressor safety interlock protection system.

4) Scope of supply for instruments and control systems supplied with equipment packages

Instruments for compressor package will be supplied with the equipment.

5) Size of control points in the unit

DCS detection points about 580 and control loops about 50.

SIS detection points about 200 and control loops about 60.

FGDS detection points about 30.

(6) 900 KTA hydrocracking unit

1) Description of the control system

The unit features in complex process technology with flammable and explosive fluids requiring rigorous operation safety. Therefore, automatic control system shall not only have perfect control capabilities but also possess high reliability and high safety for safe, reliable and long term operation of the units so as to improve reliability of the automatic control system, ensure safe production, promote operation management level and yield better economic returns from unit operation. According to the properties of the unit and the requirements for safe production, the following control systems will be installed:

DCS

SIS

CCS

FGDS

AMS

A WRS will be installed to improve staff management.

a) The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 4 sets. Each operation station shall be equipped with separate electronic unit, display and key board.

- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets

will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

b) Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe and long term operation of the unit.

c) According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

d) CCS

Circulating hydrogen compressor package will be equipped with a special compressor control system (CCS) to execute governing, anti-surge control, load control, process control, and interlock protection functions. The system is capable of communication with DCS. CCS will apply TMR or DMR redundant and fault tolerant system and use special application software, e.g., RPM control and anti-surge control with event sequence recording function. CCS will be supplied by compressor package supplier.

CCS shall communicate with DCS. CCS operation shall be monitored on DCS displays. Signal transmission between CCS and DCS will use RS485, Modbus RTU communication protocol.

e) RDAS

RDAS will be used in online monitoring of rotary equipment, e.g., circulating hydrogen compressor and will conduct analysis and diagnostic on equipment performance.

Major parameters to be monitored for rotary equipment include shaft vibration, shaft displacement, phase, and rotational speed. Operators may directly read rotary equipment data from the online monitoring equipment.

Signal input and data processors for equipment analysis and diagnostic will be installed in CCR. Equipment operation engineer may conduct online diagnostics and analysis on equipment operation performance.

RDAS will hardwire any data participating interlock protection to CCS. Other parameters will be communicated to CCS.

f) Equipment package control system (PLC)

PLC system for small but independent equipment, e.g., feed oil filter and circulating hydrogen compressor inlet coalescer will usually be supplied with equipment packages. Such system will be usually installed in local explosion proof and weather proof control panels (cabinets) and communicate with DCS via redundant serial communication interface with MODBUS protocol.

2) Major control loops of the unit are as following:

- Feed rate control

A level-flow rate cascade ratio control plan will be configured according to feeding property of the unit.

- Pressure control for reaction system

Benchmark pressure control point of reaction system is configured on circulating hydrogen compressor inlet KO drum to control reaction system pressure through control of fresh hydrogen makeup rate.

- Reactor temperature control

Reactor inlet temperature is controlled through the control of outlet temperature of reactor feed heater, while reactor bed temperature will be controlled by the flow rate of hydrogen injected via cold hydrogen injection point of the reactor.

- Level monitoring and control of thermal high pressure separator

Based on the rigorous conditions of high temperature and high pressure in the thermal high pressure separator:

Multiple level detection and protection (differential pressure and high pressure magnetic float level field observation) measures will be configured to ensure highly reliable and stable level control for the thermal high pressure separator.

- Level and interface monitoring and control of cold high pressure separator

Its level and interface will be controlled by the openness of the high pressure/high pressure drop regulating valve. Double level control valves will be configured.

Based on the operation conditions of cold high pressure separator, multiple level detection and protection (HP buoy level gauge control, HP level switch interlock protection and high pressure magnetic float level field observation) measures will be configured to ensure stable control of level and interface in the HP separator.

- Stripper bottom level control

Stripper bottom level cascades with fractionators feed flow rate. Advantages of the plan is when stripper bottom level fluctuates within permissible range, fractionators feed flow rate will be controlled according to fixed rate so as to ensure stable operation of upstream and downstream processes.

3) Major interlock protection systems of the unit are as following:

- Emergency relieving safety interlock system.
- Reaction feed heater safety interlock system.
- Fractionation feed heater safety interlock system
- Hydrogenation feed pump safety interlock system.
- Lean solvent pump safety interlock system.
- Fresh hydrogen compressor safety interlock system.

4) Size of control points in the unit

DCS detection points about 900 and control loops about 150.

SIS detection points about 260 and control loops about 50.

FGDS detection points about 50.

(7) 150 KTA Isomerization Unit

1) Description of the control system

The unit features in complex process technology with high product quality requirements. In order to ensure safe, stable, long term, full load, and high quality operation of the unit, it is required to use new generation distributed control system (DCS) to control, monitor, record, and alarm the whole unit. Operation status of major compressors and pumps will be displayed via DCS. In order to ensure unit and operator safety and safe operation, the following control systems will be installed according to the properties of the unit and the requirements for safe production:

DCS

SIS

CCS

FGDS

AMS

A WRS will be installed to improve staff management.

a) The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 2 sets. Each operation station shall be equipped with separate electronic unit, display and key board.

- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

b) Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe and long term operation of the unit.

c) According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

2) Major control loops of the unit are as following:

Most control loops in the unit will use proven single loop fixed set point control with special controls as following:

- Reaction feed heater outlet temperature cascades with fuel gas pressure.

- Isomerization reactor will be equipped with multiple thermometers to detect bed temperature. Feed heater will be equipped with furnace tube surface temperature detection thermocouples.

- Heater will be equipped with chamber vacuum control and zircornia oxygen analyzer for flue gas to control heater combustion efficiency.

- Stabilizer will be equipped with overhead pressure control and bottom level control. Stabilizer reflux drum level cascades with reflux flow to ensure stable operation of the tower.

- Where flammable gas and H2S leakage or accumulation is possible, flammable gas

and H2S content detection transmitters shall be installed with central display and alarm in CCR.

3) Major interlock protection systems of the unit are as following:

- Upon upsetting in reaction section, emergency venting and relieving interlock system will be initiated.
- Heater fuel gas pressure low-low and heater chamber pressure extra high interlocks.
- Circulation hydrogen compressor inlet KO drum high-high interlock.
- Circulating hydrogen compressor safety interlock protection system.

4) Size of control points in the unit

DCS detection points about 150 and control loops about 30.

SIS detection points about 80 and control loops about 20.

FGDS detection points about 30.

(8) 25 KTA H_2 Production unit

1) Description of the control system

Fluids in the unit feature in flammable and explosive requiring advanced, proven and reliable control system. Therefore, PC based DCS will be used to conduct central management and distributed control of the whole unit so as to improve system reliability and to facilitate operation optimization during normal production as well as long term, safe and stable operation. According to the properties of the unit and the requirements for safe production, the following control systems will be installed:

DCS

SIS

CCS

FGDS

AMS

A WRS will be installed to improve staff management.

a) The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 3 sets (for H2 Production and PSA). Each operation station shall

be equipped with separate electronic unit, display and key board.

- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

b) Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe and long term operation of the unit.

c) According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

d) CCS is responsible for interlock protection of the package and communication with DCS. It shall be supplied by the compressor supplier with the package.

2) Major control loops of the unit are as following:

- Reformer water/carbon ratio control: A water/carbon ratio control will be configured for steam flow rate and feed gas flow rate into the reformer. Total carbon value of the feed gas will be analyzed on real time by an online analyzer and be determined against feed gas flow rate in DCS.

- Reformer outlet temperature control: Reformer outlet temperature adjustment will be done by a cascade control between reformer outlet reforming gas temperature and fuel gas (primary stream and secondary stream) flow rate. During H2 Production unit startup, temperature of reforming gas leaving the reformer cascades with system secondary fuel gas. When PSA gas is switched in, temperature of reforming gas leaving the reformer will cascade with the primary fuel gas stream. Switching of both conditions above will be executed by switches.

- Steam system control: Waste heat boiler in the steam system will be controlled by

boiler level, boiler feed water flow rate and boiler steam flow rate.

- Load and temperature management system: H2 Production capacity will be managed via feed gas flow rate, steam flow rate, reformer air and fuel supply adjustment, maintaining stable reformer water/carbon ratio, and reforming gas temperature adjustment.

- PSA outlet will be equipped with an online hydrogen content analyzer.

- Where flammable (toxic) gas leakage is possible, e.g., blow down points and pump station, flammable (toxic) gas detectors with display and alarm in CCR will be installed.

3) Major interlock protection systems of the unit are as following:

- Compressor shaft temperature high-high, lub oil pressure low-low and machinery vibration interlock protection will initiate SIS to trigger a compressor shutdown.

4) Size of control points in the unit

DCS detection points about 400 and control loops about 65.

SIS detection points about 200 and control loops about 100.

FGDS detection points about 50.

(9) Sulfur Recovery Unit

1) Description of the control system

The unit consists of acid water stripping, solvent regeneration and sulfur recovery sections. It is an environmental protection unit with its social benefits far bigger than its economic benefits. Only its safe, stable and long term operation will ensure emission method and concentration of major pollutants, especially sulfur, SO2 and other sulfur compounds from the refinery meet national air pollutants emission environmental protection standard.

The unit features in advanced and complex process with toxic, flammable and explosive process fluids. Any accidents during operation would result in injuries. Therefore, there are strict requirements for the reliability and automatic level of field instruments and control system. Automatic instruments selected shall be reliable in quality, advanced in technology, reasonable in economy and stable in performance with proven application experience and technical support to meet the requirements of the unit for automatic instruments. According to the properties of the unit and the requirements for safe production, the following control systems will be installed:

DCS

SIS

CCS and RDAS

FGDS

AMS

A WRS will be installed to improve staff management.

a) The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 4 sets. Each operation station shall be equipped with separate electronic unit, display and key board.

- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

b) Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe and long term operation of the unit.

c) According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

2) Major control loops of the unit are as following:

- Ratio control system

According to sulfur conversion principle, when the ratio of H2S and SO_2 in process gas from the combustion furnace is controlled at 2:1 under proper air supply, element sulfur yield in the converter will be the highest. The ratio control system allocates air supply according to the chemical equivalent of feed acid gas volume, i.e., conducts acid gas and air ratio control. Because H_2S in acid gas varies during operation, error of ratio control system is inevitable, a

quality control system is configured besides the ratio control system to maintain H_2S/ SO_2 ratio.

Air volume adjustment in the program is divided into two parts: The first is the ratio control system to adjust air volume according to acid gas volume to regulate acid gas/air ratio. The second is the cascade adjustment system between H_2S/SO_2 online ratio analyzer and air volume for the correction of air and acid gas proportion to ensure close H_2S/SO_2 ratio during operation.

- Combustion furnace blower applies typical anti-surge control.
- Primary condensing cooler applies double impulse control, i.e., steam flow rate and level to control water supply valve.
- MP steam drum of waste heat boiler for acid gas combustion furnace applies triple impulse control.
- Tail gas incinerator chamber temperature cascades with fuel gas pressure.
- Hydrogenation type acid water stripping feed water pump outlet flow constitutes ratio control with primary stripper side line total purification water flow and primary stripper stripping steam flow.
- Hydrogenation type primary stripper overhead pressure cascades with side line acid water flow.
- Hydrogenation type primary stripper overhead temperature difference cascades with acid gas pressure.
- Non hydrogenation type primary stripper overhead hot feed constitutes ratio control with primary stripper steam flow.
- Solvent regenerator rich solution flow constitutes ratio control with regenerator bottom heating steam flow.
- Solvent regenerator overhead reflux drum level cascades with overhead reflux flow.

3) Major interlock protection systems of the unit are as following:

- SRU shutdown.
- Fan shutdown.
- Liquid sulfur deaeration shutdown.
- Tail gas treatment shutdown.

Size of control points in the unit

DCS detection points about 500 and control loops about 120.

SIS detection points about 120 and control loops about 90.

FGDS detection points about 60.

(10) Dry Gas / LPG Treatment Unit

1) Description of the control system

The unit consists of dry gas scrubbing and LPG Treatment sections according to process with flammable, explosive, toxic and corrosive process fluids. Only stable and long term operation of the unit would ensure on-spec emission methods and concentration of major pollutants from refineries. Therefore, control systems and filed instruments designed shall be advanced in technology, proven and reliable to meet the requirements for continuous operation. According to the properties of the unit and the requirements for safe production, the following control systems will be installed:

DCS

FGDS

AMS

A WRS will be installed to improve staff management.

a) The unit will be equipped with a DCS to conduct central control and management for it.

DCS hardware configuration: The feasibility study will not select specific DCS, but specifies the following requirements for configuration:

- Operation stations: 2 sets. Each operation station shall be equipped with separate electronic unit, display and key board.

- Engineering stations will be used in system configuration and online system maintenance.

- Control stations, monitoring stations, safety barrier cabinets, and terminal cabinets will be separately configured according to the needs of control and monitoring points.

- Engineering stations, alarm printers and report printers will be configured according to the needs of plant wide control system.

b) Separate SIS compatible with safety rating of units will be installed according to the requirements of design specifications. System size will be determined according to actual number of points. Safety and reliability will be the top priority of SIS, safety level of which will meet the requirements of that of the unit. Design of SIS will incorporate system integrity, safety, reliability, automatic and semi-automatic operation flexibility, and safety and convenience in system maintenance to make a safe and convenient system so as to ensure safe and long term operation of the unit.

c) According to the requirements of design specifications, sufficient flammable gas and toxic gas detection sensors shall be installed according to the distribution of leakage sources from units. Data from the sensors shall be connected with flammable gas and toxic gas detection and alarm system (FGDS) of individual units for comprehensive monitoring on leakage of flammable gas and toxic gas from the units in CCR.

2) Major control loops of the unit are as following:

- Product outlet pressure control.
- LPG scrubbing tower interface control and caustic solution circulation flow rate control.
- Water scrubbing circulation flow rate control.
- Where flammable gas and H_2S leakage or accumulation is possible, flammable gas and H2S content detection transmitters shall be installed with central display and alarm in CCR.

3) Size of control points in the unit

DCS detection points about 300 and control loops about 40.

FGDS detection points about 25.

6.4.3 Instrument selection and scope of package supply

Describe scope of detection and control instruments for the unit and specify instrument types. Specify technical requirements and scope of manufacturer supply of instruments and control systems for package process equipment.

Select proper instruments of reliable performance, advanced technology, reasonable price, and satisfactory after-sale service and technical support from famous global manufacturers.

Smart field instruments using 4～20mA DC standard signals and compatible with HART protocol are preferred.

Intrinsic safe instruments with explosion proof rating not lower than iaIICT4 are preferred for hazardous areas. When intrinsic safe instruments are not available, explosion proof models with explosion proof rating not lower than dIICT4 may be used. ON/OFF instruments will be of explosion proof types.

Control system will use new generation DCS of current configuration.

SIS comprising redundant/fault tolerant PLCs shall be of accident safe type and independent from DCS.

Based on the principle of fewer but better and not choosing at random, configuration of

online analyzers shall be in line with process requirements of each unit and the requirements of the customer.

Surge protector shall use imported products.

Safety barriers shall be of isolation types.

6.4.3.1 2,000KTPA ADU and 1,500 KTPA VDU

Most field instruments in the unit will be of intrinsic safe models and some will be of explosion proof types.

All temperature, pressure and differential pressure transmitters will be of smart types.

Differential pressure type flow meters are preferred in flow measurement. Mass flow meters are preferred for the measurement of major materials at unit BL/plant boundary. Flow rate measurement for high temperature and viscous fluid (temperature ≥200℃) will use wedge type flow meters. Flow rate measurement for medium and low temperature viscous fluid (temperature < 200℃) will use target flow transmitter. Flow rate measurement of steam and fuel gas at the inlet of the unit and blower will use averaging pitot tube flow meter.

Level gauges will normally use differential pressure or flange type differential pressure transmitters. For small range levels, electric external buoy or pneumatic external buoy level gauges will be used.

Normally regulating valves to be used include cage type regulating valves, pneumatic piston cutoff valve, pneumatic long travel actuator, and self powered regulating valve. Regulating valves for high flow viscous oil fluid usually use eccentric rotary valves.

Thermocouples in heater tube wall will be of double edge models.

Online analyzers: Naphtha dry point analyzers, online pH meters and zirconia analyzers for heater flue gas will be installed according to process requirements.

Safety detection instruments: Where flammable gas leakage is possible, e.g., blow down points, compressor room and pump station, flammable gas detectors will be installed with signals transmitted to CCR for display and alarm in FGDS.

Input safety barriers for temperature adjustment loops will use isolation types with temperature transmitting functions.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

6.4.3.2 700 KTPA Delayed Coking Unit

Most field instruments in the unit will be of intrinsic safe models and some will be of explosion proof types.

Temperature measurement instruments: Double metal thermometers will be used for field temperature measurement. Special enclosed thermometer protection thermowells shall be used for field temperature measurement at HP locations.

Remote temperature signals will be equipped with thermocouples. Temperature measurement of compressors will usually use RTD. Heater tube surface temperature measurement will use knife type armored thermocouples. Column wall surface temperature will be measured by armored surface thermocouples, thermowell material of which will be determined according to temperature to be measured.

Pressure gauges: Normally, bourdon tube pressure gauges will be used. Stainless steel safe pressure gauges will be used at HP points. Diaphragm type micro pressure gauges will be used in furnace chamber pressure detection. Remote pressure signals will be transmitted by pressure transmitters or DP transmitters. Diaphragm type products shall be used for viscous, corrosive and crystalline fluids. Outlet of power equipment or other locations with vibration shall use vibration proof pressure gauges.

Flow meters: Normally, throttling devices with DP transmitters will be used. Measurement of critical flow rate for materials entering/leaving unit will be done by volumetric or mass flow meters. Large size water flow measurement entering unit will use electromagnetic flow meters. Small pipes or clean fluids will be measured by metal tube float flow meter. Flow rate of viscous fluids will be measured by wedge type flow meters or target flow meters.

Level (interface) gauges: Local measurement will use quartz tube level gauges. Wide range measurement will use magnetic float level (interface) gauges. Wide range remote level measurement will use double flange DP transmitters. Elevated water tanks will be equipped with radar level gauges. Critical or interlocked level measurements will use float ball level switches.

Selection of actuators

- Pneumatic diaphragm regulating valves are normally used. Regulating valves for HP and high differential pressure locations shall use imported products. Regulating valves for high differential pressure locations shall use high pressure drop resistant, vacuum proof and low noise regulating angle valve. Eccentric rotary valves, angle valves or T regulating valves shall be selected according to fluids or process requirements.

- Cutoff valves for interlocks shall use tight closure single cylinder ON/OFF ball valves equipped with single electric solenoid valves and valve position transponders.

Temperature, pressure and DP transmitters: Use smart transmitters.

Online analyzers: Use imported zirconia oxygen analyzer to measure oxygen content of flue gas in furnace chamber.

Safety barriers: Use isolating type safety barriers.

Safety instruments: Flammable gas detectors and toxic gas transmitter sensors shall be installed in unit area with signals sent to CCR.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

Supporting instruments and control system for packaged process equipment:

- Design of control systems for compressors, HP water pumps and hydraulic decoking will be provided by supplier.

6.4.3.3 500 KTA Continuous Catalytic Reforming Unit

Advanced, reliable and easy to install and operate instruments will be selected for the unit according to process conditions and requirements. Electric instruments will be of intrinsic safe or explosion proof models in line with explosion proof rating of process atmosphere. Measurement elements exposed to corrosive fluids will use corrosion resistant materials. Metering gauges of different accuracies meeting industrial standards will be selected according to different effluent requirements.

Local temperature indication will use directional double metal thermometers. Remote temperature indication or control will use E or K type thermocouples according to IEC standard.

Temperature measurement usually uses retractable armored thermocouples. Temperature measurement for regenerator will use flexible thermocouples. Surface temperature measurement for equipment or pipelines will use surface thermocouples. Armored thermocouples will be used in reactor.

For temperature measurement points in heater and regenerator, multiplex field collectors with communication bus connections with DCS will be used for temperature indication.

Thermocouples in heater tube wall will be of double edge models.

Local pressure indication will use pressure gauges. Vacuum indication will use capsule pressure gauges. Remote pressure indication and control will use pressure transmitters. Interlock and alarm will use pressure switches.

Flow rates are usually measured by flanged standard throttling elements with DP transmitters. Mass flow meters are preferred for the measurement of major materials at unit

BL. Flow rate measurement for high temperature and viscous fluid (temperature ≥200℃) will use wedge type flow meters. Flow rate measurement for medium and low temperature viscous fluid (temperature < 200℃) will use target flow transmitter. Flow rate measurement of steam and fuel gas at the inlet of the unit and blower will use averaging pitot tube flow meter. Flow rate indication for nitrogen back purge to instrument measurement pulse line will use local glass rotameter. Metal rotameters will be used for locations only requiring field indication and CCR alarm.

Local level indication will use double color level glass. Remote measurement will use double flange DP transmitters and buoy level/interface transmitters. Interlock and alarm will use level switches. Level measurement for catalyst in regenerator will use radioactive level gauge, radioactive level switch and capacitor level gauge.

In order to reduce energy consumption, improve heater heat efficiency, zirconia oxygen analyzers will be used in heater chamber and flue gas duct.

Where necessary, hydrogen, oxygen and water analyzers will be installed.

Flammable gas alarms will be installed at location where flammable gas leakage is possible.

Pneumatic and cylinder type actuators will be used. Single or double seat regulating valve, angle valve, butterfly valve, eccentric rotary valve, and ball valves shall be selected according to requirements of different process parameters. Special ball valves and V-notched ball valves or special rotary valves will be used in catalyst pipelines. Large size gas control will use butterfly valve. Large flow and viscous oil fluids will use eccentric rotary regulating valve.

Input safety barriers for temperature adjustment loops will use isolation types with temperature transmitting functions.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

Supporting instruments and control system for packaged process equipment:

- Interlock hopper control system (patent control equipment).
- Catalyst regeneration control and interlock protection system (patent control equipment).

6.4.3.4 1,4 000KTPA kerosene and diesel hydrofining unit

Most field instruments in the unit will be of intrinsic safe models and some will be of

explosion proof types.

All temperature, pressure and differential pressure transmitters will be of smart types.

Armored RTDs/thermocouples are preferred in remote temperature measurement. Flexible thermocouples will be used in reactor bed temperature measurement. Surface thermocouples will be used in equipment and pipeline surface temperature measurement.

DP flow meters are preferred in flow measurement. Vortex flow meters, electromagnetic flow meters, mass flow meters, averaging pitot tube flow meters, and ultrasonic flow meters may also be selected according to requirements. Mass flow meters shall be used for major process materials at unit BL and flow requiring accurate measurements.

Level measurement with range less than 1500 mm will usually use external buoy type level transmitters. Buoy type level transmitters, magnetic float level gauges and level glasses usually use domestic products. Level gauges with proper certified safety ratings will be used at critical, HP or interlocked high/low level detection and control points. Level measurement for wide range HP vessels will use HP double flange level transmitters and narrow range HP vessels will use HP buoy level transmitters.

Circulating hydrogen compressor inlet pipeline will be equipped with online hydrogen analyzer.

Regulating valves use pneumatic diaphragm actuators normally with straight run valve bodies. Angle regulating valves are used at HP and high pressure drop applications. Regulating valves are usually equipped with smart electric/pneumatic valve positioners.

Input safety barriers for temperature adjustment loops will use isolation types with temperature transmitting functions.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

Design principle for F & G system: Separate from DCS and SIS and capable of communication with DCS.

Safety barriers: Use isolation type safety barriers.

Scope of instruments and control system to be supplied with equipment packages.

Instruments for compressor package will be supplied with the equipment package.

6.4.3.5 550 KTA Naphtha Hydrotreating Unit

Most field instruments in the unit will be of intrinsic safe models and some will be of

explosion proof types.

All temperature, pressure and differential pressure transmitters will be of smart types.

Differential pressure type flow meters are preferred in flow measurement. Mass flow meters are preferred for the measurement of major materials at unit BL/plant boundary. Flow rate measurement for high temperature and viscous fluid (temperature ≥200℃) will use wedge type flow meters. Flow rate measurement for medium and low temperature viscous fluid (temperature < 200℃) will use target flow transmitter. Flow rate measurement of steam and fuel gas at the inlet of the unit and blower will use averaging pitot tube flow meter.

Level gauges will normally use differential pressure or flange type differential pressure transmitters. For small range levels, electric external buoy or pneumatic external buoy level gauges will be used.

Normally regulating valves to be used include cage type regulating valves, pneumatic piston cutoff valve, pneumatic long travel actuator, and self powered regulating valve. Regulating valves for high flow viscous oil fluid usually use eccentric rotary valves.

Thermocouples in heater tube wall will be of double edge models.

Online analyzers: Naphtha dry point analyzers, online pH meters and zirconia analyzers for heater flue gas will be installed according to process requirements.

Safety detection instruments: Where flammable gas leakage is possible, e.g., blow down points, compressor room and pump station, flammable gas detectors will be installed with signals transmitted to CCR for display and alarm in FGDS.

Input safety barriers for temperature adjustment loops will use isolation types with temperature transmitting functions.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

6.4.3.6 900 KTA Hydrocracking Unit

Most field instruments in the unit will be of intrinsic safe models and some will be of explosion proof types.

All temperature, pressure and differential pressure transmitters will be of smart types.

Thermometers: Thermocouples will be armored single type with K graduation in line with IEC. Reactor with be equipped with multiple point thermocouples. Surface temperature measurement for furnace tube will use knife type devices. High temperature and high pressure

(over 1500#) will use special thermocouples with thermowells. Multiple point thermocouples manufactured according to licensor requirements will be used for reactor beds.

Pressure and pressure differential switches shall use products of reliable technology.

Accuracy requirements for metering instruments: Grade 1.0-1.5 within unit, Grade 0.5-1.0 at unit BL and Grade 0.2 at plant BL. Volumetric flow meters will be used for major liquid feeds and products at unit BL and mass flow meters for other fluids.

Level gauges: Transparent level glasses will be used. Central measurement will use external buoy, DP and radar level gauges or level switches.

Analyzers: Online circulating hydrogen content analyzer and flammable gas and toxic gas alarm. Online H_2S content analyzer.

Actuators: Regulating valves will be equipped with pneumatic actuators. Electric/pneumatic valve positioners will be used. Regulating valves will be used for high temperature, HP, and high pressure drop locations of ANSI1500# and above. Cutoff valves/vent valves for automatic protection will be used in SIS.

Input safety barriers for temperature adjustment loops will use isolation types with temperature transmitting functions.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

Design principle for F & G system: Separate from DCS and SIS and capable of communication with DCS.

Safety barriers: Use isolation type safety barriers.

Scope of instruments and control system to be supplied with equipment packages.

Instruments for compressor package will be supplied with the equipment package.

6.4.3.7 150 KTA Isomerization Unit

Most field instruments in the unit will be of intrinsic safe models and some will be of explosion proof types.

All temperature, pressure and differential pressure transmitters will be of smart types.

Heater will be equipped with zirconia oxygen analyzers.

Mainly pneumatic diaphragm type actuators will be used. Single or double seat regulating valves shall be selected according to different process conditions.

Differential pressure type flow meters are preferred in flow measurement. Mass flow meters are preferred for the measurement of major materials at unit BL/plant boundary. Flow rate measurement for high temperature and viscous fluid (temperature ≥200℃) will use wedge type flow meters. Flow rate measurement for medium and low temperature viscous fluid (temperature < 200℃) will use target flow transmitter. Flow rate measurement of steam and fuel gas at the inlet of the unit and blower will use averaging pitot tube flow meter.

Level gauges will normally use differential pressure or flange type differential pressure transmitters. For small range levels, electric external buoy or pneumatic external buoy level gauges will be used.

Thermocouples in heater tube wall will be of double edge models.

Online analyzers: Zirconia analyzers for heater flue gas will be used according to process requirements.

Safety detection instruments: Where flammable gas leakage is possible, e.g., blow down points, compressor room and pump station, flammable gas detectors will be installed with signals transmitted to CCR for display and alarm in FGDS.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

6.4.3.8 25 KTA H_2 Production Unit

Most field instruments in the unit will be of intrinsic safe models and some will be of explosion proof types.

All temperature, pressure and differential pressure transmitters will be of smart types.

Field pressure indication shall use flange type diaphragm pressure gauge. Pressure measurement for remote display in CCR will use pressure transmitters. Pressure measurements for fluids with suspended matter and solid particles or crystalline and viscous fluids will use flange type remote pressure transmitters.

Metering of critical liquid materials at unit BL will use mass flow meters.

Large water pipes will use ultrasonic flow meters.

Common flow measurements will use standard throttling devices. Steam will be measured by nozzles.

Large size control valves will be of butterfly types.

Level meters usually use double flange type remote transmitters or guided wave electric

radar level transmitters. Field level indication usually uses magnetic flap type level gauges or quartz tube color level gauges. Level switches are normally of tuning fork or float types.

Major actuators used in the unit include pneumatic regulating valves for continuous control and pneumatic valves for on/off control (including on/off pneumatic ball valves and on/off pneumatic control gate valves). Pneumatic regulating valves usually use pneumatic diaphragm actuators with valve positioners or electric transducers. Automatic interlock valves use cylindrical O type ball valve. On/off pneumatic ball valves shall be equipped with solenoid valves and limiting switches.

Online analyzers: Zirconia oxygen analyzers for oxygen content in heater flue gas will be installed according to process requirements.

Safety detection instruments: Where flammable gas leakage is possible, e.g., blow down points, compressor room and pump station, flammable gas detectors will be installed with signals transmitted to CCR for display and alarm in FGDS.

Input safety barriers for temperature adjustment loops will use isolation types with temperature transmitting functions.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

Instruments to be supplied with equipment packages.

Some equipment, e.g., blowers and heaters in the unit will be equipped with baffle valves. Automatic controls will be equipped with proper actuators.

PSA supporting instruments will be supplied with equipment packages.

6.4.3.9 Sulfur Recovery Unit

Most field instruments in the unit will be of intrinsic safe models and some will be of explosion proof types.

All temperature, pressure and differential pressure transmitters will be of smart types.

Local temperature measurement instrument will use double metal thermometers. Remote temperature measurement element will use IEC thermometers and multi-point armored thermocouples.

Temperature measurement in sulfur production furnace will use special online infrared thermometers.

Differential pressure type flow meters are preferred in flow measurement. Mass flow

meters are preferred for the measurement of major materials at unit BL/plant boundary.

Local level indication will use level glasses. Remote level gauges will use buoy electric level transmitters or single/double flange smart level transmitters.

Analyzers: H_2S/SO_2 ratio analyzers and hydrogen concentration analyzers will be installed according to process requirements.

Regulating valves will be of cylindrical butterfly or pneumatic diaphragm models. Cutoff valves for interlock and automatic protection systems will use pneumatic cutoff valves or hard seal pneumatic metal cutoff butterfly valves.

Input safety barriers for temperature adjustment loops will use isolation types with temperature transmitting functions.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

Design principle for F & G system: Separate from DCS and SIS and capable of communication with DCS.

Safety barriers: Use isolation type safety barriers.

Scope of instruments and control system to be supplied with equipment packages.

Instruments for compressor package will be supplied with the equipment package.

6.4.3.10 Dry Gas / LPG Scrubbing Unit

Most field instruments in the unit will be of intrinsic safe models and some will be of explosion proof types.

All temperature, pressure and differential pressure transmitters will be of smart types.

Local temperature measurement instrument will use double metal thermometers. Remote temperature measurement elements will use IEC thermometers and multi-point armored thermocouples.

Temperature measurement in sulfur production furnace will use special online infrared thermometers.

Differential pressure type flow meters are preferred in flow measurement. Mass flow meters are preferred for the measurement of major materials at unit BL/plant boundary.

Local level indication will use level glasses. Remote level gauges will use buoy electric level transmitters or single/double flange smart level transmitters.

Analyzers: H_2S/SO_2 ratio analyzers and hydrogen concentration analyzers will be installed according to process requirements.

Regulating valves will be of cylindrical butterfly or pneumatic diaphragm models. Cutoff valves for interlock and automatic protection systems will use pneumatic cutoff valves or hard seal pneumatic metal cutoff butterfly valves.

Input safety barriers for temperature adjustment loops will use isolation types with temperature transmitting functions.

In order to meet the high requirements of process for automatic control systems, world advanced, proven and reliable DCS will be used in the unit.

SIS shall be product certified by corresponding international safety qualification organizations. Safety rating of the systems selected shall not be lower than that of process unit.

Design principle for F & G system: Separate from DCS and SIS and capable of communication with DCS.

Safety barriers: Use isolation type safety barriers.

6.4.4 Selection of major instruments and equipment

List of major instruments and equipment divided into domestic procurement and offshore procurement are attached below.

The following illustrates selection and scope of supply for instruments and control systems for grass root units. I/O points for DCS and SIS will be calculated with 15% margin. A large DCS will be used with operation stations configured according to process unit configuration to achieve process control of all units. A separate SIS will be configured according to the requirements for unit interlock protection.

6.4.4.1 2,000 KTPA ADU and 1,500KTPA VDU

Table6.4-1 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Armored thermocouples (with external thermowell)	Piece	240
2	Knife type armored thermocouples	Piece	60
3	Double metal thermometers	Piece	50
II	Flow meters		
1	Throttling devices	Set	75
2	Electromagnetic flow meters	Set	2
3	Rotameters	Set	28

Item	Description	Unit	Quantity
4	Double rotameters	Set	7
5	Wedge type flow meters	Set	31
6	Mass flow meters	Set	5
7	Averaging pitot tube flow meters	Set	9
8	Target type flow meters	Set	28
9	Ultrasonic flow meters (mono channel)	Set	3
III	Level gauges		
1	Level glasses	Set	37
2	Magnetic flap level meters	Set	15
3	Magnetic hysteresis retractable level transmitters	Set	6
4	Buoy level transmitters	Set	16
5	Float level transmitters	Set	5
IV	Actuators		
1	Regulating valves	Set	88
2	Eccentric rotary regulating valves	Set	65
3	Butterfly valves	Set	13
4	T type regulating valves	Set	2
5	Pneumatic cutoff valve	Set	17
6	Self-powered regulating valves	Set	7
7	Electric track ball valves	Set	2
8	Electric butterfly valves	Set	2
9	Electric gate valves	Set	66
10	Smart valve positioners	Set	166
V	Transmitters		
1	Smart pressure transmitters	Set	80
2	Smart DP transmitters	Set	120
3	Smart single flange transmitters	Set	10
4	Smart double flange transmitters	Set	65
VI	Analyzers		
1	Online naphtha dry point analyzers	Set	1
2	Zirconia oxygen analyzers	Set	4
3	Online pH analyzers	Set	3
4	Fuel gas density analyzers	Set	1
5	Kerosene distillation range analyzer	Set	1
6	Flammable gas detectors	Set	40
7	Toxic gas detectors	Set	8
VII	DCS	Set	1

Item	Description	Unit	Quantity
VIII	SIS	Set	1
IX	FGDS	Set	1
X	AMS	Set	1
XI	Miscellaneous instruments		
1	Field rotating alarm lights	Set	20
2	Automatic flame endoscope	Set	2
3	Polling logging system	Set	1
4	Isolation and Flushing Unit	Set	1
5	Analytic cabin	Set	2
6	Corrosion detection system	Set	1
7	Isolating safety barriers	Set	750
8	Surge protectors	Set	1000
9	Signal isolators	Set	40
10	Local indicators	Set	20
11	Multiplex temperature collecting system	Set	13

6.4.4.2 700 KTPA Delayed Coking Unit

Table6.4-2 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Double metal thermometers	Piece	200
2	Thermocouples	Piece	166
3	Armored surface thermocouples K type PN10	Piece	6
II	Pressure gauges		
1	SS pressure gauges	Set	221
2	Diaphragm type pressure gauges	Set	50
3	Micro pressure gauges	Set	20
4	Pressure switches	Set	8
III	Level gauges		
1	Level glasses for viscous fluids	Set	7
2	Level glasses	Set	65
3	Electric external buoy level/interface transmitters	Set	15
4	Electric float level transmitters	Set	13
5	Radar level gauges	Set	10
6	Radioactive level gauges	Set	1
7	Level switches	Set	2
IV	Flow meters		
1	Ultrasonic flow meters	Set	4
2	Thermal conductor flow meters	Set	4
3	Throttling devices	Set	80
4	Mass flow meters		4
V	Actuators		
1	Regulating valves	Set	115
2	Cutoff ball valves	Set	8
3	Long travel actuators	Set	16
4	Smart electric/pneumatic positioners Electric/pneumatic transducers	Set	133
5	Solenoid valves	Set	32
6	Self-powered regulating valves	Set	9
7	Butterfly valves	Set	5
VI	Transmitters		
1	Smart temperature transmitters	Set	40
2	Smart pressure transmitters	Set	50

Item	Description	Unit	Quantity
3	Smart DP transmitters	Set	80
4	Smart double flange transmitters	Set	30
5	Smart micro DP transmitters	Set	14
VII	Analyzers		
1	Flammable gas content alarms	Set	30
2	H2S content alarms	Set	5
3	Zirconia oxygen analyzers	Set	2
VIII	DCS	Set	1
IX	SIS	Set	1
X	FGDS	Set	1
XI	AMS	Set	1
XII	Miscellaneous instruments		
1	Polling logging system	Set	1
2	Isolation and Flushing Unit	Set	1
3	Analytic cabin	Set	1
4	Isolating safety barriers	Set	626
5	Surge protectors	Set	700
6	Signal isolators	Set	30

6.4.4.3 500 KTA Continuous Catalytic Reforming Unit

Table6.4-3 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Double metal thermometers	Set	100
2	Internal leakage free armored thermocouples with SS thermowells	Piece	165
3	Internal leakage free armored thermocouples with Monel thermowells	Piece	10
4	Surface thermocouples	Piece	20
5	Knife type furnace tube surface thermocouples	Piece	20
6	Multi-point armored thermocouples, 7 points	Set	2
7	Multi-point flexible thermocouples, 16 points	Set	1
8	Multi-point temperature collection unit, 8 points	Set	20
II	Pressure gauges		
1	SS pressure gauges	Piece	200
III	Flow meters		
1	Throttling devices	Set	47
2	Venturi tubes	Set	5
3	Rotameters	Set	12
4	Mass flow meters	Set	4
5	Thermal mass flow meters	Set	1
6	Ultrasonic flow meters	Set	3
7	Internal orifice + Transmitters		
	ANSI 150lb	Set	1
	ANSI 300lb	Set	1
8	Target type flow meters	Set	4
IV	Level gauges		
1	Level glasses	Set	42
2	Buoy level transmitters	Set	5
3	Capacitor type level switches	Set	1
4	Nuclear level switches	Set	4
5	Nuclear level transmitters	Set	5
6	Radar level transmitters	Set	1
V	Smart transmitters		
1	Pressure transmitters	Set	50
2	DP transmitters	Set	140

Item	Description	Unit	Quantity
3	Double flange level transmitters	Set	4
VI	Actuators		
1	Pneumatic plunger type regulating valves		
（1）	ANSI 150lb		
	Carbon steel	Set	18
	Stainless steel	Set	3
（2）	ANSI 300lb		
	Carbon steel	Set	14
	Stainless steel	Set	7
	Chromium-molybdenum steel	Set	6
（3）	ANSI 600lb		
	Carbon steel	Set	4
	Stainless steel	Set	7
2	Pneumatic V-notched ball valve		
	ANSI 300lb，Stainless steel	Set	3
3	Pneumatic eccentric rotary valves		
（1）	ANSI 150lb	Set	5
（2）	ANSI 300lb	Set	8
4	Pneumatic eccentric butterfly valves		
	ANSI 150lb	Set	9
5	Smart valve positioners, electric/pneumatic transducers	Set	84
6	Electric gate valves	Set	24
7	Pneumatic on/off cutoff valves		
	Solenoid valves		
（1）	Pneumatic on/off ball valves		
	ANSI 150lb	Set	14
	ANSI 300lb	Set	13
	ANSI 600lb	Set	3
（2）	Pneumatic on/off plunger valves		
	ANSI 150lb	Set	9
	ANSI 300lb	Set	12
（3）	Eccentric rotary valves	Set	5
（4）	On/off V-notched ball valves		
	ANSI 300lb，Stainless steel	Set	13
（5）	On/off eccentric butterfly valves		
	ANSI 150lb	Set	5

Item	Description	Unit	Quantity
8	Electric on/off butterfly valves		35
9	Self-powered regulating valves		10
VII	Flame detection		
	Chamber flame video supervision system		
	Totally 18 vediocams	Set	1
VIII	Analyzers		
1	Online zirconia oxygen content analyzers	Set	8
2	Online H2 content analyzers	Set	1
3	Online H2 content analyzers (Double sensor)	Set	1
4	Online trace water analyzers	Set	1
5	Online near infrared RON analyzers	Set	1
6	Online nitrogen/hydrocarbon/oxygen content analyzers	Set	1
7	Gas density analyzers	Set	1
8	Flue gas composition analyzers	Set	1
9	Field flammable gas detection and alarm instruments		
（1）	Flammable gas detectors (hydrocarbon)	Set	30
（2）	Flammable gas detectors (H2)	Set	6
（3）	Portable flammable gas alarms	Set	2
（4）	Field rotating alarm lights	Set	10
（5）	Sirens	Set	10
IX	Control system		
1	DCS	Set	1
2	SIS	Set	1
3	CCS	Set	1
4	FGDS	Set	1
5	Catalyst and regeneration control system	Set	1
6	AMS	Set	1
X	Miscellaneous instruments		
1	Explosion proof field current indicators	Set	20
2	Analytic cabin	Set	2
3	WRS	Set	1
	Polling points: 30		
4	Isolating safety barriers	Set	700
5	Surge protectors	Set	1000
6	Signal isolators	Set	60

6.4.4.4 1,300KTPA Diesel Hydrofining Unit

Table6.4-4 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Double metal thermometers	Set	25
2	Normal armoured thermocouples	Set	90
3	Surface thermocouples (heaters)	Set	16
4	Reactor HP multi-point flexible thermocouples	Set	3 Set (18 points)
5	Reactor armored surface thermocouples	Set	20
II	Pressure gauges		
1	SS pressure gauges	Set	90
2	Capsule pressure gauges	Set	12
III	Flow meters		
1	Throttling devices	Set	40
2	Rotameters	Set	2
3	Ultrasonic or vortex flow meters	Set	4
4	Mass flow meters	Set	2
5	Annubar flow meters	Set	2
6	Target type flow meters	Set	6
IV	Level gauges		
1	Level glasses	Set	20
2	Electric buoy level gauges	Set	6
3	Magnetic flap level meters (field + remote)	Set	10
4	Radar level gauges	Set	6
V	Smart transmitters		
1	Smart pressure transmitters	Set	30
2	Smart DP transmitters (with 3-valve manifold)	Set	60
4	Smart single flange DP transmitters	Set	3
5	Smart double flange DP transmitters	Set	10
VI	Regulating valves		
1	Pneumatic diaphragm regulating valves	Set	50
2	Self-powered regulating valves	Set	2
3	Explosion proof T type solenoid valves	Set	5
4	Long travel actuators	Set	3

Item	Description	Unit	Quantity
5	Pneumatic cutoff gate (ball) valves	Set	40
6	Electric fire proof cutoff gate (ball) valves	Set	5
7	Electric/pneumatic transducers	Set	4
8	Smart valve positioner	Set	50
VII	Online analyzers		
1	Zirconia analyzers	Set	2
2	Hydrogen content analyzers	Set	1
VIII	Safety detection instruments		
1	Flammable gas detection transmitters	Set	20
2	H2S gas detection transmitters	Set	15
3	H2 gas detection transmitters	Set	10
4	Portable flammable gas, H2S and H2 detectors	Set	3
5	Explosion proof loudspeakers	Set	6
6	Explosion proof lights	Set	6
IX	DCS	Set	1
X	SIS	Set	1
XI	FGDS	Set	1
XII	AMS	Set	1
XIII	Miscellaneous instruments		
1	Production safety inspection system	Set	1
2	Safety barrier cabinets and terminal cabinets	Set	3
3	Isolating safety barriers	Set	400
4	Surge protectors	Set	700
5	Signal isolators	Set	30
6	Explosion proof field current indicators	Set	5

6.4.4.5 550 KTA Naphtha Hydrotreating Unit

Table6.4-5 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Double metal thermometers	Set	30
2	Common armored thermocouples with SS thermowells	Piece	92
3	Reactor HP multi-point flexible thermocouples, 40 points	Set	3
4	Surface thermocouples (for heater)	Piece	10
5	Reactor armored surface thermocouples	Piece	10
II	Pressure gauges		
1	SS pressure gauges	Piece	105
III	Flow meters		
1	Throttling devices	Set	45
2	Rotameters	Set	6
3	Mass flow meters	Set	3
4	Ultrasonic flow meters	Set	4
5	Averaging pitot tube flow meters	Set	3
6	Target type flow meters	Set	6
IV	Level gauges		
1	Level glasses PN5.0	Set	15
2	Buoy level transmitters	Set	6
3	Magnetic flap level meters (field + remote)	Set	10
4	Radar level transmitters	Set	1
V	Smart transmitters		
1	Pressure transmitters	Set	30
2	DP transmitters	Set	66
3	Single flange level transmitters	Set	3
4	Double flange level transmitters	Set	10
VI	Regulating valves		
1	Pneumatic plunger type regulating valves	Set	57
2	Smart valve positioner	Set	57
VII	Pneumatic on/off cutoff valves (with solenoid valves)		
	ON/OFF ball valves	Set	46
VIII	Electric fire proof cutoff ball valves	Set	8
IX	Self-powered pressure regulating valves	Set	6
X	Field flammable gas detection and alarm instruments		

Item	Description	Unit	Quantity
1	Flammable gas detectors (H2S)	Set	15
2	Flammable gas detectors (H2)	Set	10
3	Flammable gas detectors (hydrocarbon)	Set	5
4	Portable flammable gas alarms (flammables, H2S and H2)	Set	3
5	Field rotating alarm lights	Set	7
6	Sirens	Set	7
7	Ultraviolet flame detectors	Set	28
XI	Online analyzers		
1	Online zirconia oxygen content analyzers	Set	3
XII	DCS	Set	1
XIII	SIS	Set	1
XIV	CCS	Set	1
XV	AMS	Set	1
XVI	Miscellaneous instruments		
1	WRS	Set	1
2	Explosion proof field current indicators	Set	12
3	Isolating safety barriers	Set	560
4	Surge protectors	Set	850
5	Signal isolators	Set	30

6.4.4.6 900 KTA Hydrocracking Unit

Table6.4-6 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Double metal thermometers	Piece	50
2	Armored thermocouples	Piece	93
3	Furnace tube surface thermocouples	Piece	27
4	HP armored thermocouples	Piece	72
5	HP multi-point thermocouples (3 points)	Piece	12
6	HP multi-point thermocouples (22 points)	Piece	4
7	Surface thermocouples	Piece	104
II	Pressure gauges		
1	Common pressure gauges	Piece	114
2	Capsule pressure gauges	Piece	6
3	Vibration proof pressure gauges	Piece	50
4	Diaphragm pressure gauges	Piece	15
III	Flow meters		
1	LP flanged throttling devices	Set	74
2	HP flanged throttling devices	Set	30
3	Vortex flow meter	Set	10
4	Electromagnetic flow meters	Set	2
5	Integrated small orifice	Set	8
6	Mass flow meters	Set	6
7	Annubar flow meters	Set	4
IV	Level gauges		
1	Double color level glasses	Set	60
2	Magnetic flap level meters	Set	8
3	LP external buoy level transmitters	Set	30
4	HP external buoy level transmitters	Set	14
5	Magnetic retractable level gauges	Set	4
V	Smart transmitters		
1	Smart pressure and DP transmitters	Set	170
2	Smart double flange DP transmitters	Set	10
3	Smart high static pressure double flange DP transmitters	Set	18
4	Safety barriers	Set	950
5	Surge protectors	Set	1300

Item	Description	Unit	Quantity
VI	Safety instruments		
1	FGDS	Points	70
VII	Actuators		
1	Regulating valves	Set	70
2	Eccentric rotary valves	Set	17
3	HP diaphragm regulating valves	Set	30
4	HP cutoff valves	Set	10
5	Self-powered regulating valves	Set	10
6	LP gate valves	Set	10
IX	Analyzers		
1	Gas density analyzers	Set	1
2	Zirconia flue gas oxygen content analyzers	Set	2
X	SIS	Set	1
XI	DCS	Set	1
XII	CCS	Set	1
XIV	FGDS	Set	1
XV	Miscellaneous instruments	Set	8
1	Safety barriers, surge protectors and terminal cabinets	Set	8
2	Power supply cabinets	Set	1
3	WRS	Set	1

6.4.4.7 150 KTA Isomerization Unit

Table6.4-7 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Double metal thermometers	Set	30
2	LP single/double thermocouples	Piece	40
II	Pressure gauges		
1	SS pressure gauges	Set	40
III	Flow meters		
	Mass flow meters	Set	2
	Electromagnetic flow meters	Set	2
	Metal Rotameters	Set	1
	Throttling devices	Set	25
IV	Level gauges		
	Double color level glasses	Set	20
	Explosion proof level switches	Set	5
	Electric external buoy level (interface) transmitters	Set	10
V	Smart transmitters		
	Smart temperature transmitters	Set	5
	Smart pressure transmitters	Set	20
	Smart DP transmitters	Set	25
	Smart double flange DP transmitters	Set	2
VI	Actuators		
	Pneumatic regulating valves	Set	30
	Pneumatic long travel actuators	Set	1
	Electric/pneumatic valve positioners	Set	30
VII	Flammable gas detectors and alarms	Set	10
VIII	Analyzers		
	Online zirconia analyzers		1
IX	DCS	Set	1
X	SIS	Set	1
XI	FGDS	Set	1
XII	AMS	Set	1
XIII	Miscellaneous instruments		
1	Production safety inspection system	Set	1
3	Isolating safety barriers	Set	150

Item	Description	Unit	Quantity
4	Surge protectors	Set	400
5	Signal isolators	Set	20

6.4.4.8 25 KTA H_2 Production Unit

Table6.4-8 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Double metal thermometers	Piece	20
2	Internal leakage free armored RTD with SS thermowells	Piece	24
3	Internal leakage free armored thermocouples with SS thermowells	Piece	101
II	Pressure gauges		
1	SS pressure gauges	Set	50
2	Stainless steel DP gauges	Set	12
III	Flow meters		
1	Throttling devices	Set	33
2	Rotameters	Set	7
3	Mass flow meters	Set	2
4	Ultrasonic flow meters	Set	1
IV	Level gauges		
1	Level glasses	Set	10
2	Magnetic flap level meters	Set	7
3	Level switches	Set	4
4	Radar level gauges	Set	4
V	Smart transmitters		
1	Smart pressure transmitters	Set	102
2	Smart DP transmitters	Set	99
VI	Control valves (with smart positioners)		
1	Plunger valves	Set	79
2	Butterfly valves	Set	7
3	Gate valves	Set	3
4	Angle control valves	Set	8
5	Eccentric butterfly valves	Set	2
VII	Pneumatic cutoff valves (with valve position switches)		
1	Ball valves	Set	10
2	Eccentric butterfly valves	Set	6
VIII	Online analyzers		
1	pH analyzers	Set	1
2	DMW conductivity analyzers	Set	1
3	Zirconia analyzers	Set	2

Item	Description	Unit	Quantity
4	CO concentration analyzer	Set	1
5	H2 concentration analyzer	Set	4
IX	Field part of FGDS		
1	Flammable gas detectors (with acoustic and visual alarms)	Set	56
2	Manual alarm push buttons	Set	25
3	Rotating alarm lights	Set	25
4	Sirens	Set	25
X	Flame detectors	Set	5
XI	DCS	Set	1
XII	SIS	Set	1
XIII	FGDS	Set	1
XIV	AMS	Set	1
XV	Miscellaneous instruments		
1	Temperature transmitting isolation barriers	Set	125
2	Isolating safety barriers	Set	601
3	Surge protectors	Set	812
4	Signal isolators	Set	12
5	Production safety inspection system	Set	1

6.4.4.9 900 KTA Hydrocracking

Table6.4-9 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Armored thermocouples (with external thermowell)	Piece	50
2	Special thermocouples for sulfur reactor	Piece	12
3	Double metal thermometers	Piece	40
4	Infrared thermometers	Set	5
5	Multi-point armored thermocouples	Set	10
II	Flow meters		
1	Throttling devices	Set	40
2	Electromagnetic flow meters	Set	4
3	Rotameters	Set	4
4	Wedge type flow meters	Set	4
5	Thermal gas mass flow meters	Set	9
6	Ultrasonic flow meters (mono channel)	Set	10
7	Averaging pitot tube flow meters	Set	3
III	Level gauges		
1	Level glasses	Set	40
2	Magnetic flap level meters	Set	10
3	Buoy level transmitters	Set	14
IV	Gas analyzers		
1	Flammable gas detectors	Set	15
2	Toxic gas detectors（H2S）	Set	12
V	Actuators		
1	Regulating valves	Set	45
2	Smart valve positioner and transducers	Set	45
3	Pneumatic cutoff valves with solenoid valves	Set	30
VI	Smart transmitters		
1	Smart pressure transmitters	Set	50
2	Smart DP transmitters	Set	20
3	Smart single flange transmitters	Set	4
4	Smart double flange transmitters	Set	10
七 VII	Analyzers		
1	Online pH analyzer	Set	2
2	Zirconia analyzers	Set	3

Item	Description	Unit	Quantity
3	H2 analyzers	Set	1
4	SO2 analyzers	Set	1
5	H2S/SO2 ratio analyzers	Set	2
VIII	DCS	Set	1
IX	SIS	Set	1
X	FGDS	Set	1
XI	AMS	Set	1
XII	Miscellaneous instruments		
1	Field rotating alarm lights	Set	20
2	Automatic flame endoscope	Set	2
3	Polling logging system	Set	1
4	Analytic cabin	Set	1
5	Multiplex temperature collecting system	Set	2
6	Isolating safety barriers	Set	570
7	Surge protectors	Set	800
8	Signal isolators	Set	20

6.4.4.10 Dry GAS / LPG Treatment Unit

Table6.4-10 List of Major Instruments and Equipment

Item	Description	Unit	Quantity
I	Thermometers		
1	Multi-point armored thermocouples (with integrated temperature transmitters)	Set	3
2	Integrated temperature transmitters	Set	50
II	Flow meters		
1	Throttling devices	Set	40
2	Electromagnetic flow meters	Set	2
3	Rotameters	Set	3
4	Mass flow meters	Set	5
5	Vortex flow meter		10
III	Level gauges		
1	Level glasses	Set	30
2	Buoy level transmitters	Set	10
3	Float controllers	Set	5
4	Radar level gauges	Set	4
IV	Gas analyzers		
1	Flammable gas detectors	Set	15
2	Toxic gas detectors	Set	10
V	Actuators		
1	Regulating valves	Set	60
2	Smart valve positioners	Set	60
VI	Smart transmitters		
1	Smart pressure transmitters	Set	40
2	Smart DP transmitters	Set	60
3	Smart double flange transmitters	Set	15
VII	DCS	Set	1
VIII	AMS	Set	1
IX	FGDS	Set	1
X	Miscellaneous instruments		
1	Polling logging system	Set	1
2	Field rotating alarm lights	Set	20
3	Isolating safety barriers	Set	220
4	Surge protectors	Set	350

5	Isolation liquid automatic flushing system	Set	1

6.5 Automatic Control Program for Logistics System

6.5.1 Tank Farm Monitoring and Management

6.5.1.1 Tank farm monitoring and management consists of the following targets:

(1) Monitoring of process parameters including tank level, temperature and pressure;

High precision tank detection instruments will be used, e.g., radar, servo, static pressure level gauges and other instruments. Average thermometers, pressure transmitters and level switches will be installed according to practical needs. All field signals will be transmitted to remote I/O stations for the tank farm, from where they are transmitted via fiber optic into DCS in CCR for central display and control.

Oil tank level will be equipped with tank side indicators without any other field instruments.

(2) Tank inventory calculation function;

(3) Process parameter over limit alarm;

(4) Oil-water interface detection and automatic water cutting (for crude storage tank);

(5) Tank oil inventory calculation;

(6) Automatic switching between tanks;

Pump suction and discharge pipelines will be equipped with pneumatic wedge type gate valves with manual operation and field explosion proof control box. Valve operation could be done on site or in control room with valve status display in CCR.

(7) Flammable gas detection and alarm

6.5.2 Selection of Major Instruments

(1) Level, interface and density for final products including diesel and kerosene will be measured by servo level gauges. Tank temperature will be measured by averaging thermometers with tank side indicators.

(2) Crude tank and intermediate product tank levels will be measured by radar level gauges with tank side indicators.

(3) LPG tank level will be measured by servo level gauges and tank temperature will be measured by averaging thermometers with tank side indicators.

(4) Tank temperature will be measured by Pt100 platinum RTD.

(5) Cutoff valves will be pneumatic wedge type gate valve with manual operation.

6.5.3 Major Instruments and Equipment

6.5.3.1 Crude Storage Tank Farm

Table6.5-1 List of Major Instruments and Equipment

Item	Description	Unit	Quantity	Remarks
1	Platinum RTD	Set	6	
2	Smart level gauges	Set	6	
3	Level switches	Set	12	
4	Pneumatic cutoff valves	Set	12	
5	Flammable gas alarms	Set	24	

6.5.3.2 Intermediate Product Storage Tank Farm

Table6.5-2 List of Major Instruments and Equipment

Item	Description	Unit	Quantity	Remarks
1	Platinum RTD	Set	24	
2	Smart level gauges	Set	24	
3	Level switches	Set	48	
4	Pneumatic cutoff valve	Set	48	
5	Flammable gas alarms	Set	60	

6.5.3.3 Oil Product Storage Tank Farm (kerosene and diesel)

Table6.5-3 List of Major Instruments and Equipment

Item	Description	Unit	Quantity	Remarks
1	Platinum RTD	Set	23	
2	Smart level gauges	Set	23	
3	Level switches	Set	46	
4	Pneumatic cutoff valve	Set	46	
5	Flammable gas alarms	Set	60	

6.5.3.4 Heavy Oil Storage Tank Farm

Table6.5-4 List of Major Instruments and Equipment

Item	Description	Unit	Quantity	Remarks
1	Platinum RTD	Set	4	
2	Smart level gauges	Set	4	
3	Level switches	Set	8	
4	Pneumatic cutoff valve	Set	8	

5	Flammable gas alarms	Set	15	

6.5.3.5 LPG Storage Tank Farm

Table6.5-5 List of Major Instruments and Equipment

Item	Description	Unit	Quantity	Remarks
1	Platinum RTD	Set	15	
2	Smart level gauges	Set	15	
3	Level switches	Set	30	
4	Smart pressure transmitters	Set	15	
5	Pneumatic cutoff valve	Set	30	
6	Flammable gas alarms	Set	20	

6.6 Automatic Control Program for Utilities and Auxiliary Production Facilities

6.6.1 Control Level and Major Control Program

Utilities include air compression station, nitrogen station, fire water pump station, water feed system, circulating water system, water purification plant, waste water treatment plant, DMW plant, plant water supply and drainage pipe system, and water pollution control and prevention system (including clean rainwater collection system, polluted rainwater collection system and water pool and emergency polluted water collection system and water pool), and pumping system.

Large utility facilities, e.g., air separation and boilers shall be equipped with local control room (LCR) with separate DCS and PLC control systems capable of communicating with CCR.

Other utility facilities may use local panels (LP) with critical process parameters and alarm signals connected to CCR.

6.6.2 Instrument Selection

Identical with process units.

6.6.3 Major Instruments and Equipment

Table6.6-1 List of Major Instruments and Equipment for Boilers

Item	Description	Unit	Quantity	Remarks
1	Transmitters	Set	260	
2	Pneumatic regulating valves	Set	95	

3	Online conductivity analyzers	Set	2	
4	Online conductivity analyzers	Set	2	
5	Dissolved oxygen analyzers	Set	2	

Table6.6-2 List of Major Instruments and Equipment for Utilities

Item	Description	Unit	Quantity	Remarks
1	Pressure and level transmitters	Set	95	
2	Flow transmitters	Set	40	
3	Regulating valves	Set	30	
4	Online pH value analyzer	Set	2	
5	Online COD analyzer	Set	2	
6	Online analyzer for oil content in water	Set	2	
7	Online dissolved oxygen analyzers	Set	3	
8	Online dissolved oxygen analyzers	Set	3	

6.7 Central Control Room

6.7.1 General

This section covers study on control rooms for grass root units and revamp units in the Project.

CCR is a critical plant wide operation area for the control and management of all grass root production units, logistic facilities including feed stock tank farm and intermediate feed tank farm as well as utilities.

DCS will be installed in CCR for data acquisition, information processing, process control, input/output material metering, alarm, and safety interlocks for all process units, logistic facilities and utilities.

6.7.2 Specific Configuration Program

Because existing control room could not meet the requirements of the new refineries, a new CCR will be built to meet the requirements of refineries, logistic system and water supply and drainage system.

The new CCR will be built in non explosion hazard area with explosion proof structures. Each control room will be equipped with DCS operation room, cabinet room, engineer room, instrument reference room, dispatching/communication room, shift room, administration office, meeting room, changing room, lounge, training room, workshop, toilets, UPS room, and air conditioner room.

Table6.7-1 Building Area, Control Range and Configuration of CCR

Description	Building Area (m2)	Control Range	Configuration
Central control room	2000	New refineries	32 operation stations
		New logistic system	2operation stations
		Water supply and drainage system	1 operation station

6.8 Major Codes and Standards Referenced in Design

Name and number of major Codes and standards referenced in design are shown below:

RP 30-6 Design of Protective Instrument Systems (IEC 61508)

ISA Instrument Society of America

ISA S5.1 (1984) Instrumentation Symbols and Identification

ISA S50-1 (1982) Compatibility of Analogue Signals for Electronic Industrial Process Instruments

ISA S75-01 (1995) Flow Equations for Sizing Control Valves

ISA RP 55.1 Hardware Testing of Digital Process Computers

API American Petroleum Institute

API RP500 Manual on Installation of Refinery Instruments and Control Systems

API RP551 (1993) Process Measurement and Instrumentation

API RP554 (1995) Process Instrumentation and Control

API RP555 (1995) Process Analyzers

API 670 (2000) Vibration, Axial Position and Bearing Temperature Monitoring Systems

ANSI /NFPA American National Standards Institute / National Fire Protection Association 70 National Electric Code (NEC)

IEC 60381 Analogue Signals for Process Control Systems

Part 1 (1982) Direct Current Signals

Part 2 (1978) Direct Voltage Signals

IEC 60382 (1991) Analogue Pneumatics Signals for Process Control Systems

IEC 60534 (1987) Industrial – Process Control Valves

IEC 60751 (1995) Industrial Platinum Resistance Sensors

IEC 61508

Part 1 (1999) Functional Safety Of Electrical/Electronic/ Programmable Electronic Safety-Related System: General requirements

Part 2 (2000) Requirements for electrical/ Electronic/Programmable/Electronic Safety related systems

Part 3 (1999) Software Requirements

Part 4 (1999) Definitions and Abbreviations

Part 5 (1999) Example of Methods for the Determination of Safety Integration Levels

Part 6 (2000) Guideline on the Application of IEC 61508-2 and IEC 61508-3

Part 7 (2000) Overview of Techniques and Measures

IEC 61000-4 (2001) Electromagnetic Compatibility (EMC) – Part 4: Testing and Measurement Techniques

NFPA 70 National Electrical Code and National Fire Protection Agency Standards

ASME B40.100 (1998) Pressure Gauges and Gauge Attachments

ANSI/FCI 70-2(1991) Quality Control Standard for Control Valve Seat Leakage

ASME B16. 10(2000) Face To Face Dimensions For Ferrous Valves

AGA Measurement of Gas by Multipath Ultrasonic Meters: Transmission Measurements Committee Report 9 (1998)

ISO 5167 (1980) Measurement of Flow of Fluids by Means of Orifice Plates, Flow Nozzles and Venturi Tubes Inserted in Circular Conduits Running Full

ISO 5167-1 (1998) Specifications for Square Edged Orifice Plates, Nozzles and Venturi Tubes

AGA Orifice Metering of Natural Gas Report 3 (1990)

IEEE-802.3 (2000) Information Processing Systems – Local Area Networks

DIN V 19250 (1994) Measurement and Control Fundamental Safety Aspects for Measurement and Control Protective Equipment.

Stipulations on the Preparation of Feasibility Study Report for Refinery Projects with Overseas Investment.