TECHNICAL SPECIFICATION

SVC Light®

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SECTION 1

INTRODUCTION GENERAL DESCRIPTION

ABB takes pleasure in presenting the following proposal for a Static Var Compensator (SVC Light) for XX Steel. By selecting ABB for the supply and implementation of the SVC Light®, the delivery will be based on state-of-the-art technology. In addition, project management, design and engineering will be performed by a dedicated SVC organisation. The organisation has unique knowledge of Electrical Arc Furnaces compensated by Static Var Compensation.

ABB would like to highlight the following key features of our proposal:

- **Arc Furnace operation improvement:** ABB has unique experience of SVC Light for Arc Furnace applications, including documented furnace power increases and other profitability enhancing features.
- **Excellent flicker mitigation performance:** Well proven and documented flicker mitigation performance.
- **World Class System Study Expertise:** ABB has the in-house expertise needed and experience required to perform the required and necessary system studies. We also possess great skills in magnetic and sound level calculations.
- **Key components:** All major key components are manufactured within ABB.
- **MACH 2 control and protection system:** The MACH 2 system is the most advanced and high performance control and protection system for high voltage applications on the market.
- **Dedicated SVC organisation:** Over 500 people, including professional engineers as well as other dedicated staff, highly skilled for ABB's long-term commitment in this business.

In addition to the project engineers, the organisation includes the following:

- System engineers
- Mechanical design engineers
- Electrical design engineers
- Control system engineers
- Quality ensuring personnel
- Installation and commissioning engineers

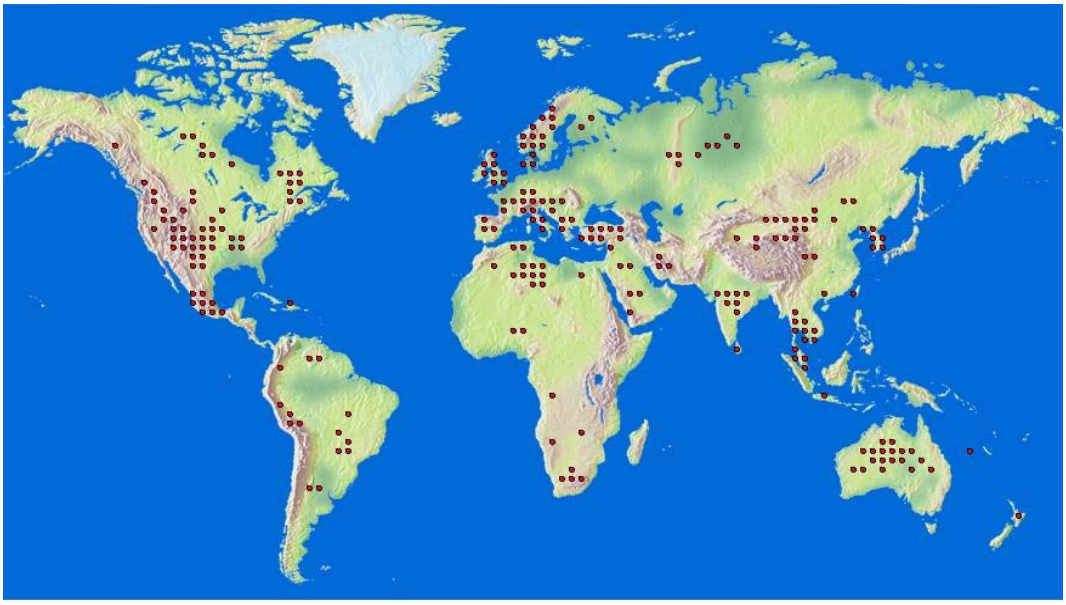


ABB has acquired more than 40 years of satisfactory operation of Static Var Compensators. In 1972 the first SVC was commissioned for an electric arc furnace, which has been followed by a number of successful installations.

Over the past decades ABB has supplied more than 400 SVC s in more than forty countries.

By our count ABB has supplied more SVCs over the past years than have been supplied by all of our competitors combined.

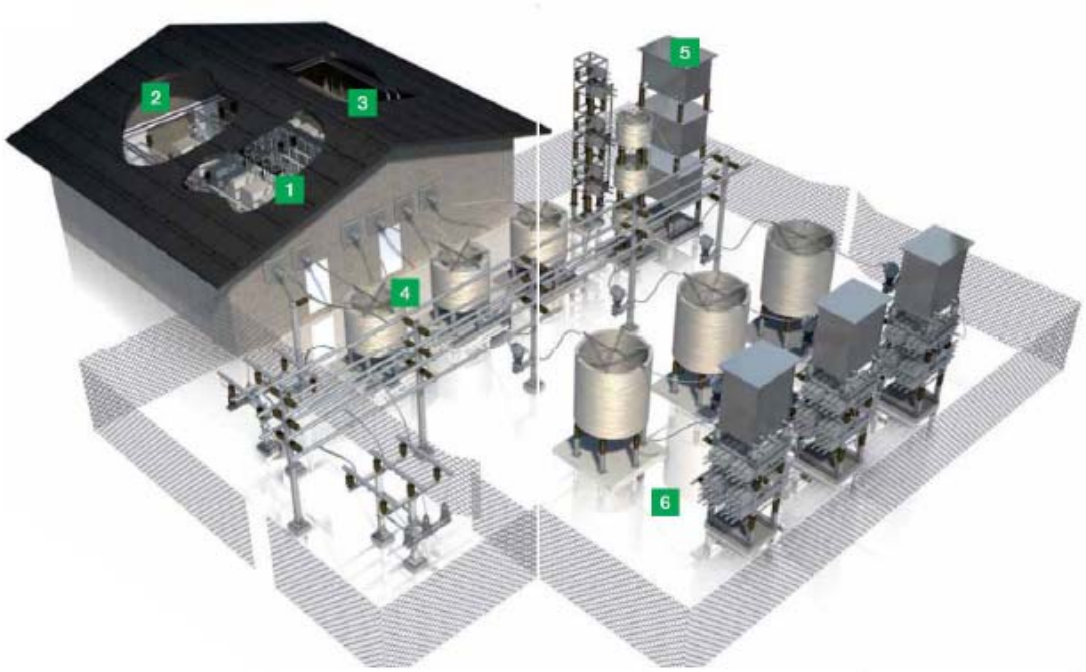
ABB is certified according to ISO 9001 and ISO 14001.

SVC L g , N x g ra

The next generation of the SVC Light is the result of an R&D project within ABB by the units ABB FACTS and ABB HVDC. It is based on the same platform as the original SVC Light but with a new valve topology. A multi-level topology (Cascaded H-bridge) instead of the previous three-level converter. This new valve topology gives several advantages compared to the previous version:

- Same or better flicker reduction as the previous version
- Larger dynamic range possible
- Lower harmonic emissions (due to lower switching frequency)
- Modernized control platform (longer life time of circuit boards etc.)
- Lower losses
- Simpler installation (IGBT stack self-supporting structure)
- Lower EMF emissions

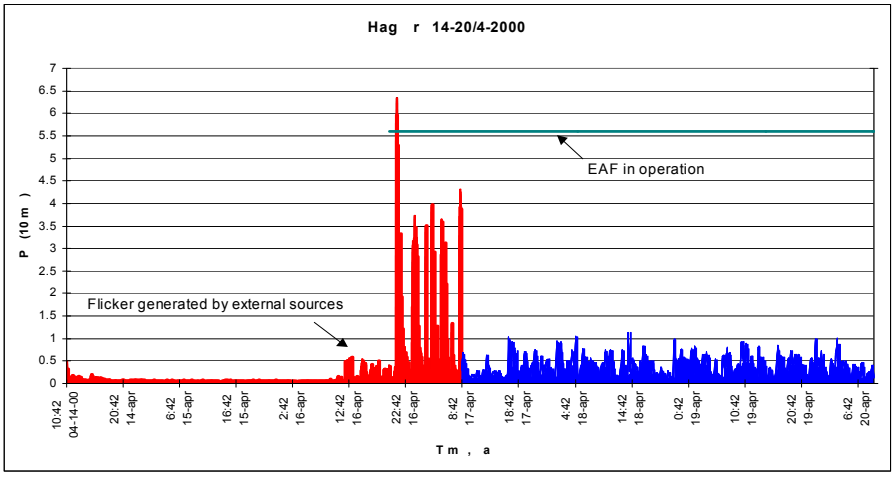
A schematic drawing of an SVC Light system is shown below:



1. VSC | 2. Control and protection system | 3. Cooling system | 4. Phase reactors | 5. High pass filter | 6. Harmonic filter (optional)

U k r m ga

The SVC Light almost instantaneously compensates the fast reactive power variations created by an Electrical Arc Furnace. Flicker mitigation up to 6-7 times has been verified by field measurements. Figure below shows one flicker registration from an actual SVC Light installation.



Ar F r a ra m r m

An ideal operation of an Electrical Arc Furnace requires a constant and stable voltage supply. The power to the furnace is sensitive to instable and large voltage variations.

By means of a SVC Light, the voltage at the feeding network is stabilised and kept nearly constant during the whole power-on time.

The melting power is the product of the arc current and voltage. With a stable voltage support at the furnace bus, the available melting power would be higher which results in a shorter tap-to-tap time. A reduced tap to tap provides increased production, energy savings, and reduced electrode consumption. The table below shows an example of increased furnace power evaluated from actual field measurements.

Description	**Boring**	**Melting**	**Red. Melt.**	**Superheat.**
Tap no.	13	15	13	12
Without SVC Light	13.96 MW	21.72 MW	17.94 MW	15.47 MW
With SVC Light	15.88 MW	24.64 MW	19.68 MW	16.98 MW
Difference	1.912 MW	2.914 MW	1.742 MW	1.517 MW
Increased power	**+13.7 %**	**+25.2 %**	**+9.7 %**	**+9.8 %**

R r ar

The following projects have been successfully installed or are under construction.

Project	Rating	Application	Order
Hellsjön	3 MW	Interconnection	1994
Hagfors	0-44 Mvar	Flicker mitigation	1997
Gotland	50 MW	Wind power	1997
Tjæreborg	7 MW	Wind power	1998
Directlink	180 MVA	Interconnection	1998
Trier	0-38 Mvar	Flicker mitigation	1999
Eagle Pass	36 MW	Asynchronous Tie	1999
CSC	330 MW	Interconnection	2000
Murraylink	200 MW	Interconnection	2000
Tornio	0-164 Mvar	Flicker mitigation	2001
Evron	0-36 Mvar	Balancing	2002
Holly	-80-110 Mvar	Dynamic voltage support	2003
ZPSS	0-164 Mvar	Flicker mitigation	2006
Ameristeel	0-64 Mvar	Flicker mitigation	2006
Siam Yamato	0-120 Mvar	Flicker Mitigation	2008
Martham	1 MW/15 min	Energy Storage	2008
Kotobuki	0-64 Mvar	Flicker mitigation	2008
GHC	0-164 Mvar	Flicker mitigation	2009
Uni Steel	0-164 Mvar	Flicker mitigation	2009
South Steel	0-175 Mvar	Flicker mitigation	2010
Abul Khair Steel	2x 0-110 Mvar	Flicker mitigation	2011
Bremen	-32 – 48 Mvar	Flicker mitigation	2011
MGI	0 – 164 Mvar	Flicker mitigation	2012
Evraz	0 – 80 Mvar	Flicker mitigation	2012
POSCO vina	0 – 144 Mvar	Flicker mitigation	2012
SSAB	0 – 220 Mvar	Flicker mitigation	2013

G ra a m a SVC LIGHT

The electrical supply to large and varying loads in an industrial process raise a number of questions to which attention must be paid when load and system networks are designed. Large load variations of heavy-duty power equipment, e.g., in industrial steel plants such as electrical arc furnaces or rolling mills, have disturbing effects on the electric supply system. The disturbances are mainly caused by fluctuations in the reactive power and/or asymmetrical loading of the supply network.

Although large electrical loads, as mentioned above, may have different behaviour in terms of cyclic and magnitude profiles, still some common characteristics could be noted:

- High ratings of individual loads, e.g., electrical arc furnaces or rolling mill connected to weak networks.
- Generation of flicker.
- Large and abrupt changes in active and reactive profiles.
- Generation of harmonic current components.
- Poor fundamental power factor.
- Voltage fluctuations.

These disturbing factors lead to the concept of power stabilisation by means of a Flicker Compensator, sold under the product name SVC Light. The voltage stabilising effect of the reactive power compensation equipment leads to an appreciable productivity increase compared to a system running without an SVC Light. The main features and benefits of a SVC Light installation are:

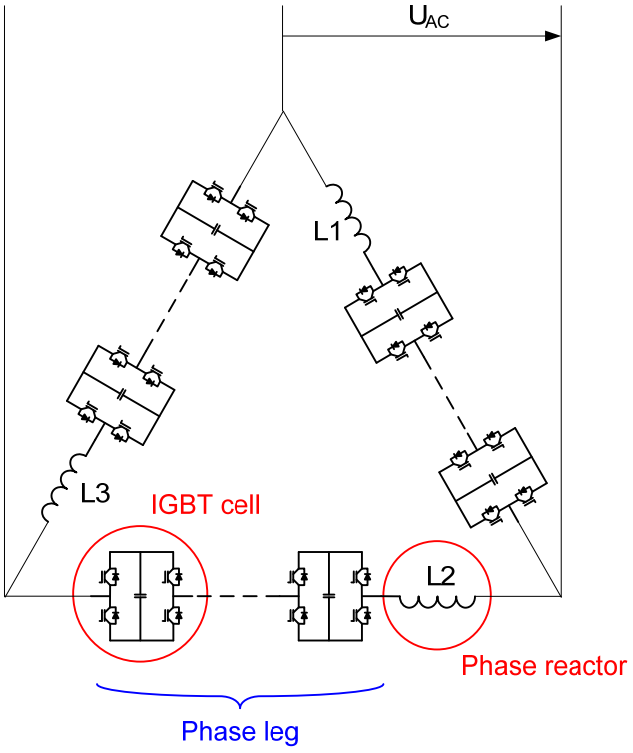
- Ultra-fast stabilisation of work’s bus voltage.
- Excellent flicker reduction.
- Increased melting power of EAF.
- Lower electrode consumption.
- Decreased melting time.
- Harmonic reduction by electronics.
- Small footprint
- Very low harmonic contents into the supply system.
- High power factor.

C m a r r

The basic design of the circuit can be seen from the Single Line Diagram. A vital part of the circuit is the Voltage Source Converter (VSC). The converter is based on transistors, so called IGBT's (Insulated Gate Bipolar Transistor). This kind of semiconductor is also used for motor control in all kinds of applications for more than a decade. ABB has, however, extended the power range of the converter in order to be suitable for the Flicker Compensator application. The converter is connected in series with a phase reactor to enable efficient current control. This reactor is of the same air core type, which is used for conventional harmonic filters and SVC's.

The converter configuration is called Chain-link, see also the converter circuit outline diagram below. This is a multi-level topology, which offers an excellent output waveform. The converter consists of three Chain-link legs which in turn are built up by series connected H-bridge converters. These converter legs are connected in delta to obtain high current rating and high performance during unsymmetrical operation. The H-bridges has an AC-side and a DC-side. The DC-side is equipped with powerful DC capacitors to provide enough energy for the converter to meet the most severe transients on the bus, which is an important source of flicker.

The high power rating of the Voltage Source Converter enables it to instantaneously produce reactive power corresponding to the full range of the furnace. No supporting shunt filters are normally needed which gives the advantage of less complexity and low losses during no-load conditions.



Converter circuit outline

F m a r

The function of the proposed Flicker Compensator can be described as follows:

When the furnace starts, the need for reactive power will change from one instant to the next. If not compensated, this will lead to dramatic voltage variation on the furnace bus, leading to variation at the Point of Common Coupling (PCC) and from there, on to the rest of the network.

With an SVC Light installed, however, the Compensator's control system measures the power drawn by the furnace and provides the reactive power necessary to compensate the furnace's need. Technically, this is done by controlling the current through the phase reactor connected in series with the IGBT valve.

Since the converter is normally controlled +1000 times per second, even the fastest variations can be counteracted. As a comparison, it can be mentioned that a conventional SVC system is controlled 100 times per second. This speed is afforded by the capability of the IGBT transistors used for switching in the converter.
In addition, the high control speed of the converter allows compensation of several of the harmonics generated by the furnace.

The reactive power rating of the Compensator has to be chosen to match the reactive power need of the furnace.

C m a r m

The compensator is built up of the following main components:

- VSC consisting of a water-cooled IGBT valve, DC capacitors, and series reactors. The IGBTs are cooled by means of water-to-water heat exchanger.
- Control and protection equipment.
- MV Power distribution equipment.

T IGBT

In the SVC Light, the voltage from the Voltage Source Converter is controlled to obtain exact and correct reactive current through the phase reactors. The VSC is designed around Insulated Gate Bipolar Transistors, IGBT.

Example: IGBT module

To achieve the sufficient control range, the converter has stacks of series connected IGBT cells for each switching function.

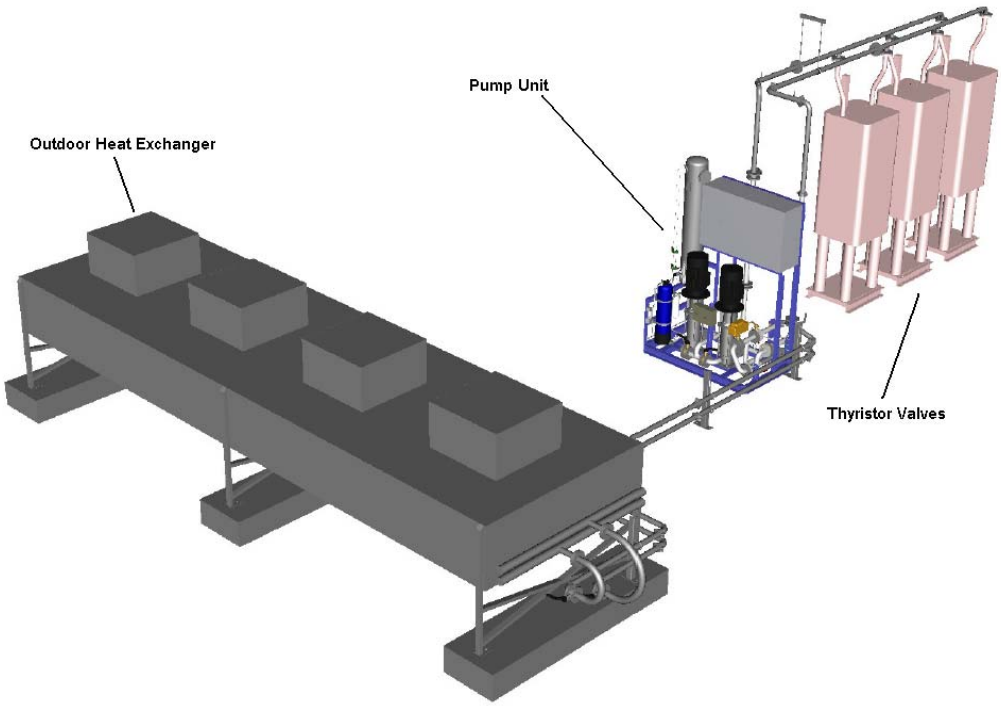
IGBT redundancy guarantees high availability. If one of the series IGBT's fails, the valve is still fully operational. Replacements can be done during scheduled maintenance.

IGBT's are extremely fast, highly dynamic electronic switches based on semiconductor technology. They are fully maintenance free and highly reliable. The same type of transistors are used for many different applications such as UPS's (Uninterruptible Power Supplies), drives, traction converters (locomotives, etc.) as well as SVC Light Flicker Compensator systems. The main advantages of the IGBT's are:

- High reliability, 100% factory tested
- Extremely fast
- Extremely powerful due to high blocking voltage and high rating currents.
- Capability to switch off the current during short circuit conditions in the load
- Compatible with tough environments due to the dust tight metal-ceramic housing.
- Absolutely maintenance free

C g m, a r ar

The VSC valve is water cooled by means of a cooling system consisting of an internal closed fine water system (supplied by ABB). The fine water system includes a water-to-air heat exchanger (supplied by ABB) through which the heat losses are dissipated.



Example: Cooling system, Water to Air

The VSC valve is water cooled by means of a cooling system consisting of a pump unit with an outdoor heat exchanger through which the heat losses are dissipated. The pump unit is equipped with one or two pumps, depending on the redundancy requirements.

The fine water system consists of two circuits, the main circuit and the water treatment circuit.

The cooling liquid (deionized water) is circulated by the centrifugal pump through the main circuit to the IGBT valve and the outdoor heat exchanger. A strainer ensures that the cooling liquid doesn't contain any particles when it enters the IGBT valves.

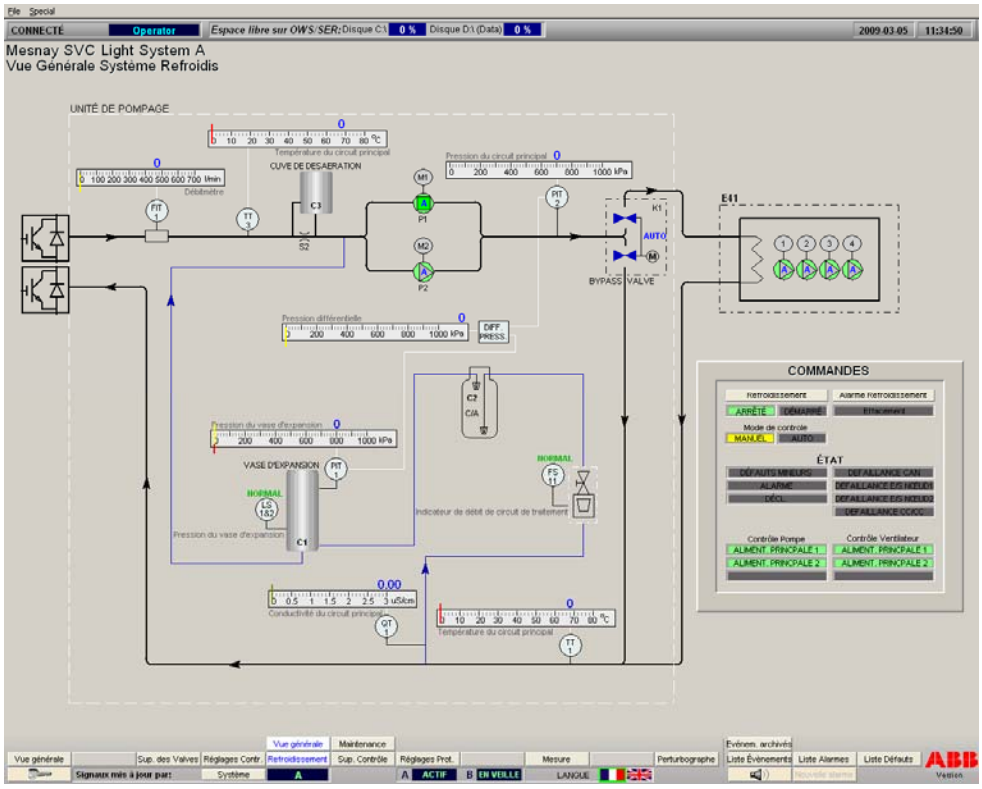
Since the cooling liquid will be in contact with the electrical environment of the IGBTs, the conductivity of the coolant must be low. To maintain the conductivity at a low level, a certain part of the cooling liquid is continuously flowing through the water treatment circuit that is connected in parallel with the main circuit. The water treatment circuit consists of a deionizer filled with deionising resin, an expansion vessel, a mechanical filter, and valves and monitoring instruments. Through the deionizer the conductivity decreases to below 1.0 µS/cm. The filter after the deionizer purifies the cooling liquid from particles before it reaches the main circuit. The expansion vessel absorbs the volume changes caused by thermal fluctuations as well as possible leakage. The expansion vessel is pressurised with air.

Important data points of the fine water system are constantly monitored. Alarm and trip signals are given for flow, temperature, conductivity and expansion vessel water level. The flow in the water treatment circuit is visually indicated.

All parts of the fine water system in contact with deionized water are made of non-corrosive materials to minimise the risk of corrosion and electrolytic effects and to keep the proper characteristics of the water.

All parts of the fine water system itself are mounted on a single skid for easy delivery and installation.

A factory test of all functions is carried out before shipment where a pressure drop in the VSC valve is simulated and the cooling system is tested regarding flow, pressure drop, vibrations, noise, signal interface and instrument settings.



Example: Cooling system visualization in HMI

Harm r

With the total harmonic generation in mind, it is important to tune and rate the needed filters ensuring that no situations exist where a resonance mode will be hit where any significant harmonic generation by the furnace is present.

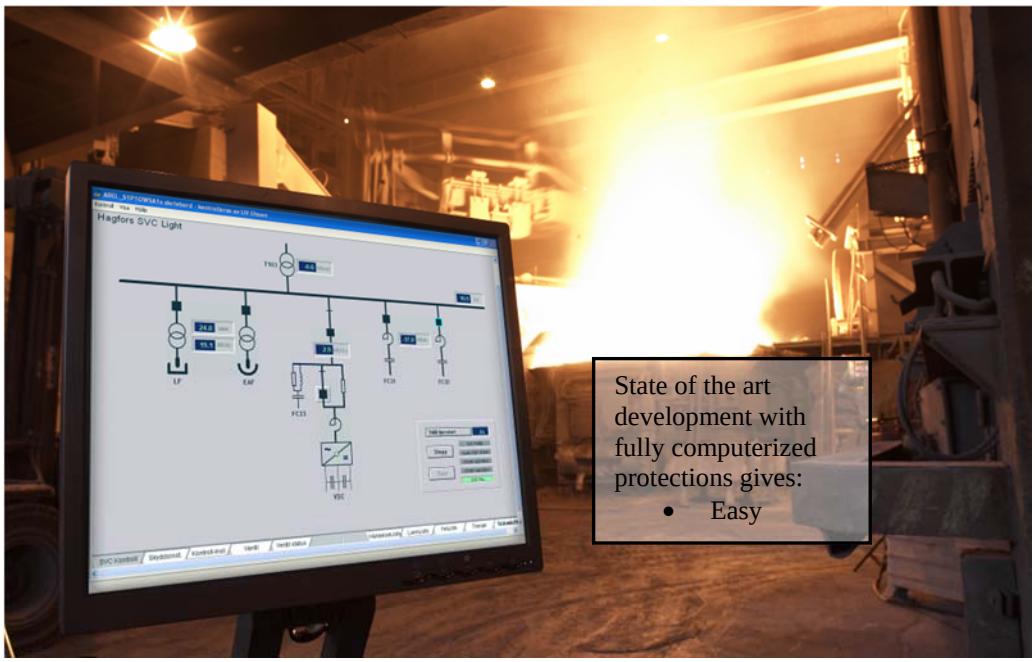
The IGBT-valve suppresses harmonics in a very effective way. However, STATCOM technology is self-generating of high frequency harmonics. For the same reason we have included a small high pass filter.

The proposed filter configuration will ensure that one of the main goals of the design work - that of avoiding the introduction of resonances - is met. The other main goal, to limit the harmonic distortion at PCC bus, will also be met with the proposed SVC Light configuration. Typically 2:nd and 3:rd harmonic filter will be utilized in the proposed design and a high pass filter will be added. The STATCOM can be operated in reduced mode with only VSC and HP filter, with reduced performance.

Example: Harmonic filter

C r a Pr S m (MACH 2)

In order to achieve todays and future demands, ABB has developed a fully computerised and microprocessor based control and protection system for industrial environment. The system is named MACH 2.



The MACH 2 system is the most advanced and highest performance control and protection system for high voltage applications on the world market. The system has gradually evolved from an unequalled installed base of High Voltage DC (HVDC), Static Var Compensator (SVC), SVC Light, and Series Compensation (SC) control systems. Important control functions are built around a host computer based on latest processors, a general-purpose processor and four high performance digital signal processors.

Standard functionality with the following highlights:

- Redundant controller
- Sequence of Events Recorder (SER) with 1 ms GPS resolution
- TFR functionality
- Integrated protection functionality
- Remote Access through Firewall modem GSM/3G (subscription required, not included)
- Full graphical status presentation (HMI)
- Environmental proof controller cabinet (IP5X for MACH2 and IP2X for I/O)
- GPS clock time synchronisation
- Firewall protected electronic perimeter
- Access Point with file transfer server and malware protection software (subscription required, not included)

Redundant controllers
The base concept of MACH2 control system consists of redundant (duplicated) controllers. Redundant controls systems have been requested by many customers e.g., power utilities over decades.

The availability will be improved by running two controllers in parallel in order to achieve a “seamless” switchover, in case of malfunction.

In addition, the redundant controllers give the incomparable possibility for software upgrades and/or fault tracing, without switching off the SVC Light. Maintenance of the controller can easily be performed with the other controller running the SVC Light.

The MACH 2 system is built up of the following major parts:

- High-speed digital programmable SVC Light control system hosting the following:

  - SVC Light control, e.g. Mvar, flicker, power factor control.
  - SVC Light sequence control, e.g. start and stop of the SVC Light
  - Protection system

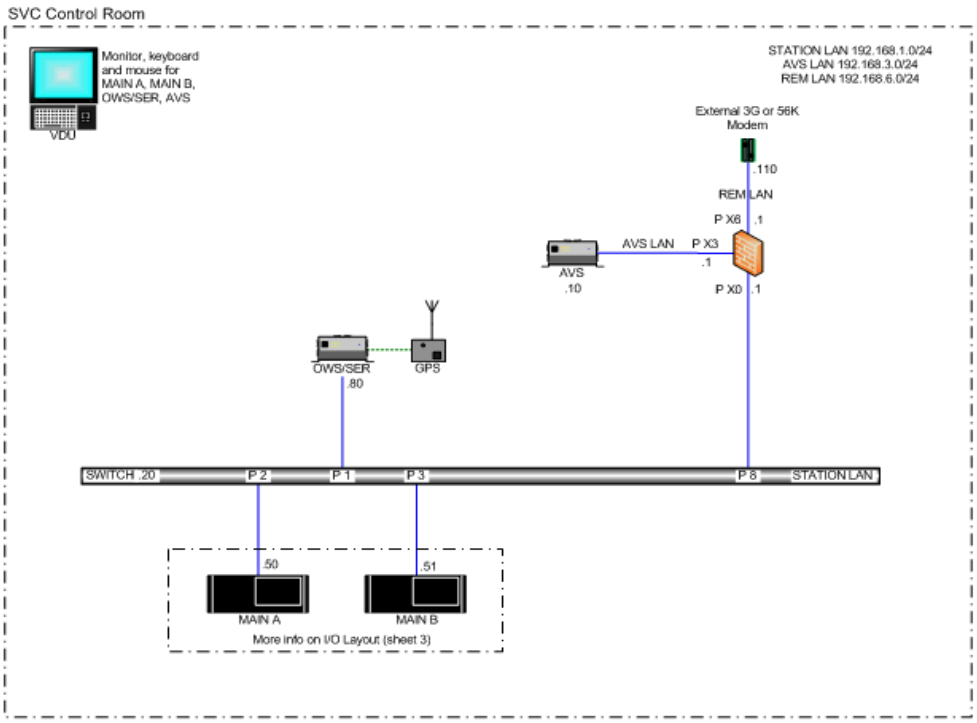
  The control computer uses the inputs from the nearby instrument transformers, evaluates the signals and controls the VSC with advanced algorithms to achieve the best possible results based on your needs. The control computer also handles the protection of the SVC Light. Examples of protections include, but are not limited to, are under voltage-, over voltage-, over current-, over load-, unbalance and earth fault protections.

  The programming is realized by using graphical block function.

- Optical interface for thyristor valve (Valve Control Unit)

  The Valve Control Unit, VCU, can be seen as a fast I/O system to the IGBT valves. The design comprises one central unit per phase and a number of cell controllers and optical units. The overall Control system is continuously sending references to the valve control. In the cell controller the voltage references are converted to short firing pulses for firing of the IGBTs via the optical units in the VCU, light guides and Gate Unit (GU) in the valve. The valve control system can be split up into the following main components:

  - Valve Control Unit
  - Light signal transmission.
  - IGBT monitoring.



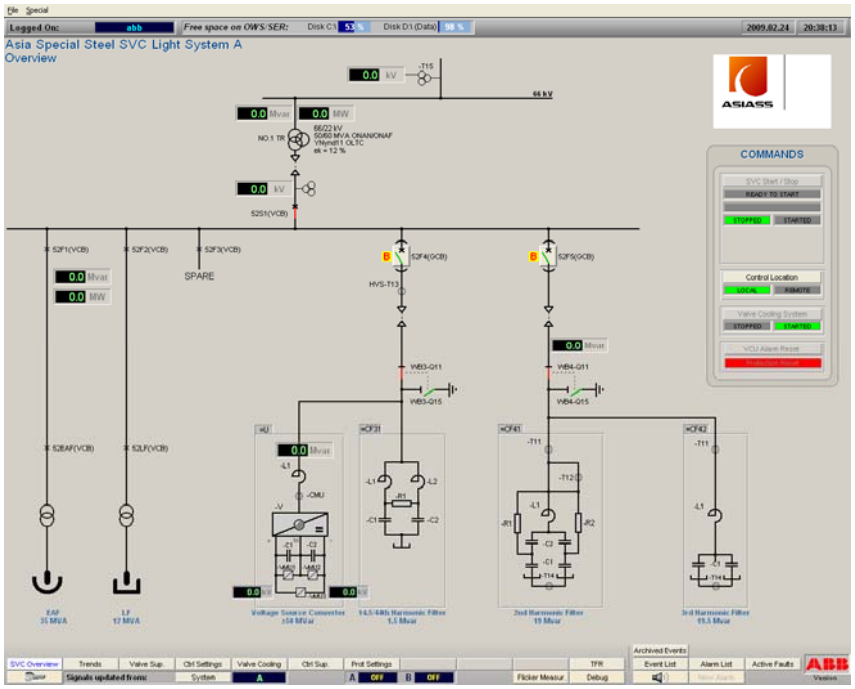
Example: Control and HMI configuration

- Operator Work Station:

  The Human Machine Interface to the control system is implemented with an industrial type PC, called Operator Work Station (OWS), connected via a local LAN (Ethernet) to the control computer.

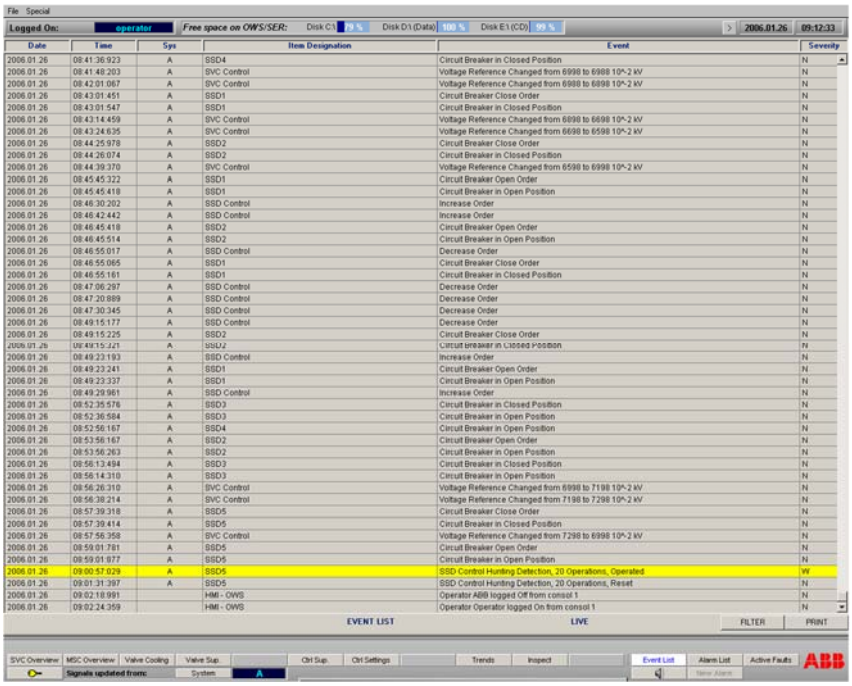
  The main features of OWS are:

  - Full graphic status indications of the SVC Light
  - SVC Light sequence control, e.g. start and stop of the SVC Light, reference settings, manoeuvring of breakers and disconnect switches, etc.
  - IGBT Monitoring. A graphic presentation of the actual status of each IGBT and valve control circuit boards.
  - Supervision of each circuit board.
  - Setting and monitoring of protections.
  - Sequence Event Recorder. The Event, Alarm and Active faults are shown on separate lists with a time resolution of 1 ms. The time synchronisation is performed by a GPS-clock.
  - Trend curves of voltages and reactive power.
  - Debugging facilities for the main application programs e.g. sequence control.
  - Standard Transient Fault Recorder (TFR) functionality with TFR evaluation tool.



Example: Picture from the OWS, SVC Light overview.

English language will be used for all text on the OWS in the base concept (options for other languages are available). The software running on the OWS for the operator control is InTouch program from Wonderware.



Example: Picture from the OWS, Sequence Event Recorder Event list

SECTION 2

DESIGN DATA

The design of the compensator is based on the following data below. Modifications during project phase that is being requested/caused by the buyer may bring additional costs and may also have impact of time of delivery and performance of the plant.

P C mm C g (PCC) a a

Short circuit capacity in Point of Common Coupling, PCC, (min/max)	2900 MVA[1]
Rated voltage	161 kV, 3-phase + 5 , -5 %
Frequency	60 ± 1%
System grounding	Grounded

S - ra rm r a a

Rated power	110 MVA
Rated voltage	161 / 34.5 kV
Impedance main tap (for performance)	12
Number of parallel transformers	0 pc

SVC a a

Rated voltage	34.5 kV, 3-phase + 5, -5 %
Grounding system	xx
Maximum operating voltage	36.2 kV
Outdoor impulse withstand voltage	200 kV
Outdoor power frequency withstand voltage	80 kV

[1] First Energy requires all substation equipment to be rated for 40 kA, corresponding to 8692 MVA. This value will be used for short-circuit calculations.

EAF Tra rm r

Transformer rated power	75 MVA
Transformer impedance (based on rated power)	xx %
Transformer voltage ratio	34.5 kV/ 1050 V

EAF R a r(a a)

Impedance of main operative tap	xx Ohm

L a a a, E r a Ar F r a

Rated capacity	xx MVA
Power factor	xx p.u.
Furnace reactance	xx mOhm
Furnace resistance	xx mOhm
Severity factor, Kst	xx

Harm rr g ra r m E r a Ar F r a r ra rr

Harmonic order	Harmonic current (%)	Harmonic order	Harmonic current (%)
2:nd	4.3	3:rd	12.7
4:th	1.6	5:th	6.2
6:th	0.9	7:th	2.5
8:th	0.5	9:th	1
10:th	0.3		

L a a a, La F r a

Rated capacity	NA
Power factor	0.77 p.u.

Harm rr g ra r m La F r a r ra rr

Harmonic order	Harmonic current (%)	Harmonic order	Harmonic current (%)
2:nd	17.2	3:rd	3.8
4:th	3.8	5:th	2.5
6:th	1.7	7:th	1.2
8:th	0.8	9:th	0.8
10:th	0.7		

M a a a A m (T r B r)

AC Supply 3-phase	480 V ± 10 % , 3-phase 63 A (AC Load typically < 15 kVA building supply excluded)
AC Supply 1-phase	120 V ± 10 % , 1-phase 25 A
Control voltage DC	125 V, DC ± 10 %
DC Supply	20 A (preliminary) (DC Load typically <1000W)

E r m a Da a TBD

Maximum wind velocity, steady	
Maximum wind velocity, gusts	
Maximum out door temperature	
Minimum out door temperature	
Maximum relative humidity	
Control room temperature	
Valve room temperature	
Altitude above sea level	
Contamination	
Seismic intensity	
Sound requirements	

SECTION 3

TECHNICAL DATA OF MAIN EQUIPMENT

VSC a

Rated power	100 Mvar
Rated current for the IGBT	960 A
Connection	1 x 3-phase in delta
Cooling	Water
Erection	Indoor
Indoor temperature	+41 F to 104 F (+5 C to +40 C)
Firing system	Fibre optic
IGBT type	ABB
Standards	IEC 61954

DC a a r

Fuseless with segmented self-healing film technology, non-PCB. Assembled in racks and cans of stainless steel.

Cooling	Natural
Erection	Indoor
Standard	IEC 61071

VSC a r a r

Type	air-core
Number of coils	3 x 1
Rated power, 3-phase	100 Mvar
Rated current	960 A
Cooling	Natural
Erection	Outdoor
Standards	IEC 60079-6

F r r)

Harmonic order	2nd2	3rd3	HPth	
Rated voltage	34.5	34.5	34.5	kV
Rated power	xx	xx	1	Mvar

For emergency, the SVC is designed to operate with the following running modes but with reduced performance:

VSC + HP+2nd

VSC + HP

F r a a r

With internal fuses, discharge resistors (Within 5 minutes down to 50 V), all-film technology, and non-PCB, assembled in racks and cans of stainless steel.

Cooling	Natural
Erection	Outdoor
Standard	IEC 60871-1

F r r a r

Type	air-core
Number of coils	3 x 1
Cooling	Natural
Erection	Outdoor
Standard	IEC 60076-6

F r r r

Cooling	Natural
Erection	Outdoor
Standard	Latest IEC

[2]Existing filter will be used
[3]Existing filter will be used

C r r ak r

Type	SF6, Outdoor Dead Tank
Rated voltage:	72.5 kV
Rated nominal current:	3000 A
Rated short-time withstand current	40 kA
Capacitive Switching Class	C2
Standard	IEC 62271-100

C arg g r r

Type	Outdoor
Rated voltage:	34.5 kV
Rated no events (events per time)	max 1/hour
Energy per event	TBD kJ
Standard	IEC

Please note that all above data on equipment are preliminary and may be subject to change at final design.

SECTION 4

SELLER S SCOPE OF SUPPLY

One Static Var Compensator in accordance with the enclosed single-line diagram and layout. We have based our offer on inputs given. Modifications during project phase that are being requested/caused by the buyer may bring additional costs and may also have impact on time of delivery and performance of the plant. These extra costs will be back-charged to the buyer. The converter dynamic range will be +/- 100 Mvar and with the two existing filters the total range compensator regulation range will be from -xx (inductive) to +xx (Capacitive) Mvar reactive power generation.

The SVC Light will be designed in accordance with ABB standard and IEC where relevant.

VSC a m

3	1-phase, water cooled IGBT valve for dynamic control
3	1-phase set of DC capacitors for the IGBT valves
1	Valve control unit and IGBT monitoring.
1	Cooling system for the IGBT valve. The system comprises: two pumps (one as 100 % standby, equal ware) deionization equipment, valves, piping, control and meters equipment all mounted on a skid. Heat exchanger is also included.
1	Tool box for changing IGBTs
1	Set of valve grounding equipment capable of grounding 3 one phase valves at a time.

C arg g r r

3	Naturally cool resistors for limitation of the valve charging current during start-up, one coil per phase, including a by-pass circuit breaker.

VSC a r a r

3 Air-cooled reactors of air-core type, one coil per phase

F r

Typical 2:nd and 3:rd filter will be utilized.

1 High Pass filter capacitor bank tuned preliminary 50th harmonic order, including damping resistors.

The capacitor bank comprises of the following:
Capacitor units, frames, insulators and interconnection material. Air core reactors in series with the capacitor bank for tuning of the filter to the specific harmonic.

SVC L g S g ar

2	Outdoor type, dead tank SF6
2	Disconnector, manual
2	Grounding switch, manual
3	CT: s (one per phase) for incoming circuit breakers
2	ECT or LEM

SVC A x ar r

1	DC distribution board
1	AC distribution board

SVC P a g

The Plant design is performed based on industry standards such as IEC, IEEE, EN and ASCE in combination with electrical system data and environmental data.

Necessary steel structures, busworks, connection materials, insulators, wall bushings etc. for installation of the SVC equipment and optical fibre control cables for connections within the SVC are included .

Electromechanical dimensioning

Due to the relatively high current levels in SVC plants aluminium busbars are frequently used and their ampacity is determined using IEEE 605 and environmental data.

Mechanical dimensioning

Calculation and dimensioning of the plant is based on the ASCE 113 substation structure design guide using the environmental data specified by the buyer in combination with electrical system design data as input.

Steel structure

The steel structures are highly standardized by ABB and used for every project, in order to provide for fast design time with proven reliability. As a consequence of this, European standard steel profiles are used all over the world.
Typical qualities are S275 and S355, which has yield limits of 275 MPa and 355 MPa.
The steel is hot dip galvanized with a procedure carried out according to EN ISO 1460/1461, which is equivalent with ASTM A123. The average weight of the zinc coating is not less than 610 g/m^2 or 85 µm.

C r a r S m

A microprocessor based control and protection system type MACH 2 including:

- High-speed digital programmable SVC Light control and protection system (duplicated for improved availability. One computer as hot standby).
- Optical interface for IGBT valve (Valve Control Unit)
- Operator Work Station (OWS)

The following protections are integrated in the system.

- Over voltage and under voltage protections for SVC Light
- Overcurrent, and overload protection for VSC – (existing 2nd and 3rd filter bank, can be incorporated in SVC protection scheme)
- Ground fault protection of SVC bus
- Overvoltage and unbalance protection for exiting 2nd and 3rd filter bank, can be incorporated in SVC protection scheme.

S r

Project Administration including:

- Project Management
- Supply Management
- Quality Control
- Logistics
- Shipping, DDP

Engineering including:

- System Engineering;
- Main Circuit Equipment Design
- Harmonic Study
- Protection Coordination and Settings
- Electrical Engineering
- Software programming
- Mechanical Engineering;
- Design of mechanical details, such as steel structure, bus works, supports etc.
- Site layout, Foundation plan and Foundation load etc.

Site works including:

- Installation supervision
- Conceptual civil design
- Proper interlocking and responsibility for setting up rigid safety instructions and procedures, for personal safety
- Commissioning
- 2 day on-site training (in conjunction with commissioning)

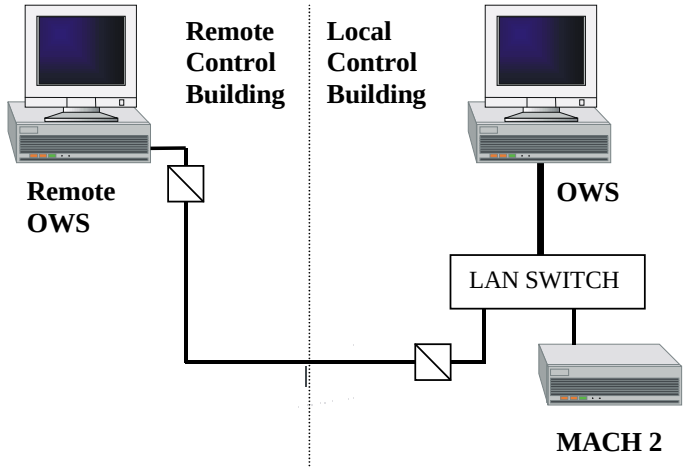
Site works including (for turnkey option):

- Civil design
- Civil work
- Installation
- Control and SVC Light building with heat and air-conditioning systems
- Grounding material below ground.
- Outdoor lightning protections.
- Security fences around the SVC Light and circuit breakers.
- Proper interlocking and responsibility for setting up rigid safety instructions and procedures, for personal safety
- Erection and erection material
- Commissioning
- 2 day on-site training (in conjunction with commissioning)

OPTIONS BELOW ARE NOT INCLUDED IN THE BASE OFFER THEY CAN BE QUOTED SEPARATELY AT REQUEST

R m O ra W rk S a (RWS)

The RWS will have the same functionality as the local OWS, enabling a remote control of the SVC LIGHT.
In order to connect the RWS to the local PC LAN in the SVC Light control building, the LAN has to be extended by means of electrical/optical converters and optical fibre cables.



1 Industrial type PC.
1 Optical fibre cable connection. The length of the fibre optical cable is limited to 200 m.
1 Software with applicable licences.

O , OWS La g ag

The language of the HMI and “eventlists” is in English language. Other languages can be supplied upon request.

O , B - k r m r

ABB can provide a built-in flicker meter, normally connected to the Point of Common Coupling. The flicker level is evaluated and presented continuously at the HMI screen. The flicker meter is fully compatible with IEC recommendations but is not approved and tested by applicable authorities.

O , Ga Wa S a (GWS)

A Gate Way Station, GWS, could be connected to the local area network, LAN. The GWS will handle the communication with a remote SCADA system if such a system is installed at the site. The output of the GWS is a serial RTU protocol, e.g. RP570 (ABB), DNP3.0 (Harris) or IEC 870-5-101. The signals are available in the SVC Light control room.

1 Gate Way Station
1 Software with applicable licences.
Design, installation, testing and documentation.

O , r a r x r a LAN

If you want to connect the SVC Light controllers to an external network (LAN), a “firewall” has to be installed. This firewall is configured for correct access from outside computers.

O , a FACTS O -L S r

ABB can offer service connected to the FACTS On-Line support. We offer different levels of services including phone support, corrective maintenance, preventive maintenance, passive remote access and active remote access. We can provide 24h access of dedicated engineers who can monitor your SVC Light from remote, helping to trouble-shoot if requested

With Remote Access Service (RAS) function, it is possible to access the local PC LAN from remote via modems over an ordinary telephone line. For this, a modem is connected to the OWS. From a remote PC it is then possible to call the OWS PC over a telephone line and log in on the OWS. From the remote PC it is for instance possible to:

- Retrieve event lists.
- Retrieve trend curves.
- Retrieve TFR records.
- Get status from the SVC Light via InTouch *)
- Enables ABB personnel to trouble-shoot the SVC Light from remote if desired.

Telephone connection and fees are not included in ABB scope.
The hardware for the functionality mentioned above is included in the base concept.

It is also possible to create a dedicated SVC Light homepage, and through the Internet retrieve above information. This option will bring some additional costs.

O , S ar ar

Spare parts can be quoted separately with reference to section 7

SECTION 5

TESTS AND GUARANTEED PERFORMANCE

To be discussed

SECTION 6

SPARE PARTS AND SPECIAL TOOLS

(NOTE Ca ara)

The following spare parts and special tools are recommended by ABB, and they are included in our offer as an option.

Pcs	Description
	VSC valve
7	IGBT.
7	Gate unit
2	DC/DC converter for GU cross supply
2	Resistor kit
11	Light Guide
1	Set of Pex tubes
1	Set of O-rings.
	IGBT Valve Control
1	Valve control unit, PS970E
1	I/O Control, PS975E
1	El/opto I/O converter, PS990E
1	Backplane, PS982
1	End termination, PS985E
	Cooling equipment
2	Service kit for pump, 8810026
1	Deraeration valve, 3120112
1	Grease gun, 9480001
1	Grease cartridge, 9420002
1	Contactor for pump
1	Overvoltage protection for pump
1	Aux. relay SL180724
1	Aux. relay MR 11-pol
1	DC/DC converter
1	PS950-card, 6470001
1	Temperature PT-100 Sensor, 6220011
1	Temperature PT-100 Transmitter, 6360036
2	Pressure transmitter exp.vessel, 6240016
1	Level switch, 6210058
1	Conductivity transmitter, 6110040
1	Conductivity sensor
1	Filter cartridge in proc. circuit, 2500015
1	Deionizer filter compl. with resin, 190126
	Electronic boards for control
1	High performance DSP board, 803FA
1	CAN/HDLC Optical Bridge, PS831

1	Switch control board, PS850E
1	110/125V Digital input board, PS851
1	Digital output board, PS853
1	AC Voltage Measurement board, 4 kHz, PS841
1	AC Current measurement board, PS846(5A)
1	High performance I/O DSP board, PS861
1	Isolation Amplifier Board, PS862G
1	Isolation Amplifier Board, PS862XQ
1	Bus extension & termination board, PS873B
1	Power Supply Unit, PS896E 24V DC, 30W
1	Electrical and optical communication board PS932
	Control & Protection Computers
1	MACH computer, DCC800
1	OWS/SER computer
1	Computer maintenance kit
	Panel equipment
1	Panel ventilation fan
1	Exhaust filter (5 pcs)
1	Fan cover
	Power supplies
2	Power Supply Unit, QUINT-PS-1AC/24VDC/20A
	Capacitors
2	DC Capacitors
1	Capacitor units for HP
	Circuit breaker
1	Spare part kit
	Special tools and instruments
1	Portable Capacitance Bridge
1	Combiflex tool set

SECTION 7

SELLER S SUPERVISION OF INSTALLATION, COMMISSIONING AND ACCEPTANCE TESTS

(N a a r r k)

Responsibilities of the Buyer and Seller during installation and commissioning:

Seller's responsibilities
The Seller will undertake supervision of the installation and complete commissioning of the SVC. The terms and conditions of these services are in accordance with the following:

The ABB Installation Supervisor shall, during the installation work period, provide technical assistance to the Buyer within the following areas:

- Interpretation of the installation requirements from drawings and installation manuals etc. The instructions will be given in English.
- Co-ordination of the communications between the site and the ABB Home Office/ Suppliers when technical clarifications are required.
- To give necessary instructions for the installation of the product.
- Supervise the manner in which the instructions are carried out

The Seller is only liable for work done by the Buyer's personnel to the extent that they have acted on the basis of incorrect instructions from the Seller's supervisor.

Commissioning and training

- ABB will perform complete commissioning.
- On-site training (1-2 days) performed by commissioning engineer on site. This training will provide basic skills in maintenance and operation of the SVC.

Buyer's responsibility

- The Buyer shall send to ABB the civil design drawings for information.
- The Buyer shall inform ABB when the civil work is completed and the equipment is unloaded at site. The ABB checklist "***Inspection of Site work"*** shall be filled in, signed and sent back to ABB together with pictures which show the work performed. Based on this information ABB will together with the Buyer, decide the start date of installation work.
  A notice from Buyer of minimum 30 working days is required, depending on VISA and work permit procedures in the Buyers country and availability of ABB resources.
- The Buyer is responsible for manpower at site. A site manager from the Buyer shall be present during the installation. The site manager shall be in power to make decisions in matters about the installation work and capable to speak and read the English language, if not Buyer shall provide an interpreter.
- The Buyer is responsible for coordination and planning of the actual site works. Seller will provide necessary input when required.

- The Buyer is responsible for the installation equipment and the tools necessary for the installation work.
- The installation work will be performed by the Buyer's own installation crew, the personnel must be qualified to perform the work in question.
- The Buyer shall ensure that their personnel is well informed of the conditions under which the work is carried out, and of the risks that may exist on the working site, and in the use of tools and equipment provided by the Buyer.
- The Buyer shall ensure that that the premises in which the work is to be carried out are in a suitable condition for the work to be performed
- In view of the nature of the work and under the conditions which the work is carried out, the Buyer shall do all that may reasonable be required in order to prevent the personnel from being exposed to any health hazards or risk of injury, or damage to the object of work
- The Buyer is sole responsible for that relevant safety, security, health and environmental rules and regulations are implemented and followed by all personnel at site.

Others

- The Buyer shall assist ABB with VISA and Work Permit applications to be able to send personnel to site.
- The Seller will send test equipment required for the commissioning, for use by the Commissioning Engineers.
  The test equipment shall be returned back to Seller at the end of commissioning. The Buyer shall assist in completing the custom formalities applicable for bringing and sending back the test equipment.
- The SVC will **not be allowed** to be taken into commercial operation unless the Buyer has taken over the responsibility of the SVC by signing the Provisional Acceptance Certificate or Taking over Certificate. The transfer of risk occurs when the Buyer takes over the SVC. However if the Buyer should take the SVC into commercial operation without signing PAC/TOC take over shall be deemed to have occurred.

- The commissioning will NOT start until the installation is fully completed.
  If the commissioning cannot start in direct connection to the installation work, the Buyer must inform ABB about a new requested start date for the commissioning. The ABB checklist ***"Commissioning start"*** shall be filled in, signed by the Buyer and sent back to ABB.
  Based on this information ABB will decide, together with the Buyer, the commissioning start date.
  A notice from Buyer of minimum 30 working days is required depending on VISA and work permit procedure in the Buyers country and availability of ABB recourses.

- It is considered that the ABB personnel can stay and perform work at site without interruptions. It is considered one two-way ticket for each person that will be sent to site. If the above work is delayed or interrupted due to Buyer and more trips are required, the Seller has the right to charge Buyer for direct cost + 10 % handling fee.

- Responsible site manager from the Buyer shall sign all time sheets for the supervisor of the installation work.

- Performance test activity can take place separately at other time, for instance after trial operation period. A notice from Buyer of minimum 30 working days is required depending on VISA and Work Permit procedure in the Buyers country and availability of ABB recourses. Seller has considered separate travel cost for this purpose.

Definition: Seller = ABB Inc., Buyer: Charter Steel Inc.

SECTION 8

DOCUMENTATION

All documents will be delivered in their native electronic format as well as PDF.
All documentation will be as per ABB FACTS standard where nothing else is stated

Paragra 1 - Ba g m

Within 1 month after the contract comes into force, the Seller shall submit for approval the following documents:

* Single-line diagram
* Protection block diagram
* Design Basis Document (to be completed by Buyer)
* SVC layout
* Case marking proposal
* PAC draft /TOC draft

Comments shall be made by Buyer latest within 2 weeks after received documents; otherwise the documents are deemed accepted. For modifications to already approved documents ABB will be entitled to time and money.

Paragra 2 - D g r r a r a

Within 3 months after the contract comes into force, documentation of the design calculations and interface of the SVC will be submitted to the Buyer.

Drafts of the following documents should be submitted:

* Main Component Design Report
* Interface diagram (to be completed by Buyer within two weeks of draft submittal)

Paragra 3 - C g rma

Within 4 months after Seller has received the approved SVC layout and Single-line diagram from Buyer, the Seller shall submit the following documents as base for the civil design:

* Busbar System data
* Heating/Ventilation
* Cable Trenches
* Foundation Plan
* Foundation Data
* SVC building
* Grounding Plan below ground with required Cu wire dimension

Paragra 4 - Gr g a a rma

Within 5 months after the Seller has received approved SVC layout and Single-line diagram from the Buyer, the Seller shall also submit the following information:

* Grounding Plan & Grounding Details
* List of materials for grounding
* Preliminary cable list
* Grounding Plan & Grounding Details above ground

Paragra 5 - I a a m a

The Seller shall submit 1 CD of the Installation Documentation Manuals at FOB delivery, including the following documents.

* Final drawings according to Paragraph 1 - 3.
* General instructions for installation
* Branch drawings including material lists
* Steel structure drawings
* Detail drawings (connectors, bus bars, bushings, insulators, labels etc.)
* Dimension & Rating plate drawings of High Voltage equipment
* Installation manuals for High Voltage equipment
* Installation of Control Cables
* Assembly drawing of Control Panels
* Cable table & Connection table

Paragra 6 - P a m a

The Seller shall submit 1 CD with Plant Documentation within one month after delivery FOB, including the following documents:

* Applicable documents according to paragraph 1 - 5.
* Descriptions & Instructions
* Protection setting list
* Operation-, maintenance- & fault tracing manuals
* Control System description
* Component Lists
* Connection Tables
* Plant Circuit & Software diagrams
* Factory routine test reports

Paragra - La g ag

The language of all documentation is English.

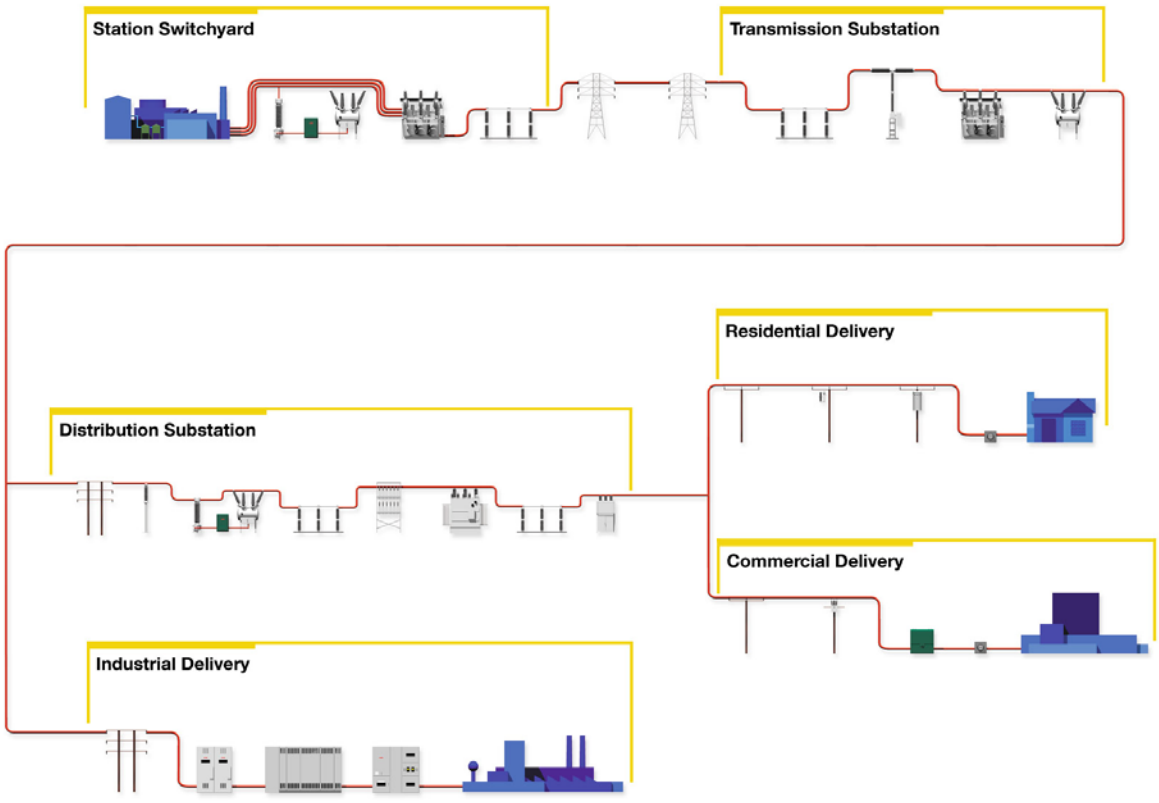
Paragra - A - m a

2 sets of paper copies of the as-built documents and one CD that have been modified after site erection and commissioning will be delivered to the Buyer 1 month after completion of commissioning and test

B g Pr a
T a M a
E r a Ca Pr
ABB R r N 16Q2 24 5

Electrical Equipment

Featuring ABB Medium Voltage Switchgear, ABB MNS-MCC Low Voltage Motor Control and ABB VPI Transformers



March 24, 2016

Tenova Metals

Attention: Michele Specogna

Subject: Electrical Equipment
Electrical Cabin Project
ABB Reference No. 16Q2924958

Dear Michele Specogna;

In response to your request for quotation we are pleased to submit our preliminary proposal for the Electrical Equipment for the Electrical Cabin Project as described herein. Our proposal is based on the drawings submitted for your Request for Quotation except as indicated by our Clarifications in the Technical and Commercial sections of this proposal.

The opportunity to provide this equipment to Tenova Metals is greatly appreciated, and this offering is intended to meet with your highest expectations.

We look forward to your consideration of this proposal, and will be pleased to answer any questions you may have. The ABB Sales Representative for this project is Dan Verhill, Verhill Associates. Please contact Dan or me, if you require any additional information.

Best regards,

Jacqueline Armanious
ABB Inc.-Packaging
Ph: 407-732-2130
E-mail: jacqueline.armanious@us.abb.com

Dan Verhill
Verhill Associates
Ph: 412-417-3667
Email: dan.verhill@verhill.com

Pr m ar Dra F r D O - C a

Technical Specification

Transformers

Q	D r
7	2500 KVA VPI Secondary Unit Substation Transformer

3 Phase 60 Hertz, 150/150 Degree C Rise, AA
30 Average / 40 Maximum Ambient
5.75 Percent Impedance with +/- ANSI Standard Tolerance
Phase relation Dyn1
3300 Feet Maximum Altitude
68 dB(a) Guaranteed Sound Level (AA)
Approximate Dimensions: Ht 102 in X Wd 126 in X Dp 66 in
Approximate Total Weight: 12954 lbs

HIGH VOLTAGE 4160 D a

30 KV BIL
Taps: +2 -2 2.5%
Copper Conductor
Customer To Supply Coordination Drawings - HV

LOW VOLTAGE 600Y/346

10 KV BIL
Taps: No Taps
Copper Conductor
Braided Flex Connectors - LV
Customer To Supply Coordination Drawings - LV

DOCUMENTS

Customer Drawings

ENCLOSURES

Frame Material 11 GA.
Copper Ground Bus, .25" X 2.00"
NEMA 1 (Indoor Ventilated)

FINISH

ANSI 61 Paint

MONITORING

Qualitrol 3-Phase Series 118 ITM Temperature Monitor

TEST

100% QC Impulse Test
Standard Applied Potential Test
Standard Excitation Current Test
Standard Impedance Voltage Test
Standard Load Loss Test
Standard No-Load Loss Test
Standard Polarity Test
Standard Ratio Test
STD Induced Potential Test
STD Phase Relation Test
STD Resistance Measurements

Pr m ar Dra F r D O - C a

The calculated efficiency @ 50% Load, PF of 1, NL @ 20 Degrees C and LL @ 75 Degree C for units offered on this quotation is not in compliance with the DOE efficiency standard which became effective January 1, 2016.

CSA Certification

Efficiency: CSA EEV program per CSA C802.2-12

Transformers are designed, built and tested in accordance with all applicable ANSI/ IEEE C57, NEMA, and CSA C9 standards. Exception is taken to all other codes and standards unless otherwise noted in this quotation.

Q	D r
1	630 KVA VPI Secondary Unit Substation Transformer

3 Phase 60 Hertz, 150/150 Degree C Rise, AA
30 Average / 40 Maximum Ambient
5.75 Percent Impedance with +/- ANSI Standard Tolerance
Phase relation Dyn1
3300 Feet Maximum Altitude
64 dB(a) Guaranteed Sound Level (AA)
Approximate Dimensions: Ht 102 in X Wd 120 in X Dp 72 in
Approximate Total Weight: 10744 lbs

HIGH VOLTAGE 34500 D a

150 KV BIL
Taps: +2 -2 2.5%
Copper Conductor
Customer To Supply Coordination Drawings - HV

LOW VOLTAGE 600Y/346

10 KV BIL
Taps: No Taps
Copper Conductor
Braided Flex Connectors - LV
Customer To Supply Coordination Drawings - LV

DOCUMENTS

Customer Drawings

ENCLOSURES

Frame Material 11 GA.
Copper Ground Bus, .25" X 2.00"
NEMA 1 (Indoor Ventilated)

FINISH

ANSI 61 Paint

MONITORING

Qualitrol 3-Phase Series 118 ITM Temperature Monitor

TEST

100% QC Impulse Test
Standard Applied Potential Test
Standard Excitation Current Test
Standard Impedance Voltage Test
Standard Load Loss Test
Standard No-Load Loss Test
Standard Polarity Test
Standard Ratio Test
STD Induced Potential Test
STD Phase Relation Test
STD Resistance Measurements

Pr m ar Dra F r D O - C a

The calculated efficiency @ 50% Load, PF of 1, NL @ 20 Degrees C and LL @ 75 Degree C for units offered on this quotation is not in compliance with the DOE efficiency standard which became effective January 1, 2016.

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Low Voltage Motor Control

MNS-MCC Low Voltage Motor Control Center

I r

The ABB UL845 Motor Control Center is engineered for safety and performance. Our unique system design dramatically reduces the potential for arc flash. It doesn't rely on shutters for isolation or upstream protective devices to limit fault currents. Units can be removed with doors closed and locked-out, but not removed, while positively and visually disengaged from the vertical bus. Coupled with a robust C-channel structure and several options to further enhance safety and provide operational data – ABB is raising the bar on safety.

S a ar F E a a V r a B

- IP20 Finger safe bus wall in lieu of mechanical shutters prevents operator exposure to energized parts when removing buckets
- Patented bus wall provides passive arc mitigation and isolation by fully enclosing bucket stabs before they contact the energized bus

Pa Ar M ga

- Extinguishes Arc Flash in under 2 cycles without relying on an upstream clearing device
- Highest measured incident energy during testing was 1.3 cal/cm2 on load side of wall, meeting NFPA 70E for Category 1 PPE

C D r B k R m a / l r

- Operators remain protected by integral closed door on each removable unit
- No exposure to potentially energized parts to verify open stabs or pull fuses prior to unit removal

MNS-MCC

- Two-piece design of load and control terminal blocks located in vertical wireway means power and control wiring is disconnected / reconnected via bucket removal / insertion process – without tools and no opening bucket door to separate / reconnect terminal blocks
- Handles on door fronts for easy pull

H a D R ar D

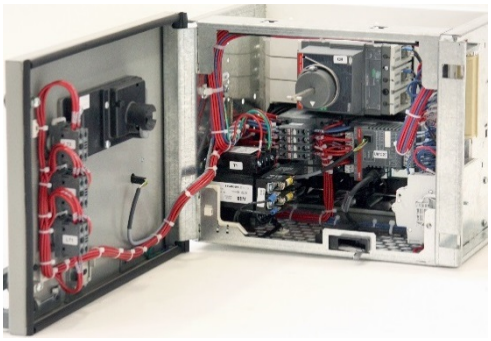
- Capability of lockout with bucket pulled out 1inch from structure (bucket stabs disengaged from the vertical bus and visual indication of disengagement)
- Disconnect handle fully integrated with the bucket removal mechanism requiring the operator to rotate the handle through the breaker open position before the bucket can be removed from the vertical bus
- Capable of handling three locks for lockout/tagout

T r -S B k R m a Pr R g a L k g W ra a M a m

- 1st pull disengages unit stabs from vertical bus with mechanical stop 1 inch out of structure
- 2nd pull removes bucket 5 inches out of structure with second mechanical stop
- 'Toe Stop' latch prevents accidental unit drop from structure
- Insertion process is reverse of removal process
- Quick removal of bucket from structure facilitates fast / easy replacement and encourages inspection / repair outside of the flash hazard boundary area

IP-20 Finger Safe Vertical Bus Wall

Rotary Disconnect



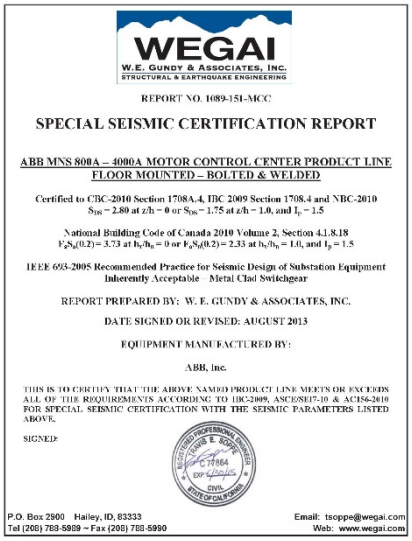
Withdrawable Unit

S m a C r MCC S r r

- C-channel frame constructed from 12 and 14 gauge steel, doors and side/rear panels from 16 gauge steel
- CBC2010, IBC2009 Shake Table Tested
- Galvanized steel construction prevents rust and corrosion
- Panels and buckets not needed to square up and offer rigidity for MCC

T MNS-MCC g a a r a g r a ar a g

- UL845 — Low Voltage Motor Control Centers
- UL50 — Enclosures for Electrical Equipment
- NOM NMXJ853 — Normas Oficiales Mexicanas
- NFPA 70E — National Electric Code Safety Requirements
- NFPA 70 — National Electric Code
- NEMAICS 1B — Motor Control Centers
- NEMA 250 — Enclosures for Electrical Equipment
- IEEE 1584 — Arc Flash Calculations Standard
- CSA C22.2 — Canadian Low Voltage Electrical Equipment


WEGAI
W.E. GUNDY & ASSOCIATES, INC.
STRUCTURAL & EARTHQUAKE ENGINEERING

REPORT NO. 1089-151-MCC

SPECIAL SEISMIC CERTIFICATION REPORT

ABB MNS 800A – 4000A MOTOR CONTROL CENTER PRODUCT LINE
FLOOR MOUNTED – BOLTED & WELDED

Certified to CBC-2010 Section 1708.4, IBC 2009 Section 1708.4 and NBC-2010
S_{DS} = 2.80 at z/h = 0 or S_{DS} = 1.75 at z/h = 1.0, and I_p = 1.5

National Building Code of Canada 2010 Volume 2, Section 4.1.8.18
$F_aS_a(0.2)$ = 3.73 at h_r/h_n = 0 or $F_aS_a(0.2)$ = 2.33 at h_r/h_n = 1.0, and I_p = 1.5

IEEE 693-2005 Recommended Practice for Seismic Design of Substation Equipment
Inherently Acceptable - Metal Clad Switchgear

REPORT PREPARED BY: W. E. GUNDY & ASSOCIATES, INC.

DATE SIGNED OR REVISED: AUGUST 2013

EQUIPMENT MANUFACTURED BY:

ABB, Inc.

THIS IS TO CERTIFY THAT THE ABOVE NAMED PRODUCT LINE MEETS OR EXCEEDS ALL OF THE REQUIREMENTS ACCORDING TO IBC-2009, ASCE/SEI7-10 & ACI 56-2010 FOR SPECIAL SEISMIC CERTIFICATION WITH THE SEISMIC PARAMETERS LISTED ABOVE.

SIGNED:

P.O. Box 2900 Hailey, ID, 83333
Tel (208) 788-5889 – Fax (208) 788-5990
Email: tsoppe@wegai.com
Web: www.wegai.com

MCC T a Da a

E r a Ra g	
Available nominal operating voltages	208Vac, 240Vac, 480Vac, 600Vac +/-10%
Available power system types	3 phase, 3 wire; 3 phase, 4 wire
Frequency	60 Hz +/-1%
Short circuit current withstand, 480Vac	42KA, 65KA, 100KA
Short circuit current withstand, 600Vac	25KA, 42KA, 65KA
C C rr Ra g	
Horizontal main bus	800A, 1200A, 1600A, 2000A, 2500A, 3200A, 4000A
Vertical distribution bus	800A, 1600A

Project Scope

S m Pr r	UNLOADING AREA MCC	BRIQUETTING MCC1	BRIQUETTING MCC2	ROTARY FURNACE MCC
Model	MNS - MCC	MNS - MCC	MNS - MCC	MNS - MCC
Design Standards	UL 845	UL 845	UL 845	UL 845
Ambient Temperature	40°C	40°C	40°C	40°C
Humidity at 40 °C (Non-condensing)	95%	95%	95%	95%
System Insulation Voltage	1000VAC	1000VAC	1000VAC	1000VAC
System impulse withstand voltage	8kV	8kV	8kV	8kV
Peak Short Circuit Rating	96.6kA	96.6kA	96.6kA	96.6kA
Test voltage power / control circuits	2.5 kV / 2.0 kV 1min	2.5 kV / 2.0 kV 1min	2.5 kV / 2.0 kV 1min	2.5 kV / 2.0 kV 1min
Altitude above sea level[m]	2000m and below	2000m and below	2000m and below	2000m and below
Label Type	UL Labeled	UL Labeled	UL Labeled	UL Labeled
System				
System Type	3Phase-3Wire	3Phase-3Wire	3Phase-3Wire	3Phase-3Wire
Main Bonding Jumper	No	No	No	No
System Voltage	600VAC	600VAC	600VAC	600VAC
Short Circuit Current Rating	42kA	42kA	42kA	42kA
System Frequency	60Hz	60Hz	60Hz	60Hz
Construction				
Installation	Indoor	Indoor	Indoor	Indoor
Enclosure Type	NEMA 1A	NEMA 1A	NEMA 1A	NEMA 1A
MCC Arrangement	Front Only	Front Only	Front Only	Front Only
Structure Gauge	14 USG (Standard)	14 USG (Standard)	14 USG (Standard)	14 USG (Standard)
Enclosure Gauge	16 USG (Standard)	16 USG (Standard)	16 USG (Standard)	16 USG (Standard)
Arc Resistant [Type 2b]	No	No	No	No
Seismic Structure - Zone 4	No	No	No	No
Structure Finish	Galvanized	Galvanized	Galvanized	Galvanized
Paint Color[Interior]	Galvanized	Galvanized	Galvanized	Galvanized
Paint Color[Enclosure]	ANSI 61	ANSI 61	ANSI 61	ANSI 61
Cable Supports	No	No	No	No
Strip Heater With Thermostat	No	No	No	No
Vertical Wireway mm[in]:	100 [4"]	100 [4"]	100 [4"]	100 [4"]
Vertical Wireway	No	No	No	No

Lighting				
Top/Bottom plate	No	No	No	No
Sill Channel	No	No	No	No
Depth mm[in]:	500 [20"]	500 [20"]	500 [20"]	500 [20"]
Height mm[in]:	2300 [90.5"]	2300 [90.5"]	2300 [90.5"]	2300 [90.5"]
Approximate Weight(Kgs)	350	1750	1400	1400
Approximate Heat loss (Watts)	340	1700	1360	1360
Width mm[in]:	1040 [40.9"]	3140 [123.6"]	2540 [100"]	2540 [100"]
Main Bus Bar				
Material	Copper	Copper	Copper	Copper
Bus Plating	Tin Plated	Tin Plated	Tin Plated	Tin Plated
Main Bus Insulation	No	No	No	No
Main Bus Rating [A]	2500A	2500A	2500A	2500A
Main Bus Bar Dimension [mm]	2x2[40x10]	2x2[40x10]	2x2[40x10]	2x2[40x10]
Neutral Bus Bar Rating [%]	N/A	N/A	N/A	N/A
Bus bar Density	Standard	Standard	Standard	Standard
Bus Hardware Type:	Galvanized	Galvanized	Galvanized	Galvanized
Vertical Bus Bar				
Vertical Bus Rating [A]	800A	800A	800A	800A
Vertical L-shaped Bus Bars [mm]	[50+30x5]	[50+30x5]	[50+30x5]	[50+30x5]
Earthing System				
Ground Bus	Top	Bottom	Bottom	Bottom
Ground Bus Bar Dimension [mm]	30x10	30x10	30x10	30x10
Ground Bus Bar Rating [A]	400A	400A	400A	400A
Vertical Ground Bus Bar	Yes	No	No	No
Equipment service connection				
Main Incoming Direction	Top	Top	Top	Top
Main Incoming Connection Type	Cable	Cable	Cable	Cable
Feeders/Starters Incoming Direction	Bottom	Top & Bottom	Top & Bottom	Top & Bottom
Individual Details				
Main Breaker Operation	Mechanical Oper.	Mechanical Oper.	Mechanical Oper.	Mechanical Oper.
Control Power Voltage in Bucket	120VAC (Std)	120VAC (Std)	120VAC (Std)	120VAC (Std)
Wiring Type	Class I type B (std)	Class I type B	Class I type B	Class I type B
Control Wiring Type	PVC (Std)	PVC (Std)	PVC (Std)	PVC (Std)
Control Wiring	16 AWG (Std)	16 AWG (Std)	16 AWG (Std)	16 AWG (Std)

gauge				
Color Phase Identification	No	No	No	No
Mimic Bus	No	No	No	No
Nameplates [Lamicoid]	Black w/White lettering	White w/Black lettering	White w/Black lettering	White w/Black lettering
Padlock [Rotary Handle]	Plastic Hasp (Std)	Plastic Hasp (Std)	Plastic Hasp (Std)	Plastic Hasp (Std)
Test Position [Withdrawable Starters]	No	No	No	No
Voltage Indication	No	No	No	No
Metering				
Metering	Yes	Yes	Yes	Yes
Meter Network Protocol	No	No	No	No
Network Protocol				
Network Protocol	No	No	No	No
24VDC Power Supply	No	No	No	No
Starters Protection Relay				
Protection Relay Model	N/A	N/A	N/A	N/A
HMI for UMC per bucket	N/A	N/A	N/A	N/A
Ground Fault Protection [Starters w/ UMC]	N/A	N/A	N/A	N/A

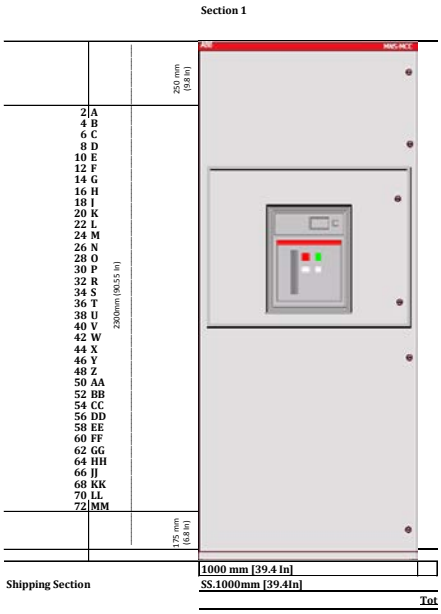
Project Scope

S m Pr r	STEEL MELT MCC	BAG FILTER MCC	WATER TREATMENT MCC1	WATER TREATMENT MCC2
Model	MNS - MCC	MNS - MCC	MNS - MCC	MNS - MCC
Design Standards	UL 845	UL 845	UL 845	UL 845
Ambient Temperature	40°C	40°C	40°C	40°C
Humidity at 40 °C (Non-condensing)	95%	95%	95%	95%
System Insulation Voltage	1000VAC	1000VAC	1000VAC	1000VAC
System impulse withstand voltage	8kV	8kV	8kV	8kV
Peak Short Circuit Rating	96.6kA	96.6kA	96.6kA	96.6kA
Test voltage power / control circuits	2.5 kV / 2.0 kV 1min	2.5 kV / 2.0 kV 1min	2.5 kV / 2.0 kV 1min	2.5 kV / 2.0 kV 1min
Altitude above sea level[m]	2000m and below	2000m and below	2000m and below	2000m and below
Label Type	UL Labeled	UL Labeled	UL Labeled	UL Labeled
System				
System Type	3Phase-3Wire	3Phase-3Wire	3Phase-3Wire	3Phase-3Wire
Main Bonding Jumper	No	No	No	No
System Voltage	600VAC	600VAC	600VAC	600VAC
Short Circuit Current Rating	42kA	42kA	42kA	42kA
System Frequency	60Hz	60Hz	60Hz	60Hz
Construction				
Installation	Indoor	Indoor	Indoor	Indoor
Enclosure Type	NEMA 1A	NEMA 1A	NEMA 1A	NEMA 1A
MCC Arrangement	Front Only	Front Only	Front Only	Front Only
Structure Gauge	14 USG (Standard)	14 USG (Standard)	14 USG (Standard)	14 USG (Standard)
Enclosure Gauge	16 USG (Standard)	16 USG (Standard)	16 USG (Standard)	16 USG (Standard)
Arc Resistant [Type 2b]	No	No	No	No
Seismic Structure - Zone 4	No	No	No	No
Structure Finish	Galvanized	Galvanized	Galvanized	Galvanized
Paint Color[Interior]	Galvanized	Galvanized	Galvanized	Galvanized
Paint Color[Enclosure]	ANSI 61	ANSI 61	ANSI 61	ANSI 61
Cable Supports	No	No	No	No
Strip Heater With Thermostat	No	No	No	No

Vertical Wireway mm[in]:	100 [4"]	100 [4"]	100 [4"]	100 [4"]
Vertical Wireway Lighting	No	No	No	No
Top/Bottom plate	No	No	No	No
Sill Channel	No	No	No	No
Depth mm[in]:	500 [20"]	500 [20"]	500 [20"]	500 [20"]
Height mm[in]:	2300 [90.5"]	2300 [90.5"]	2300 [90.5"]	2300 [90.5"]
Approximate Weight(Kgs)	2100	350	1400	1050
Approximate Heat loss (Watts)	2040	340	1360	1020
Width mm[in]:	3540 [139.3"]	540 [21.3"]	2640 [103.9"]	2140 [84.2"]
Main Bus Bar				
Material	Copper	Copper	Copper	Copper
Bus Plating	Tin Plated	Tin Plated	Tin Plated	Tin Plated
Main Bus Insulation	No	No	No	No
Main Bus Rating [A]	2500A	1200A	2500A	2500A
Main Bus Bar Dimension [mm]	2x2[40x10]	2[40x10]	2x2[40x10]	2x2[40x10]
Neutral Bus Bar Rating [%]	N/A	N/A	N/A	N/A
Bus bar Density	Standard	Standard	Standard	Standard
Bus Hardware Type:	Galvanized	Galvanized	Galvanized	Galvanized
Vertical Bus Bar				
Vertical Bus Rating [A]	800A	800A	800A	800A
Vertical L-shaped Bus Bars [mm]	[50+30x5]	[50+30x5]	[50+30x5]	[50+30x5]
Earthing System				
Ground Bus	Bottom	Bottom	Bottom	Bottom
Ground Bus Bar Dimension [mm]	30x10	30x10	30x10	30x10
Ground Bus Bar Rating [A]	400A	400A	400A	400A
Vertical Ground Bus Bar	No	No	No	No
Equipment service connection				
Main Incoming Direction	Top	Top	Top	Top
Main Incoming Connection Type	Cable	Cable	Cable	Cable
Feeders/Starters Incoming Direction	Top & Bottom	Top & Bottom	Top & Bottom	Top & Bottom
Individual Details				
Main Breaker Operation	Mechanical Oper.	Mechanical Oper.	Mechanical Oper.	Mechanical Oper.
Control Power Voltage in Bucket	120VAC (Std)	120VAC (Std)	120VAC (Std)	120VAC (Std)

Wiring Type	Class I type B	Class I type B	Class I type B	Class I type B
Control Wiring Type	PVC (Std)	PVC (Std)	PVC (Std)	PVC (Std)
Control Wiring gauge	16 AWG (Std)	16 AWG (Std)	16 AWG (Std)	16 AWG (Std)
Color Phase Identification	No	No	No	No
Mimic Bus	No	No	No	No
Nameplates [Lamicoid]	White w/Black lettering	White w/Black lettering	White w/Black lettering	White w/Black lettering
Padlock [Rotary Handle]	Plastic Hasp (Std)	Plastic Hasp (Std)	Plastic Hasp (Std)	Plastic Hasp (Std)
Test Position [Withdrawable Starters]	No	No	No	No
Voltage Indication	No	No	No	No
Metering				
Metering	Yes	Yes	Yes	Yes
Meter Network Protocol	No	No	No	No
Network Protocol				
Network Protocol	No	No	No	No
24VDC Power Supply	No	No	No	No
Starters Protection Relay				
Protection Relay Model	N/A	N/A	N/A	N/A
HMI for UMC per bucket	N/A	N/A	N/A	N/A
Ground Fault Protection [Starters w/ UMC]	N/A	N/A	N/A	N/A

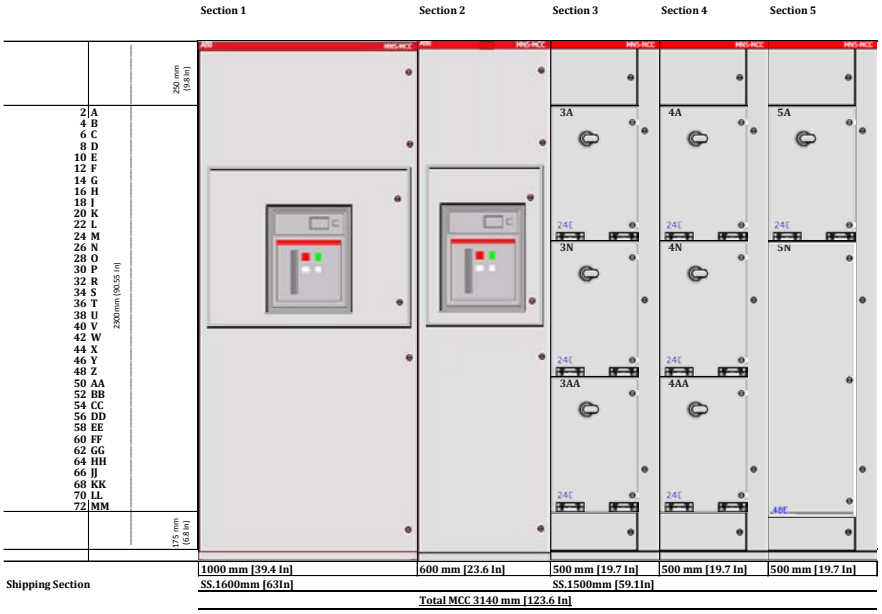
- **G ra Arra g m UNLOADING AREA MCC**



L a L

L a L	Q	S
MAIN ACB 2500A	1	92E 1000mm
T a	**1**	

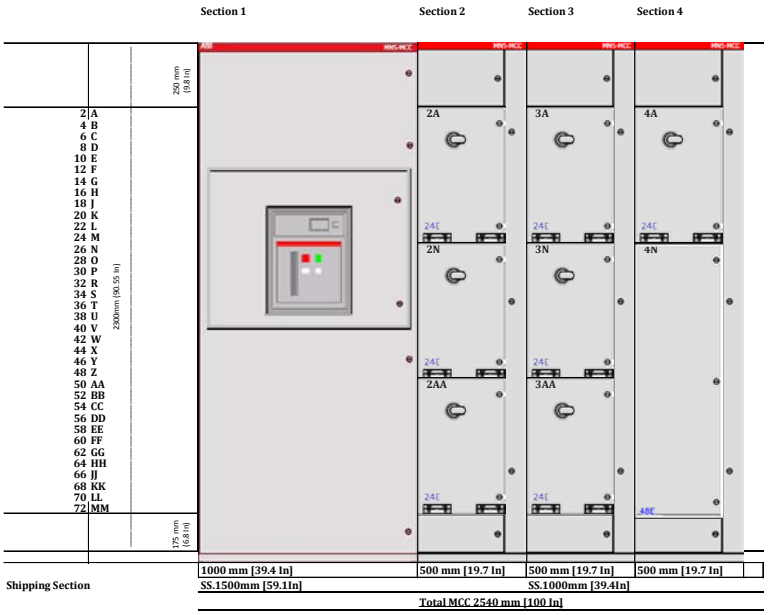
- **G ra Arra g m BRIQUETTING MCC1**



L a L

L a L	Q	S
FDR 1250 A	1	92E 600mm
FDR 250A	7	24E
MAIN ACB 2500A	1	92E 1000mm
T a		

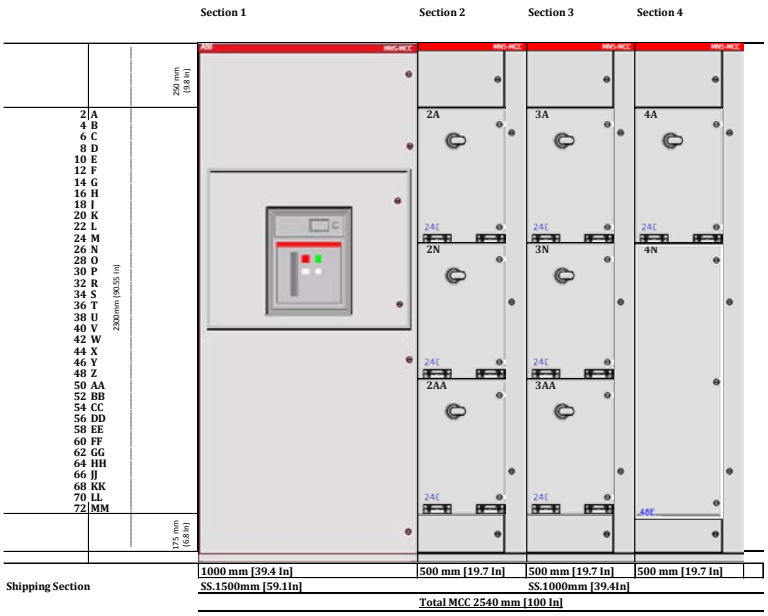
- **G ra Arra g m BRIQUETTING MCC2**



L a L

L a L	Q	S
FDR 250A	5	24E
FDR 400A	2	24E
MAIN ACB 2500A	1	92E 1000mm
T a		

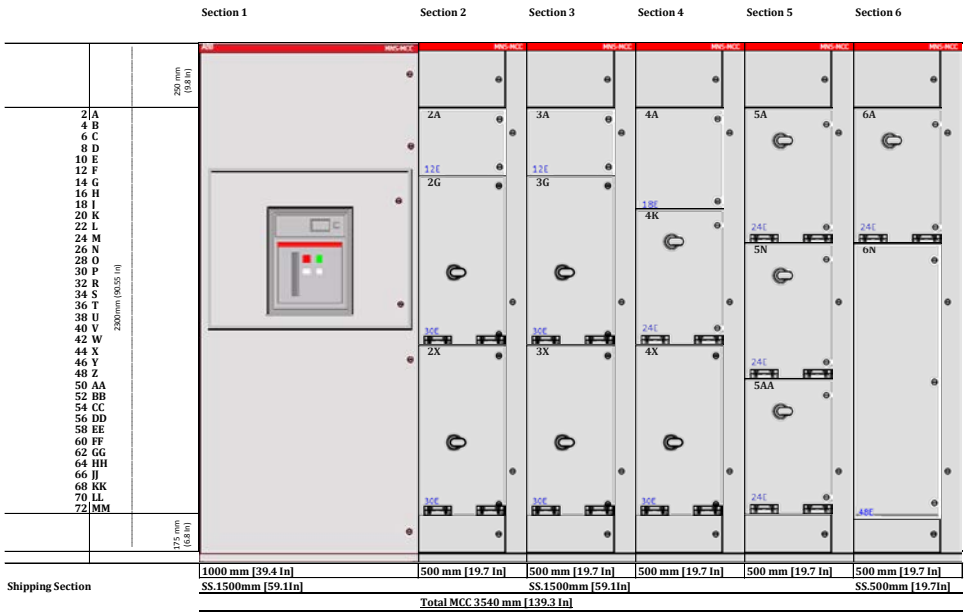
- **G ra Arra g m ROTARY FURNACE MCC**



L a L

L a L	Q	S
FDR 250A	5	24E
FDR 400A	2	24E
MAIN ACB 2500A	1	92E 1000mm
T a		

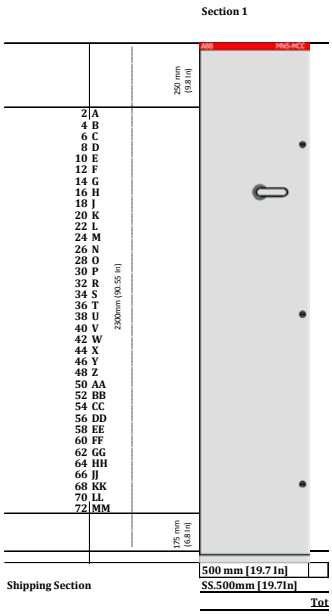
- **G ra Arra g m STEEL MELT MCC**



L a L

L a L	Q	S
FDR 250A	5	24E
FDR 630 A	5	30E
MAIN ACB 2500A	1	92E 1000mm
T a	**11**	

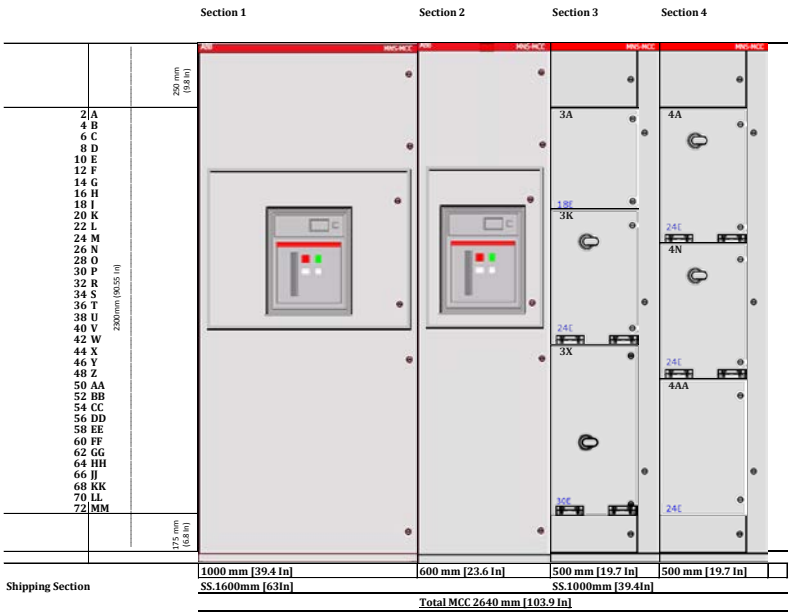
- **G ra Arra g m BAG FILTER MCC**



L a L

L a L	Q	S
MAIN MCCB 630 A	1	92E 500mm
T a	1	

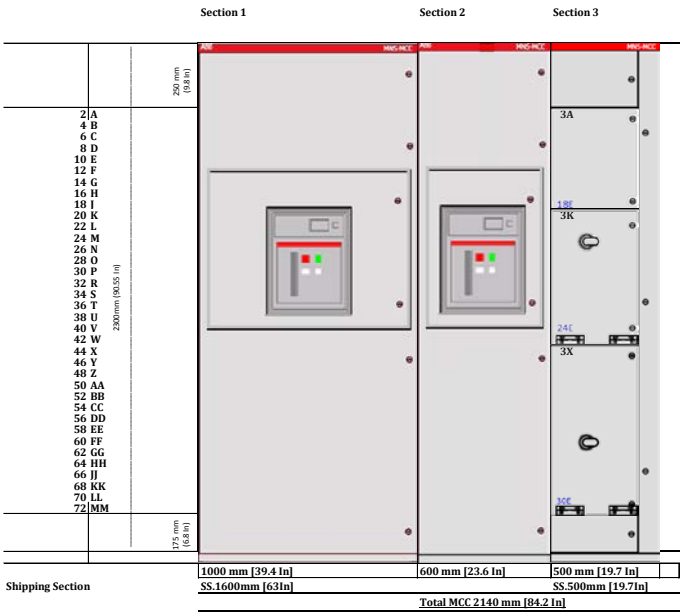
- **G ra Arra g m WATER TREATMENT MCC1**



L a L

L a L	Q	S
FDR 1250 A	1	92E 600mm
FDR 250A	3	24E
FDR 630 A	1	30E
MAIN ACB 2500A	1	92E 1000mm
T a	**6**	

- **G ra Arra g m WATER TREATMENT MCC2**



L a L

L a L	Q	S
FDR 1250 A	1	92E 600mm
FDR 250A	1	24E
FDR 630 A	1	30E
MAIN ACB 2500A	1	92E 1000mm
T a	**4**	

G ra E m L

U Nam	D r
MAIN ACB 2500A	EMAX, 2500.0A, E6, 3Phase 3 Wire, Top Entry, 1000mm (40 In) wide (10) 500MCM lugs per phase
MAIN MCCB 630 A	Tmax, 1200.0A, T7, 3Phase 3 Wire, Top Entry, 500mm (20 In) wide (3) 500MCM lugs per phase
FDR 1250 A	EMAX, 1600.0A, E3, 3Phase 3 Wire, Top Entry, 600mm (24 In) wide (6) 500MCM lugs per phase
FDR 630 A	Plug-In Circuit Breaker, T6L 800, 800.0A, 30E, Thermal Magnetic TMA Adjustable Thermal and Magnetic, Top Entry (1) 500MCM mechanical lugs per phase [maximum 4 cables per phase]
FDR 250A	Branch Feeder Circuit Breaker T4L 250, 250.0A Thermal Magnetic TMA Adjustable Thermal and Magnetic, CCU300 (1) 250MCM lug per phase
FDR 400A	Branch Feeder Circuit Breaker T5L 400, 400.0A Thermal Magnetic TMA Adjustable Thermal and Magnetic, CCU300 (2) 250MCM lugs per phase

Technical Clarifications and Exceptions

Items or services not included in equipment layout or bill of material are not included or implied.

Quoted Standard ABB MCC specification, no end user specification supplied.

2500 A Main Circuit Breakers are fixed, withdrawable design is not standard.

1250 A and 630 A Feeder breakers are fixed, withdrawable design is not standard.

Commercial Specification

Pr g l rma

I m	Tag	D r	T a Pr USD
1	Steel Melt Shop Cabin Nr. 1		**141,1 0**
		Dr -T Tra rm r - B a	
		2500kVA	
		LV M r C r - ABB	
2	Bag Filter Electrical Cabin Nr.X		**236,430**
		MV S g ar - ABB A a (5kV, 1200A, 25kA, 3 Fram , 4-ADVAC Br ak r)	
		Accessories	
		Dr -T Tra rm r - B a	
		630kVA	
		LV M r C r - ABB	
3	Water Treatment Plant Electrical Cabin Nr. 3		**3 5, 20**
		MV S g ar - ABB A a (5kV, 1200A, 25kA, 3 Fram , 4-ADVAC Br ak r)	
		Accessories	
		Dr -T Tra rm r - B a	
		2500kVA	
		2500kVA	
		LV M r C r - ABB	
		Water Treatment (Left)	
		Water Treatment (Right)	
4	Unloading Area Electrical Cabin Nr. 2		**251,550**
		MV S g ar - ABB A a (5kV, 1200A, 25kA, 3 Fram , 4-ADVAC Br ak r)	
		Accessories	
		Dr -T Tra rm r - B a	
		2500kVA	
		LV M r C r - ABB	
5	Briquetting and Drying Electrical Cabin Nr. 3		**460,2 0**

		MV S g ar - ABB A a (5kV, 1200A, 25kA, 4 Fram , 6-ADVAC Br ak r)	
		Accessories	
		Dr -T Tra rm r - B a	
		2500kVA	
		2500kVA	
		LV M r C r - ABB	
		Briquetting	
		Drying	
6	Rotary Hearth Furnace Electrical Cabin Nr. 4		**36 , 40**
		MV S g ar - ABB A a (5kV, 1200A, 25kA, 4 Fram , -ADVAC Br ak r)	
		Accessories	
		Soft Starters NOT INCLUDED	
		Dr -T Tra rm r - B a	
		2500kVA	
		LV M r C r - ABB	
		TOTAL PO PRICE USD	**1, 53,0 0**

ABB Or r A a Pr r

ABB will review PO documents for conformance to ABB Quotation. Once mutually agreeable contract terms are reached, a contract start date will be established. All delivery schedule lead-times will be based on this agreed contract start date.

To expedite order acceptance, please provide the following information on your Purchase Order Documents:

- PO shall reference the ABB CCP # 16Q2924958.
- PO shall reference the agreed terms and conditions.
- PO shall include Freight terms and “Ship To” address.
- PO shall include and reference all customer provided data and requirements necessary to complete the project engineering and design, and must be provided at time of order placement.

D r S

Contract drawings, information submittals, manufacturing, and shipment schedules will normally follow the outline below.

- Approval Drawings – Class I & II: 4 to 6 weeks from contract start date and after receipt of purchase order conforming documents. Submittal will include FV, FP, SV, SLD, EBOM, NP, 3-line & Breaker Schematic diagrams. Refer to Technical Offering for submittal definitions.
- Customer drawing approval time is normally 2 weeks, but may be extended if necessary.

- Record or Optional Class III Approval Drawings: 4 to 6 weeks after return of Class I & II approval drawings from Customer. Submittal will include (CD) connection diagram, (ICD) interconnection diagrams and Class I & II drawings for record with Customer comments incorporated.
- Switchgear/MCC Ready for Shipment: 14 to 16 weeks after return of all approval drawings with customer release to manufacture.
- Transformer Ready for Shipment: 12 to 14 weeks after return of all approval drawings with customer release to manufacture.
- Electronic Instruction Books: 2 weeks after shipment of switchgear.
- As-Built (Final Record) Drawings: 2 to 4 weeks after shipment of switchgear.

Schedule is subject to customer-selected level(s) of Approval Drawing Class, and customer approval time and return of drawings. Please Note; if Class III Approval level is selected this will increase the total lead time of the project, please consult the factory for details.

All customer provided data and requirement must be finalized at the time of purchase order placement. Revision to contract requirements may result in schedule changes and delays. All lead-times are subject to prior sale, please contact factory for actual lead-times at time of order placement.

D a S m

Should the Purchaser request that ABB delay shipment, once material is released and/or manufacturing has started, ABB will store such equipment, subject to the following conditions:

a) Purchaser shall issue a written request on Purchaser's letterhead including the following information in b) through d).
b) Upon Completion, the Purchaser will allow ABB to issue an invoice for the equipment and process said invoice, within the payment terms of the purchase order, as if the equipment had actually shipped.
c) Purchaser agrees to assume title and ownership of the equipment on the date the invoice is issued. Warranty will start at time of ownership transfer.
d) Purchaser agrees to pay ABB applicable handling and storage fees until time of shipment. If shipment is delayed for more than 4 weeks, an additional fee will be assessed for inspection and cleaning of the equipment prior to shipment.
e) Prices are subject to escalation in the event of customer requested/caused delay at the rate of 1% per month, (or fraction there-of) and any additional storage or holding fees.

F S r Ra
S U S A

D m r 2013

T a S a S r
ABB, Inc. maintains a complete staff of trained field engineers and technicians who are available to provide advisory assistance, installation, inspection, commissioning, testing, troubleshooting, start up, engineering studies, maintenance and repair services of electrical apparatus.

N ABB r N Warra l
Customer to provide at least 3 weeks of advance notice for ABB to coordinate Service personnel for all non-warrantable issues.

Pr mar W rk H r
Primary Working Hours (PWH) are defined as an 8-hour period beginning between 7:00 A.M. and 10: 00 A.M. Monday through Friday, excluding national and ABB recognized holidays. The primary work hours include a one half-hour non-paid lunch period and two 15-minute breaks during the day.

S a Ra (P r P r)

C a a	Da Ra (1)	Da Ra P r D m	H r O r m Ra (2)	H r S a, Sa & H a Ra (3)
Tra rm r S r				
Standard	$1800	$2300	$400	$600
Emergency	$2300	$2800	$500	$700
MV, LV C r Br ak r S r Pr & C r E m S r				
Standard	$2000	$2500	$400	$750
Emergency	$2500	$3000	$500	$875
H g V ag S r				
Standard	$2500	$3000	$500	$650
Emergency	$2750	$3250	$700	$800
Ga l a S a (GIS) S r G ra C r Br ak r (GCB) S r				
Standard	$2500	$3000	$500	$650
Emergency	$2750	$3250	$700	$800
A r E m S r				
Standard	$2500	$3000	$500	$650
Emergency	$2750	$3250	$700	$800

1. **Da Ra** This rate applies to all time worked or traveled during a normal **g r rk a** . The shift is defined as any consecutive eight hour period (Monday – Friday, holidays excepted) with an allowance for lunch.

2. **O r m ra** This rate applies to all hours worked in excess of eight hours on weekdays and all time worked or traveled on Saturdays.

3. **S a a H a ra** This rate applies to all hours work or traveled on Sundays or holidays.

A a Ra

4. I **r a a Ra** All work performed outside the United States will be charged at 2X the Daily Rate.

5. **Ra r U S** For work scheduled at a Union site, rates will vary, and will be quoted on an individual basis.

ABB policy is a maximum of (12) twelve working hours per day per person including travel time. Under special circumstances and with prior ABB Business Unit approval, the maximum work hours can be extended to (16) sixteen working hours per day per person including travel time.

Hourly and daily rates are exclusive of all travel and living costs.

Charges for travel and living expenses will be billed at cost plus a 25% handling charge.

P r D m
Where purchasers specify or require daily rates for field services inclusive of local traveling and living expenses, a flat charge will be billed for all time worked or traveled per eight hour weekday or fraction thereof (Monday through Friday). All hours worked or traveled in excess of eight hours per weekday and all hours on Saturdays, Sundays, and holidays will be billed at the applicable hourly overtime rates. Per Diem rates exclude the cost of airfare to/from the job site and headquarters.

Air travel duration of over 6 hours will be booked in Business Class; all other travel will be booked as Economy Class.

Tra g T m
The maximum billing for traveling time, at the applicable rate, shall be eight hours per person for any one calendar day.

Traveling time and expenses for each person will include departing from and returning to the employee's headquarters.

M m m B g
A minimum billing for one day's service will be charged for each day or fraction thereof that a Technician or Engineer spends on the customer's premises.

S a T m
When Technical Specialists are on the customer's premises but are unable to perform the services requested because of circumstances beyond the control of ABB, Inc., the purchaser will be charged at the applicable rate.

O r C arg
The following charges will be in addition to the service rates stated previously:

A. **P r a Ma ra**
When the job requires the purchase of materials or services from subcontractors or other vendors or expendable tools, such items will be billed at cost plus a service charge not to exceed 25%.

B. **S a T a E m F r ABB**
A rental charge shall be made for all specialized tools, equipment, and instruments. Refer to ABB, Inc. Field Service Equipment Rental Rate Schedule.

C. **C m a V M ag Ra**
The cost of mileage for company vehicles to travel to and from the standard job site will be billed at a rate of $0.75 per mile and a $200 per day for equipment vehicles.

D. **O Pr g Tra r**
The daily rate for an oil processing trailer will be billed at $2,500 per day, if required. Mobilized and demobilization charges will be billed at a rate of $3.50 per mile each way. The usage of an oil processing trailer requires the contract of at least four service personnel.

T rm Pa m Net 30 days
T rm a C Please see ABB Inc. - "General Terms and Conditions of Sale".

T rm a C Sa

This offering is based on purchaser's acceptance of ABB Inc. Terms & Conditions of Sale, Form ABBGTC073101, or as may be otherwise mutually agreed upon.

In any event the following article must be included in the final contract terms:

ABB, ra r a r a r, a a ra , r (g g g r r a) r r r amag r r r r r m , r r r , m r r m, a a , r a r r a m r r m rar m (g a a x rr g x g a), a m m r P r a r, r r a a , r , a , r a amag a r

Pr S T rm

Fr g T rm
FCA Point: ABB Factory (Origin), INCOTERMS 2010
ABB Standard Commercial Packaging included

F rm Pr g
T ABB r r m ar a - g l r r a a rm ra ABB a , , mak a a g a ABB r

Tax / D / F
No taxes, duties, fees or commissions of any kind are included.

T rm Pa m
20% Net 30 upon submittal of Approval drawings
80% Net 30 after Equipment Delivery
Payment terms are subject to credit approval by ABB Treasury Department

B Va
This offering is budgetary.

Warra
Warranty offered is for (12) months from date of initial operation, not to exceed (18) months from date of shipment. Extended warranty provisions may be purchased prior to equipment shipment and may be extended in 1-year increments for up to 5 additional years at the rate of 2% per year.

Ca a S
10% After order entry
20% After drawings issued for approval
45% After release to order major material
75% After receipt of major material
100% After start of fabrication

10.4.8 Fines and Sludge Briquetting Plant

As seen in the process section, the fines of IO pellets proceeding from the IO pellets screening, will be recovered in a dedicated silo and briquetted together with the fines of the plant baghouse and the dried sludge proceeding from the water treatment plant.

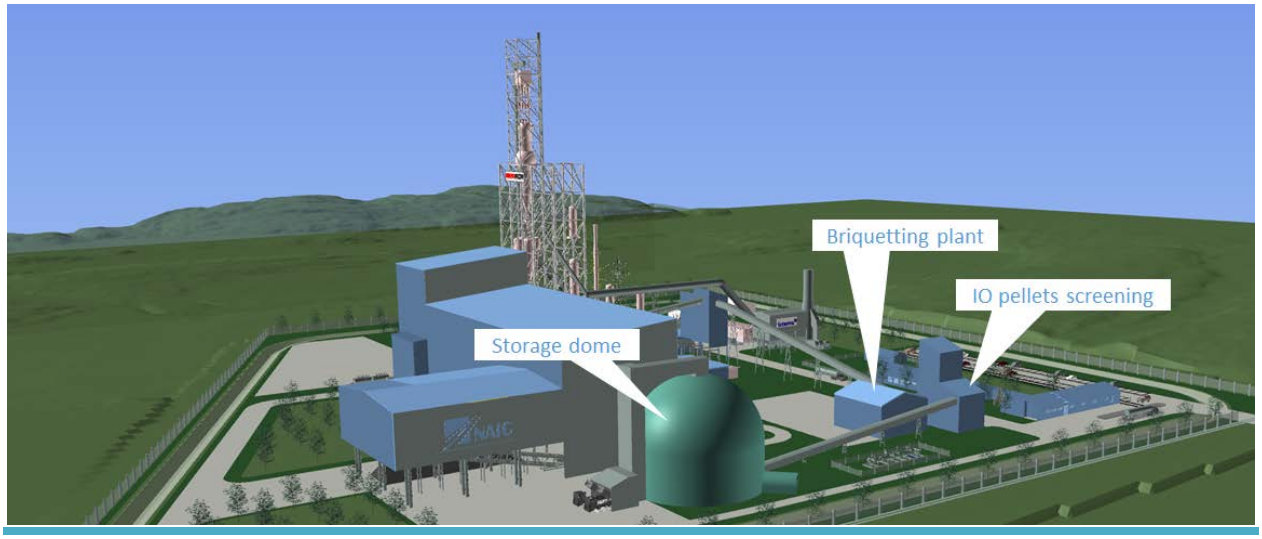


Figure 10.4-27.: location of the Briquetting plant in the general layout

The briquetting plant will be built next to the IO pellets screening station, so that the storage silo for the IO fines will be located adjacent to the screens and into the briquetting building/shelter.

The equipment of the briquetting plant is listed in the main equipment list and is made of belts, silos, dryers and the briquetting machine.

The material handling system will be provided by Tenova, while the briquetting machine selected for this plant has been studied and quoted by Komarek Inc., copied in the following pages.

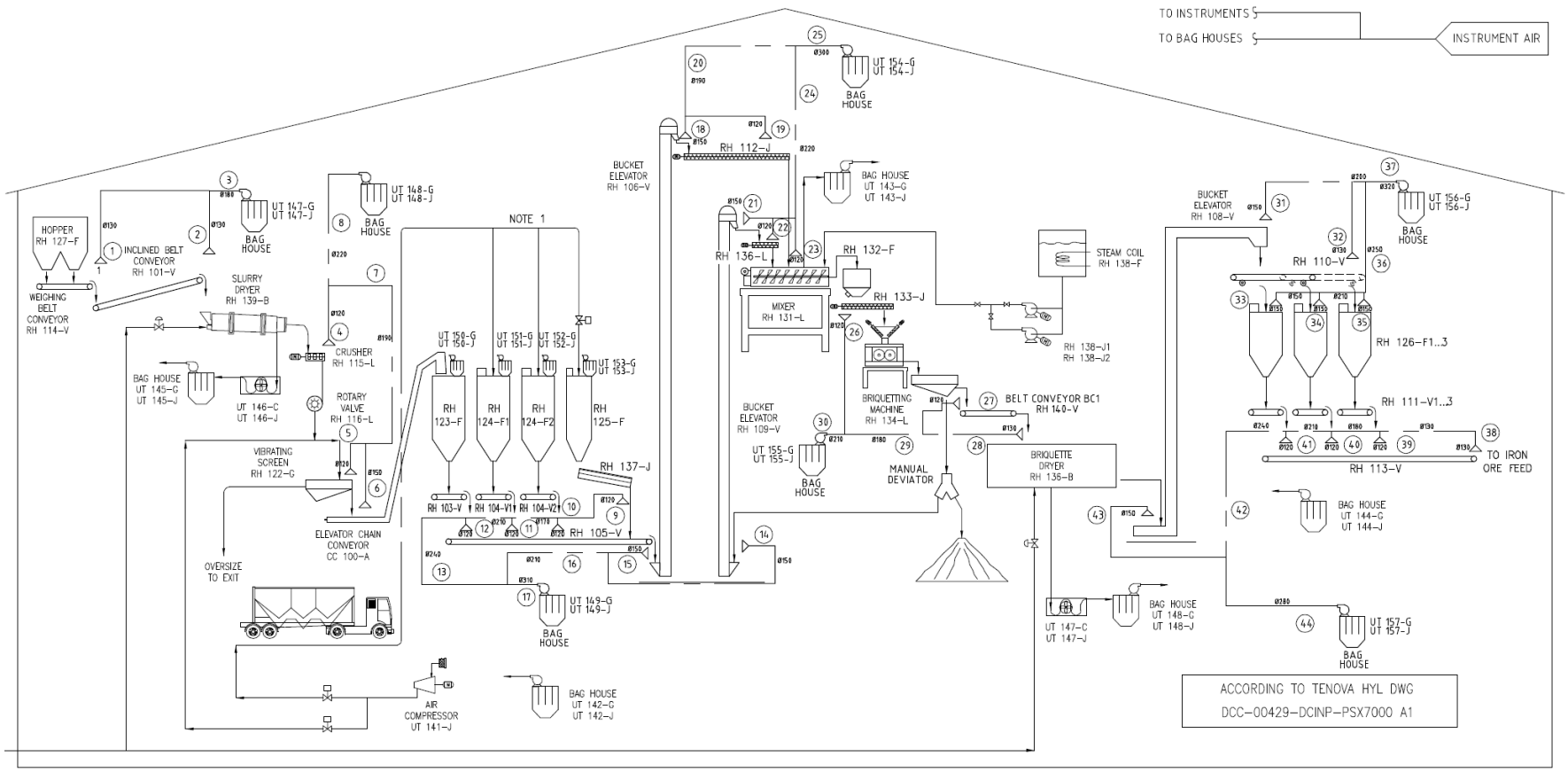


Figure 10.4-28.: Flow diagram of the briquetting plant

Shaping the Industry

KOMAREK

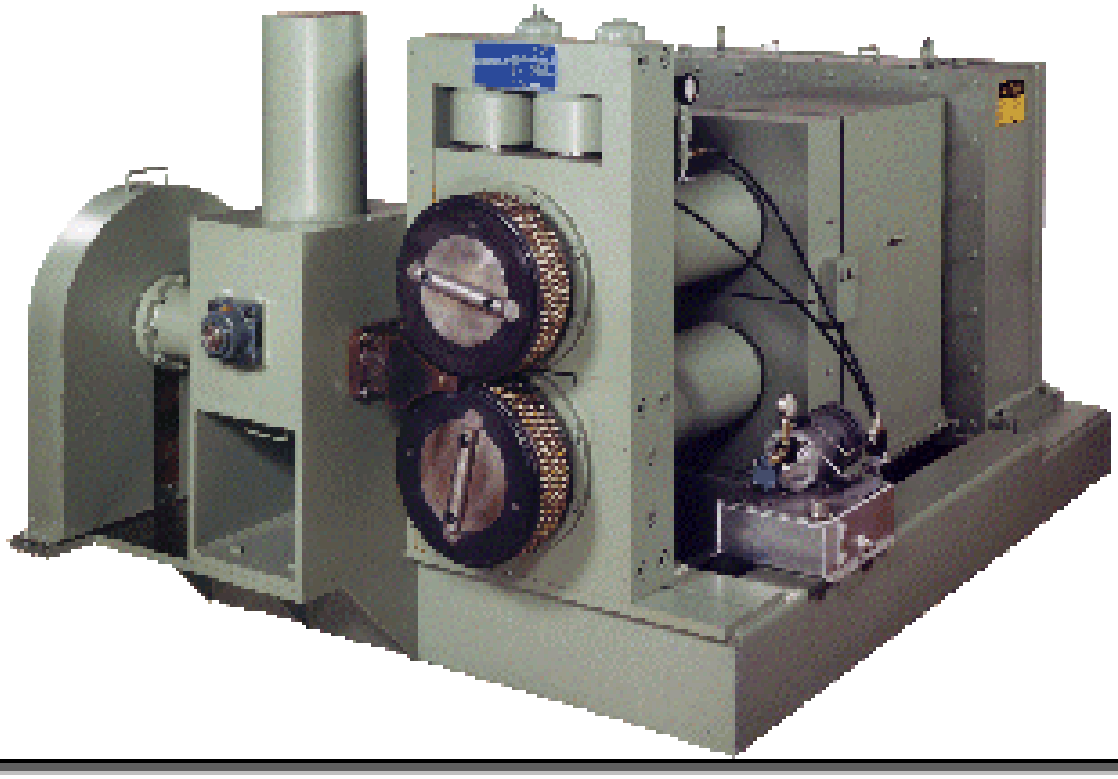
Briquetting & Compacting Systems

M B-400-B

T M B-400-B a r gg ma g a r r g ra r r g g r r m a r a g T a a a rga m a a k m (CaO) a m a r

F a r

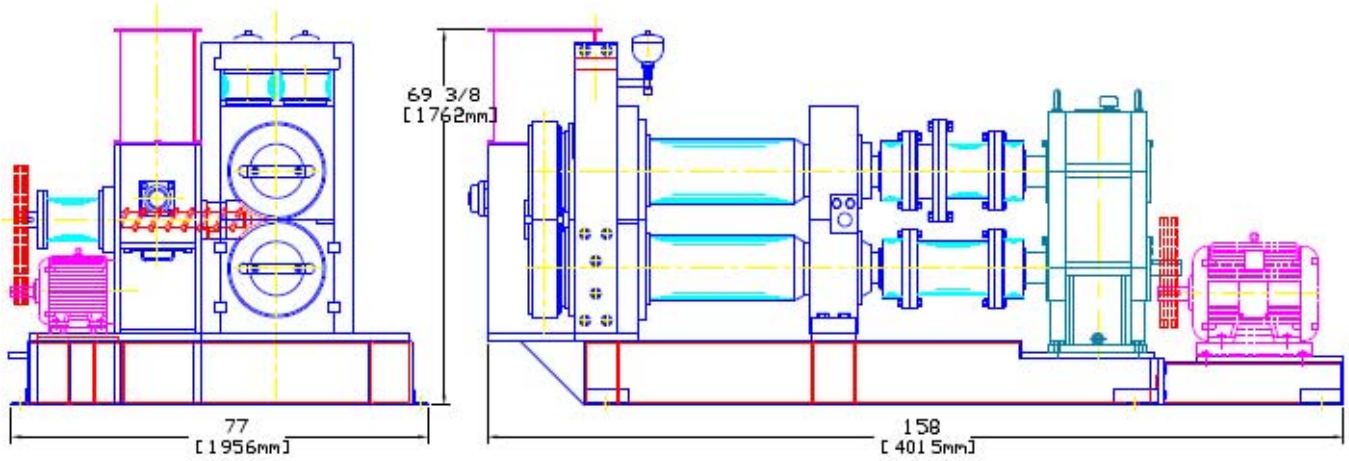
- Ca r r g r a r r a m
- T r a r r m r r a a r r
- A a a r k a a
- Va m -a ra a a a r r a a
- Var a r a r r r max m r a
- R a r ar a a a a ar r a ma r a
- R gg r a ram r
- H a g a g ar g a r m
- D g r a ma a



M B-400B G ra S a

R D am r	1	460 mm
R W	6	150 mm
R S ara g F r	120 T	106 kN
R Dr (a)	100	5 kW
F r Dr (a)	15	11 kW
T r g ra g	3 - 10	2 - m
Ma W g (a)	26,000 L	11, 5 kg

M -B400B G ra Arra g m a D m



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KOMAREK

Briquetting & Compacting Systems

K.R Komarek Inc. 548 Clayton Court, Wood Dale, Il. 60191
Phone: 847 956-0060 Fax: 847 956-0157
Email: info@Komarek.com, Website: www.komarek.com

10.4.9 Slag Processing Equipment

At the time of issuance of this FS, PURE FONTE LTÉE was in touch with different providers of slag processing services.

PURE FONTE LTÉE plan, relevant to this part of the process, it that the slag will be processed by a third party, as customary for the industry, and the relevant equipment (grinders, mobile equipment, slag pots, etc.) would be provided by the third party.

The cost for this service is considered in the Opex section of this FS

Figure 10.4-29.: location of the slag processing plant in the PURE FONTE LTÉE Layout

The area dedicated for the slag processing has been calculated based on the required space for a plant producing the amount of slag defined in the process section of this FS. The processed slag will then be further handled as defined in the environmental section of this FS.

2	ISSUED	4/4/18	LOR	SAG	MES	MES
1	FOR INFORMATION	8/22/16	LOR	SAG	MES	MES
0	PRELIMINARY	6/9/16	SAG	SAG	MES	MES
REV.	**DESCRIPTION**	**DATE**	**PROJ.**	**EXEC.**	**CHECK.**	**APPR.**

Pure Fonte Ltée

PURE FONTE LT E

PIG IRON PRODUCTION PLANT FEASIBILITY STUDY
CUSTOMER N 1 21

TENOVA

TECHINT ENGINEERING & CONSTRUCTION

SECTION 10 – PLANT EQUIPMENT

CHAPTER 10 5

PLANT AUTOMATION

ESC.: N/A

JOB: CD-335

REVISION 2

REVISION

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NOTICE

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10.5 P a A ma

The present section includes the technical description of the plant automation which is divided in the following sections

1. DRI Plant Automation
2. EAF Automation
3. Plant Instrumentation
4. Automation Design Criteria

10.5.1 Automation Design Criteria

The purpose of this section is to describe the general concepts for the Automation Design Criteria for the new, Greenfield Pig Iron Production Plant project, owned by North Atlantic Iron Corporation, located in Port Saguenay, Quebec, Canada.

Present Design criteria in conjunction with design standards and engineering practices provide the basis for the engineering design for the instrumentation and control system for the PURE FONTE LTÉE project.

This section is intended for use by the project instrument and control engineering design team and where applicable for external design consultants engaged to complete design work for the project directly or as part of the external design of major plant areas.

10.5.1.1 Scope of Works & Exclusions

The criteria contained in this document must be understood as guide in design process, subject to be changed some of them for a specific application, according to the project general conception and to standards and codes stated in the Standards and Codes chapter. Any change must be highlighted in italic or bold fonts.
In this section, minimum demands are described which must fulfill designs, instrument and control equipment and materials.
This document must be read in conjunction with following documents:

3786-TARG-I-SP-000-001	Instrumentation – Technical Specification
3786-TARG-E-DC-000-001	Electrical Installations - Design Criteria
3786-TARG-E-DC-000-002	Electrical Package Equipment – Design Criteria

Table 10.5-1.: Documents for Automation Design Criteria

In addition to present design criteria, there are indicated parameters and special conditions which must be considered for the execution of instrument and control installations design.

Instrument and control installations must be designed under complete resources exploitation concept, focusing in safety for people, equipment's and efficient use of energy and process continuity.

10.5.1.2 Responsibilities

It is CONTRACTOR responsibility to expose to COMPANY any discrepancy between documents. CONTRACTOR shall not proceed with any such aspect of the work until he has received any necessary confirmation, in writing form the COMPANY.

10.5.1.3 Design Life

Facilities are typically designed with an expected design life in the order of 20 years. It is not practical to achieve such a design life for electronic based equipment without the requirement for upgrading.
The design shall therefore take into account the requirement that the electronic based systems and associated software will have to be upgraded during the design life of the facilities.
At the Bid stage, the VENDOR shall detail his lifecycle management strategy focusing on product obsolescence, support options and further migration alternatives.

10.5.1.4 Abbreviations used in present section

ACR	Area Control Room;
A&E	Alarms & Events;
AMS	Asset Management System;
CAD	Computer Aided Design;
CCTV	Closed Circuit Television;
COM	Component Object Model;
CPU	Central Processing Unit;
DA	Data Access;
DCOM	Distributed Component Object Model;
DCS	Distributed Control System;
DMS	Data Management System;
E-Stop	Emergency Stop Device;
ESD	Emergency Shutdown
EWS	Engineering Work Station;
FAT	Factory Acceptance Test;
HART	Highway Addressable Remote Transducer;
HAZOP	Hazard and Operability Study;
HMI	Human Machine Interface;
I/O	Input/Output;
ISA	Instruments Society of America;
LCS	Local Control Station;
LOP	Local Operator Panel;

LOS	Local Operator Station;
MCC	Motor Control Centre;
MCR	Main Control Room;
OIT	Operator Interface Terminal;
OLE	Object Linking and Embedding;
OOS	Out Of Service;
OPC	OLE Platform Control;
P&ID	Piping and Instrumentation Diagram;
PSCS	Process & Safety Control System;
PCN	Process Control Network;
PLC	Programmable Logic Controller;
PDH	Process Data Historian;
PIMS	Production Information Management System;
PIN	Process Information Network;
PRN	Printer;
RTD	Resistance Thermal Detector;
SAT	Site Acceptance Test
SCADA	Supervisory Control And Data Acquisition;
SI	International System Of Units;
SS	Stainless Steel;
UPS	Uninterruptible Power Supply.
VSD	Variable Speed Drive;

Table 10.5-2.: Abbreviations used in Automation Design Criteria section

10.5.1.5 Codes & Standards

For all the references made in this specification to standards of acceptability, the latest issues, amendments and supplements apply, unless stated otherwise:

- CSA – Canadian Standard Association
  - C22.1 Canadian Electrical Code, Part 1
  - C22.2 Canadian Electrical Code, Part 2
  - C22.3 Canadian Electrical Code, Part 3
  - Z432-04 (R2014) - Safeguarding of Machinery

- AGA - American Gas Association, Inc.
  - AGA R3: Orifice Measurements
  - AGA R7: Measurement of Natural Gas by Turbine Meter
  - AGA R8: Compressibility Factor of Natural Gas and Related Hydrocarbon Gases
  - AGA R9: Measurement of Gas by Multipath Ultrasonic Meters
  - AGA R10: Speed of Sound in Natural Gas and Other Related Hydrocarbon Gases.
  - AGA XQ0010 / ANSI B109.3 - 2000 for Rotary-Type Gas Displacement Meters American Gas Association.

- AISI – American Iron and Steel Institute

- API - American Petroleum Institute
  - RP-500: Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities
  - RP 540: Electrical Installations in Petroleum Processing Plants
  - RP 551: Process Measurement Instrumentation
  - RP 552: Transmission Systems
  - RP 554: Process Instrumentation and Control
  - RP 557: Guide to Advanced Control Systems
  - RP 540: Electrical Installations in Petroleum Processing Plants
  - API STD 6D: Specification for Pipeline Valves.
  - API STD 607: Fire Safe design for ball valves.
  - API RP 500: RP for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I Division 1 and Division 2.
  - API STD 598: Valve Inspection and Testing.
  - API STD 520: Sizing, Selection and Installation of Pressure-relieving Devices in Refineries.

- API STD 521: Pressure-relieving and Depressuring Systems.
- API STD 526: Flanged Steel Pressure Relief Valves.
- API STD 527: Seat Tightness of Pressure Relief Valves.
- API RP 551: Process Measurement Instrumentation.
- API RP 554: Process Instrumentation and Control.
- API - Manual of Petroleum Measurement Standards - Chapter 21 - Flow Measurement Using Electronic Metering System.

ANSI - American National Standard Institute

- ANSI B1.1: Nuts and stud bolts for process equipment.
- ANSI/ASME B1.20.1: Connection threads (NPT).
- ANSI/ASME B16.5: Flanged connections.
- ANSI/ASME B16.10: Dimensions between valve ends.
- ANSI/ASME B16.20: Metallic Gaskets for Pipe Flanges – Ring Joint, Spiral Wound and Jacketed.
- ANSI/ASME B 16.36: Orifice flanges.
- ANSI B16.25: Butt welding ends.
- ANSI B16.34: Valves with flanged, threaded and welded ends.
- ANSI B16.37: Control valves hydraulic test.
- ANSI C85.1: Terminology for Automatic Control.
- ANSI C96.1: Temperature measurement thermocouples.
- ANSI / FCI 70-2-2006: Control Valves Seat Leakage Classifications.

ISA - The International Society of Automation.

- ANSI/ISA 5.1: Instrumentation Symbols and Identification
- ISA S7.0.01: Quality Standard for Instrument Air.
- ANSI/ISA S75.01.01-2002: Flow Equation for Sizing Control Valves.
- ISA Guide: Control Valves, Practical Guides for Measurement and Control.
- ISA S75.02: Control valve capacity test procedures.
- ISA S75.03: Face to face dimension for integral Flanged Globe style control valves bodies (ANSI classes 125, 150, 250, 300 and 600).
- ISA S75.05: Terminology.
- ISA S75.11: Inherent flow characteristics and "rangeability".
- ISA S75.19: Hydrostatic testing of control valves.
- ISA RP 71.01: Environmental Conditions for Process Measurement and Control Systems (Temperature and Humidity).
- ISA STD S12.4: Instruments Purging for Reduction of Hazardous Area Classification.

- ASME - American Society of Mechanical Engineers
  - ANSI ASME B31.4: Liquid Petroleum Transportation Piping Systems.
  - ANSI ASME B31.8: Gas Transmission and Distribution Piping Systems.

- NFPA - National Fire Protection Association.
  - NFPA 70: National Electrical Code
  - NFPA 72: National Fire Alarm Code

- ASTM - American Society for Testing and Materials.

- NEMA - National Electrical Manufacturers Association.
  - NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)
  - ICS 4: Terminal Blocks for Industrial Use
  - ICS 6: Enclosures for Industrial Controls and Systems

- NACE - National Association of Corrosion Engineers.
  - MR0175 / ISO 15156-1: Petroleum and natural gas industries—Materials for use in H2Scontaining environments in oil and gas production systems.
  - MR0103: Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments.

- IEC - International Electrotechnical Commission.
  - IEC 62061: Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems.
  - IEC 62381: Automation systems in the process industry - Factory acceptance test (FAT), site acceptance test (SAT), and site integration test (SIT)
  - IEC 61131: Programmable controllers
  - IEC-61000: Electromagnetic compatibility (EMC)

- IEEE - Institute of Electrical and Electronic Engineers, Inc.
  - IEEE 802.3: IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.

- AWS - American Welding Society.

- EIA - Electronic Industries Association.

- MSS - Manufacturers Standardization Society of the Valve and Fittings Industry.
- TIA / EIA - Telecommunications Industry Association / Electronics Industry Alliance.
- OSHA - Occupational Health and Safety Administration.

10.5.1.6 General Conditions of Services

For site conditions refer to document 3786-TARG-R-ME-000-001.
Also must be taken in consideration that design should consider that according to the Canada National Building Code the Peak Ground Acceleration (PGA) in case of seism is 0.31. Seismic loads shall be according to NBCC –Volume 2 –Division B - 4.1.8
For Outdoor installations a maximum of 1m of snow accumulation must be considered. Snow loads shall be according to NBCC –Volume 2 –Division B - 4.1.6.
Instruments and equipment located in electrical rooms or any instrumentation building shall be designed to operate under the following Indoor Ambient Design Conditions. HOLD

10.5.1.7 Units of Measurement

The SI system of measurement shall be used in documents, DCS or SCADA system and instrumentation displays.
Exceptions: Pipe / tube sizes and related valves and fittings shall be in inches.
Date format: mm-dd-yyyy > To be confirmed by PURE FONTE LTÉE
Being the most used units:

Parameter	Unit	Symbol
Flow — Gas	Cubic meter per second (Note 1)	Nm3/s
Flow —Liquid/Slurry	Cubic meters per hour	m3/h
Flow Steam	Kilogram per hour	kg/h
Flow - Solids	Metric tons per hour	t/h (metric tons)/h
Level	Note 2	m or %
Pressure	kilo Pascal	kPa
Temperature	Degrees Celsius	°C
Weight	Metric Tons or Kilogram	t or Kg
Force	Newton	N
Moment	Newton - meter	Nm
Belt Speed	Meter per second	m/s
Voltage	Volt, kilovolt	V, kV
Current	Ampere, kiloampere	A, kA
Power	Watt	W (mW, kW, MW

Table 10.5-3.: Units of Measurement

Multiples or submultiples per Canadian standard CAN/CSA Z234.1 Canadian Metric Practice Guide.
See also CAN/CSA Z85.3 Abbreviations for Scientific and Engineering Terms.
Notes:
1.- N: Normal conditions t = 0°C & p = 1 atm.
2.- As a general procedure, Scales will be 0 -100 % except when meter [m] prove to be a better option.

10.5.1.8 Protection Indexes for Electrical Equipment

Ingress protection shall be defined as per criteria stated in items 5.3.1 and 5.3.2 according to NEMA 250 rule.
In any case the project defines protection levels as per IEC 60529 standard, it shall be stated the equivalent as per recommendations in publication NEMA “A Brief Comparison of NEMA 250 and IEC 60529”.
Enclosures shall comply with CSA Standard C22.2 No. 94
For external instrument and control installation the index protection shall be Type 4.
When necessary due to environmental conditions, it shall be demanded fulfillment of Type 4X, due to corrosive environments like gases, sea environment, others, indicating in equipment data sheets the type of environment.
For indoor locations the index protection for control cabinets shall be Type 12.

For PLC/Remote IO panels the protection shall be specify depending on the installation location. In general for Outdoor but inside a building a NEMA 12 is sufficient unless there is a specific requirement. For outdoor installation a minimum of NEMA Type 4 is mandatory.
Network Server cabinets, that are installed in dust and climate controlled rooms, will be NEMA 1.

10.5.1.9 Area Classification

Enclosure of instruments and panels shall be suitable for operation in the environmental conditions specified and suitable for the electrical hazard classification of that area.
Hazardous Area Classification will be per Section 18 of the Canadian Electrical Code. When applicable Art.500 from NEC will be followed.
Dangerous places shall be classified by vapor properties, inflammable liquids or gases and combustible fibers or dusts existing in them and the possibility of creation of inflammable or combustible concentrations. For this classification, each room, section or area shall be considered separately.

10.5.1.10 Control & Safety Systems

10.5.1.11 General

- The design of the PSCS shall be based on a hierarchical breakdown of the plant into areas, systems and sub-systems representing logical groupings of related equipment, which can be controlled and operated as a unit.
- The PSCS shall be capable of data acquisition, manipulation, transfer and retrieval of real time and transactional type of data. It shall also be capable of conditioning and making these data available to the Data Management System located in the Control Room.
- Every critical electronic card shall be designed to comply with the IEC-61000 electromagnetic and immunity standards.
- The electronic modules of the Control System shall be protected against electrostatic discharge, radio frequency and switch contact bounce.
- Programmable Logic Controllers (PLCs) shall be used as Process control system.
- PSCS shall be designed for continuous operation 24hs per day, 365 days per year.
- Software and hardware inventory tool shall be fully integrated with corporative AMS.
- When required by Plant Personnel Safety or to protect plant assets there will be separate controllers for Process Safety (Safety controllers);e.g. NG Metering and Reducing Gas Plant; for Package equipment will be per Vendor´s proved criteria taking in mind safety as main objective.
- PCSC to be supplied will take control of those package or auxiliary process equipment not supplied with theirs own PLC. For all those pieces of equipment or Process Plants that will be supplied with theirs own PLC, the PSCS will work as an SCADA System.
- PSCS will also monitor electrical parameters at each substation in order to emphasize an efficient use of energy.
- Process control events and alarms management, shall be defined according to EEMUA 191, ISA-18.2 recommendations. To reduce the amount of unnecessary alarms, all alarms configured in the PLCs / PCSC HMI's shall comply with the ASM recommendations.
- Central control room located in EAF Building shall be the focal point of control for operation and shall contain the necessary equipment to operate the process area as well as other auxiliary processes that require central control operation. By its design a great visibility of EAF operation and DRI process area will be possible.

10.5.1.12 Language

- HMI screens, operator manuals and identification plates on the equipment will be written in English.
- All the remaining specifications (functional specifications, descriptions and other manuals) will be written in English too.
- PURE FONTE LTÉE to confirm if French language is mandatory.

10.5.1.13 Technical Requirements

- The PSCS shall provide high speed efficient and secure communications at all levels, along with redundancy and security. The Process Control Network (PCN) shall link all PSCS devices.
- The system architecture shall be designed such that all configurations may be performed in the Engineering Workstation located in the engineering room adjacent to the Control Room.
- Integrated function controllers, data processing units, and I/O multiplexers shall be located in environmentally controlled room.
- CPU racks shall include all communication modules to the remote I/O cabinets.
- The PSCS architecture shall be distributed, modular and maximize the utilization of remote I/O cabinets. System expansion shall be possible without changing the system architecture.
- Remote I/O cabinets will be connected to the PSCS via copper or fiber optic communication depending on application and distance between pieces of equipment.
- The reliability of communications paths shall be achieved by using high quality devices in conjunction with single mode, redundant fiber optic networks, using geographically diverse paths.
- PSCS and Package Process Controls will be from vendors approved by PURE FONTE LTÉE (see Par. 19). Preferably platforms will be Allen Bradley ControLogix PLC family and Factory Talk View for HMI configuration. During next engineering stage the use of Wonderware InTouch for HMI configuration will be discussed.
- PSCS shall be capable to work over a virtualized platform.
- Integration with others systems through standard for data acquisition and system availability based on OPC A&E, OPC DA and COM/DCOM via OPC servers.
- For updating Process Screens shall be considered minimum 1 second for real time applications and 2,5 second for trends applications.
- The PSCS shall support HART protocol.

10.5.1.14 Redundancy

- As a guide, the PSCS will have redundancy as defined by main process Package vendors and when the specific process requires it, what will be resolved during next stage of the engineering design.
- In general, redundancy requirements may be defined as follows:
-

Item	Redundancy
Power Supplies — CPU and I/O Modules	No, except an specific safety requirement
Power Supplies — HMIs, Engineering Workstation (EWS)	No
Controllers CPU	No
Communication Network, Backbone, CPU, HMI and EWS	High Level Network: Yes Backbone: For each fiber run used; there will be an spare run.
General Data Links	No
Hot Stand by HMI servers	Yes (Virtual Platform)
Local I/O Modules	Shall be evaluated case by case. It depends on process needs

Table 10.5-4.: Items and Redundancy Information

10.5.1.15 Spare Capacity

Item	Spare Capacity
Power Supplies	50% (N +1)
Spare I/O (Per Subsystem)	20% (installed)
Space in Cabinets for Extra I/O	30%
CPU Processing Time	50%
Communication Capacity	50%
Memory Usage	50%

Table 10.5-5.: Spare Capacity

10.5.1.16 Networks

Type	Redundancy	PSCS
Remote I/O Modules	Ring Topology will be adopted.	Ethernet/IP
Process Control Network	Ring Topology will be adopted.	Ethernet
Intelligent motor control center	No	Ethernet/IP – Modbus TCP (Only with written acceptance)
Medium Voltage Switchgear	No	IEC-61850

Table 10.5-6.: Networks

10.5.1.17 Controllers

- The PLCs shall be programmed using standard configuration software developed by the PSCS supplier. Tools to revise configuration program will be supplied as part of any package control system scope of supply.

10.5.1.18 Control Centers

- Motor control shall always be done through an MCC.
- Local operation of equipment will be by use of Local Control Stations (LCS)
- Local control stations (LCS) comprised of Stop (mushroom type) and Start pushbuttons located near the equipment being controlled, to enable line-of-sight operation. All motors shall have a dedicated LCS.
- The start button shall be operational when the respective equipment is selected to "Local' from the HMI. The start function shall be used for maintenance and testing.
- Local Control Boxes will be equipped with an Emergency Push Button, and commands & lamps as are required but without exceeding the number of 10 (ten) elements. If this number is reached, a Touch Screen panel has to be used instead.
- The Local Stop button shall be wired to a remote I/O and from that to a PLC. The Emergency Stop shall be hardwired directly to MCC. The Stop button shall stop the equipment regardless of the mode of control of the equipment. The button shall be mushroom head and maintained contact type.

10.5.1.19 PCS Cabinet Design

- Cabinets must be constructed complete with steel, and must be able to be mounted inside, outside and/or in heavy industrial atmosphere like a melt shop is. Enclosure degree protection must be NEMA 12 or higher.
- Cabinets must have lifting eyes, that must be designed to move the cabinets plus all the components installed inside it without any risk.
- In all cases must be guaranteed the right cooling / heating for the internal components. For cooling purposes, power fans with adequate filters are required. Those filters must be easily changeable by maintenance staff. For heating controlled electrical space distributed heaters will be used. Internal temperature controller may be required per application.
- PLC or Communication Cabinets will have two front doors with glass window allowing maintenance people to see modules lights codification from exterior.
- Every PSCS Cabinet should have an 18 Watt light or higher, with a door switch. Also must have a 120 VAC socket to connect a commissioning PC or similar.
- Dimensions: Height: 2000 mm plus a socle of 200 mm; Depth: 600 mm; Wide: 800 mm.
- Colors: External: equivalent to RAL 7035; Internal: per applicable CSA 22.2.
- Remote I/Os or PLC cabinets to be installed outdoors, must be supplied with controlled heaters (120 V 60 Hz 2 Ø – to be confirmed during detail engineering) to maintain inside temperature within operating parameters. Special considerations should be given when equipment is installed in classified areas; external box temperature must be lower than area temperature classification.
- For small size control boxes standard freeze protection boxes may be used.
- Outdoor boxes must remain undamaged by the external formation of ice on the enclosure. Design per CSA 22.2 N° 94 Type 4X.
- For remote I/O panels dimensioning must also be considered clearance space around all electronics, space enough for easy access and cabling maintenance, if required optical converter and ODF (6 fibers) DIN Rail mounted shall be supplied.

10.5.1.20 Operation Control Desks

- Usually operation control desk are located inside Pulpits or Cabins because of the environment near the line could be not convenient for operation people (noise, dust, etc);
- The preferred operation control desk used shall be with touch screen monitors or similar graphic HMI.
- Cabins and pulpits must be designed considering enough space and ergonomic conditions for people that will work on it.
- The upper part of the control desk should be made with stainless steel plate with matte finishing.
- Remote I/O or any other kind of equipment (such as Communication Devices, PCs, Converters, etc.) may be mounted inside of control desks when convenient for a safer operation.
- Also the necessary terminal strips for pushbuttons and power supply for monitors will be included.
- The design of control desks has to be with a minimal number of pushbuttons and lights. Only the Emergency Stop is allowed.
- Pulpit and Control desk must be pre-tested and delivered to the site complete with all necessary elements to be installed on site (in case pulpit dimensions are higher than permitted to be transported, it can be divided in sections). Onsite installation must only be communication bus, power supply and emergency push button connection.
- All electrical and automation components must be previously installed as approved drawings. Mechanical design must consider good maintenance accessibility for all PSCS components installed.
- Operation of main equipment as DRI or EAF will be thru Operating workstations supplied by Package Vendors.

10.5.1.21 Local Control Boxes

- Local control boxes shall be placed on field, as close as possible to the controlled equipment. Conditions of space and ergonomics for easy access for Maintenance Personnel must be considered.

10.5.1.22 Fail Safe Design

- Latch-off stop buttons, pull wire switches, other personnel safety devices and auxiliary contacts of local disconnect switches, shall be connected in a hardwired fail safe circuit. It will be hardwired directly to MCC.
- All alarms and safety interlock systems shall be designed to be fail-safe. Under normal operating conditions, contacts initiating an alarm and/or shutdown shall be closed, and relays and actuating devices (solenoids) shall be energized.
- Whenever equipment stops on a trip condition, a positive action from the operator shall be required prior to restarting that equipment.
- All alarms shall be programmed and generated into PLC/PSCS and communicated to the HMI- SCADA stations.

10.5.1.23 Uninterruptible Power Supply (UPS)

- The PLC controllers shall be powered from 120 VAC, 60Hz UPS, supplied by the Technologic Package Supplier, when applicable. The PLC controllers must stay powered for an hour minimum after the main line power loss.
- Industrial Computers, communications network equipment, extenders and monitors of the PSCS shall be powered from UPS sources, which shall keep all devices powered from the UPS operational for at least 30 minutes in the event of a power failure.
- The UPS status information shall be continuously monitored and alarmed as the need arises;
- The PSCS shall be automatically shut down in an orderly fashion by the Low Battery signal from the UPS. The Level 2 servers have to be connected to the UPS through an Ethernet communication (preferred).

10.5.1.24 Fire Alarm System

- Fire alarm and all sensors and hardware associated shall be from a vendor according to final PURE FONTE LTÉE's preferences.
- All Plant will be covered, process units, administrative buildings and open areas.
- Final System, detectors, etc. shall perform local loops in each building connected to local fire alarm panels interconnected by a fiber optic system to Main Control Panel.
- Fire suppression will be defined by a future study.
- For description of proposed Fire Alarm System, see 3786-TARG-M-MR-000-003 Fire Fighting & Detection System and 3786-TARG-I-BD-000-003 System Architecture – F&G Detection System.

10.5.1.25 Machine Monitoring System

- No central Machine Monitoring System is foreseen. If required shall be part of Control Systems supplied by Process Units Vendors. Reporting alarms to monitors in Control Room.

10.5.1.26 Machine Monitoring System

- No central Machine Monitoring System is foreseen. If required shall be part of Control Systems supplied by Process Units Vendors. Reporting alarms to monitors in Control Room.

10.5.1.27 Voice Communication System

- A telephone system using Voice over Internet Protocol (VoIP) shall be installed. At least a set will be located in each electrical room; control rooms and where necessary to facilitate plant equipment operation.
- Administration building telephones and central exchange will be by others.
- Paging System (Gai-Tronics or similar) will be installed. The system shall provide facilities for both page and common-talking party line operation at various locations throughout the plant. Two-way conversations shall take place between stations using telephone type handsets. Handsets shall perform in areas as high as 115 dB (Sound Pressure Level) ambient noise without the use of acoustical enclosures or booths (to be defined during detail design). Speakers shall be design for use in noisy industrial locations.

10.5.1.28 Process CCTV System

- Process operation will be monitored from main control room in Melting / Casting building
- The process CCTV system shall consist of the following components:
    - CCTV Cameras covering process equipment that will use a fiber optic net for communication with servers;
    - A Central Video Control and Storage System located in the main control room area, video monitors, operator interfaces and the required network switches and fiber converters.
- For surveillance, a CCTV and Access control system will be supplied and CCTV server for this application shall be independent from CCTV used for Process Monitoring.

10.5.1.29 Cathodic Protection

- Not defined at this stage of project. Hardwire signals shall be used to monitor equipment from plant control system. Reporting alarms to monitors in Main Control Room.

10.5.1.30 Instrument Numbering

- All instruments shall be identified with a unique instrument tag number in accordance with the Project Numbering System to be developed during next phase of project (based on ISA S5.1/ ISA S5.3).
- The tag numbers shall be used to identify the instruments on drawings, the instrument itself and mounting locations.
- All instrumentation shall be supplied with stainless steel instrument tags permanently attached by stainless steel wire, pins or screws.
- Instruments furnished as part of major equipment package units shall be identified on Vendor P&ID. The Vendor shall tag the instrumentation in accordance with the Project instrument tagging procedure.

10.5.1.31 General Instrumentation Requirements

- Instrument selection and installation practices must take into consideration the process characteristics and the operating risks as material spillage, etc. and particular attention must be paid to outdoors climatic conditions.
- Instruments shall be easily accessible for maintenance.
- All instruments shall be housed in winterized enclosures when installed in areas where fouling due to process conditions are expected, and when ambient conditions require winterization.
- Subject to environmental conditions, instruments shall be protected against direct sun radiation by shades. The shades material shall be stainless steel or fiberglass reinforced polyester.
- Typical Process Connection Sizes and rating for Instrumentation: will be defined during next engineering stage.
- Transmitters shall be used in place of process switches whenever practical. Transmitters shall be configured to fail low as a default unless this conflicts with

safety or operating requirements. Fail status shall be noted on data sheets. Switches (on/off) will be added where required for pump protection or safety and as a backup to the transmitters such as in tanks etc.

- Transmitters shall have an integral indicator display in engineering units as standard.
- The project standard for electronic instrumentation signals shall be 4-20 mA with HART protocol.
- The action of controllers, alarm switches, final control devices, etc., shall be such that the system is failsafe. That is, upon failure of air supply and/or power, the final control device shall move in the direction which presents the least hazard. Fail positions of valves shall be shown on Flow Diagrams or P&IDs and noted on instrument data sheets. Valves shall be configured to fail closed as a default unless this conflicts with safety or operating requirements.
- Proximity sensors (to suit 24 V DC) shall be used in preference to mechanical type limit switches wherever possible (e.g. valve limits).
- Where only contact outputs are available from primary actuated devices (field pull wire switches) contacts shall be double pole double-throw (DPDT) isolated contacts, rated for 2A minimum at 120 VAC, unless otherwise specified.
- All mechanical contacts shall be Single Pole Double-Throw (SPDT) and capable of reliably switching 2A minimum at 120VAC. Contacts shall be suitably coated or hermetically sealed to prevent high contact resistance.
- Switch contacts will be closed when process is in normal conditions and open to alarm.
- Pneumatic instrumentation shall be supplied only when accepted by Engineer or PURE FONTE LTÉE.
- Each field-mounted pneumatic controller, transmitter, and valve transducer or positioner shall be furnished with an air isolation valve, adjustable air filter/regulator combination with output gauge assembled into instrument. Each instrument shall be provided with its own supply pressure shutoff valve, upstream of the filter/regulator.
- In-line instruments shall be flanged to match the piping code and lined as required for the service. Screwed process connections shall only be used where they are consistent with the piping specification.
- Materials in direct contact with the process shall be selected on the basis of the piping material specification, process fluid and process conditions. Stainless steel (type 316) shall be the minimum requirement for process contact. Non-standard material finishes and pressure applications shall be supplied with material certificates.

- Field devices will be connected to local junction boxes and signals will be wired by use of multi-conductor cables. Instrument Junction boxes shall be (Type 4 or Type 4X (according to point 7 protection indexes for electrical equipment), stainless steel (or glass reinforced fibre in corrosive areas require approval by Detail Engineering) hinged door lockable boxes with rail mounted terminals. All wiring shall enter the boxes through either the bottom or sides.
- Local indicators (e.g. pressure gauges) shall be selected on the basis of readability, rugged construction, safety, vibration resistance, shatter proof glass, and shall be liquid filled.
- Instruments with visual indication, which require enclosures, shall have windows for easy observation.
- Field instruments shall be mounted on building steel or on separate stands or supports, as applicable, with due consideration given to remoteness from heat or vibration sources, as well as water and material spillage. Field instruments shall be located so that they are accessible from grade or adjacent platforms, but shall not obstruct walkways or passageways. Standard instrument mounting shall be a 2" pipe mount.
- Diaphragm seals, when required, shall have flushing ring connections installed to facilitate periodic flushing with appropriate media. Flushing ring connections shall be ½'' size. Flushing shall be carried out manually.
- Instrument ranges shall be selected so that the normal operating range is between 60% and 80% of the instrument's calibrated range unless otherwise indicated on the instrument data sheet. The maximum process operating value should not exceed 95% of the calibrated range.
- Electronic instrumentation shall be designed to comply with the IEC-61000 electromagnetic and immunity standards.
- For standardization purposes, whenever possible, the instrumentation provided with packages shall be of the same Manufacturer, brand and type as the one, supplied for the Project. Variety of instruments to be installed shall be as limited as possible to facilitate maintenance activities.
- For general requirements to each type of variable to be measured, see 3786-TARG-I-SP-000-001 INSTRUMENTATION - TECHNICAL SPECIFICATION

10.5.1.32 Flow Instruments

- The preferred measurement for gas flow is square edge orifice plate and differential pressure transmitter or vortex flowmeter. For large lines and where gas being measured is clean an “annubar" may be used.
- Magnetic flow meters may be used for water services when low pressure losses and accuracy are required.
- Orifice plates (lines P 2"), Venturi and nozzle flowmeters shall conform to the flow metering standard ISO 5167.
- For small lines (below 2") integral orifice transmitters may be considered.
- All differential pressure transmitters shall have a 3 way, 316SS manifold.
- Flow Switches, thermal dispersion or area variable (vane type) flow switches shall be used to detect low flow conditions in clear liquids.

10.5.1.33 Level Instruments

- Non-contact level instruments (ultrasonic, radar) shall be the preferred way of measuring solids level in bins, and liquid level in tanks. Remote flange mounted elements with accessible separate transmitters at ground or walkway level are preferred. Alternately approved integral transmitters shall be mounted adjacent to access walkways as a second option.
- Differential pressure transmitters may be used for level measurement in tanks containing liquids of constant density or dual transmitters with a vertical separation shall be installed to compensate for density.
- All differential pressure transmitters shall have a 3 way, 316SS manifold.

10.5.1.34Level Switches

- Where use of a level transmitter is impractical, conductivity type level switches may be used for water, slurries, and other conductive, non-flammable liquids. The switches shall be electronic and of the differential control type which require a minimum of two electrodes and a ground connection. Vibrating forks are also acceptable in some applications.
- Ultrasonic level switches will use is on sumps.
- Capacitive type switches may also be used for level applications.
- Tilt type level sensors may be used to detect plug chute conditions, high pile level and "material-on-belt" conditions. Direct wired tilt switches are preferred with timers in the PSCS. If an integral part of the field tilt switch is a field control unit it shall have a 0-10 second adjustable time delay to prevent false operation. Where conditions exist to make tilt switches impractical for plugged chute detection, microwave or capacitance probes type level switches shall be used.
- For conveyor blocked chutes where tilt switches are not viable, microwave or capacitance probes through beam units are preferred. There shall be a transmitter and receiver on opposite sides of the chute with non-metallic (e.g. HDPE or ceramic) inserts in the chute wall through which the microwave unit is directed. Warning signs shall be supplied with microwave level switch applications.
- For bin or tank applications flanged connections are preferred.

10.5.1.35 Level Gauges

- Level gauges shall be installed on pressure vessels containing liquid according to process requirements.
- Magnetic Level gauges with bi color indicating flags shall be used for safety.
- Transparent or through vision type are preferred to reflex. Gauge glasses shall be protected and secured along their entire length. Multiple gauges shall overlap by at least 25 mm. Isolation valves shall be provided on the vessel or bridle. The gauge shall have a drain/vent connection. Flange and instrument ratings shall be consistent with the pressure vessel. Offset block valves are used to connect level gauge to vessel in addition the isolation valves.

10.5.1.36 PH/ORP/ Conductivity Sensors

- The electrodes for process applications shall be industrial, rugged construction immersion type. They shall be connected to remote mounted indicating transmitters. When installed in process tanks from the top the probes shall be able to be retracted without disassembling or removing support tubing from within the tank. The electrodes for standard service shall be immersion type with quick disconnect. In line electrodes shall be valve retractable type or mounted in bypass line.
- All electrodes, whether in line or in a tank, shall be able to be removed and recalibrated without stopping the process, shutting down a pump or pipeline or emptying a tank. Suitable bypass piping shall be provided for inline instruments where necessary to allow this.
- Automated cleaning system shall be provided for electrodes mounted in pipe line.

10.5.1.37 Pressure Instruments

- Direct connected gauge or differential pressure indicating transmitters shall be used for pressure measurements except where slurry, temperature, corrosive fluids or vibration dictates the use of remote diaphragm seals and capillaries. For high temperature applications silicon capillary fill fluid shall be used.
- The transmitters shall have body and fittings of appropriate pressure rating and 316 SS diaphragm as a minimum standard. Appropriate diaphragm materials (e.g. tantalum, ceramic) shall be specified when the process fluids are aggressive to the transmitter's wetted parts. Teflon coated stainless steel is not acceptable.
- Double block and bleed piping valves shall be provided at the process isolation point for high pressure or corrosive service pressure instrument connections.
- Standard connections shall be 1/2” NPT for electrical and 1/2” NPTF for process. There shall be an integral scalable loop powered indicator in the transmitter housing and may be either LCD or analog but must display in engineering units. LCD displays shall be quoted unless otherwise specified.
- Transmitter housing shall be polyurethane/epoxy resin coated cast aluminum as standard with stainless steel as an option. When harsh environmental conditions apply, transmitters have to be collected and mounted in an Instrumentation Cabinet.
- Output Fail mode shall be low as standard.
- A pressure test, a conformance and /or a calibration certificate shall be supplied as required by the data sheet.

10.5.1.38 Pressure Gauges

- Pressure gauges shall be liquid filled (capable of withstand ambient and process temperature) with 115 mm diameter dial (white face with black graduations), shatterproof glass, stainless steel case, blowout back protection, and 1/2" NPTM process connections. Gauges for air sets shall be 65 mm.
- Normal working pressure shall be from 40 to 70 % of range with overload capacity of 130% of full scale without damage. Overload stops are required. Accuracy shall be +/- 1 %.
- Measuring elements (bourdon tube) shall be 316SS. Bronze may be used for pneumatic signals only.
- Process Isolation valves shall be installed for isolating the pressure indicators and there shall be a gauge (block and bleed) valve at the pressure gauge. For viscous, corrosive, or slurry service, diaphragm seals shall be provided with flange connections.

10.5.1.39 Temperature Instruments

- Sensing elements shall be Pt-100 ohm platinum 3 wire RTD's or thermocouples complete with integral head mounted transmitters.
- Platinum RTD's, Pt-100 ohm three-wire type, shall be used for temperature measurements of up to 500°C. Type K (chromel-alumel) thermocouples shall be used for temperatures of up to 1250°C, with compensation cables.
- Technological package Vendors will select temperature sensors according to their experience
- All process temperature-sensing instruments shall be furnished with thermowells. Thermowells shall be 304 or 316 stainless steel unless other materials are required to suit the process conditions. Thermowells shall be constructed from solid bar stock, not "built-up" from piping or tubing. Flanged thermowells are required for all temperature sensing devices that are inserted into pressure vessels, high pressure piping, tanks and slurry applications. Standard process connections for thermowells shall be 2" flanged.
- Connections to Thermowells shall be 1/2“ NPT union type to facilitate ease of alignment and removal of elements. When thermocouple terminal heads, nipples, unions and thermowells are supplied they shall be furnished as a completed assembly.

- All thermowells shall be supplied with material and test certificates. And verification per ASME 19.3 TW PTC
- Scanner temperature devices shall be used where thermo well insertion is not possible.

10.5.1.40 Temperature Gauges

- Temperature Indicators shall be dial type, bi-metallic, fixed angle type with 115mm diameter face and shatter proof glass or Plexiglas. In vibration service they shall be fluid filled. Cases and stems shall be stainless steel. Normal operating temperature shall be 50-75 % of dial scale.
- Flanged thermowells are required for all temperature sensing devices that are inserted into pressure vessels, high pressure piping, tanks and slurry applications. Standard process connections for thermowells shall be 2" flanged.
- Connections to Thermowells shall be 1/2“ NPT
- All thermowells shall be supplied with material and test certificates. And verification per ASME 19.3 TW PTC

10.5.1.41 Control Valves

- All automatic On/Off valves shall be supplied with open/closed position sensors. The position switches and solenoid valves shall be wired to a junction box on the valve.
- Pneumatic actuators are preferred and shall be sized for minimum air pressure 5,0 Kgf/cm2.
- Control valve bodies shall be flanged or suitable for insertion between pipeline flanges.
- Construction materials for control valves shall be selected on the basis of the physical and chemical properties of the controlled media.
- Minimum flange rating shall conform to the project piping specifications. Except for 3” and minor control valve bodies that will be minimum rating of 300#
- Directions of flow shall be indicated on the valve body.
- Valve position shall be indicated on the valve stem and be clearly visible.

- Solenoid valves shall be 24 VDC, with Class F molded coils. Cable entry shall be 3/4" NPT with screwed terminals. Coils shall be minimum current type (maximum current less than 0.5 A) with associated surge suppression diodes.
- Control valves shall have manual isolation and bypass valves as shown on the Flow Diagrams.
- Automatic control valve operators shall be selected on the following basis:
    - Valves installed outdoors or in the areas where instrument air is not available shall be electrical-motor operated;
    - Failure positions shall be: fail open, fail close, or fail last, depending on process and safety requirements. Air operated valves shall go to the fail position by spring actuation upon loss of air. The fail position shall be shown on the Flow Diagrams and noted on data sheets;
    - All control valves shall be equipped with an electro pneumatic positioner with input and output gauges mounted on the valve body, to accept a 4 – 20 mA + HART control signal. The valve position of critical control valves and shut-off valves shall also be monitored from the control room operator workstations. All modulating valves shall have an on board air filter regulator;
    - Self-contained (flow and pressure) regulators shall be used in instances where a manually adjustable fixed-flow rate or pressure is required.
- Solid State position limit switches for fully open and fully closed indication shall be provided wired back to an onboard NEMA 4 or NEMA 4X junction box with cable entry where required. The valve datasheets shall specify number and type.

10.5.1.42 In-Line Analyzers and Emission Monitoring

- Where required by process and operation, in-line analyzers and emission analyzers shall be installed. They shall be monitored by the PSCS on a continuous basis. The location of the sample points shall be clearly indicated on drawings. The sampling frequency, data reporting methodology, and accuracy of the system supplied shall comply with the local codes and regulations. All transmitters have to be collected and mounted in an Instrumentation Cabinet.
- For emission monitoring non extractive, calibrate in situ devices are preferred.

- Separately mounted emission monitoring and gas analyzers shall preferably be cabinet mounted in air conditioned analyzer rooms with provision for the storage of test gases.
- Particle and gas emission must comply with requirements of Quebec's Clean Air Regulations Environment Quality Act.

10.5.1.43 Local Control Panels

- Panels shall be powered by 120VAC, 60Hz UPS power supply. In cases where 24VDC is required, a 24VDC power supply shall be located inside the cabinet. All voltage levels shall be clearly marked.
- Cabinets shall maintain both a common and isolated instrument ground bus.
- All wiring shall enter the control panel through either the bottom or sides of the panel. Bottom entry shall be the preferred entry type. Wiring shall not enter the top of the panel.
- Panels shall have receptacles (inside panel) for test equipment.
- The control and marshaling panels selected shall be the standard product of the selected equipment vendor(s) regularly engaged in the production of the required type of equipment and shall meet current applicable codes and standards.
- Separate terminal strips shall be provided for the any type of signals:
    - Terminal blocks for instrument and control wiring shall be medium duty, CSA approved 300 to 600 volt rating, barrier type, or non-hygroscopic material shields shall be connected on a dedicated isolated bar, installed next to the signal terminal strip.
    - Bars will then be connected to the reference grounding circuit Terminals shall be a pressure type connector, or approved equal.
- All 120V DC or AC power distribution terminals shall have protective covers.
- The general requirements for electrical grounding and bonding of electrical insulation shall be in accordance with CSA 22.1, section 10, Grounding and Bonding.

10.5.1.44 Instruments Mechanical Installation

- For instruments impulse lines, tubing technology shall normally be used.
- All instrument tubing shall be manufactured in bars of 6 meters each. Tube diameters shall be defined in Imperial units.
- Impulse lines will be self-draining; 15° minimum slope except where otherwise stated.
- All instrument tube fittings shall come from a single supplier and standardized for the whole project instrumentation — Swagelok / Hoke . A mix of fittings from separate suppliers is not acceptable. Tubing fittings shall be from manufacturer as required in the Instrument Vendor List.
- For tubing installations all threaded fittings shall be NPT and double ferrule.
- Pneumatic Tubing shall be a minimum of 1/4" OD x 0.035” wall thickness seamless 316 stainless steel tube. Preferably ½” OD x 0.049” for standardization purposes.
- Process Impulse Tubing and connections to air headers shall be 1/2” OD x 0.049" wall thickness seamless 316 stainless steel tube.
- Stainless steel tubing shall be fully annealed and pickled seamless type 316 austenitic ASTM A269 or equivalent with hardness of Rb 80 or less supplied in 6 meter lengths. Certificates of conformance shall be provided where specified.
- Non-metallic (plastic) tubing may only be used in highly corrosive environments. Acceptable types are Nylon, Polythene, Polypropylene and PFA, TEE. PVC or copper tubing not approved.
- Tube Supports shall be 'Stauff' clamp type or equal, securely mounted within support channel or angle. Tube shall be adequately supported to prevent damage due to lifting, transport or equipment installation and operation.
- Wherever possible tubing shall terminate at fixed valve manifolds or block and bleed assemblies. I all cases first root or primary isolation valve will be per Piping Specifications.
- Choice between socket weld flanged and NPT screwed connection to first process block valve shall be done taking into account parameters as pressure, temperature and fluid type.

10.5.1.45 Power Supplies and Signal Levels

- The power supply to four wire field devices e.g. transmitters, shall be 120V, 60Hz (other than for loop-powered instruments). Critical emergency shutdown devices or panels shall be UPS supported. A dedicated instrument power supply distribution board shall be provided and no other devices will be wired to this.
- Analog inputs and outputs power supplies shall be 24V DC. The neutral may be switched at the input/output cards. There shall be isolating links on the field wiring terminal strips for each signal at the process control system panels or at any field control panel.
- 4-20mA + HART transmitters shall be used for measurement and control everywhere in the plant. Preference shall be given for loop-powered instruments wherever possible. Four-wire instruments shall provide isolated signals where possible or shall incorporate a signal-isolating device.
- The 120V, 60 Hz power to instruments shall be individually protected by circuit breakers.
- At 24 VDC, main panel power supplies and distribution shall be circuit breaker protected but individual process control system outputs or instruments shall be fuse protected. Power supplies for instrumentation in 24 VDC shall be regulated and filtered. For critical emergency shutdown service the 24 VDC power supply shall be UPS supported and redundant DC supplies supplied as standards or hazard analysis dictates.
- The following transmission signal levels shall be used:

Transmitter/Analogue signals	4-20mA + HART
Alarm Signals	24 VDC
Counters	24 VDC
Solenoid Valves	24 VDC
On-Off controls	24 VDC
Status signals	24 VDC
Local pneumatic control	3 -15 psig (20 — 100 kPA)
Instrument Air Supply (nominal)	690 kPa
Instrument Air Supply (design)	550 — 850 kPa

Table 10.5-7.:Transmission Signal Levels

- Discrete inputs to the PSCS shall be by means of voltage free contacts suitable for sustained use with 24 VDC. These voltage free dry contacts can handle DC and AC voltages. Contacts shall be self-cleaning (wiping) action or be hermetically sealed.

10.5.1.46 Wiring

- All signal wiring, and power wiring associated with instrumentation that enters or leaves a skid or a package system shall be terminated in frame mounted IP66 316 stainless steel (or reinforced glass fiber in corrosive environments) junction boxes with a hood. Junction boxes shall have hinged lockable doors and bottom entry gland plates and containing numbered, labeled terminal strips.
- Similar signal types shall be grouped to avoid electrical interference between signals. All entry to and exit from the junction boxes shall be through the bottom entry gland plate only, using approved cable glands and cables suitable for the application (e.g. hazardous area).
- As a minimum requirement analogue and digital signals shall use UV stabilized individual and overall screened instrument twisted multi-pair cable. Pulse signals shall have individually screened twisted pair cables.
- Digital or analogue signals shall not share thermocouple, mV signal nor pulse signal cables.
- Screens (shield) shall be continuous through all terminals and panels and only be terminated at the control system end to avoid earth loops. Insulated terminals shall be provided for screens in junction boxes. The screen shield at the instrument end shall be taped and insulated.
- In general, all wiring terminations shall be at numbered vibration resistant terminal blocks with no pigtails. Wire splices are not permitted. All wiring and terminations shall be clearly marked and identified with wire markers which can be replaced without disconnecting the terminated cable. Markers similar to Weidmueller (Weidmueller PT type sleeve c/w engraved TM-I tags.) will be used, which will not be dislodged. The full wire number shall be used on each wire. All cables shall also be numbered at both ends.
- Labeled, numbered terminal strips shall be provided for connection of all field wiring, and for panel interconnections where required. Terminal strips and wire-ways in panels shall be segregated by voltage levels and function as follows:
    - 120 VAC power and control wiring (shroud and warning label);
    - 24 VDC digital signals. (if used, IS signals must be segregated);
    - Instrument or control system communications;

- 4 to 20 mA analogue signals as required.
- Communication type signals;

- Instrument cables shall be routed supported by aluminum cable trays and rigid galvanized steel conduit open and protected ends in accordance with Article 500 of the NEC, NFPA 70 (for hazardous areas), UL or CSA certificated armored cable shall be used . For cable tray installation, wiring should be minimum #18 AWG twisted, shielded pairs. Each connection on field instruments shall be made with a "drip loop" in the cable of 20 to 30 cm. Cable glands shall be metallic non-corrosive NPT ends approved per area classification
- In corrosive areas conduit shall be stainless steel or PVC covered conduit. All other materials shall be chosen to provide the effective plant life as specified with due regard to the plant location and process environment. Any non-metallic materials shall be UV stabilized and low temperature resistant.
- More details on Instrument cables installations see 3786-TARG-E-DC-000-001 ELECTRICAL EQUIPMENT DESIGN CRITERIA, ELECTRICAL INSTALLATIONS.
- Wiring to switches, solenoids, relays, trip coils and other control devices shall be 24 VDC using #14 AWG minimum, type THHN (#16 AWG in control panels). #16 AWG may be used for low power solenoids and low power relays.
- All instrument cables shall be screened twisted pairs 16 AWG complete with individual and overall shield. All shield wires shall be continuous through junction boxes and terminals and grounded only at one point, preferably at the PSCS I/O termination cabinet.
- Ducts, cable trays, conduits and instrument tubing runs shall not interfere with removal or prevent routine maintenance of instruments.
- Redundant communication cables if any (shall be routed by two different ways).
- All cables crossing construction walls and fire walls shall be sealed with MCT (Multi Cable Transit) suitable for the classified area.

10.5.1.47 Instrument Air

- Instrument Air shall comply with one of the following two standards:

o ISO 8573 standard for air quality to class 2 for solids contaminants, class 3 for maximum pressure dew point and class 3 total oil content;
o ISA S7.0.01 'Quality Standard for Instrument Air' and ISA 'Recommended Practice for Producing Quality Instrument Air' as follows:

Pressure dew point	at least 10°C below minimum ambient temperature
Solids contaminants	3 micrometer
Total oil content	less than 1 ppm, w/w or v/v

Table 10.5-8.: Recommended Practice for Producing Quality Instrument Air

- For more details see also document 3786-TARG-M-MR-000-001 COMPRESSED AIR SYSTEM MATERIAL REQUISITION
- All air distribution lines shall be connected to the main air header with a shut off valve. Headers shall be sloped to drain points.
- Air header shall be within 6 meters of instruments requiring instrument air supply with provision for future take offs via spare valves or plugged taps. There shall be one connection per instrument or panel to the air header unless otherwise approved.
- The air supply connection from the header isolation valve to the local instrument air isolation valve or individual filter regulator shall be by at least 1/2" pipe with termination in ½" OD stainless steel tubing (0.049" wall thickness). There shall be a filter regulator with gauge for each air user.

10.5.1.48 Surge Protection

- Electronic equipment may be exposed to lightning, power line disturbances, etc. All external wired circuits shall be provided with surge protection. As a minimum, equipment shall be designed to protect against:
    - Electrostatic discharge;
    - Radio frequency interference;
    - Switch contact bounce;
    - Load switching.

10.5.1.49 Testing & Certification

- All in line pressure instruments shall be subjected to non-destructive testing to the applicable piping code or vessel specification, including the following as a minimum in the absence of any other guide:
    - Pressure tests to 1.5 x system design pressure at design operating temperature;
    - Radiographic testing of welds to detect all flaws (by a qualified operator).
- Traceable material certification shall be in accordance with Canadian standards of all pressure containing instruments in process service.
- Conformity and calibration certificates must accompany each instrument or valve supplied.

10.5.1.50 Control & Instrumentation Suppliers

- Any control and instrumentation to be supplied apart from main equipment packages shall be from a Vendor List to be presented for PURE FONTE LTÉE approval.

10.5.1.51 Attachment #1

TYPICAL ARQUITECTURE, for details see drawing 3786-TARG-I-BD-000-001

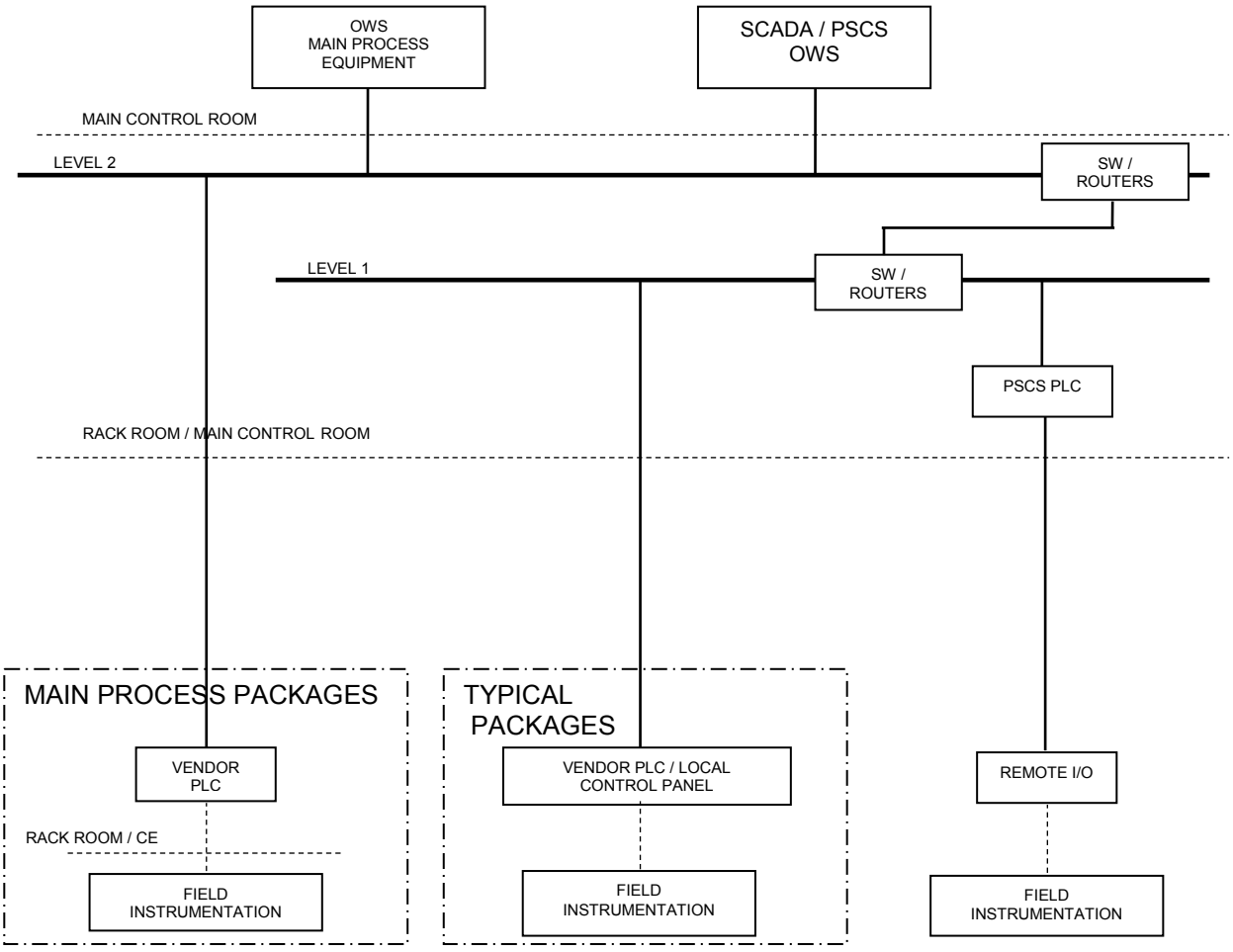

Figure 10.5-1.: Typical Architecture

10.5.2 DRI Automation

Final Integrated Automation System Components (IAS) arrangement and equipment may change depending on the final system supplier and specific characteristics of such system.

All electrical equipment shall meet NFPA 70E no more than level 2.

10.5.2.1 Introduction

There are several control systems on a Energiron Direct Reduction Plant, some with specifically dedicated function, but these are integrated into one main Integrated Automation System (IAS) which can perform control, monitoring, alarming, Shut Down and data logging functions. The IAS is a distributed control system with control components primarily located in the Main Control Room. It has many of the Plant's functions embedded into its programming, and interfaces to the other special purpose systems of the package equipment. There are three main areas of Control for the IAS:

1. Regulatory Control which maintains process parameters such as pressure, temperature, flow, speed, etc.
2. Sequential Control which as the name implies, handles all the sequences for the automatic operations in the plant. This system handles mainly the solids flow from Iron Ore to DRI within DR Plant.
3. IEC61508 SIL3 certified Safety Instrumented System for the Emergency Shut Down of the Plant. This system is autonomous but is fully integrated into the Main IAS.

Additionally, the IAS will include the following devices:

- Engineering station
- Operation stations
- Multipurpose Printers
- Application and Asset Management Server
- Server (or Equivalent) To Communicate IAS with Level 2

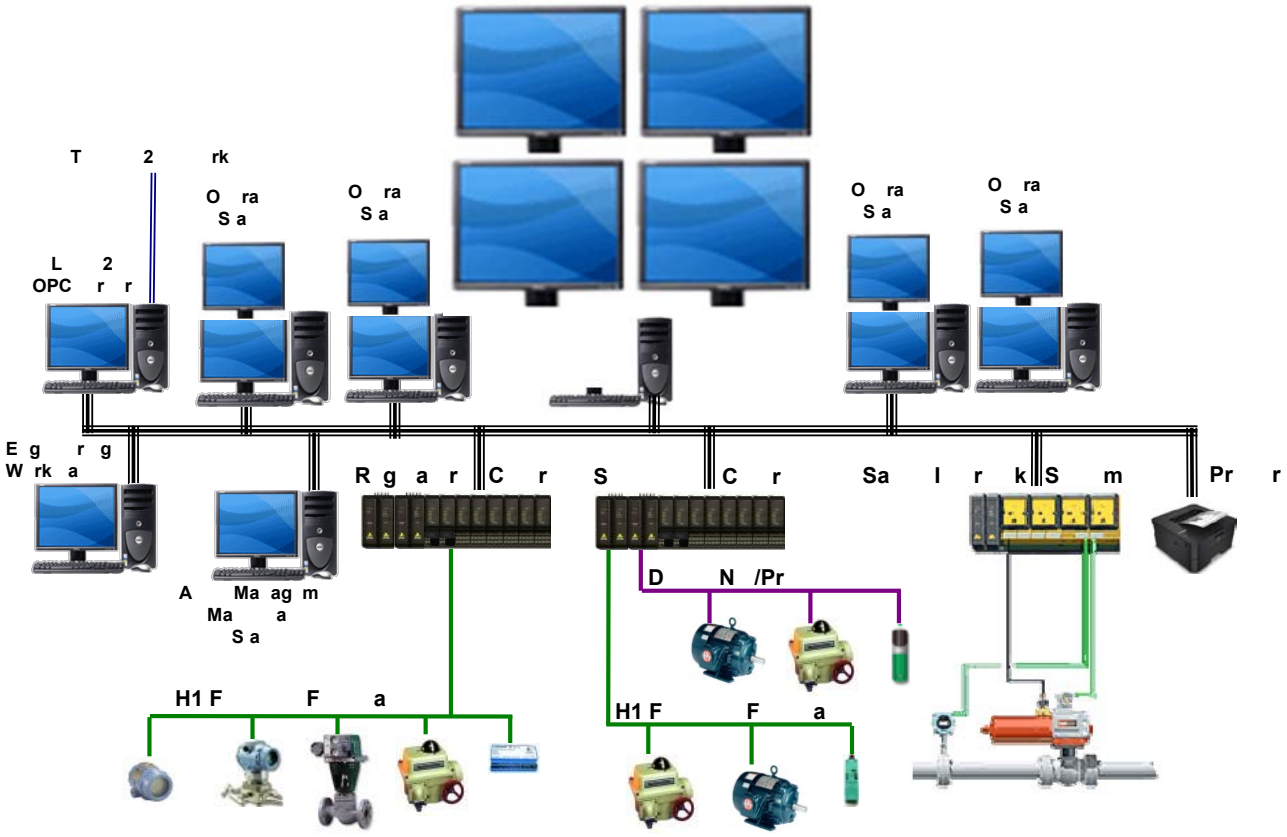

Figure 10.5-2.: Typical Simplified Control System Architecture for an HYL DRP

10.5.2.2 Engineering Station

The IAS will include one engineering station to configure all the required devices from the system, such as Regulatory control, Sequential control, Safety Instrumented System, Operation displays, etc. This station will have the following characteristics:

Quantity	1
Characteristics	Conventional PC with the required software & hardware
Monitor	Two monitors
Mouse	Yes
Conventional Keyboard	Yes

Table 10.5-9.: Technical Data for Engineering Station

10.5.2.3 Operator Stations

The IAS will include four (4) operating stations with dual monitor. These stations are used to visualize and manipulate the process including the regulatory, sequential and Safety Instrumented System. The stations will have the following characteristics:

Quantity	Four (4) local operating stations
Characteristics	Conventional PC with the required software & hardware
Monitor	Two (2) monitors per station
Mouse	Yes
Conventional Keyboard	Yes

Table 10.5-10.: Technical Data for Operator Stations

10.5.2.4 Giant Supervision Station

The IAS will include a giant supervision station to shown a process overview and main plant alarms. This station will have the following characteristics:

Quantity	1
Characteristics	Conventional PC with the required software & hardware
Monitor	Four (4) monitors of 60”
Mouse	Yes
Conventional Keyboard	Yes

Table 10.5-11.: Technical Data for Giant Supervision Station

10.5.2.5 Application Server and Asset Management System

The IAS will include an application server and asset management system with the following characteristics:

Quantity	1
Characteristics	Conventional PC with the required software & hardware
Monitor	1
Mouse	Yes
Conventional Keyboard	Yes

Table 10.5-12.: Technical Data for Application Server and Asset Management System

10.5.2.6 Server (Or Equivalent) to Communicate IAS with Level 2

The IAS will include a Server (or equivalent) to communicate with Client's Level 2.

The server has a monitoring system with the aim of carrying out detailed analysis of various process variables and events. This provides the capability of off-line data display and analysis, and allows long-term storage and permit access to third-party programs

This server will be capable of accessing historical data from the IAS as well as laboratory data and calculation in order to generate reports for the operation of the plant.

These reports will contain information about, production, quality, Specific consumptions, Total consumptions, and other plant parameters.

These reports will be issued daily and monthly at least.

Level 2 server will be capable of on line process analysis to forecast changes in DRI quality. The system will warn the process engineer so that proper measures can be taken in order to keep DRI quality within specs.

Level 2 server will also make on line performance diagnostics for main equipment, Process gas heater, Partial combustion, and Compressors in order to warn the process engineer and/or the operator about equipment degradation or measurement errors.

10.5.2.7 Alarm Management

All alarms, messages and operator actions, as well as system events will be announced audible and/or visually. They will also be logged in the system server for access and analysis.

Alarms will have at least two priorities according to its importance. Each will be identified by a different sound and/or color.

Sequence of events (SOE) will be included in order to identify the root of any trip of the plant.

10.5.2.8 Multipurpose Printer

The IAS will include at least one multipurpose laser printer in order to print several documents such as screen print outs, system reports, system historical information, alarms and events, etc.

10.5.2.9 Regulatory Control System

The IAS will include a regulatory control system with all the software and hardware required to control the DRP. This system will use mainly Foundation Fieldbus signals wired directly to main control room.

According to the amount of signals and functions, the regulatory control system will comprise of one or several controllers (DCS, PLC or similar) capable of performing at least the following algorithms:

- PID control
- PID Gap control
- PID feed forward control
- Override selector (high and low)
- Auto-manual station
- Ratio control
- Flow compensation
- Mathematical calculations
- Signal selector

These controllers will execute the function for regulating the analog parameters required for the reduction process and related equipment.

10.5.2.10 Sequential Control System

The IAS will include a sequential control system with all the software and hardware required to control the DRP. This system will use conventional (24 VDC) digital inputs and outputs, Profibus DP to communicate with MCCs and Foundation Fieldbus signals to integrate instrumentation.

According to the amount of signals and functions, the sequential control will comprise one or several controllers capable of executing logic control including all Boolean functions in the form of Ladder logic and/or function blocks.

This logic will be controlling the sequences for charge and discharge of reactor as well as normal start and stop of equipment such as but not limited to:

- Pumps
- Compressors
- Blowers
- Conveyor belts

10.5.2.11 Safety Instrumented System (SIS)

This IAS will include a Safety Instrumented System (SIS) including all the software and hardware required to protect safely the DRP. This safety PLC will be certified for up to SIL 3 as per IEC 61508. This system must be totally autonomous from the regulatory and sequential systems but integrated to IAS under same operating stations and time base for events and alarms. This system will use conventional signals such as (24 VDC) digital inputs and outputs and 4 to 20 mA HART for analog signals.

The safety system will execute logic for protecting equipment such as but not limited to:

- Process gas heater
- Reducing gas compressor
- Reactor
- CO_2 plant

SIS will have an algorithm menu specialized for safety functions.

On line monitoring of the status of the Safety System will have:

- The ability to announce and store that a trip has occurred indicating the first out.
- The ability to reset the trip with a repeat confirmation step of the operator command from HMI and SIS.
- The ability to bypass the trip for maintenance purposes indicating the status of the initiator to show if a trip would occur when the bypass is removed.

10.5.2.12 IAS Cabinets

Cabinets for the control system will be designed to accommodate the CPUs and I/O for the system. Due that the fact that DCS I/O cards have built in electronic circuits to limit the amount of current in case of a ground fault, and diagnostics to alert of such condition, Tenova will not supply terminal blocks with fuses to decrease the need of additional connections and increase the overall system reliability.

Field wiring will enter via marshalling panels composed of fused terminal blocks if necessary. For digital inputs and outputs only, a blown fuse indicating light will be included. Safety digital outputs will have circuit integrity diagnostics in this case; there will not be light indication because it might hinder this safety feature. In order to optimize wiring, the IAS will use, as much as possible, remote I/O's for gathering the signals from the process. These remote I/O Systems will be housed following the cabinet rules explained before.

These cabinets, however, shall be constructed for outdoor service with local cooling system, if required to ensure proper operation. Communication between CPU and remote I/Os will be redundant and routed by different cable ways to ensure fault tolerance.

It is foreseen to have remote I/O panels in the following areas:

1. Reactor Charge area
2. Reactor discharge area
3. Process Gas Compressors area
4. CO_2 Removal area
5. Process Gas Heater area
6. Iron Ore handling area
7. Product handling area
8. Water Systems

For long distances, remote I/O shall connect via Optic Link Modules to ensure proper communication speed. During detail engineering these locations will vary depending on final lay out of the plant and location of sensors and valves.

Gas Analysis

On line process gases Analyzers such as mass spectrometer and flue gas analysis will be connected to the Control system and the data will be available for the operator and level 2 users.

Off line analysis such as quality results from the lab will be connected to the OPC Server (level 2) via Ethernet. The laboratory shall have the analyzers, laboratory equipment and lab computer (by others) connected in a network and after the manual procedures for getting the material analysis the data shall be archived in the lab local server/computer. From this device, all the lab analysis shall be made available to level 2 users.

10.5.2.13 Closed Circuit Television (CCTV)

For Energiron DRPs little process video surveillance is required. The only place foreseen for using Closed Circuit Television (CCTV) is the Iron Ore coating system having only one camera at the coating agent discharge into the conveyor belt.

CCTV will be connected via I/P and it will be recorded digitally in a CCTV server. The video live or recorded will be displayed as an embedded window in the same monitor used for the control system.

10.5.2.14 Uninterrupted Power Supply (UPS)

Power supply to the IAS shall be guaranteed even in the event of a main AC power failure. To fulfill this, an UPS will feed AC power to power supplies for the control system and all the power supplies used to feed the instrumentation and control valves. The UPS system will be for industrial use and will include the following components:

- Batteries (maintenance free type)
- Solid state battery charger
- Solid state DC-to-AC inverter
- Static transfer switch
- Manual transfer switch

UPS for the IAS will be fed from both main and emergency supplies, and capable of meeting the full load requirements of the system concerned for 60 minutes in the event of failure of both power feeds, and will be capable of being bypassed for maintenance.

10.5.2.15 Factory Acceptance Test (FAT)

The Automation system has to be tested for integral operation at the vendor's facilities prior to shipping to site. This is called Factory Acceptance Test (FAT). The purpose of the FAT is to ensure that the nodes on the system operate and communicate among them and that the application software is loaded and ready to perform commissioning and tuning. There are two parts of this test:

Hardware test. - Cabinet wiring and hardware physical integrity is performed. All devices shall perform without failure or diagnostic error.

Software test.- All system software shall be loaded into the system and be performing trouble free. All Application software shall be loaded hence some control loops, logic and operator displays can be simulated to a limited extent due to the fact that no field devices are present.

All I/O equipment can be sent so site after hardware test and prior to finishing the application software in order to speed up the installation and field wiring.

10.5.3 EAF Automation

TENOVA will provide a modern and fully integrated control system to perform all the basic automation and process control functions required to run the Electric Arc Furnace and its auxiliaries under safe conditions while achieving the best production performances.

The control will be performed by powerful Allen Bradley ControlLogix Programmable Logic Controllers while the HMI supervisory system will be Wonderware Intouch in Terminal Services server/client configuration.

The proposed System allows for Ethernet connection with auxiliary systems both at Equipment Level (HMI Network) and at Plant Level (Melt shop Network).

PLC/PLC as well as Database/Database and HMI/PLC communication are natively granted by the proposed systems while special communication requirements will be analyzed on case by case basis.

The proposed system includes the required system hardware and software to interface with auxiliary systems; however, it is intended that any PLC, HMI or Level 2 application development, not related to the proper operation or process control of the proposed equipment and not included in the technical description, is not included in the Scope of Supply.

10.5.3.1 System Equipment Location

The Electrical and Automation equipment will be located in the main areas of the plant:

- Meltshop Server Room
- EAF Main Control Room
- EAF Electrical Room
- EAF Transformer
- EAF Switchgear Room
- EAF Hydraulic Room
- Field (On Board or near relevant equipment)

The main PLC panel, Motor Control Center and TDR-H digital regulator will be located in the Electrical Room while the control desks will be installed in the Main Control Room. The system design allows some Remote IO Panels to be located in particular technological locations in proximity or “on board” of the field equipment.

10.5.3.2 System Main Components

The main components of the basic automation and process control system of the EAF are the following (number of equipment is defined in the Scope of Work):

- PLC Panel for EAF system
- Server System units complete with service monitor and keyboard
- HMI Client units
- PCS Client units
- Engineering unit for HMI/PLC programming/maintenance
- MCC (Option)
- UPS System
- EAF Operator Control desk
- EAF Tapping desk.
- Set of field instruments, sensors and local control stations
- Set of special cables including:
    - High temperature cable for RTD on board of hot parts of the EAF, including flexible connections to fixed boxes
    - Cables for load cells
    - Thermocompensation cables for thermocouples

10.5.3.3 System Networks

The System design foresees different network types each one dedicated to a specific task; the media will be copper or fiber optic depending on application and distances.

The typical networks used are:

- Field Networks: the field equipment (PLC and Remote I/O panels, Graphical Operator Panels, etc.) are connected via a dedicated Ethernet network configured as a ring using the Allen Bradley Embedded Switch Technology with Ethernet/IP protocol. (RIO Net).
- The MCC equipment is connected to the PLC System through a dedicated network. (MCC Net)
- Ethernet Networks:
    - Server System, Clients PLCs, etc communicate through a dedicate
        - Ethernet network (HMI Net).
    - The automation system allows a connection with the Plant Network in order to establish communication with Scrap Yard, MES/Level3 Systems, Laboratory, etc.

The supply includes the necessary equipment (Cables, Media Converters, Network Interface Cards, etc.) to properly connect the different equipment within the scope of supply.

10.5.3.4 System Language

Unless otherwise noted the language for all system and application software is English.

10.5.3.5 PLC System Configuration and Arrangements

The PLC and Remote IO Stations will be installed in carbon steel vertical panels with an adequate protection degree according to the installation location (NEMA 12 or 4).

The main PLC Panel will contain a powerful ControlLogix L7x series CPU, power supply module and all the Ethernet communication cards needed; the Remote I/O Panels will be equipped with ControlLogix or PointIO Remote I/O Stations.

Figure 10.5-3.: Typical PLC Control Cabinet

The system design promotes the use of Remote I/O panels located near relevant technological areas in proximity or “on board” of the equipment:

- EAF Control desk
- EAF MCC
- EAF Tapping desk
- EAF/Trufire™ process instrumentation
- EAF shell panels and EAF bottom RTD’s

- EAF High Pressure hydraulic unit
- EAF HRR
- EAF Hydraulic valve bench
- EAF transformer
- EAF MV switchgear
- EAF stirring valve stand
- EAF tapping car
- EAF tapping car stirring valve stand
- MHS Materials at tap

10.5.3.6 Operator Control Desk

The Operator Control Desk will be installed in the EAF Control Room; the Desk provides the main point of control for all movements and actions to properly operate the furnace. It will be a desk type arrangement, fabricated of carbon steel with a flat stainless steel top surface.

A minimum number of joysticks/push buttons are installed on the stainless top:

- A, B and C electrode movement control
- Master electrode movement control
- Furnace Tilting movement control
- Furnace movement enable key
- Electrode Slipping permissive key
- Kirk Key System
- Emergency Pushbuttons

All other needed commands will be performed through touch HMI screens readily accessible from the desk position.

10.5.3.7 Server/Client System Architecture and Components

The Server System architecture is designed in compliance with the VMware High Availability prerequisites which require a cluster of ESXi servers sharing a physical network Storage (SAN). The Server System configuration as well as the set of configured virtual machines are managed through VMware vCenter installed on a dedicated virtual environment.

The Client System is composed by a number of Client units configured for RDP (Remote Desktop Protocol) connection to one of the virtual application servers (HMI or PCS) configured to provide the services of Terminal Server.

The Server System will be installed in a suitable server enclosure located in the Melt shop Server Room.

The Clients (HMI and PCS) will be installed in a suitable PC enclosure located in the EAF Control Room; where necessary KVM extender kits will be provided.

10.5.3.8 Server Units

HP ProLiant DL380 (or equal) with the following characteristics:

- Processor(s): 2 x Intel® Xeon® E5-2440 (2.4GHz/6- core/15MB/95W)
- Cache Memory: 15MB (1x15MB) Level 3
- Memory: 32GB (1333MHz)
- Network Controller: HP Ethernet 1Gb 4-port 366i Adapter
- Network Controller: HP NC112T PCI Express Gigabit Server Adapter
- Storage Controller: HP Dynamic Smart Array B320i/512MB FBWC
- Hard Drive: 3 x HP 146GB 6G SAS SFF Raid 1 w/hot standby
- Optical Drive: DVD-RW
- Power Supply: 2 x HP 460W CS Gold Plus Hot Plug

10.5.3.9 SAN

HP P2000 G3 (or equal) with the following characteristics:

- Network Controller: 1 x GbE iSCSI (4) Ports per Controller
- Storage Controller:2 x P2000 G3 iSCSI MSA Controller
- Hard Drive: 6 x HP 450GB 6G SAS Raid 5 w/hot standby
- Power Supply: 2 x HP

10.5.3.10 Thin Clients

HP t610 Flexible (or equal) configured as follows:

- Operating System: HP ThinPro
- Processor: AMD G-T56N 1,65 GHz
- Memory: 4 GB SDRAM DDR3
- Video: AMD Radeon HD 6320
- Peripheral: 8 x USB 2.0, 1 x VGA, 1 x DVI-D, 1 x serial, 1 x RJ45

10.5.3.11 Engineering Station

HP 6305 Pro (or equal) configured as follows:

- Operating System: Windows 7 Pro, English
- Processor:1 Intel® Core Duo
- Memory:4 GB SDRAM DDR3
- Disks:1 x 250 GB SATA
- Optic:DVD-RW

The proposed System foresees the connection to the servers using remote desktop protocol; due to this technology thin clients are enough to perform the task without the need of operative system configuration/settings which can be difficult to manage in case of machine substitution.

This is the TENOVA preferred solution for both HMI and PCS Systems, however, in case the use of “FAT” client is mandatory, the systems can be developed accordingly at no additional cost.

The Engineering Stations foreseen will be the preferred hardware.

The basic SW suite of the Server Room Engineering Station includes the following:

- Microsoft® Windows® 7 Pro (64 bits)
- Wonderware Intouch Development Studio (1 License)

The basic SW suite of the Electrical Room Engineering Station includes the following:

- Microsoft® Windows® 7 Pro (64 bits)
- Allen Bradley ControlLogix 5000 (1 License)

10.5.3.12 User Interfaces

- PCS Monitor:HP LCD 22” Widescreen 1680 x 1050
- HMI Touch Monitor:ELO Touch LCD 22” Widescreen 1680 x 1050
- Keyboard & Mouse:Office style

10.5.3.13 HMI Application Server

The HMI Application Server resides on a dedicated virtual machine hosted in the main Server System.

The HMI Application Server software suite includes the following:

- Microsoft® Windows® Server 2012 (64 bits), Standard Edition
- Microsoft® Windows Terminal Services (one RMT DS CAL for each thin client)
- Wonderware Intouch Runtime TS w/IO

10.5.3.14PCS Database and Application Servers

Two virtual machines in the main Server System have the function of Melt Shop Database Server and EAF PCS application server. The Melt Shop Database Server is shared among the different areas Application Servers (EAF and VTD).

The subsystems of the PCS Application Software are developed with the RAD kit DELPHI while the reporting subsystem is built as a WEB service.

The Melt Shop Database Server software suite includes the following:

- Microsoft® Windows® Server 2012 (64 bits), Standard Edition
- Relational data base engine MS SQL SERVER 2012 standard Edition w/ 5 CAL

The EAF PCS Application Server software suite includes the following:

- Microsoft® Windows® Server 2012 (64 bits), Standard Edition
- Microsoft® Windows Terminal Services (one RMT DS CAL for each thin client)
- OPC Data Access Server for I/O communication with PLCs

10.5.3.15 PLC System Functions

Tenova Core will design and program the Level 1 hardware and software to provide a modern and integrated control system interface.

The EAF PLC will manage the following main functions:

- Digital and Analog I/O signals management
- Communication with TDR Electrode Regulator
- Communication with the auxiliary equipment
- Communication with other plant PLCs (MHS, Baghouse, EFSOP®, etc.)
- Communication with the HMI supervisory system
- Communication with Level 2/PCS system
- Management of Logic Sequences (such as "ladder diagrams" or similar languages) for the equipment operation and control, including:
  - Hydraulic Unit & Movement Control
  - Cooling Water supervision
  - Temperatures Supervision
  - Ladle and Furnace Stirring Control
  - MV Equipment Supervision & Control
  - Furnace Transformer and MV Supply Line
  - MHS Batch Recipes
  - MHS Material Delivery to Ladle at tap or EAF (fifth hole)
- Alarm conditions management

The main interlocks enforced by the EAF PLC are:

- Roof cannot be swung, unless fully raised
- Roof cannot be lowered until correctly positioned over the shell
- Roof cannot be raised and swung, unless shell is at 0°
- Roof cannot be raised and swung with power on
- Roof cannot be raised and swung until electrode is fully raised

- Power to electrode cannot be applied with roof swung or completely raised
- Shell cannot be tilted with roof raised
- Shell cannot be tilted with roof swung aside
- Rear bumpers cannot be raised with shell tilted backwards
- Electrode raise movement stops if electrode arms reach top travel limit
- Electrode lower movement stops if electrode arms reach bottom travel limit
- Forward tilting not allowed over +2° with bottom tap closed
- EBT can be opened only if ladle car in tapping position
- All Necessary interlocks auxiliary equipment for coordination and interferences (Baghouse, MHS, etc.)

10.5.3.16 HMI System Functions

The HMI Supervisory System will visualize and control every aspect of the equipment and its auxiliaries. It will manage the following main functions:

- Monitoring of EAF/MHS plant status
- Commands to the plant through video buttons
- Analog signals historical and actual graphical trends
- Analog signals tuning parameters
- Reference parameters for manual mode plant control.
- Historical and actual alarm logging and reporting.

List of main graphical screens:

- EAF/ Trufire™ Monitoring
- EAF Mechanical Equipment Position Screens
- EAF Hydraulic Power Unit
- EAF HRR Power Unit
- EAF Hydraulic Schematics

- EAF Pneumatic Schematics
- EAF Water System Temperatures
- EAF Shell, Roof and Bottom Temperatures
- EAF Transformer Monitoring.
- EAF Medium Voltage Monitoring
- EAF Sequences Permissive Screen.
- MHS Monitoring
- MHS Recipe Control
- MHS Material at Tap
- Network and System Diagnostics.
- System Technological Parameters.
- Analog Input Scaling and Alarms Setting.
- Historical and Actual Alarm/Event List.
- Historical and Actual Graphical Trends.

10.5.3.17 PCS System Functions

The EAF Process Control System (PCS) was developed by TENOVA in order to completely manage the melting process of an EAF Furnace, continuously controlling all of the electrical and chemical energy flows. The application collects a great number of operational and consumption data that are stored and made available for further analysis.

The maximum efficiency and productivity are the main objectives of the entire application that is structured in order to achieve the optimal results regardless of the operators' decisions and reaction skills.

All of the collected data are saved and stored in the Melt Shop Database, from which they are made available for detail reporting, transmission to Level 3 Systems or shared for the further steps of the steel making process in the melt shop.

The EAF PCS is directly connected via an OPC connection and through an Ethernet network to the EAF level one PLC. This link allows the application to recognize the EAF

status (preparation, bucket charging, melting, refining, tapping and heat end), to collect the consumption data and to transmit the process progress status based on some models (thermal, energetic, etc.).

The application is also connected to the electrodes regulation unit in order to exchange data such as automatic and manual working points or actual running information.

A typical sample of the Factory Acceptance Test Plan for the PCS can be found attached to this section.

EAF Process Control System Functions

The standard functions included in the EAF PCS are:

- New heat data visualization and data entry. The data input can be automatic or manual depending on the available interface with Level 3 archives. It is always possible to modify or introduce all data manually.
- Operating Practices management.
- Heat phase tracking.
- Melting Control of the scrap from bucket.
- Final heating management.
- Furnace charge liquid yield evaluation.
- Chemical consumption calculation (chemical add in energy evaluation).
- Counting and visualization of charged materials in the bucket or in the furnace (scrap, additives, alloys...)
- Counting and visualization of charged materials in the ladle during tapping phase.
- Alloy and additives calculation based on steel chemical analysis.
- Counting and visualization of incoming electric energy.
- Counting and visualization of incoming fluids (Oxygen, Nitrogen, Natural Gas,)
- Visualization of the main running parameters (Electrics, flow rates, temperatures, analysis).
- Counting and visualization of the time duration of each phase in which the process is divided.

- Consumption reporting referred to each phase in which the process is divided.
- Counting and visualization of power ON and power OFF for each phase in which the process is divided.
- Counting and visualization of all the delays during one heat. A justification code has to be typed in for each reported delay.
- Incoming energy control (electrical and thermal) using power profiles.
- Power profiles management.
- Steel temperature estimation during the final refining phase.
- Visualization of measured steel temperature.
- Visualization of steel chemical analysis.
- Detailed heat reporting system (Actual and Historical).
- Detailed event viewer (Actual and Historical).
- User and Password management.

The application performs the complete melting process control and progress monitoring automatically modifying and adjusting the furnace running parameters during the heat.

The availability of the real scrap mix allows the system to calculate each time the best theoretical running profile consistent with those configured and stored in the system.

The system also acts as an operator guide during the critical phases of the heat reducing the power-off time:

- Next bucket charging: the system alerts the operator when it's time to prepare the next bucket.
- Multiple temperature sampling procedures during refining phase: the system visualizes the estimated temperature.

Operative Modes

The EAF PCS foresees a Manual and an Automatic operative mode. The operator selects the operative mode from the level 1 control system.

In case of manual operative mode selection, the system just “listens”, storing all the available information.

Input Data

All the input data are introduced in the system manually and/or automatically through the links to the lower / higher level systems.

Automatic data receptions are from:

- Electrode regulator.
- Temperature, ppm and % sampler equipment.
- Steel analyser.
- Level one EAF PLC (used as a gateway to collect data from all auxiliary equipment).
- Scrap Yard
- Level 3 or MES Systems

Manual data entry consists of:

- Calculations constants and parameters (depending on the access rights)

All heat data are available for manual modification / entry.

Output Data

- Supply the electrodes regulator with the electrical parameters that have to be applied.
- Visualization and reporting of inlet electrical energy.
- Visualization and reporting of inlet thermal energy.
- Visualization of the actual injected flow rates (oxygen, natural gas...).
- Visualization and reporting of the injected fluid consumptions divided per phase and total (oxygen, natural gas...).
- Visualization of the main running parameters (electric, temperatures, analysis,)
- Visualization and reporting of all the heat phases related times (durations, power ON and OFF, delays with their justification codes…).

- Visualization and reporting of all the heat phases related consumptions.
- Visualization of the steel estimated temperature during the final refining phase.
- Visualization of measured steel temperature.
- Visualization of steel chemical analysis.
- Visualization and reporting of the additives, alloys and scrap quantities discharged in bucket, ladle and furnace divided per heat phase.

Available Reports

At the end of each heat, the EAF Process Control Systems stores all data that are available for report generation. Under the operator request, the Report utility generates a detailed heat report where the following are tabulated:

- Main operating data.
- Energy consumptions (total, specific...).
- Fluid consumptions.
- Power ON, Power OFF, tap to tap times.
- Analysis report.
- Temperature samples.
- Delays with justification codes and stoppages.
- Main heat events (bucket charge, power on…)

In addition to the heat report three summary reports are available:

- Shift report.
- Daily report.
- Monthly report.

Those summary reports show also the average values of the main parameters.

The reporting tool is built as Web service in order to be accessed by remote computer in the plant network. It is possible to export the reports' data in TXT or CSV format, which are directly opened with EXCEL.

10.5.4 Plant Instrumentation

The purpose of this section is to cover the minimum requirements and specification of instruments used for measurement and control that are not supplied as part of any TECHNOLOGICAL PACKAGE EQUIPMENT.

This specification applies to the Greenfield North Atlantic Iron Corporation PURE FONTE LTÉE Pig Iron Production Plant.

This is not a specification for PURCHASING instrumentation, it should only be used in conjunction with 3786-TARG-I-MR-000-002: Instrumentation Material Requisition (out of scope of package equipment) to get a budgetary quotation.

10.5.4.1 Documentation – Codes & Standards

10.5.4.2 Reference Documents

Instrumentation and related components shall be designed, manufactured, stamped and certified in accordance with the latest editions of the regulations, codes, standards and specifications as detailed in 3786-TARG-I-DC-000-001Automation - Design Criteria.

In all cases where more than one regulation, code, standard or specification applies to the same conditions, the most stringent one shall apply. Conflicts among any of the provisions of these listed codes, standards or specifications shall be referred to COMPANY for resolution.

10.5.4.3 Project Documents

3786-TARG-I-DC-000-001	Automation - Design Criteria
3786-TARG-I-MR-000-002	Instrumentation Material Requisition (out of scope of package equipment)
3786-TARG-I-LI-000-001	INSTRUMENT LIST - FS Class 2 - Instrument & Control Equipment List

Table 10.5-13.: Project Documents

10.5.4.4 Definitions & Abbreviations

COMPANY (CPY)	PURE FONTE LTÉE – North Atlantic Iron Corporation
CONTRACTOR (CTR)	Any company PURE FONTE LTÉE has signed a contract with for the Engineering, Procurement, Construction, and Installation of part of a project.
SUPPLIER (S)	Subcontractor(s) and/or Vendor(s). Subcontractor is in charge of manufactured product (specific Scope Of Work) delivery and Vendors is in charge of Standard product delivery.

Table 10.5-14.: Definitions and Abbreviations

10.5.4.5 Acronyms

For abbreviations see 3786-TARG-I-DC-000-001Automation - Design Criteria.

10.5.4.6 Environmental & Operating Conditions

For site conditions refer to document 3786-TARG-R-ME-000-001.

Also must be taken in consideration that design should consider that according to the Canada National Building Code the Peak Ground Acceleration (PGA) in case of seism is 0.31. Seismic loads shall be according to NBCC –Volume 2 –Division B - 4.1.8

For Outdoor installations a maximum of 1m of snow accumulation must be considered. Snow loads shall be according to NBCC –Volume 2 –Division B - 4.1.6.

10.5.4.7 Instrumentation Design Criteria

10.5.4.8 General Requirements

- In case of discrepancies among technical description of instrumentation to be supplied and Data Sheets, information on Data sheets will prevail.
- Electronic transmitters shall be smart, 2-wires 4-20 mA isolated output, loop powered, capable of communicating digitally with HART protocol.
- Field transmitters (flow, level, pressure, temperature) shall be provided with integral LCD type indicator for local reading. The indicator shall be configured in the engineering unit for direct reading.
- Pressure Transmitters, indicator shall display the measured variable in engineering units [kPa].
- Level transmitters, the local LCD indicator shall display the measured variable as a percentage (0 – 100 %); and when differential pressure transmitters are used as a flow transmitter, indicator units will be as required on Data Sheets.
- Temperature Transmitters, indicator shall display the measured variable in engineering units [°C].
- Field instruments shall be supplied with a 2" corrosion resistant pipe mounting bracket except for pressure and temperature gauges; instrument mounted directly on line and level instruments.
- Transmitter cases, solenoid valves, switches, etc. shall be weatherproof and watertight CSA TYPE 4X. Electrical Area Classification: as specified in particular Instrument Data Sheets.
- Electronic transmitters shall have a high common mode rejection ratio and high immunity to electrical noise (RFI and EMI).
- All threaded connections shall be by ANSI standard B1.20.1 (NPT).
- Instrument electrical entries shall be threaded ½” and alternatively ¾ inch NPTF.
- All valve ends must be blanked off by wooden, metal or plastic plugs.

10.5.4.9 Flow Instruments

Orifice Plats

- For Orifice Plates and Restriction Orifices Conventional Square Edge Concentric type design shall be used.
- For Special Applications other types of orifice plates shall be used.
- When Restriction Orifice Plate are required, these will be installed between conventional flanges supplied by others.
- Multiple Orifice Plates and Restriction Orifices: Vendor shall provide a complete multiple restriction orifice arrangement including Orifice Plates and Restriction Orifices, spacers, seamless pipe and flanges.
- Vendor shall perform orifice bore, ratio d/D and plate thickness calculations, these calculations shall be sent for Client's approval, before manufacturing.
- Plate faces shall be smooth, free from pits, burrs and scratches. The orifice edge shall be square and sharp, free from both burrs and rounding, so that viewed without magnification light is not reflected. Orifice plates shall be inspected and approved by a certified agency.
- Unless otherwise noted, restriction orifice plates material shall be AISI 316. For Multiple Orifice Plates and Restriction Orifices materials see Instrument Data Sheet.
- Plate construction and orifice calculation shall be per ISO 5167.
- Orifice Flanges shall be according to ANSI ASME B16.36.
- After calculation reports approval, Vendor shall submit a drawing with all dimensions and tolerances, for each plate. All dimensions shall be in millimetres.
- Each plate shall be packed within a transparent bag of high density polypropylene, properly sealed to prevent eventual damages due to hits or dust accumulation during their shipment and storage.
- Screwed and flanges machined surfaces shall have an adequate protection to avoid corrosion. The protection shall remain unalterable during 12 months exposed to a normal industrial atmosphere. This protection shall be waterproof.

- Plate faces shall be protected with hardboard type material or equal for shipment and storage.
- Beta ratio (d/D) should be within the limits 0.25-0.7, preferably around 0.6.
- Differential pressure to be measured shall be 0-25 kPa (0-250 mbar) as far as practicable.
- The following other ranges may be used: 0-5, 0-12.5 or 0-50 kPA (0-50, 0-125 or 0-500 mbar).
- For specific process constraint (low pressure loss available), the delta pressure value could be optimized and could be different of the standard delta pressure.
- Except for retractable type, each orifice plate shall be supplied with the upstream side engraved with the following information:

    a.Tag number;

    b.“D” and “d” dimensions in mm;

    c.Flange / Hub rating;

    d.Material.
- This information shall be readable even when the orifice is in position.
- The minimum pipe diameter for meter runs using orifice plates shall be 2 inches.
- Minimum rating of an orifice flange shall be ANSI 300#.
- Orifice tap orientation for liquids shall be between 90° horizontal and 45° down and taps for gases shall be on the top 180° and 45° above.
- Wherever possible, orifice plates shall be mounted on horizontal piping lines. If not possible, vertical mounting shall be up flow for liquids and down flow for gases.
- Straight length requirements are given by ISO 5167 standard. When upstream or downstream straight length is shorter than the “zero additional uncertainty” values and equal to or greater than the bracketed values, then ±0.5% additional uncertainty can be used.
- Before installation, orifice plates bores shall be carefully inspected for concentric roundness, sharpness and absence of burns and nicks.

Differential Pressure Transmitters – Flow

- For Differential Pressure Transmitters used for flow measurements see Chapter 10 Pressure Instruments.

Ultrasonic Flow Transmitters

- Where large rangeability and/or very low pressure loss is required, ultrasonic flow measurement is the preferred type of measurement.
- In case of high accuracy with intrusive-type ultrasonic flowmeters, SUPPLIER shall provide a flanged spool piece in strict accordance with the applicable piping class. CONTRACTOR shall provide all required details to ensure that SUPPLIER provides a spool piece that is perfectly flush with the connecting piping.
- Sensor cable shall be steel wire braid armor.
- In case two intrusive type flowmeters are required at one place (e.g. one PCS and one safety system transmitter), then the two flowmeters shall be integrated in one spool piece. However, all associated parts (process connections, sensors, local flow computer, power supply, etc.) shall be strictly segregated (nonshared).
- The performance of the ultrasonic non-intrusive shall be as follows:

    a. Accuracy at minimum ± 2 % and at maximum ± 5 % of flowrate.

Turbine Flow Transmitters

- Turbine configuration (with Transmitter, indicator or totalizer, etc.) will be defined applicable Instrument Data Sheet.
- Transmitter and turbine flowmeter shall have an integral mounting; also transmitter can be removed from the meter without disrupting the service.
- Turbine flowmeter material shall be as per indicated in particular Instrument Data Sheets.
- Turbine flowmeter process connection: as required by particular Instrument Data Sheet.
- Turbine flowmeter flow range and calibration factor (“K” factor) shall be informed by Vendor, and shall be in accordance with process flow already stated in the particular Instrument Data Sheets.

- The electronic transmitter shall have dual isolated and configurable outputs, one 4-20 Ma + HART analog output and the other one a pulse output.
- Transmitter internal power supply: one lithium 2.4 Ah battery. Transmitter external power supply: 24VDC loop powered, powered in 4-20 mA analog output. Vendor shall inform transmitter power supply and power consumption
- Vendor shall clearly specify meter/transmitter connection type and transmitter signal output quantity and type.
- Transmitter calibrated range and output meter scale range shall be programmable.
- Main operating parameters shall be indicated for transmitters in Vendor's Bid: accuracy, repeatability, stability, response time, vibration effects, mounting position effects, temperature/relative humidity effects, power supply effects, hysteresis and dead band parameters.
- Accuracy (turbine): +/- 2% of the reading.
- Transmitter materials (case, internals, etc.) shall be able to work at minimum ambient low temperature of –30°C.
- Vendor shall inform operating/ambient temperature range in Bid stage. Also shall be clearly specified environmental conditions for quoted devices.

10.5.4.10 Level Instruments

General

- Level instruments shall be selected to suit the environmental conditions of the facilities and specified liquid level and interface measurements taking into account accuracy requirements. Other criteria to affect the selection of level measurement devices are changing density, pressure, temperature, condensing vapours, foam, viscosity, dielectric, vessel turbulence, etc. Information pertaining to all these factors shall be clearly stated on the level instrument data sheets.
- Differential pressure shall be sensed through remote diaphragm seals. In order to standardize remote seal connection shall be threaded 1" NPTF.
- Installation methods shall be employed to minimize the impact of solar factors on instrument feed legs.
- The selected size shall ensure that the operating range covers all control and shutdown ranges.
- In interface services conventional glass gauges are acceptable.
- Nozzle position:
    a. Wherever possible the level taps shall be the maximum distance away from the vessel inlet and drawoff nozzles;
    b. Where the operating conditions require taps in the bottom, the nozzles shall be extended so that to penetrate of 50 mm inside the drums.
- In order to avoid vibration, level instruments shall be installed as close as possible to the drum.
- Level instruments shall be fitted with a drain valve and a vent plug.
- Level sketches showing all level related instruments (transmitters, gauges...) shall be provided before placing any purchase order.

Differential Pressure Transmitters – Level

- Differential pressure type level instruments shall be generally used.
- These instruments shall have zero suppression and elevation adjustments.
- The differential pressure instruments shall be mounted at the same level or below the bottom level tapping.

Level Glass Indicator

- Gauge glasses shall be provided on all vessels except storage tank, to cover the complete operating range of level including the span of level transmitters.
- Gauge glasses shall generally be of armoured transparent type except for special applications.
- Each level gauge shall be fitted with a plugged vent tap and a purge tap fitted with a full bore isolating valve and plug (if drained products are not collected).
- Fluid connections shall be top and bottom with shutoff valves in order to permit orientation of the gauge.
- Level glass indicators shall meet the hereafter characteristics:
    a. Type: Transparent n°9 type glass. Maximum 5 glasses for one item;
    b. Number of glasses shall be stated on data sheets;
    c. Where greater length visibility is required, multiple gauge glass units shall be used with 50 mm overlap (on the vessel or on standpipe);
    d. Body carbon steel, unless otherwise required by process fluid;
    e. Gauge cocks 3/4-inch stainless steel angle valve with ball check feature offset type with screwed bonnet, trim to be stainless steel;
    f. Connections:
        - Process: Side-side 3/4 inch flanged;
        - Gauge: Top and bottom (in order to allow gauge orientation);
        - Vent: 1/2 inch NPT female, plugged vent;
        - Drain: 1/2 inch NPT female.
- Note: total visible length and center to center length shall be stated on data sheets.
- The visible length shall cover:
    a. Maximum level positions under operation conditions;
    b. Range of level instruments installed on the same vessel;
    c. Functional zone of high and low alarms plus 20 %.

Ultrasonic Type Level Transmitters

- The ultrasonic level instruments must have output acoustic power sufficient to penetrate the dust, mist or foam caused by the process conditions.
- The value of acoustic power must be specified in the Data Sheet.
- Ultrasonic type level measurement devices shall be provided with a built in reference device, to compensate for variations in gas temperature. The beam angle shall be a maximum of 10°. The accuracy shall be 1.0% or better.
- The electronic transmitters shall be smart, 2-wires 4-20 mA + HART output optically isolated.
- Ultrasonic transmitters shall have programmable outputs for remote alarm purpose. When required in particular Instrument Data Sheets transmitters shall have internal switches. Switches shall comply with the following requirements:
    a. Switch type: snap “C” action, with SPDT contact.
    b. Contact rating shall be 4A @ 220VAC, non-inductive.
    c. Transmitters electronics shall have automatic temperature compensation in all the operating range.
- Transmitters will be loop powered, if required, available power supply is 120VAC – 60Hz. Vendor shall inform power consumption at bidding stage.
- Local Zero and span adjustments may be done locally.
- Accuracy shall be ± 0.25 % of the instrument range, or better.
- Transmitter / Switches environmental conditions:
    a. Location: indoor / outdoor
    b. Altitude: 140 masl maximum
    c. Ambient Temperature: -30 to +30°C
- Ultrasonic transducer shall be remote mounted with its electronic unit. Vendor shall supply interconnection cable.
- For sensor and transmitter materials, refers to applicable Instrument Data Sheet.
- For particular Sensor mounted requirement refers to applicable Instrument Data Sheet.

- Transmitters/Electronic Unit shall be wall-mounting type or 2” pipe mounting bracket.
- All instruments will be supplied with permanent stainless steel tag fixed by stainless steel screws. As a minimum, Manufacturer’s serial number, model number, instrument tag number, maximum working pressure will be stamped.
- Vendor shall provide Conformance and Calibration Certificates for each specified device.

Radar Type Level Indicators

- Non-Contact (Pulse-Burst) Radar type level measurement is preferred for tank gauging in heavy oil service (e.g., bunker, asphalt) where an accuracy of 1.5 mm or better is required. Guided Wave Radar technology shall not be used for sticky, viscous heavy oil services.
- Radar transmitters shall be electronic 2-wire type. Transmitters shall not contribute more than 630 Ω (for guided wave radar) or 400 Ω for (pulse burst radar) to the overall loop impedance at 24 VDC. Loop power will be provided from the Owner’s PSCS.
- Guided wave radar techniques shall be used in certain level and interface applications in medium to light liquid services. The project instrument data sheets will specify these applications.
- Options with high signal noise ratio shall be selected.

10.5.4.11 Pressure Instruments

- Generally, the following measuring elements shall be used:
    a. Bourdon tube type for a wide-range of pressure services (normally used for pressure gauges;
    b. Repeaters and local controllers);,
    c. Diaphragm and bellows elements for low pressure local measurements;
    d. Diaphragm (generally used for pressure transmitters);
    e. Diaphragm seals will be generally used on dirty fluids or as freeze protection.
- Pressure instruments taps on pipes shall be 3/4 inch sized. Different sizes may be exceptionally taken into account (for mechanical seals for example).
- Block and bleed valves shall always be supplied unless process or safety requirements forbid it. Two instruments shall never be connected to the same process tapping point.
- Manometers mounting accessories shall not cover the safety disks insert. A block and bleed type integrated manifold shall be installed adjacent to the instrument when close coupling mounting is not possible and impulse pipe length exceed 5 meters.
- Instruments shall be equipped with pulsation dampers when required by process conditions. The device shall be capable of being adjusted while the instruments are pressurized.
- Suitable over-range protection shall be provided for pressure transmitters and gauges that may be subject to pressures that could damage or alter the calibration of the instrument.
- Pressure instrument ranges shall be selected so that normal operating pressure is below 75% of the maximum range. For services where pressure pulsation can be anticipated, this figure should be reduced to 60%.
- All pressure instruments connections shall be installed with a block & bleed valve assembly, body and trim
- Shall be of AISI 316 stainless steel material. For differential pressure instruments a three or five valves manifold will be used.

Pressure Gauges

- Pressure gauges shall be installed per the P&ID requirement.
- Pressure gauges shall be bourdon tube type unless otherwise stated in the particular Instrument Data Sheets with 100 mm dials and stainless steel case and movement. The bourdon tube shall be 316 stainless steel minimum, but other alternatives should be provided to meet the service conditions. The gauges shall be safety pattern type with a solid front and incorporating a rear blow out disc and safety glass.
- For low pressure ranges (order of mm H20) diaphragm elements shall be used.
- All gauges shall be glycerin or silicone filled.
- Overpressure: the gauge shall admit an overpressure of 30 % of the range without losing accuracy.
- Case: 4 ½" (114 mm) dial size, SS case material. Smaller gauges may only be used on filter regulators.
- Pressure Gauges shall have ½" NPTM bottom connections.
- Measuring range of pressure gauges shall be selected in such a way that operating pressure will fall between 33% and 66% of full scale reading, and also be in accordance with manufacturer's standard.
- Unless otherwise stated in the particular Instrument Data Sheets all instrument shall have ranges with the lower limit equal to zero (relative pressure).
- Dial: made of aluminum, mounted above the Bourdon base and independent from the case.
- Scale: white, with black lines and numbers, 270° arc approximately.
- Pointer: made of steel, bushed, painted black with a micrometric screw (internal) for zero adjustment.
- Mechanism: movement material shall be made of 304 stainless steel, high quality, mounted on the bourdon base and independent from the case; right movement, same material coupling rod and extensive runner that allows reasonable displacements on both sides.
  Pressure gauges shall have safety devices (blowout disk) as per API RP 551 section 4.3.3. Solid front gauge design shall be supplied.
- Accuracy: ± 0.5 % full scale (ASME Grade 2A).
- Units: scales shall be in KPa.

- For pulsating or vibrating service, suitable damping methods shall be provided: silicone liquid filled, dampers, etc. In the case that Vendor will has additional equipment to avoid vibration shall be provided an Alternative Bid with these options.
- The pressure gauges shall be identified with its tag number in the dial.
- Diaphragm seals shall be used for viscous or dirty service when pressure line might be clogged as per stated in the particular Instrument Data Sheets. Diaphragm seal shall comply with the following technical characteristics:
    a. Integral type; a locking device shall be supplied to prevent the gauge from being removed from the seal without tools.
    b. Diaphragm seal design shall allow for the removal of the top housing c/w gauge and seal diaphragm without loss of fill fluid.
    c. 316 SS diaphragm material.
    d. ½" NPT (F) instrument connection size; ½" NPT (M) process connection size.
- Pressure gauge materials (case, internals, etc.), oil fill liquid, diaphragm materials and liquid filling shall be able to work at minimum ambient low temperature of –30°C. Vendor shall inform operating/ambient temperature range at Bid stage. Also shall be clearly specified environmental conditions for quoted devices.
- All instruments will be supplied with permanent stainless steel tag fixed by stainless steel screws. As a minimum, Manufacturer's serial number, model number, instrument tag number, maximum working pressure will be stamped.
- Pressure Gauges ranges will be selected within the following standardized ranges:

0 – 40 KPa	0 – 1,000 KPa
0 – 60 KPa	0 – 1,600 KPa
0 – 100 KPa	0 – 2,500 KPa
0 – 160 KPa	0 – 4,000 KPa
0 – 250 KPa	0 – 6,000 KPa
0 – 400 KPa	0 – 10,000 KPa
0 – 600 KPa	

Pressure Transmitters

- The following description applies to Gauge Pressure and Differential Pressure Transmitters.
- Transmitter electronics shall have temperature and static pressure compensation.
- Transmitters shall support remote calibration.
- Transmitter bodies, cells and sensors may work under static pressures determined by the rating without affecting the operating parameters.
- Transmitter process connection shall be ½" NPTF.
- The body material shall be as indicated in attached Instrument Data Sheets. The sensor material, in contact with the process, will be AISI 316L. All the assembly shall be suitable for the operating conditions detailed in the data sheets.
- Main operating parameters are indicated as follows:
  a. Reference accuracy: ±0.1 % of the instrument span.
  b. Total performance: +0.15 % of span for +28°C temperature changes.
  c. Stability: +0.125 % of URL for 5 years.
  d. RFI Effect: +0.1% of span from 20 to 1000MHz and for field strength up to 30 V/m.
- The sensing elements shall be protected for overpressures of 1.3 times the design pressure.
- Where seals are required, they shall use 316L stainless steel type with armored capillaries.
- Vendor shall provide Conformance and Calibration Certificates for each transmitter to be supplied.
- Transmitter materials (case, internals, etc.) shall be able to work at minimum ambient low temperature of –30°C.
- Vendor shall inform ambient, operating, storage and transport temperature range in Bid stage. Also shall be clearly specified environmental conditions for quoted devices.
- All instruments will be supplied with permanent stainless steel tag fixed by stainless steel screws. As a minimum, Manufacturer's serial number, model number, instrument tag number, maximum working pressure will be stamped.

10.5.4.12 Temperature Management

- Temperature measurement devices shall be selected to suit the environmental conditions of the facilities and the process fluid flow design conditions taking into account a range choice that is inclusive of normal operating temperature and design temperature and accuracy requirements.
- In general, non-intrusive three wire PT100 Resistance Temperature Devices (RTD) Class B (DIN IEC 751) shall be specified with head mounted smart transmitters giving a 4-20mA + HART output signal.
- For high temperature applications, thermocouple type shall be used, if the temperature and design permit, these shall also be head mounted type.
- When used, thermocouples shall conform to IEC 60584 or ANSI MC 96.1 standard.
- Temperature gauges shall be installed per the P&ID requirements. Temperature gauges shall be bimetal every angle unless approved otherwise by COMPANY.
- Consideration should be given to non-intrusive temperature measurement. However, where there is a definite requirement, local temperature indicators shall be bimetallic with a 4-inch dial.
- Generally, thermos-wells shall be provided for all in line temperature applications. The thermos-wells shall be flanged with a tapered construction and machined from bar stock or forging. The material shall be suitable for the process conditions, but shall be 316 stainless steel as a minimum.
- Flange shall always meet the relevant piping material requirements for material selection and dimension. When no information is given size will be 2” rating per data sheet.
- The dimension from the tip of the thermo-wells to the bottom side of the flanges shall be long enough to permit the sensitive portion of the thermo-wells to be immersed in the liquid or gas to be measured.
- For process measurements, the thermo-well tip should not penetrate more than 50 mm the inner pipe wall to minimize vibrations. Outer thermal insulation shall be added in order to minimize temperature gradients. See Data Sheets for particular requirements.
- All thermos-well verification per ASME 19.3 TW PTC is mandatory. A set of calculations sheets must be sent for approval.

- When choosing the length of the thermo-wells, it shall be taken into account the dead length to pass through the pipe connection.
- For pipe less than 6 inches, either an increase in pipe diameter to 6 inches shall be made (expander and reducer).
- Temperature indicators shall present engineering values (deg C).

Temperature Transmitters

- Transmitters shall use a thermocouple or RTD sensor, as required and will be supplied with a stainless steel thermo-well for process connection.
- They will constitute a unique assembly: sensor / thermo-well / transmitter. Eventually, the transmitter may be mounted separately on a 2" pipe, if required.
- The accuracy shall be ± 0.2 % of the instrument span, or better.
- Main operating parameters shall be indicated in the offer: Accuracy, repeatability, hysteresis and dead band. Calibration stability over the time, output deviations due to operating temperature changes and voltage supply required shall also be indicated.
- Output shall be lineal with temperature.
- All transmitters shall be supplied with a built-in junction box, with a ½" NPT electric connection. In case of a second electric connection, it shall be provided with a bronze plug.
- Zero and span adjustments may be done locally.

10.5.4.13 Control Valves

- Control valves shall fully comply with the project data sheets and specifications.
- Valves shall be manufacturer's standard design, provided they meet the requirements of this specification.
- Welded bodies or welded connections to the bodies will not be accepted. The bodies shall have an arrow indicating the direction of flow, etched or cast in the valve body.
- The control valves actuators shall be fail-safe type (fail-safe) to return to safe position in case of power failure. Its operation will be pneumatic, positioners will accept 4-20mA + HART signals and be certified for the area classification for which they are specified.
- Actuators will be sized considering maximum (rating) and minimum (operation) pneumatic pressure supply indicated in the data sheets.
- Normally a 3-15 psig instrument air pressure range will be used for the actuators. A 6-30 psig range will be accepted in order to reduce the actuator size.
- Actuator springs exposed to the atmosphere will be protected against corrosion (electrochemical protection) and painted following the vendor standards.
- The flow direction (to close/open) will coincide with the valve safe position. If not, the spring will be designed with a 2-safety factor.
- Actuators, positioners and accessories shall be from well-known suppliers as Fisher Controls, Masoneilan or equivalent.
- The actuator should incorporate visual indication of valve position.
- Unless otherwise specified all Control Valve bodies will be flanged or suitable for insertion between pipeline flanges. Flange rating will conform to the project piping specifications.
- Valves bodies will support as a minimum the maximum pressure and temperature determined by ANSI B 16.5 for the rating and material specified in Data Sheet.
- Valves dimensions will be according to the referred standards.
- Valve trims should be able to be repaired and / or replaced easily without removing the valve from line.
- The specified materials will meet the composition and characteristics corresponding to the detailed ASTM or AISI description, or the standard

characteristics and composition of the materials described by their commercial names.

- Valve Body and trim materials shall be as per Data Sheet Specification. Different materials than requested, can be quoted for the valves, but they shall meet or exceed the specified requirements. A technical justification for these changes will be presented during the offering stage. These changes may be approved or not.
- The valves shall be designed and constructed to be operable under the specific conditions defined on the data sheets. Control Valve Inherent Flow Characteristic shall be as indicated in particular Data Sheet.
- 1 ¼", 2 ½", 3 ½", 4 ½", 5" and higher odd nominal size Valve Bodies shall not be used.
- Valve Bodies smaller than 1" nominal size shall not be used. If necessary reduced internals will be provided.

Accessories for Control Valves, General Characteristics

- The stem position will be indicated on a scale with a pointer, directly attached to it.
- All accessories supplied with the valve must be mounted on it.
- All tubing interconnecting, filter, regulator, positioner, etc. must be stainless steel tube with NPT St. St. fittings double ferrule type.
- When solenoid valves are supplied they must comply with data sheet specification.
- When specified, limit switches will have micro-switches, dry contacts, snap action, SPDT, rating 10A @ 125/250 VAC, enclosure CSA TYPE 4X.
- Solenoid valves for control valves, except when specified in contrary, will be mounted between the positioner and the diaphragm in such a way that when de-energized the diaphragm chamber will be vented and the valve go the fail position.
- Positioners and I/P Transducer shall be mounted on the control valve and adjusted by the control valve manufacturer. Positioners shall have a filter-regulator, adjustable valve travel, and gauges for indicating air supply, and signal output.
- All Valve and Actuators shall have a Stainless Steel Tag Plate indicating tag number, nominal size, rating, material of construction, model, standards, FO (fail open). FC (fail close), CV, operating pressure, etc.
- All vents shall have a bug's screen and be protected for rain.
- All electrical connection (conduit) shall be ½" NPTF Minimum.
- Electronic cards and instrument components shall be tropicalized.
- Plastic shall not be used for any dial or indicator face. Shatterproof glass shall be used.

Control Valve Calculations

- Valve vendor shall submit calculations for each valve process conditions indicated in data sheets and for special conditions, if necessary (i.e. Start-Up conditions).
- All valves shall be verified for Flashing, Cavitation and Choked Flow.
- Rangeability and controllability for all process condition must be verified.

- Shut off condition shall also be verified.
- Vendor to inform stem position and Cv value for each Flow Process Condition
- Cv Calculations shall be made with ISA S75.01, “Flow Equations for Sizing Control Valves”. Corrections shall be applied for Piping Geometry (Valves mounted between pipe reducers) and low Reynolds Numbers (below 10000, Viscosity / Non turbulent Flow Conditions).
- ISA S 75.01 and ISA RP75.23, together with manufacturer cavitation index data shall be used for determining the severity of cavitation, choked flow or flashing conditions. Cavitation shall be avoided under all operating conditions. Choked flow together with excessive noise shall be avoided since it will physically damage the control valve.
- The maximum Vibration levels of the control valve shall be less than 12.5 mm/sec Root Mean Square (0.5 mm/sec RMS).
- Trim and Body Outlet Velocities must be verified in order to reduce control valve vibrations and trim erosion. For single phase liquids the Trim exit velocity shall be bellow 30m/sec and bellow 23 m/sec for cavitating, flashing and/or erosive service.
- The installed rangeability of the control valve shall meet all flow conditions specified. The specified minimum flow condition shall be fully controllable.
- The Vendor will verify the preliminary sizing of the control valves according to the following criteria:
- Valves in throttling service will be sized such that under normal process conditions, the valve will be 55% to 65% open. Maximum sizing will be the larger of 1.2 times the maximum flow or 1.8 times the normal flow.
- If Butterfly Control Valves in throttling service are used, they shall not operate over 60° open under maximum flow rate condition.
- Sound Levels for all equipment shall not exceed 85 dBA measured 1 m from the pipe and 1 m downstream from the valve.
- The Vendor will indicate the operating sound level for each equipment item. If the indicated sound level of any items exceeds the specified requirements, then the Vendor will describe additional measures to reduce these. He shall estimate the cost of these measures, and the original and resultant sound levels.

10.5.4.14 On-Off Block Valves

- On/Off valves actuated shall fully comply with the project data sheets, General Specifications and Piping Material Classes.
- The actuators and local control panel (when required) to On/Off Valves shall be according to functional and construction requirements.
- Functional schematic drawings for each one of the On/Off valves are given in the P&ID process documents.
- Actuated Block Valves shall be Ball, Gate or Butterfly type according to data sheet requirements.
- Whenever possible, valves will be the manufacturer standard provided they meet this specification requirement.
- The replacement of valves specified as being made of cast or forged steel by welded fabrication shall require Final Client acceptance. Different materials can be offered for the valves provided, and they shall meet or exceed the specified requirements. A technical justification for these changes will be presented during the offering stage. These may be approved or not.
- Valves bodies will have an arrow showing the flow direction. This arrow will be stamped, grabbed or melted on the valve body.
- Block valves will be capable of blocking the flow rate indicated in the data sheets
- Valves bodies will support as a minimum the maximum pressure and temperatures determined by the rating and material specified and the corresponding hydraulic test.
- Vendor standard quality materials will be used for parts, actuators and accessories not detailed in this specification, according with the other specified materials and the process conditions.
- Lined Butterfly Valves will be used in large lines with corrosive media.
- Butterfly Valves shall comply with API Std 609
- For Butterfly Valves Vendor shall confirm that mating pipework bore will give adequate disc swing clearance.
- Gate Valves will be used in lines with slurries media.
- The followings: API 600, ASME B 16 10 and MSS SP 42 shall be the main complementary Standards for steel gate valves.

- Ball Valves will be used for on-off applications on clear liquids, clean gases or non-abrasive reagents.
- all Valves covered by this specification must be manufactured according to API-6D.
- All ball valves shall be bi-directional.
- Ball Valves trim, 3 inches and above shall be of the “Trunnion type”.
- "ENC" in the data sheets refers to "Electroless Nickel Coating".
- Shutoff classifications indicated in the datasheets correspond to standard ANSI B16.104. Valve seats shall be designed to ensure positive sealing at low differential pressures.
- The packing design will avoid the chance of being ejected by the internal pressure. For non-Teflon packing (TFE), if recommended, the valve will include a packing lubricator with a valve.
- When fireproof design is required for the block valves bodies, API 607 standard test procedure should be applied, as an alternative API RP6F or ISO 10497 recommendations, can be applicable.
- Block valves shutoff will be of the "tight-shutoff" type.

Actuator Characteristics

- Each valve will be supplied with its corresponding actuator, of the type required in the datasheets.
- In general, actuators may be:
  a. Single effect piston type, with reset spring to fail position with solenoid valve or manual valve as required.
  b. Single effect diaphragm type with spring with solenoid valve.
- In all cases, actuators sizing will be performed using the shutoff pressure of the datasheets as the max. static differential pressure the actuator will support. However, the vendor will consider for sizing, dynamic forces to be supported by the actuator while opening or closing the valve.
- Actuators will be sized considering the pneumatic pressure supply indicated in the datasheets, as a minimum, output torque to exceed by at least 30 %, the required torque to open/close the valve, operating with a differential pressure equal to the shutoff pressure specified in the datasheets, and with a gas supply pressure equal to minimum specified.
- Actuator springs exposed to the atmosphere will be protected against corrosion (electrochemical protection) and painted following vendor standards.

Accessories Characteristics

- The stem position will be indicated on a scale with an indicating pointer, directly attached to it.
- All accessories required and/or supplied with the valve will be mounted on it (yokes, etc.). All tubing and fittings of pneumatic circuit will also be furnished to conform a fully operational unit, ready for operation.
- For normal and fireproof actuators, stainless steel tube with NPT SS double ferrule fittings will be used.
- For gas pipeline services all tubing and accessories will be stainless steel.
- Solenoid valves will be, 3 way 24VDC low consumption, with CSA TYPE 4X enclosure certified for area classification
- Limit switches will be dry contacts , snap action , SPDT , rating 5 A @ 220 VAC, with CSA TYPE 4X enclosure certified for area classification

Valve Inspection and Testing

- Ball Valves
  a. The valve shall be tested assembled, at Vendor's facilities prior to shipping.
  b. All valves must be 100 % visually inspected as per the API 598 and MSS SP 55.
  c. All valves (100 % of the supply) shall undergo pressure tests in accordance with the requirements of the API 6D Specification, completed by the API standard 598.
  d. Detailed testing procedure shall be submitted for approval.
  e. High pressure hydrostatic seat test leakage rates shall comply with API 6D.
  f. Low pressure hydrostatic seat test leakage rates: Vendor acceptance criteria must be submitted for PURCHASER approval.
  g. Valves to be supplied shall pass a testing of the seat relief design effectiveness. Testing procedure shall be submitted for approval and Test certificates must be supplied.
  h. Test certificates must be supplied for each valve of the supply.
  i. Material full traceability is required.

Actuator Inspection and Testing

- Actuator shall be tested assembled on valve, at Vendor's facilities prior to shipping.
- Minimum factory testing shall include verification of rated output torque, output speed, manual override operation, local and remote control and signalization.
- Manufacturer shall submit welding procedures for all actuator components according to ASME SEC IX.
- Functional testing of sub-assemblies as well as the complete system must include adjustment of end of stroke trigger devices, limit switches, etc.
- Testing shall conform as close as is practical to actual field operating conditions, these conditions to be understood as Valves being cycle tested at full differential pressure.
- Test Data Protocols must be certified by Vendor and submitted prior to shipment of valve and actuator.

10.5.4.15 Pressure Regulators – Self Operated Valves

- Vendor will verify valve sizing for the specified operating conditions. Calculations shall accompany the offer.
- Valve springs will be selected by the manufacturers based on the set pressures.
- Self-Operated Valves shall be provided. If as a result of not practical, alternates way be sent for Client / Engineer evaluation.
- Self-Operated Valves shall be manufacturer standard design, provided they meet this specification requirement. Valves will be pressure regulators or back pressure types.
- Welded bodies won't be accepted.
- Valves bodies will have an arrow showing the flow direction. This arrow will be stamped, grabbed or melted on the valve body.
- Valves bodies will support as a minimum the maximum pressure and temperature determined by ANSI B 16.5 for the rating and material specified in Data Sheet.
- The specified materials will meet the composition and characteristics corresponding to the detailed ASTM or AISI description, or the standard characteristics and composition of the materials described by their commercial names.
- Valve Body and trim materials shall be as per Data Sheet Specification. Different materials than requested, can be quoted for the valves, but they shall meet or exceed the specified requirements. A technical justification for these changes will be presented during the offering stage. These changes may be approved or not.
- The valves shall be designed and constructed to be operable under the specific conditions defined on the instrument data sheets annexed to this specification.
- 1 ¼", 2 ½", 3 ½", 4 ½", 5" and higher odd nominal size Valve Bodies shall not be used.

10.5.4.16 Pressure Relief Valves

- Safety relief valves shall fully comply with the project data sheets according to General Specifications and Piping Material Classes.
- Vendor will verify valve sizing for the specified operating conditions. Calculations shall accompany the offer.
- Selection of safety and relief valves that are required shall be in accordance with Standard API RP-520 (Parts I & II) and ASME Codes for Unfire Pressure Vessels and Pressure Boilers.
- Manufacturer standard design valves will be preferred provided they meet these specification requirements and offer the maximum parts interchange ability, to reduce the spare parts stock.
- Flanged Relief Valves will have enclosed spring, bolted bonnet, screwed caps and full one-piece nozzle.
- Nozzle and Disk will be forged Stainless Steel.
- Lifting levers will be supplied on valves used in steam and air service. No lifting levers are required for process valves.
- Nozzle/disk/spring design valves will be used. Pilot operated valves may be accepted for special conditions.
- The manufacturer will verify materials compatibility with the specified service conditions for the valve; compatibility between metals in contact for relative shift to avoid excessive friction will also be verified.
- Screwed valves will not be used when inlet size is 1-1/2 inches or larger. Maximum connection for screwed valves will be 1 inch.
- Valve discharge capacity will be certified in accordance with ASME code, section VIII. Discharge coefficient will not be lower than K= 0.953 (for air, steam, vapor & gases) ; K= 0.724 (for ASME Code Liquid) ; K= 0,64 (For Non ASME Code liquids).
- For liquid service, valves to be used for protection against thermal expansion will have characteristics of gradual opening with overpressure, requiring a maximum of 25% overpressure for total opening. On the contrary, valves for gas or vapor service will have a "pop" open characteristic, this is, full opening once surpassed the set pressure.
- Valve springs will be selected by the manufacturers based on the set pressures.

- When indicated in the data sheets spring material CS, it will be considered alloy carbon steel treated for springs with a corrosion-free surface coating (electrochemical coating: nickel plated, zinc plated, etc.). For service or discharge temperatures above 232 °C, tungsten alloy steel springs will be used.
- Valves will have an adequate surface treatment allowing for a correct outdoors operation under the weather and installation conditions described in the attached documentation. This will be specially taken into consideration for open bonnet valves.
- For balanced valves with vented bonnets, the connection to the atmosphere will be provided with an accessory to avoid the introduction of insects or rain to the valve interior.
- Vendor shall perform the sizing for the valves using the API RP 520/ASME standards and the corresponding calculations for the selection conditions. These calculations will be submitted during the offering stage.

10.5.4.17 Data Sheets

Orifice Plates, Flanges & Restriction Orifices

	ORIFICE FLANGES	METER TUBE	
ORIFICE PLATE			
STANDARD: ISO-5167	TYPE: Welding neck flange (Notes 1)	RATING / TYPE: N/A	
MATERIAL: AISI 316SS	MATERIAL: CS A105	MATERIAL: N/A	
GASKET MATERIAL: (Note 1)	DRAWING:	DRAWING: N/A	
	SUPPLIER: Vendor	SUPPLIER: N/A	
GENERAL			
UNIT	NATURAL GAS SYSTEM	NG SYSTEM	NG SYSTEM
ITEM	ORIFICE PLATE + FLANGE	ORIFICE PLATE + FLANGE	ORIFICE PLATE + FLANGE
TAG	FE	FE	FE
QUANTITY	1 (ONE)	1 (ONE)	8 (EIGHT)
P&ID			
LINE	8"-NG-C1H (Estimated size)	3"-NG-C1H	2"-NG-C1H
ORIFICE FLANGE	8” WN RF 300# ASME B16.36 SCH STD	3” WN RF	2” WN RF
OPERATING CONDITIONS			
FLUID / STATE	NG / GAS	NG / GAS	NG / GAS
MAXIMUM FLOW	TBD by EPC	TBD by EPC	TBD by EPC
PRESSURE	12 kg/cm2 g	12 kg/cm2 g	12 kg/cm2 g
TEMPERATURE	20°C	20°C	20°C
MOLECULAR WEIGHT	18	18	18
CORROSIVE, EROSIVE, FOULING MATERIALS	NO	NO	NO
CALCULATION FACTORS	(Note 2)	(Note 2)	(Note 2)
RATIO β = d / D	TBD by EPC	TBD by EPC	TBD by EPC
PRIMARY ELEMENT DATA	(Note 2)	(Note 2)	(Note 2)
ORIFICE DIAMETER	_____ mm	_____ mm	_____ mm
PIPE INSIDE DIAMETER	……..	……..	……..
PLATE THICKNESS	1/8” - 3 mm	1/8” - 3 mm	1/8” - 3 mm

Table 10.5-15.: Technical Data for Orifice Plates, Flanges & Restriction Orifices

NOTES:

1. Flange material, class, face, face finishing, gasket type and stud bolts per applicable PIPNG CLASS by EPC Contractor.
2. Calculations by EPC contactor.
3. Density at 15°C and operative pressure
4. N/A

Differential Pressure Transmitters – Flow

UNIT	NATURAL GAS SYSTEM
ITEM	
TAG	FIT
QUANTITY	10 (TEN)
P&I	
LINE / VESSEL	Various sizes "-NG-C1H
TRANSMITTER	
TYPE	SMART
OUTPUT SIGNAL	4-20 mA + HART
COMM. PROTOCOL	-
OUTPUT TYPE	SQUARE ROOT
ADJUSTABLE RANGE	TBD (Note 2)
SET RANGE	0 ~ 2500 mm H2O (Note 2)
ENCLOSURE CLASS	CSA TYPE 4X
HAZARDOUS PROTECT.	EXPLOSION PROOF
ZONE CLASS	Class I Div. 2 Gr. B, C & D
BODY MATERIAL	SS 316
INNER MATERIAL	SS 316
DIAPHRAGM MATERIAL	SS 316
PROCESS CONN.	½" NPT FEMALE (Oval flanges)
ELECTRIC CONN.	½" NPT FEMALE
LOCAL INDICATOR	YES, LCD
ACCESSORIES	LIGHTNING PROTECTION 316 SS TAG PLATE
OTHER REQUIREMENTS	Calibration / configuration with test reports
OPERATING CONDITIONS	
FLUID / STATE	NATURAL GAS / GAS
OPER. TEMPERATURE	
DESIGN TEMPERATURE	40°C
DESIGN PRESSURE	15.7 Bar
DENSITY @ 15 °C	
DENSITY @ FTP	
PROCESS VARIABLE	FLOW
PROC. VARIABLE RANGE	_____ m3/h
CORROSIVE, EROSIVE, FOULING MATERIALS	NO
OTHER REQUIREMENTS	--

Table 10.5-16.: Technical Data for Differential Pressure Transmitters - Flow

NOTES:

1. Standard Conditions: 15°C, 1.033 kgf/cm2 and 0% relative humidity.
2. TBD: To be defined by EPC
3. During the detailed engineering, the existing flowmeter (FxxxT, located downstream the valves SG-P403V and SG-P403AV) shall be checked for this process conditions and analyzed if it is possible to remove it from the existing line and install it on the new line.
4. N/A.

Turbine Flowmeter

UNIT	WATER SYSTEM
TAG	FE / FIT
QUANTITY	1 (ONE)
P&I	
LINE	WATER INAKE
LINE SIZE / SPEC	HOLD 6” 150# C1A
FLOWMETER	
BODY SIZE	4”
BODY MATERIAL	CAST BRONZE
END CONN. TYPE & RATING	FLANGED 6” RF 150# FILTER MESH 10
TRANSMITTER	
TYPE	SMART
OUTPUT SIGNAL	4-20 mA + HART/PULSE (DUAL)
COMM. PROTOCOL	-
OUTPUT METER SCALE RANGE	
CALIBRATED RANGE	
POWER SUPPLY	TBD
ENCLOSURE CLASS	CSA TYPE 4X
HAZARDOUS PROTECT.	GENERAL PURPOSES
ZONE CLASS	
BODY MATERIAL	
MOUNTING	INTEGRAL / WALL or 2” PIPE
ELECTRIC CONN.	½” NPT FEMALE
LOCAL INDICATOR	YES
ACCESSORIES	LIGHTNING PROTECTION 316 SS TAG PLATE
OTHER REQUIREMENTS	Calibration for fiscal metering / configuration with test reports
OPERATING CONDITIONS	
FLUID / STATE	FILTERD WATER / LIQUID
FLOW NORM / MAX	95 / 120 m3/h
OPER. TEMPERATURE	
DESIGN TEMPERATURE	60 °C
OPER. PRESSURE	
DESIGN PRESSURE	18.6 Bar
NOTES	

Table 10.5-17.: Technical Data for Turbine Flowmeter

Ultrasonic Level Transmitter

UNIT		WATER SYSTEM
TAG		LIT
QUANTITY		1 (ONE)
P&I		
LINE / VESSEL		WATER STORAGE TANK
VESSEL DIMENSIONS		DIAM. 13,85m x 10m H
TRANSDUCER		
MOUNTING		FLANGE 3” 150#
CABLE LENGTH		
TEMP COMPENSATION		AUTOMATIC
CONE ANGLE		MIN.
TRANSMITTER		
TYPE		SMART
OUTPUT SIGNAL		4-20 mA + HART
OUTPUT TYPE		LINEAL
CALIBRATED RANGE		0 ~ 10 m
SCAL RANGE		TBD
ENCLOSURE CLASS		CSA TYPE 4X
HAZARDOUS PROTECT.		EXPLOSION PROOF
ZONE CLASS		Class I Div. 2 Gr. B, C & D
MOUNTING		WALL or 2” PIPE
ELECTRIC CONN.		½” NPT FEMALE
LOCAL INDICATOR		YES
BLOCKING DISTANCE		Minimum
ACCESSORIES		LIGHTNING PROTECTION 316 SS TAG PLATE
OTHER REQUIREMENTS		Calibration / configuration with test reports
OPERATING CONDITIONS		
FLUID / STATE		FILTERD WATER / LIQUID
OPER. TEMPERATURE		Ambient
DESIGN TEMPERATURE		66 °C
OPER. PRESSURE		Ambient
DESIGN PRESSURE		
DISTANCE	BIN FULL	0.50 m
	BIN EMPTY	10.00 m

Table 10.5-18.: Technical Data for Ultrasonic Level Transmitters

NOTES:
1. N/A.
2. TBD: To be defined by EPC
3. VENDOR SHALL PROVIDE INDIVIDUAL NAMEPLATES FOR EACH DEVICE.

Pressure Gauges

Tag Qty	FLUID / STATE	Range (Kg/cm^2 g)	Maximum Pressure (Kg/cm^2 g)	Design Temp. ºC	Notes
PG-8	Industrial Water / Liquid	0 ~ 40	18.6	60	4
PG-2	Instrument Air / Gas	0 ~ 16	9.8	60	
PG-7	Air Distribution / Gas	0 ~ 16	9.8	60	
PG-2	N2 / Gas	0 ~ 60	15.7	40	

Table 10.5-19.: Technical Data for Pressure Gauges

Notes:

1. The Gauge shall be suitable to fill with Glycerin
2. Manufacturer: ---.
3. Model: ---.
4. The Gauge shall be supplied filled with Glycerin
5. Overpressure protection must be supplied. (Maximum operating pressure is _____ kgf/cm2g)
6. Diaphragm to be defined by EPC

Pressure Transmiter (1)

GENERAL	NATURAL GAS SYSTEM	WATER SYSTEM	WATER INTAKE
ITEM			
TAG	PIT	PIT	PIT
QUANTITY	10 (TEN)	1 (ONE)	1 (ONE)
P&I			
LINE / VESSEL	Various sizes "-NG-C1H	WATER TANK	HOLD
TRANSMITTER			
TYPE	SMART	SMART	SMART
OUTPUT SIGNAL	4-20 mA	4-20 mA	4-20 mA
PROCESS VARIABLE	GAGE PRESSURE	GAGE PRESSURE	GAGE PRESSURE
RANGE	0 – 20 Kg/cm^2 g	0 –2 Kg/cm^2 g	0 – 12 Kg/cm^2 g
ENCLOSURE CLASS	CSA TYPE 4X	CSA TYPE 4X	CSA TYPE 4X
HAZARDOUS PROTECT.	EXPLOSION PROOF	EXPLOSION PROOF	EXPLOSION PROOF
ZONE CLASS	Class I Div. 2 Gr. B, C & D	Class I Div. 2 Gr. B, C & D	Class I Div. 2 Gr. B, C & D
BODY MATERIAL	SS 316	SS 316	SS 316
INNER MATERIAL	SS 316	SS 316	SS 316
DIAPHRAGM MATERIAL	SS 316	SS 316	SS 316
PROCESS CONN.	½" NPT FEMALE (Oval flange)	½" NPT FEMALE (Oval flange)	½" NPT FEMALE (Oval flange)
ELECTRIC CONN.	½" NPT FEMALE	½" NPT FEMALE	½" NPT FEMALE
LOCAL INDICATOR	YES, LCD	YES, LCD	YES, LCD
ACCESSORIES	LIGHTNING PROTECTION SIDE VENT / DRAIN 316 SS TAG PLATE	LIGHTNING PROTECTION SIDE VENT / DRAIN 316 SS TAG PLATE	LIGHTNING PROTECTION SIDE VENT / DRAIN 316 SS TAG PLATE
COMM. PROTOCOL	-	DE	DE
OTHER REQUIREMENTS	Calibration / configuration with test reports	Calibration / configuration with test reports	Calibration / configuration with test reports
OPERATING CONDITIONS			
FLUID / STATE	NATURAL GAS / GAS	WATER / LIQ.	WATER / LIQ.
OPERATING PRESSURE			
OP. TEMPERATURE		38 °C	10 °C
MAX. PRESSURE	15.7 kgf/cm2 (g) (Note 1)	11 m H2O	HOLD
MAX. TEMPERATURE	40 °C (Note 1)	40 °C (Note 1)	HOLD
CORROSIVE, EROSIVE, FOULING MATERIALS	-	-	-
OTHER REQUIREMENTS	-	-	-
MANUFACTURER			
MODEL			

Table 10.5-20.: Technical Data for Pressure Transmitters (1)

NOTES:

1. Mechanical design conditions.
2. N/A
3. N/A.
4. N/A.

Pressure Transmiter (2)

GENERAL	WATER SYSTEM	COMPRESSED AIR HEADER	COMPRESSED AIR NET
ITEM			
TAG	PIT	PIT	PIT
QUANTITY	1 (ONE)	3 (THREE)	7 (SEVEN)
P&I			
LINE / VESSEL	WATER PUMPS	4"-IA-G1A-	4"-IA-G1A-
TRANSMITTER			
TYPE	SMART	SMART	SMART
OUTPUT SIGNAL	4-20 mA	4-20 mA	4-20 mA
PROCESS VARIABLE	GAGE PRESSURE	GAGE PRESSURE	GAGE PRESSURE
RANGE	0 –20 Kg/cm^2 g	0 – 10 Kg/cm^2 g	0 – 10 Kg/cm^2 g
ENCLOSURE CLASS	CSA TYPE 4X	CSA TYPE 4X	CSA TYPE 4X
HAZARDOUS PROTECT.	EXPLOSION PROOF	EXPLOSION PROOF	EXPLOSION PROOF
ZONE CLASS	Class I Div. 2 Gr. B, C & D	Class I Div. 2 Gr. B, C & D	Class I Div. 2 Gr. B, C & D
BODY MATERIAL	SS 316	SS 316	SS 316
INNER MATERIAL	SS 316	SS 316	SS 316
DIAPHRAGM MATERIAL	SS 316	SS 316	SS 316
PROCESS CONN.	½" NPT FEMALE (Oval flange)	½" NPT FEMALE (Oval flange)	½" NPT FEMALE (Oval flange)
ELECTRIC CONN.	½" NPT FEMALE	½" NPT FEMALE	½" NPT FEMALE
LOCAL INDICATOR	YES, LCD	YES, LCD	YES, LCD
ACCESSORIES	LIGHTNING PROTECTION SIDE VENT / DRAIN 316 SS TAG PLATE	LIGHTNING PROTECTION SIDE VENT / DRAIN 316 SS TAG PLATE	LIGHTNING PROTECTION SIDE VENT / DRAIN 316 SS TAG PLATE
COMM. PROTOCOL	DE	DE	DE
OTHER REQUIREMENTS	Calibration / configuration with test reports	Calibration / configuration with test reports	Calibration / configuration with test reports
OPERATING CONDITIONS			
FLUID / STATE	WATER / LIQ.	INSTRUMENT AIR	INSTRUMENT AIR
OPERATING PRESSURE		7 kgf/cm2 (g)	7 kgf/cm2 (g)
OP. TEMPERATURE	38 °C	38 °C	38 °C
MAX. PRESSURE	45.6 kgf/cm2 (g) (Note 1)	15.7 kgf/cm2 (g) (Note 1)	15.7 kgf/cm2 (g) (Note 1)
MAX. TEMPERATURE	40 °C (Note 1)	60 °C (Note 1)	60 °C (Note 1)
CORROSIVE, EROSIVE, FOULING MATERIALS		-	-
OTHER REQUIREMENTS	-	-	-
MANUFACTURER			
MODEL			

Table 10.5-21.: Technical Data for Pressure Transmitters (2)

NOTES:

1. Mechanical design conditions.
2. N/A
3. N/A.
4. N/A.

Pressure Transmiter (3)

GENERAL	OXIGEN SYSTEM	NITROGEN HEADER
TAG	PIT	PIT
QUANTITY	2 (TWO)	2 (TWO)
P&I		
LINE / VESSEL	OXIGEN FEEDER	4"-N-C1K-
TRANSMITTER		
TYPE	SMART	SMART
OUTPUT SIGNAL	4-20 mA	4-20 mA
PROCESS VARIABLE	GAGE PRESSURE	GAGE PRESSURE
RANGE	0 –20 Kg/cm^2 g	0 – 16 Kg/cm^2 g
ENCLOSURE CLASS	CSA TYPE 4X	CSA TYPE 4X
HAZARDOUS PROTECT.	EXPLOSION PROOF	EXPLOSION PROOF
ZONE CLASS	Class I Div. 2 Gr. B, C & D	Class I Div. 2 Gr. B, C & D
BODY MATERIAL	SS 316	SS 316
INNER MATERIAL	SS 316	SS 316
DIAPHRAGM MATERIAL	SS 316	SS 316
PROCESS CONN.	½" NPT FEMALE (Oval flange)	½" NPT FEMALE (Oval flange)
ELECTRIC CONN.	½" NPT FEMALE	½" NPT FEMALE
LOCAL INDICATOR	YES, LCD	YES, LCD
ACCESSORIES	LIGHTNING PROTECTION SIDE VENT / DRAIN 316 SS TAG PLATE	LIGHTNING PROTECTION SIDE VENT / DRAIN 316 SS TAG PLATE
COMM. PROTOCOL	DE	DE
OTHER REQUIREMENTS	Calibration / configuration with test reports	Calibration / configuration with test reports
OPERATING CONDITIONS		
FLUID / STATE	WATER / LIQ.	NITROGEN
OPERATING PRESSURE		
OP. TEMPERATURE	38 °C	38 °C
MAX. PRESSURE	45.6 kgf/cm2 (g) (Note 1)	15.7 kgf/cm2 (g) (Note 1)
MAX. TEMPERATURE	40 °C (Note 1)	40 °C (Note 1)
CORROSIVE, EROSIVE, FOULING MATERIALS		-
OTHER REQUIREMENTS	**CLEANING FOR OXIGEN SERVICE**	-

Table 10.5-22.: Technical Data for Pressure Transmitters (3)

NOTES:

5. Mechanical design conditions.
6. N/A
7. N/A.
8. N/A.

Temperature Transmitter – RTD sensor

GENERAL	
UNIT	WATER SYSTEM
ITEM	
TAG	TT / TE / TW
QUANTITY	1 (ONE)
LINE / EQUIPMENT	WATER INAKE
LINE SIZE / SPEC	HOLD 6” 150# C1A
TRANSMITTER	
TYPE	SMART
OUTPUT SIGNAL	4-20 mA + HART
COMM. PROTOCOL	-
CALIBRATED RANGE	-50 to +50°C
POWER SUPPLY	24 VDC - LOOP POWERED
ENCLOSURE CLASS	CSA TYPE 4X
HAZARDOUS PROTECT.	GENERAL PURPOSES
MOUNTING	2” PIPE
ELECTRIC CONN.	½” NPT FEMALE
LOCAL INDICATOR	YES
T/C BURN OUT ACTION	UPSCALE
ACCESSORIES	LIGHTNING PROTECTION 316 SS TAG PLATE
OTHER REQUIREMENTS	Calibration / configuration with test reports
RTD	
MATERIAL	PLATINUM
RESISTANCE VALUE @ 0°C	100 OHMS
ACCURACY	Class B
SHEAT MATERIAL	SS 316
SHEAT DIAMETER	1/4 “
No. OF LEAD WIRES	3
SPRING LOADED	YES
MOUNTING	REMOTE FROM TT
HEAD	ALUMINIUM
WELL / ELECTRICAL CONN.	½” / ¾”
WELL	
TYPE	FLANGED / TAPPERED
MATERIAL	AISI 316
PROCESS CONN.	2” RF
INSERTION LENGTH “U”	3”
LAG EXTENSION “T”	-
OPERATING CONDITIONS	
FLUID / STATE	FILTERD WATER / LIQUID
FLOW NORM / MAX	165 / 200 m3/h
OPER. / DESIGN TEMPERATURE	/ 60°C
OPER. / DESIGN PRESSURE	/ 18.6 Bar

Table 10.5-23.: Technical Data for Temperature Transmitter – RTD Sensor

Control Valve (1)

1	TAG Nº	**PV-**						
2	ITEM N°	**Qty: 1 (ONE)**						
3	SERVICE	NATURAL GAS SYSTEM						
4	LINE Nº	10"-NG-C1H						
5	DWG							
6	Fluid	Natural Gas			Phase: **Gas**		Crit Pres Pc	
	SERVICE CONDITION		Units	Max Flow	Norm Flow	Min Flow	Shut-Off	
7		Flow Rate (Note 3)	kg/h					
8		Inlet Pressure	kg/cm2 g				**45.6**	
9		Pressure Drop	kg/cm2					
10		Inlet Temperature	C°					
11		Density / Mol Weight	kg/m3 / -					
12		Viscosity/Spec Heats Ratio	cp / -					
13		Vapor Pressure Pv	kg/cm2 a					
14		Required Cv	-					
15		Travel	%	(Note 1)	(Note 1)	(Note 1)		
16		Predicted SPL	dBA	(Note 1)	(Note 1)	(Note 1)		
17								

18	LINE	Pipe Line Size & Schedule	In	10"	Sch STD	53	ACTUATOR: Type **Spring & Diaphragm**
19			Out	10"	Sch STD	54	Mfr & Model
20		Pipe Line Insulation		No		55	Size **(Note 1)** Eff Area **(Note 1)**
21	VALVE BODY & BONNET	Type	Globe			56	On/Off **--** Modulating **Yes**
22		Size	6" (Budgetary)	ANSI Class	300#	57	Spring Action Open/Close **Close (FC)**
23		Max Press/Temp	45.6 kg/cm2 g / 40_ °C			58	Max Allowable Pressure
24		Mfr & Model				59	Min Required Pressure
25		Body/Bonnet Matl	A216 WCB			60	Available Air Supply Pressure:
26		Liner Material/ID	--			61	Max **7 kg/cm2 g** Min **4.2 kg/cm2 g**
27		End Connection	In	#, RF Flanged		62	Bench Range **3-15 psig**
28			Out	#, RF Flanged		63	Actuator Orientation **Vertical**
29		Fig Face Finish				64	Handwheel Type **No**
30		End Ext/Matl				65	Air Failure Valve **Close** Set at
31		Flow Direction				66	

32		Type of Bonnet		67	POSITIONER	Input Signal : 4-20 mA + HART with Lightning Protection
33		Lub & Iso Valve --	Lube --	68		Type **Smart Electro-pneumatic**
34		Packing Material		69		Mfr & Model /
35		Packing Type		70		On Incr Signal Output **Increase**
36				71		Incr/Decr Gauges **Yes** By Pass **No**
37	TRIM	Type		72		Cam Characteristic **(Note 1)**
38		Size	Rated Travel	73		NEC Class I Group B, C & D Div. 2
39		Characteristic	Equal Percentage	74	SWITCHES	Type -- Quantity --
40		Balanced/Unbalanced		75		Mfr & Model --
41		Rated C_V	F_L X_T	76		Contacts/Rating
42		Plug/Ball/Disk Material		77		Actuation Points
43		Seat Material		78		
44		Cage/Guide Material		79	AIR SET	Mfr & Model
45		Stem Material		80		Set Pressure **(Note 1)**
46				81		Filter **Yes** Gauge **Yes**
47	SPECIAL ACCESSORIES	NEC Class **I** Group **B, C & D** Div **2**		82		
48				83	TEST	Hydro Pressure **Yes**
49				84		ANSI/FCI Leakage Class **IV**
50				85		
51				86		
52				87		

Notes:
1.- Vendor to inform or confirm.
2.- N/A
3.- Valve calculation and model selection **BY EPC** AT DETAIL ENGINEERING STAGE

Table 10.5-24.: Technical Data for Control Valves (1)

Control Valves (2)

1	TAG Nº	**PV-**						
2	ITEM N°	**Qty: 1 (ONE)**						
3	SERVICE	NATURAL GAS SYSTEM						
4	LINE Nº	3"-NG-C1H						
5	DWG							
6	Fluid	Natural Gas			Phase: **Gas**		Crit Pres Pc	
	SERVICE CONDITION		Units	Max Flow	Norm Flow	Min Flow	Shut-Off	
7		Flow Rate (Note 3)	kg/h					
8		Inlet Pressure	kg/cm2 g				**45.6**	
9		Pressure Drop	kg/cm2					
10		Inlet Temperature	C°					
11		Density / Mol Weight	kg/m3 / -					
12		Viscosity/Spec Heats Ratio	cp / -					
13		Vapor Pressure Pv	kg/cm2 a					
14		Required Cv	-					
15		Travel	%	(Note 1)	(Note 1)	(Note 1)		
16		Predicted SPL	dBA	(Note 1)	(Note 1)	(Note 1)		
17								

18	LINE	Pipe Line Size & Schedule	In	3" Sch STD	53	ACTUATOR	Type **Spring & Diaphragm**
19			Out	3" Sch STD	54		Mfr & Model
20		Pipe Line Insulation		No	55		Size **(Note 1)** Eff Area **(Note 1)**
21	VALVE BODY & BONNET	Type	Globe		56		On/Off **--** Modulating **Yes**
22		Size	2" (Budgetary)	ANSI Class 300#	57		Spring Action Open/Close **Close (FC)**
23		Max Press/Temp	45.6 kg/cm2 g / 40_ °C		58		Max Allowable Pressure
24		Mfr & Model			59		Min Required Pressure
25		Body/Bonnet Matl	A216 WCB		60		Available Air Supply Pressure:
26		Liner Material/ID	--		61		Max **7 kg/cm2 g** Min **4.2 kg/cm2 g**
27		End Connection	In	#, RF Flanged	62		Bench Range **3-15 psig**
28			Out	#, RF Flanged	63		Actuator Orientation **Vertical**
29		Fig Face Finish			64		Handwheel Type **No**
30		End Ext/Matl			65		Air Failure Valve **Close** Set at
31		Flow Direction			66		

32		Type of Bonnet	67	POSITIONER	Input Signal : 4-20 mA + HART with Lightning Protection
33		Lub & Iso Valve -- Lube --	68		Type **Smart Electro-pneumatic**
34		Packing Material	69		Mfr & Model /
35		Packing Type	70		On Incr Signal Output **Increase** Incr/Decr
36			71		Gauges **Yes** By Pass **No**
37	TRIM	Type	72		Cam Characteristic **(Note 1)**
38		Size Rated Travel	73		NEC Class I Group B, C & D Div. 2
39		Characteristic Equal Percentage	74	SWITCHES	Type -- Quantity --
40		Balanced/Unbalanced	75		Mfr & Model --
41		Rated C_V F_L X_T	76		Contacts/Rating
42		Plug/Ball/Disk Material	77		Actuation Points
43		Seat Material	78		
44		Cage/Guide Material	79	AIR SET	Mfr & Model
45		Stem Material	80		Set Pressure **(Note 1)**
46			81		Filter **Yes** Gauge **Yes**
47	SPECIAL ACCESSORIES	NEC Class **I** Group **B, C & D** Div **2**	82		
48			83	TEST	Hydro Pressure **Yes**
49			84		ANSI/FCI Leakage Class **IV**
50			85		
51			86		
52			87		

Notes:
1.- Vendor to inform or confirm.
2.- N/A
3.- Valve calculation and model selection **BY EPC** AT DETAIL ENGINEERING STAGE

Table 10.5-25.: Technical Data for Control Valves (2)

Control Valves (3)

1	TAG Nº	**PV-**						
2	ITEM N°	**Qty: 8 (EIGHT)**						
3	SERVICE	NATURAL GAS SYSTEM						
4	LINE Nº	2"-NG-C1H						
5	DWG							
6	Fluid	Natural Gas			Phase: **Gas**		Crit Pres Pc	
	SERVICE CONDITION	Flow Rate (Note 3)	Units	Max Flow	Norm Flow	Min Flow	Shut-Off	
7			kg/h					
8		Inlet Pressure	kg/cm2 g				**45.6**	
9		Pressure Drop	kg/cm2					
10		Inlet Temperature	C°					
11		Density / Mol Weight	kg/m3 / -					
12		Viscosity/Spec Heats Ratio	cp / -					
13		Vapor Pressure Pv	kg/cm2 a					
14		Required Cv	-					
15		Travel	%	(Note 1)	(Note 1)	(Note 1)		
16		Predicted SPL	dBA	(Note 1)	(Note 1)	(Note 1)		
17								

18	LINE	Pipe Line Size & Schedule	In	2" Sch STD	53	ACTUATOR	Type **Spring & Diaphragm**
19			Out	2" Sch STD	54		Mfr & Model
20		Pipe Line Insulation		No	55		Size **(Note 1)** Eff Area **(Note 1)**
21	VALVE BODY & BONNET	Type	Globe		56		On/Off **--** Modulating **Yes**
22		Size	1" (Budgetary)	ANSI Class 300#	57		Spring Action Open/Close **Close (FC)**
23		Max Press/Temp	45.6 kg/cm2 g / 40_ °C		58		Max Allowable Pressure
24		Mfr & Model			59		Min Required Pressure
25		Body/Bonnet Matl	A216 WCB		60		Available Air Supply Pressure:
26		Liner Material/ID	--		61		Max **7 kg/cm2 g** Min **4.2 kg/cm2 g**
27		End Connection	In	#, RF Flanged	62		Bench Range **3-15 psig**
28			Out	#, RF Flanged	63		Actuator Orientation **Vertical**
29		Fig Face Finish			64		Handwheel Type **No**
30		End Ext/Matl			65		Air Failure Valve **Close** Set at
31		Flow Direction			66		

32		Type of Bonnet		67	POSITIONER	Input Signal : 4-20 mA + HART with Lightning Protection
33		Lub & Iso Valve -- Lube --		68		Type **Smart Electro-pneumatic**
34		Packing Material		69		Mfr & Model /
35		Packing Type		70		On Incr Signal Output **Increase** Incr/Decr
36				71		Gauges **Yes** By Pass **No**
37	TRIM	Type		72		Cam Characteristic **(Note 1)**
38		Size	Rated Travel	73		NEC Class I Group B, C & D Div. 2
39		Characteristic	Equal Percentage	74	SWITCHES	Type -- Quantity --
40		Balanced/Unbalanced		75		Mfr & Model --
41		Rated C_V F_L X_T		76		Contacts/Rating
42		Plug/Ball/Disk Material		77		Actuation Points
43		Seat Material		78		
44		Cage/Guide Material		79	AIR SET	Mfr & Model
45		Stem Material		80		Set Pressure **(Note 1)**
46				81		Filter **Yes** Gauge **Yes**
47	SPECIAL ACCESSORIES	NEC Class **I** Group **B, C & D** Div **2**		82		
48				83	TEST	Hydro Pressure **Yes**
49				84		ANSI/FCI Leakage Class **IV**
50				85		
51				86		
52				87		

Notes:
1.- Vendor to inform or confirm.
2.- N/A
3.- Valve calculation and model selection **BY EPC** AT DETAIL ENGINEERING STAGE

Table 10.5-26.: Technical Data for Control Valves (3)

Control Valves (4)

1	TAG Nº	**LV-**						
2	ITEM N°	**Qty: 1 (ONE)**						
3	SERVICE	WATER INTAKE SYSTEM						
4	LINE Nº	4"- - C1A						
5	DWG							
6	Fluid	WATER			Phase: **LIQUID**		Crit Pres Pc	
	SERVICE CONDITION		Units	Max Flow	Norm Flow	Min Flow	Shut-Off	
7		Flow Rate (Note 3)	kg/h					
8		Inlet Pressure	kg/cm2 g				**18.6**	
9		Pressure Drop	kg/cm2					
10		Inlet Temperature	C°					
11		Density / Mol Weight	kg/m3 / -					
12		Viscosity/Spec Heats Ratio	cp / -					
13		Vapor Pressure Pv	kg/cm2 a					
14		Required Cv	-					
15		Travel	%	(Note 1)	(Note 1)	(Note 1)		
16		Predicted SPL	dBA	(Note 1)	(Note 1)	(Note 1)		
17								

18	LINE	Pipe Line Size & Schedule	In	4" Sch STD	53	ACTUATOR	Type **Spring & Diaphragm**
19			Out	4" Sch STD	54		Mfr & Model
20		Pipe Line Insulation		No	55		Size **(Note 1)** Eff Area **(Note 1)**
21	VALVE BODY & BONNET	Type	Globe		56		On/Off **--** Modulating **Yes**
22		Size	3" (Budgetary)	ANSI Class 300#	57		Spring Action Open/Close **Close (FC)**
23		Max Press/Temp	45.6 kg/cm2 g / 40_ °C		58		Max Allowable Pressure
24		Mfr & Model			59		Min Required Pressure
25		Body/Bonnet Matl	A216 WCB		60		Available Air Supply Pressure:
26		Liner Material/ID	--		61		Max **7 kg/cm2 g** Min **4.2 kg/cm2 g**
27		End Connection	In	#, RF Flanged	62		Bench Range **3-15 psig**
28			Out	#, RF Flanged	63		Actuator Orientation **Vertical**
29		Fig Face Finish			64		Handwheel Type **No**
30		End Ext/Matl			65		Air Failure Valve **Close** Set at
31		Flow Direction			66		

32		Type of Bonnet	67	POSITIONER	Input Signal : 4-20 mA + HART with Lightning Protection	
33		Lub & Iso Valve -- Lube --	68		Type **Smart Electro-pneumatic**	
34		Packing Material	69		& Model /	
35		Packing Type	70		On Incr Signal Output Incr/Decr **Increase**	
36			71		Gauges **Yes** By Pass **No**	
37	TRIM	Type	72		Cam Characteristic **(Note 1)**	
38		Size Rated Travel	73		NEC Class I Group B, C & D Div. 2	
39		Characteristic Equal Percentage	74	SWITCHES	Type -- Quantity --	
40		Balanced/Unbalanced	75		Mfr & Model --	
41		Rated C_V F_L X_T	76		Contacts/Rating	
42		Plug/Ball/Disk Material	77		Actuation Points	
43		Seat Material	78			
44		Cage/Guide Material	79	AIR SET	Mfr & Model	
45		Stem Material	80		Set Pressure **(Note 1)**	
46			81		Filter **Yes** Gauge **Yes**	
47	SPECIAL ACCESSORIES	NEC Class **I** Group **B, C & D** Div **2**	82			
48			83	TEST	Hydro Pressure **Yes**	
49			84		ANSI/FCI Leakage Class **IV**	
50			85			
51			86			
52			87			

Notes:
1.- Vendor to inform or confirm.
2.- N/A
3.- Valve calculation and model selection **BY EPC** AT DETAIL ENGINEERING STAGE

Table 10.5-27.: Technical Data for Control Valves (4)

On/Off Block Valves (1)

GENERAL		NATURAL GAS SYSTEM		NATURAL GAS SYSTEM	
ITEM NUMBER	VALVE TAG NUMBER		XV		XV
QUANTITY		2 (TWO)		1 (ONE)	
LINE		10"-NG-C1H		3"-NG-C1H	
SERVICE		SHUTDOWN NG TO CONSUMERS		SHUTDOWN NG TO CONSUMERS	
P&I DRAWING					
VALVE TYPE					
BODY TYPE		BALL		BALL	
BODY SIZE	PORT TYPE	10" (Note 5)		3" (Note 5)	
CONNECTION TYPE	RATING	FLANGED RF	#150	FLANGED RF	#300
DESIGN & MATERIALS		PER PIPING CLASS C1H CS BODY, SS TRIM		PER PIPING CLASS C1H CS BODY, SS TRIM	
EXTENDED STEM	LEAKAGE TEST	NO	CLASS IV (FCI 70.2)	NO	CLASS IV (FCI 70.2)
NORMAL POSITION		OPEN		CLOSED	
PIPING DATA SHEET					
OTHER REQUIREMENTS					
PIPE SIZE					
MATERIAL		ASTM A 106 Gr B / A53 Gr B		ASTM A 106 Gr B / A53 Gr B	
THICKNESS		SCH 20		SCH 20	
ACTUATOR					
TYPE		PNEUMATIC SINGLE EFFECT (SPRING RETURN)		PNEUMATIC SINGLE EFFECT (SPRING	
ACTION STYLE		OPEN-CLOSE		OPEN-CLOSE	
SERVICE TYPE		ON-OFF		ON-OFF	
OPERATION MODES		LOCAL / REMOTE		LOCAL / REMOTE	
ELECTRICAL CONNECTION		-		-	
POSITION INDICATION		YES		YES	
POWER		INSTRUMENT AIR – (Note 6)		INSTRUMENT AIR – (Note 6)	
HANDWHEEL		NO		NO	
VALVE FAILURE POSITION		CLOSED		OPEN	
MAX. OPEN / CLOSE TIME		To be confirmed LATER		To be confirmed LATER	
ACCESSORIES					
LIMITS SWITCHES		2 (TWO) SPDT (OPEN / CLOSE POSITION)		2 (TWO) SPDT (OPEN / CLOSE POSITION)	
FIREPROOFING		NO		NO	
SAFETY CRITICAL DEVICE					
SOLENOID VALVE		THREE WAY (Note 7)		THREE WAY (Note 7)	
MANUAL RESET		YES		YES	
AREA CLASSIFICATION		Class 1 Group IIC Zone 2 T3 (Note 8)		Class 1 Group IIC Zone 2 T3 (Note 8)	
SIZING CONDITIONS					
FLUID	STATE	NG (Note 4)	GAS	NG (Note 4)	GAS

MAX. TEMP.	MIN. TEMP.	OP. TEMP.	40 °C (Note 1)	- 10°C	10 °C	40 °C (Note 1)	- 10°C	10 °C
MAX. OP. PRESSURE	OP.PRESSURE		15.7 kgf/cm2g (Note 2)		12 kgf/cm2g (HOLD)	15.7 kgf/cm2g (Note 2)		12 kgf/cm2g (HOLD)
SHUT OFF PRESSURE			15.7 kgf/cm2			15.7 kgf/cm2		
DENSITY								
VISCOSITY	MOLEC. W.	COMP.F.	C_P/C_V	-	-	-	-	-	-
MAX. FLOW	NORMAL FLOW	MIN.FLOW	(Note 5) kg/h			(Note 5) kg/h		
CORROSIVE, EROSIVE, FOULING MATERIALS			NO			NO		
VALVE MANUFACTURER / MODEL								
ACTUATOR MANUFACTURER / MODEL								

Table 10.5-28.: Technical Data for On Off Block Valves (1)

Notes:

1. Design Temperature
2. Design Pressure
3. Body: ASTM A216 WCB
4. NG: Natural Gas
5. Valve size: to be defined at a later stage, according to final NG consumptions
6. Instrument Air: actuator design for a minimum pressure of 4.2 kg/cm2 g. Maximum pressure: 7 kg/cm2 g
7. Final configuration by EPC – 24 VDC Low power
8. To be confirmed by EPC Contractor.

On/Off Block Valves (2)

GENERAL		NATURAL GAS SYSTEM		NATURAL GAS SYSTEM	
ITEM NUMBER	VALVE TAG NUMBER		XV		XV
QUANTITY		2 (TWO)		9 (NINE)	
LINE		3"-NG-C1H		1"-NG-C1H	
SERVICE		SHUTDOWN NG TO CONSUMERS		SHUTDOWN NG TO CONSUMERS	
P&I DRAWING					
VALVE TYPE					
BODY TYPE		BALL		BALL	
BODY SIZE	PORT TYPE	3" (Note 5)		1" (Note 5)	
CONNECTION TYPE	RATING	FLANGED RF	#300	FLANGED RF	#300
DESIGN & MATERIALS		PER PIPING CLASS C1H CS BODY, SS TRIM		PER PIPING CLASS C1H CS BODY, SS TRIM	
EXTENDED STEM	LEAKAGE TEST	NO	CLASS IV (FCI 70.2)	NO	CLASS IV (FCI 70.2)
NORMAL POSITION		OPEN		CLOSED	
PIPING DATA SHEET					
OTHER REQUIREMENTS					
PIPE SIZE					
MATERIAL		ASTM A 106 Gr B / A53 Gr B		ASTM A 106 Gr B / A53 Gr B	
THICKNESS		SCH STD		SCH STD	
ACTUATOR					
TYPE		PNEUMATIC SINGLE EFFECT (SPRING RETURN)		PNEUMATIC SINGLE EFFECT (SPRING RETURN)	
ACTION STYLE		OPEN-CLOSE		OPEN-CLOSE	
SERVICE TYPE		ON-OFF		ON-OFF	
OPERATION MODES		LOCAL / REMOTE		LOCAL / REMOTE	
ELECTRICAL CONNECTION		-		-	
POSITION INDICATION		YES		YES	
POWER		INSTRUMENT AIR – (Note 6)		INSTRUMENT AIR – (Note 6)	
HANDWHEEL		NO		NO	
VALVE FAILURE POSITION		CLOSED		OPEN	
MAX. OPEN / CLOSE TIME		To be confirmed LATER		To be confirmed LATER	
ACCESSORIES					
LIMITS SWITCHES		2 (TWO) SPDT (OPEN / CLOSE POSITION)		2 (TWO) SPDT (OPEN / CLOSE POSITION)	
FIREPROOFING		NO		NO	
SAFETY CRITICAL DEVICE					
SOLENOID VALVE		THREE WAY (Note 7)		THREE WAY (Note 7)	
MANUAL RESET		YES		YES	
AREA CLASSIFICATION		Class 1 Group IIC Zone 2 T3 (Note 8)		Class 1 Group IIC Zone 2 T3 (Note 8)	
SIZING CONDITIONS					
FLUID	STATE	NG (Note 4)	GAS	NG (Note 4)	GAS

MAX. TEMP.	MIN. TEMP.	OP. TEMP.	40 °C (Note 1)	- 10°C	10 °C	40 °C (Note 1)	- 10°C	10 °C
MAX. OP. PRESSURE	OP.PRESSURE		15.7 kgf/cm2g (Note 2)	12 kgf/cm2g (HOLD)		15.7 kgf/cm2g (Note 2)	12 kgf/cm2g (HOLD)	
SHUT OFF PRESSURE			15.7 kgf/cm2			15.7 kgf/cm2		
DENSITY								
VISCOSITY	MOLEC. W.	COMP.F.	C_P/C_V	-	-	-	-	-	-
MAX. FLOW	NORMAL FLOW	MIN.FLOW	(Note 5) kg/h			(Note 5) kg/h		
CORROSIVE, EROSIVE, FOULING MATERIALS			NO			NO		
VALVE MANUFACTURER / MODEL								
ACTUATOR MANUFACTURER / MODEL								

Table 10.5-29.: Technical Data for On Off Block Valves (2)

Notes:

1. Design Temperature
2. Design Pressure
3. Body: ASTM A216 WCB
4. NG: Natural Gas
5. Valve size: to be defined at a later stage, according to final NG consumptions
6. Instrument Air: actuator design for a minimum pressure of 4.2 kg/cm2 g. Maximum pressure: 7 kg/cm2 g
7. Final configuration by EPC – 24 VDC Low power
8. To be confirmed by EPC Contractor.

On/Off Block Valves (3)

GENERAL		NATURAL GAS SYSTEM	
ITEM NUMBER	VALVE TAG NUMBER		XV
QUANTITY		16 (SIXTEEN)	
LINE		2"-NG-C1H	
SERVICE		SHUTDOWN NG TO CONSUMERS	
P&I DRAWING			
VALVE TYPE			
BODY TYPE		BALL	
BODY SIZE	PORT TYPE	2” (Note 5)	
CONNECTION TYPE	RATING	FLANGED RF	#300
DESIGN & MATERIALS		PER PIPING CLASS C1H CS BODY, SS TRIM	
EXTENDED STEM	LEAKAGE TEST	NO	CLASS IV (FCI 70.2)
NORMAL POSITION		OPEN	
PIPING DATA SHEET			
OTHER REQUIREMENTS			
PIPE SIZE			
MATERIAL		ASTM A 106 Gr B / A53 Gr B	
THICKNESS		SCH STD	
ACTUATOR			
TYPE		PNEUMATIC SINGLE EFFECT (SPRING RETURN)	
ACTION STYLE		OPEN-CLOSE	
SERVICE TYPE		ON-OFF	
OPERATION MODES		LOCAL / REMOTE	
ELECTRICAL CONNECTION		-	
POSITION INDICATION		YES	
POWER		INSTRUMENT AIR – (Note 6)	
HANDWHEEL		NO	
VALVE FAILURE POSITION		CLOSED	
MAX. OPEN / CLOSE TIME		To be confirmed LATER	
ACCESSORIES			
LIMITS SWITCHES		2 (TWO) SPDT (OPEN / CLOSE POSITION)	
FIREPROOFING		NO	
SAFETY CRITICAL DEVICE			
SOLENOID VALVE		THREE WAY (Note 7)	
MANUAL RESET		YES	

AREA CLASSIFICATION			Class 1 Group IIC Zone 2 T3 (Note 8)		
SIZING CONDITIONS					
FLUID	STATE		NG (Note 4)		GAS
MAX. TEMP.	MIN. TEMP.	OP. TEMP.	40 °C (Note 1)	- 10°C	10 °C
MAX. OP. PRESSURE	OP.PRESSURE		15.7 kgf/cm2g (Note 2)	12 kgf/cm2g (HOLD)	
SHUT OFF PRESSURE			15.7 kgf/cm2		
DENSITY					
VISCOSITY	MOLEC. W.	COMP.F.	C_P/C_V	-	-	-
MAX. FLOW	NORMAL FLOW	MIN.FLOW		(Note 5)	kg/h	
CORROSIVE, EROSIVE, FOULING MATERIALS				NO		
VALVE MANUFACTURER / MODEL						
ACTUATOR MANUFACTURER / MODEL						

Table 10.5-30.: Technical Data for On Off Block Valves (3)

Notes:

1. Design Temperature
2. Design Pressure
3. Body: ASTM A216 WCB
4. NG: Natural Gas
5. Valve size: to be defined at a later stage, according to final NG consumptions
6. Instrument Air: actuator design for a minimum pressure of 4.2 kg/cm2 g. Maximum pressure: 7 kg/cm2 g
7. Final configuration by EPC – 24 VDC Low power
8. To be confirmed by EPC Contractor.

On/Off Block Valves (4)

	GENERAL		**AIR SYSTEM**	
ITEM NUMBER	VALVE TAG NUMBER		XV	
QUANTITY		1 (ONE)		
LINE		8"-PA-C1B		
SERVICE		SHUTDOWN AIR HEADER		
P&I DRAWING				
VALVE TYPE				
BODY TYPE		BALL		
BODY SIZE	PORT TYPE	8” (Note 5)		
CONNECTION TYPE	RATING	FLANGED RF	#150	
DESIGN & MATERIALS		PER PIPING CLASS C1B CS BODY, SS TRIM		
EXTENDED STEM	LEAKAGE TEST	NO	CLASS IV (FCI 70.2)	
NORMAL POSITION		OPEN		
PIPING DATA SHEET				
OTHER REQUIREMENTS				
PIPE SIZE				
MATERIAL		ASTM A 106 Gr B / A53 Gr B		
THICKNESS		SCH 20		
ACTUATOR				
TYPE		PNEUMATIC SINGLE EFFECT (SPRING RETURN)		
ACTION STYLE		OPEN-CLOSE		
SERVICE TYPE		ON-OFF		
OPERATION MODES		LOCAL / REMOTE		
ELECTRICAL CONNECTION		-		
POSITION INDICATION		YES		
POWER		INSTRUMENT AIR – (Note 6)		
HANDWHEEL		NO		
VALVE FAILURE POSITION		CLOSED		
MAX. OPEN / CLOSE TIME		To be confirmed LATER		
ACCESSORIES				
LIMITS SWITCHES		2 (TWO) SPDT (OPEN / CLOSE POSITION)		
FIREPROOFING		NO		
SAFETY CRITICAL DEVICE				
SOLENOID VALVE		THREE WAY (Note 7)		
MANUAL RESET		YES		
AREA CLASSIFICATION		GENERAL PURPOSE (Note 8)		
SIZING CONDITIONS				
FLUID	STATE	PA (Note 4)	GAS	
MAX. TEMP.	MIN. TEMP.	OP. TEMP.	60 °C (Note 1)	- 10°C	20 °C

MAX. OP. PRESSURE	OP.PRESSURE	9.8 kgf/cm2g (Note 2)	7 kgf/cm2g (HOLD)	
SHUT OFF PRESSURE		9.8 kgf/cm2		
DENSITY				
VISCOSITY	MOLEC. W.	COMP.F.	C_P/C_V	- - -
MAX. FLOW	NORMAL FLOW	MIN.FLOW	(Note 5) kg/h	
CORROSIVE, EROSIVE, FOULING MATERIALS			NO	
VALVE MANUFACTURER / MODEL				
ACTUATOR MANUFACTURER / MODEL				

Table 10.5-31.: Technical Data for On Off Block Valves (4)

Notes:

1. Design Temperature
2. Design Pressure
3. Body: ASTM A216 WCB
4. PA: Plant Air
5. Valve size: to be defined at a later stage, according to final NG consumptions
6. Instrument Air: actuator design for a minimum pressure of 4.2 kg/cm2 g. Maximum pressure: 7 kg/cm2 g
7. Final configuration by EPC – 24 VDC Low power
8. To be confirmed by EPC Contractor.

Pressure Regulator (1)

UNIT	AIR DISTRIBUTION SYSTEM	N2 DISTRIBUTION SYSTEM
ITEM		
TAG	PCV	PCV
QUANTITY	1 (ONE)	2 (TWO)
P&I		
LINE / EQUIPMENT	6”-IA-G1A	4”-N2-C1K
LINE SIZE / SPEC	6” 150# G1A Galv. HOLD	4” 150# C1K HOLD
BODY		
TYPE / SIZE	PRESS. REGULATOR / 4”	PRESS. REGULATOR / 2”
No. OF PORTS/ PORT SIZE	/	/
END CONNECTION	ANSI # 150#, RF	ANSI # 300#, RF
BODY MATL / TRIM MATERIAL	STEEL /	STEEL /
GUIDING / PACK. MATL.	/	/
LUBRICATOR / ISOL. VALVE	N.A. / N.A.	N.A. / N.A.
DISC / SEAT MATERIAL	MFR STD	MFR STD
ACTUATOR / PILOT		
TYPE / SIZE	SELF OPERATING	SELF OPERATING
ACCESORIES		
HOUSING VENT		
INTERNAL RELIEF		
SS PLATE c/w TAG	YES	YES
OPERATING CONDITIONS		
FLUID / STATE	INSTRUMENT AIR / GAS	NITROGEN / GAS
NORMAL. / MAX. TEMPERATURE	/ 60°C	/ 40°C
NORMAL. / MAX. PRESSURE	/ 18.6 Bar	/ 15.7 Bar
D/P @ NORMAL FLOW		
D/P @ MAXIMUM FLOW		
NORMAL. / MAX. FLOW	/	/
S.G. @ O.T. / MOL. WT.	/	/
D/P SHUTOFF / ANSI CLASS	15.7 / 150 #	15.7 / 150 #
VAPOUR PRESS. / CRITICAL PRESS.	/	/
VISC @ O.T. / FLASHING	/	/
% SUPERHEAT / % SOLIDS	0 / 0	0 / 0
Cv / Cg @ NORMAL / MAX. FLOW	/	/
PREDICTED NOISE dBA		

Table 10.5-32.: Technical Data for Pressure Regulators (1)

SPRING-LOADED PRESSURE RELIEF VALVE

GENERAL		BASIS OF SELECTION	
1.	Item Number:	5.	Code: ASME VIII ☐ Stamp Req'd: Yes ☐ No ☒
2.	Tag Number: PSV		Other ☐ Specify: _____THERMAL RELIEF_____
3.	Service, Line, or Equip. Number: X" –IW-C1A	6.	Comply With API Std 526: Yes ☐ No ☐
4.	Number Required: 12 (TWELFE) (By EPC)	7.	Fire ☐ Other ☐ Specify: _____
	Diagram:	8.	Rupture Disk: Yes ☐ No ☒
VALVE DESIGN		MATERIALS	
9.	Design Type:	17.	Body: ASTM A 216, Gr. WCB (Note 4)
	Conventional ☒ Bellows ☐ Balanced Piston ☐	18.	Bonnet: ASTM A 216, Gr. WCB
10.	Nozzle Type: Full ☐ Semi ☐	19.	Seat (Nozzle): 316 SS Disk: 17.4 PH
	Other ☐ Specify:	20.	Resilient Seat: No
11.	Bonnet Type: Open ☐ Closed ☒	21.	Guide: Stainless Steel
12.	Seat Type: Metal to Metal ☐ Resilient ☐	22.	Adjusting Ring(s):
13.	Seat Tightness: API Std 527 ☐	23.	Spring: Carbon Steel Washer: Stainless Steel
	Other ☐ Specify:	24.	Bellows: N/A
CONNECTIONS		25.	Balanced Piston: N/A
		26.	Comply With NACE MR0175: Yes ☐ No ☒
14.	Inlet Size _3/4" Rating #___ Facing: __NPT__	27.	Other (Specify):
15.	Outlet Size ___1" Rating #___ Facing: __NPT__		
16.	Other (Specify):		
SERVICE CONDITIONS		ACCESSORIES	
33.	Fluid and State: INDUSTRIAL WATER	28.	Cap: Screwed ☒ Bolted ☐
34.	Required Capacity Per Valve:	29.	Lifting Lever: Plain ☐ Packed ☐ None ☒
	Liquid: - Vapor: -	30.	Test Gag: Yes ☐ No ☒
35.	Molecular Weight or Specific Gravity:	31.	Bug Screen: Yes ☐ No ☒
36.	Viscosity at Flowing Temperature:	32.	Other (Specify):
37.	Operating Pressure:		
38.	Set Pressure: 16 kgf/cm2(g)		
39.	Blowdown: Standard ☒ Other ☐	SIZING AND SELECTION	
40.	Latent Heat of Vaporization:		
41.	Operating Temperature: _____°C (Note 1)	49.	Calculated Orifice Area: BY EPC mm2
42.	Relieving Temperature: _____ °C (Note 3)	50.	Selected Orifice Area: BY EPC mm2
43.	Built-up Back Pressure: _____ kgf/cm2(g) (Note 3)	51.	Orifice Designation (letter): BY EPC
44.	Superimposed Back Pressure: 0 kgf/cm2(g)	52.	Manufacturer:
45.	Cold Differential Test Pressure:	53.	Model Number:
46.	Allowable Overpressure:	54.	Manufacturer's Orifice Area:
47.	Compressibility Factor, Z:	55.	Manufacturer's Coefficient of Discharge:
48.	Ratio of Specific Heats:	56	Vendor Calculations Required: Yes ☒ No ☐

Notes:
1- Design temperature: 60°C.
2- Design Case: Line blocked.
3- To be defined at a later stage.
4- Materials to be checked against Piping Class, document "In Progress".

Table 10.5-33.: Technical Data for Pressure Relief Valves

2	ISSUED	4/4/18	SAG	SAG	MES	MES
1	FOR INFORMATION	8/22/16	SAG	SAG	MES	MES
0	PRELIMINARY	6/9/16	SAG	SAG	MES	MES
REV.	**DESCRIPTION**	**DATE**	**PROJ.**	**EXEC.**	**CHECK.**	**APPR.**

Pure Fonte Ltée

PURE FONTE LT E

PIG IRON PRODUCTION PLANT FEASIBILITY STUDY
CUSTOMER N 1 21

tenova

TECHINT

TENOVA

TECHINT ENGINEERING & CONSTRUCTION

SECTION 10 – PLANT EQUIPMENT

CHAPTER 10 6

TRAINING

ESC.: N/A

JOB: CD-335

REVISION 2

REVISION

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10.6 Tra g

The main objective of the training program is to prepare the personnel to be able to operate the process equipment in the plant. The different disciplines and all topics related to raw material and product Quality Control are included in the training program. The plant first operation is initially conducted under the experienced supervision of Tenova personnel with the plant personnel. This will allow the operators to develop their skills while obtaining a deeper knowledge and experience of the plant operation.

The program will include as main items of training the following arguments:

1. Plant Safety
2. Process Overview
3. Process Fundamental
4. Process Control System
5. Trouble Shooting
6. Interlock Systems
7. Plant Operations
8. Reactor
9. Process Gas Heater
10. Steam Generation System
11. CO_2 Removal Unit
12. DMDS Package
13. Refractory
14. EAF Feeding System Operations
15. EAF melting process
16. Material Handling
17. Dust Collection System
18. Other Plant Equipment

Dedicated meetings shall be held during the job development in order to agree on the detailed training program.

10.6.1 Training Personnel

The training organization for a typical training program includes:

- Training Manager
- Instructors

The training courses will be given in English by TENOVA instructors with extensive experience in technology transfer, in several training programs, plant commissioning, start-up and normal operation.

10.6.2 Training Resources

10.6.2.1 Training Material and Equipment

All training information is provided to trainees in written form. The Training Modules consist of books to be provided to the trainees at the beginning of the different training sessions. Each module is complemented with a workbook that permits the trainee to have a self-evaluation. Audiovisual equipment is used to support the training and for transmission of instructors' experiences and knowledge. After training sessions the trainees must study the content of their training modules prior to the evaluation of each unit. As part of the training program, it is foreseen to periodically have test for evaluation purposes of each trainee.

10.6.2.2 Facilities

The training facilities of TENOVA HYL have been implemented to provide adequate and comfortable conditions for the trainees. At Tenova HYL it will be possible to experience training on both the direct reduction and the EAF meting.

10.6.2.3 Training Program

For the training, the personnel are distributed into groups according to their job position as presented below. The training program has been divided into three phases:

- **Phase 1 – Basic Training**: General concepts are taught to the trainees, as well as Safety of Plant and personnel; this stage can be held at PURE FONTE LTÉE facilities, having duration of 5 to 15 days depending on each specific training group as indicated in Program Schedule I under Stage 1.
- **Phase 2 – Specific "hands on" training**: Under this stage trainees are involved in plant operation; they participate in the actual plant operation and maintenance routines following an assigned shift schedule. This stage has duration of 4 to 6 weeks as indicated in Program Schedule II. This stage is oriented to plant key personnel and is provided in advance of Stage 2.
- **Phase 3** – **On site specific training**: This training stage is oriented to provide trainees with the knowledge related to the plant they will operate and maintain. To be held in PURE FONTE LTÉE, having duration depending on the specific job position of trainees, of 3 to 6 weeks as indicated in Program Schedule I under Stage 2.

Duration and syllabus brake down to be covered during training are contained in Program Schedule I and II.

The training will be in English language. The training program will take place during regular working weeks of 40 hours per week, consisting of 5 training days per week with duration of 8 hours per day.

10.6.2.4 Maintenance and Operating Manuals

All training modules are based on technical information provided by equipment suppliers and all experience acquired by TENOVA. After training is provided all information contained in training modules is compiled within the Operating and Maintenance Manuals.

10.6.2.5 Technical Assistance

TENOVA has the capabilities and facilities to assist PURE FONTE LTÉE with Technology and Technical know-how transfer, and will deploy qualified personnel to achieve the required plant performance and learning curve achievement. In this regard, technical assistance services will be available for PURE FONTE LTÉE at any time during project execution and thereafter as required, based on fees to be agreed.

10.6.3 Training Groups and Schedules

10.6.3.1 Training Groups Distribution

Training group / Job position	Tra g a M x a Ca a a	Ca a a
O ra 1		
Plant manager	1	-
Operation superintendent	1	-
Process engineer	1	-
Maintenance superintendent	1	-
Quality Control superintendent	1	-
Subtotal	***5***	***-***
O ra 2		
Shift supervisor	4	-
Control room operator	7	-
Process assistant	1	-
Subtotal	***12***	***-***
O ra 3		
Field operator	-	11
Subtotal	***-***	***11***
O ra 4		
Material handling Chief	-	1
Material handling operator	-	7
Subtotal	***-***	***8***
M a a Ma a 1		
Planning engineer	1	-
Mechanical supervisor	4	-
Subtotal	***5***	***-***
M a a Ma a 2		
Mechanic	-	9
Welder	-	2
Spare parts man	-	1
Lubricator/back-up mechanic	-	1
Subtotal	***-***	***13***

Training group / Job position	Tra g a M x a	Ca a a	Ca a a
A ma Ma a			
Control engineer	1		-
Automation supervisor	1		-
Automation technician	5		-
Subtotal	***7***		-
E r a Ma a			
Electrical supervisor	-		1
Electrician	-		4
Subtotal	**-**		***5***
Q a C r			
Laboratory analyst	-		4
Subtotal	**-**		***4***
T a	**2**		**41**

Table 10.6-1.: Training group/job position information

10.6.3.2 Program Schedule

Ma a

Pr gram S I

CANADA	Stage 1			Stage 2					
Duration	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
Training Group									
Automation 7 trainees	Basic	Auto. Maint.		DR Plant Description			Control Description		
Electrical 5 trainees	Basic	Electr. Maint.		DR Plant Description			Control Description		
Mechanical 1 5 trainees				Basic	Mech. Maint.		DR Plant Description		
Mechanical 2 13 trainees				Basic	Mech. Maint.		DR Plant Description		

Table 10.6-2.: Maintenance Program Schedule I

Pr gram S II

M x						
Duration	Week 1	Week 2	Week 3	Week 4	Week 5	
Training Group						
Mechanical 1 5 trainees	Theory and Practice Energiron ZR plant					
Instruments 7 trainees	Theory and Practice Energiron ZR plant					

Table 10.6-3.: Maintenance Program Schedule II

Pr

Pr gram S I

CANADA	Stage 1			Stage 2					
Duration	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9
Training Group									
Operation 1 5 trainees	Basics on DR			Energiron Plant Description					
Operation 2 12 trainees	Basics on DR			Energiron Plant Description					Ctrl
Operation 3 11 trainees				Basic	Energiron Plant Description				
Operation 4 8 trainees				Basic	Energiron Plant Description				
Quality Control 4 Trainees			Basic	Energiron		Quality Control			

Table 10.6-4.: Production Program Schedule II

Pr gram S II

M x						
Duration	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Training Group						
Operation 1 5 trainees	Theory and Practice Energiron ZR plant					
Operation 2 12 trainees	Theory and Practice Energiron ZR plant					

Table 10.6-5.: Production Program Schedule II