TAMOIL RAFFINAZIONE S.p.A.

Ministero dell'Ambiente e della Tutela del Territorio e del Mare – Direzione Generale Valutazioni Ambientali
E.prot DVA - 2011 - 0002767 del 08/02/2011

Piazzale Caduti del Lavoro, 30 - 26100 Cremona - Casella Postale 136
Tel. 0372/5591 - Fax 0372/412567 - www.tamoil.it

EC/bf-019

RACCOMANDATA A.R.

Cremona, 28 Gennaio 2011

Spett.le
MINISTERO dell'AMBIENTE
e della Tutela del Territorio e del Mare
Direzione Generale per le Valutazioni Ambientali
Via Cristoforo Colombo, 44
00147 Roma

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE
RICEVUTO IL
07 FEB. 2011
DIREZIONE GENERALE PER LE VALUTAZIONI AMBIENTALI

Spett.le
ISPRA
Via Vitaliano Brancati, 48
00144 Roma

Spett.le
ASL della PROVINCIA di Cremona
U.O. Igiene e Prevenzione Ambienti di Vita
Via Belgiardino, 2
26100 Cremona

OGGETTO: **Autorizzazione Integrata Ambientale per l'esercizio di Tamoil Raffinazione S.p.A., decreto DVA-DEC-2010-0000368 del 06/07/2010 - Aggiornamento stato attuazione delle prescrizioni**

Facendo seguito al Decreto DVA-DEC-2010-0000368 del 6 Luglio 2010, Vi trasmettiamo una relazione tecnica di aggiornamento circa lo stato di attuazione delle prescrizioni, con i relativi allegati tecnici.

Siamo a disposizione per ogni chiarimento in merito e rimaniamo in attesa di Vostri eventuali commenti o indicazioni circa le diverse proposte e piani allegati alla predetta relazione.

Vi anticipiamo altresì che a breve seguirà una comunicazione della Società sui futuri assetti della Raffineria.

Rimanendo a disposizione per ogni ulteriori informazione, si inviano distinti saluti.

TAMOIL RAFFINAZIONE S.p.A.
Ing. Enrico Gilberti
Preposto alla Gestione della Raffineria
e relativi Oleodotti

All.: c/s

Allegato 1

Progetto per l’adeguamento alle migliori tecniche disponibili della Centrale Termoelettrica (fornito su supporto elettronico nel CD allegato)

Il presente Allegato è fornito in versione elettronica (CD allegato)

CLIENT	:	TAMOIL REFINERY
LOCATION	:	CREMONA, ITALY
PROJECT NAME	:	NEW COGENERATION PLANT IN CREMONA REFINERY
CONTRACT NO.	:	1-BD-0238A

ISSUED BY	:	A. BEFFANI
CHECKED BY	:	M. BOSATRA
APPROVED BY	:	R. DOMENICHINI

Date	Revised Pages	Issued by	Checked by	Approved by
August 2004	First Issue	L. Ottolina	S. Andreola	R. Domenichini
January 2005	General revision	L. Ottolina	S. Andreola	R. Domenichini
June 2005	Study update	A. Beffani	M. Bosatra	R. Domenichini

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SECTION A

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INTRODUCTION

A. INTRODUCTION

Purpose of this Feasibility Study is the technical/economical evaluation of a new cogeneration plant to be installed inside the TAMOIL Refinery in Cremona.
This report, issued in August 2004 and revised in January 2005, has now been consolidated in order to:

1. review plant configuration and equipment capacity to best fit the normal and upset operating cases with particular respect to refinery and district heating steam consumption;

2. design the district heating system inside refinery battery limits;

3. define the project design basis for instrumentation and control philosophy, together with preliminary control system architecture;

4. define the modification to the Refinery electrical system to set-up a new consistent configuration;

5. define the piping, electrical and instrument interconnecting and evaluate re-use of existing civil foundations;

6. define the overall project schedule;

7. update the investment cost estimate with the bids received from the possible suppliers of the main equipment.

The new Cogeneration Power Plant will substitute the existing Power Station that is composed by old and low efficient equipment.

The new Cogeneration Power Plant is mainly constituted by a Gas Turbine with steam injection for NOx reduction, a Heat Recovery Steam Generator (HRSG) supplementary fired, a Conventional Boiler and a Steam Turbine (backpressure type).

Both the Heat Recovery Steam Generator and the Conventional Boiler are equipped with Selective Catalytic Reduction systems (SCR) for NOx abatement.

The Plant will allow the production of electric power and steam flowrates required by the Refinery and by a Municipal District Heating Network, exporting to the national grid the electric power excess.

The possible future expansion of the new Cogeneration Power Plant is taken into account in the plant design; such an expansion consists on the installation of a second identical train (Gas Turbine and relevant Heat Recovery Steam Generator). In the future operating scenario the conventional boiler will be operated in cold standby mode.

The plant is designed to meet the existing and future requests in terms of power output and steam exports to the Refinery and to the District Heating system:

Electrical Power Output	:< 50	MWe max
HP steam export (at battery limits)	: 7	t/h
IP steam export (at battery limits)	: 88	t/h
LP steam export to Refinery (at battery limits)	: 25	t/h (max)
LP steam export to District Heating system (at battery limits)	: 40	MWt
BFW to Refinery users	: 50	t/h

SECTION B

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PLANT DESCRIPTION

1.0 BASES OF DESIGN

1.1 REFERENCE AMBIENT CONDITIONS AND COGENERATION POWER PLANT BATTERY LIMITS

REFERENCE AMBIENT CONDITIONS:

Temperature	:	15	°C
Pressure	:	1013	mbar(a)
Relative humidity	:	75	%
Minimum Design Temperature	:	- 15	°C
Maximum Design Temperature	:	41	°C

UTILITIES AVAILABLE AT PLANT BATTERY LIMITS

Natural Gas:

Natural gas is derived from the SNAM natural gas network. Natural Gas conditions at battery limits shall be as follows:

Pressure	:	18 min ÷20 nominal barg
Temperature	:	0÷25 °C

Composition (Typical):				Reference	min	max
Methane	CH_4	% vol	:	92.597	70.1	99.7
Ethane	C_2H_6	% vol	:	3.455	0.06	8.99
Propane	C_3H_8	% vol	:	0.854	0.01	1.55
Iso-Butane	C_4H_{10}	% vol	:	0.127	0.01	0.21
Normal-Butane	C_4H_{10}	% vol	:	0.185	0.00	0.25
Nitrogen	N_2	% vol	:	2.772	0.11	14.83
Total dry		% vol	:	100		
Water	H_2O	% vol	:	0.015 max.		
Low Heating Value			:	47510 kJ/kg		

Fuel oil (@ storage tank):

Pressure	:	atm	barg
Temperature	:	65	°C
Low heating value	:	41232	kJ/kg
Density	:	949	kg/m^3
Sulfur	:	≤ 0.3	% weight
Nitrogen	:	0.3	% weight

Refinery fuel gas:

		Pressure	Temperature
Minimum	:	3.5 barg	38 °C
Normal	:	3.5 barg	-------
Mechanical design	:	8.5 barg	70 °C

Average composition:

H_2	:	72.91	% vol
CH_4	:	10.91	% vol
C_2H_4	:	0.33	% vol
C_2H_6	:	7.03	% vol
H_2S	:	0.00	% vol
C_3H_6	:	0.36	% vol
C_3H_8	:	5.46	% vol
C_4H_8	:	0.12	% vol
i-C_4H_{10}	:	1.61	% vol
n-C_4H_{10}	:	1.03	% vol
C_5H_{12}	:	0.22	% vol
C_6H_{14}	:	0.03	% vol

Low Hating Value	:	54817	kJ/kg

LPG (@ storage tank):

Pressure	:	8	barg
Temperature	:	40	°C

Average composition:

C_2H_6	:	2.60	% vol
C_3H_6	:	2.11	% vol
C_3H_8	:	33.81	% vol
C_4H_8	:	4.55	% vol
i-C_4H_{10}	:	15.87	% vol
n-C_4H_{10}	:	37.92	% vol
C_5H_{12}	:	3.15	

Low Heating Value	:	45967 kJ/kg

Cooling water:

		Pressure	Temperature
Cooling water supply			
Minimum	:	4.0 barg	-------
Normal	:	4.0 barg	32 °C
Mechanical design	:	5.0 barg	66 °C
Cooling water return			
Minimum	:	2.0 barg	-------
Normal	:	2.0 barg	38 °C
Maximum	:	----------	38 °C

Compressed air:

		Pressure	Temperature
Plant air			
Minimum	:	5.0 barg	-------
Normal	:	6.0 barg	38 °C
Mechanical design	:	10.5 barg	70 °C
Instrument air			
Minimum	:	3.0 barg	-------
Normal	:	3.5 barg	38 °C
Mechanical design	:	14.7 barg	70 °C

Service water (well water):

		Pressure	Temperature
Minimum	:	3.0 barg	-------
Normal	:	5.0 barg	30 °C
Mechanical design	:	10 barg	50 °C

Steam condensate return:

		Pressure	Temperature
Normal	:	4.0 barg	150 °C
Mechanical design	:	6.0 barg	225 °C

UTILITIES MADE AVAILABLE AT PLANT BATTERY LIMITS:

HP Steam:			
Operating pressure	:	43	barg
Operating temperature	:	440	°C
Steam quality	:	Superheated	
IP Steam:			
Operating pressure	:	11	barg
Operating temperature	:	220	°C
Steam quality	:	Superheated	
LP Steam:			
Operating pressure	:	3.5	barg
Operating temperature	:	148	°C
Steam quality	:	Saturated	
LLP Steam:			
Operating pressure	:	1.2	barg
Operating temperature	:	120	°C
Steam quality	:	Saturated	
HP BFW to users:			
Operating pressure	:	44	barg
Operating temperature	:	105	°C
MP BFW to users:			
Operating pressure	:	12	barg
Operating temperature	:	105	°C
Electrical power:			
Voltage	:	132	kV
		15	(future 20 kV)
		6	kV
		0.4	kV
Frequency	:	50	Hz

1.2 PROJECT DESIGN BASES

The new Cogeneration Power Plant is mainly constituted by a Gas Turbine with steam injection for NOx reduction, a Heat Recovery Steam Generator (HRSG) supplementary fired (130 t/h HP steam capacity), a Conventional Boiler (130 t/h HP steam capacity) and a Steam Turbine (backpressure type).
Both the Heat Recovery Steam Generator and the Conventional Boiler are equipped with Selective Catalytic Reduction systems (SCR) for NOx abatement.

The plant shall be designed to operate for 8720 h/y, maintaining the steam export to Refinery headers between a minimum value of 85 t/h and the maximum value of 120 t/h with District Heating System not in operation.
For the expected operating modes reference shall be made to Section B, paragraph 2.0.

The LP steam export to District Heating system will be in operation for about 3000 h/y, mainly during winter period.

FUELS

The available fuels inside the Refinery to be used in the new Cogeneration Power Plant and the relevant available quantities are summarized below:

Fuel type	**Available quantity (t/y)**
Natural Gas (from SNAM network):	Unlimited
Refinery Fuel Gas:	15000
Refinery Fuel Oil:	Unlimited
LPG:	100000

The Gas Turbine will be fed by Natural Gas, LPG, or any mixture of the two fuels.
The postfiring system will be fed by fuel gas and/or fuel oil.
The conventional boiler will burn the remaining available fuel gas and the quantity of fuel oil necessary to produce the desired steam production.

ELECTRIC POWER

The plant shall be designed to produce a power output lower than 50 MW.
Most electric power production will be used to satisfy the Refinery electric consumptions; the electric power excess will be delivered to the National Grid.

STEAM AND BFW EXPORTS

The plant shall be able to export the following steam and BFW quantities:

▪ HP steam:	7	t/h	(43 barg, 440 °C)
▪ MP steam:	88	t/h	(11 barg, 220 °C)
▪ LP steam:			
- to Refinery	25	t/h	(3.5 barg, 148 °C)
- to District Heating system	112	t/h	(3.5 barg, 148 °C)
▪ HP BFW:	18	t/h	(44 barg, 105 °C)
▪ MP BFW:	32	t/h	(12 barg, 105°C)

During *summer* time consumptions will be reduced as follows:

▪ MP steam:	68	t/h
▪ LP steam:		
- to District Heating system	0	t/h

INTERNAL STEAM CONSUMPTION OF THE COGENERATION PLANT

The internal steam consumptions of the Cogeneration Power plant are mainly due to the following purposes:

- steam injection to gas turbine for NOx reduction;
- degassing steam;
- fuel oil heater:
- LPG vaporizer and heater.

In addition, the Cogeneration Plant will deliver MP steam to the steam turbine of the new air compressor (18 t/h max). This consumption is not taken into account in the the Heat&Material Balances, since the air compressor is normally driven by electric motor.

ENVIRONMENTAL IMPACT

The gaseous emissions (NO_x, SO_x, CO or particulate) from the new cogeneration power plant shall be minimized within the technological constraints imposed by the available fuels.

2.0 PROCESS DESCRIPTION

The following description refers to the process flow diagrams attached to section G.

The new cogeneration power plant is mainly constituted of a Gas Turbine, a Heat Recovery Steam Generator (HRSG) supplementary fired, a Conventional Boiler and a Steam Turbine - backpressure type.

The possible future expansion of the new cogeneration plant is taken into account in the plant design; such an expansion consists on the installation of a second identical train (Gas Turbine and relevant Heat Recovery Steam Generator). In the future operating scenario the conventional boiler will be operated in cold standby mode.

GAS TURBINE AND HRSG

The gas turbine can be fed by the following fuels:

- 100% natural gas;
- 100% vaporized LPG;
- any mixture of natural gas and LPG.

Natural gas from SNAM network is sent directly to the gas turbine burners. LPG is pressurized up to the pressure required by the gas turbine burners, vaporized and superheated.

The gas turbine fuel is generally LPG produced by the Refinery up to its maximum availability, integrated if necessary by natural gas from SNAM network.
Vaporized LPG and natural gas are mixed in the Mixing Drum D-1501 and fed to the gas turbine. The resulting fuel gas is also filtered in F-1501 before feeding the gas turbine.

The HRSG post combustion system is fed by the Refinery fuel gas and/or by fuel oil, depending on fuels availability and SO_X emission limits. Fuel oil is pumped to the HRSG by the pump P-1601 A/B (one in operation, one spare), preheated in the exchanger E-1601 A/B and filtered in the fuel oil filter F-1602.
Exhaust gases from the gas turbine are discharged to the HRSG, where their temperature is increased by means of the post combustion in line burners.
HRSG operation in fresh air when the gas turbine is under maintenance or shutdown is allowed after gas turbine isolation by means of the guillotine installed on the gas turbine outlet duct.
In this case ambient air is supplied to the HRSG by means of the air fan B-201.
An automatic switchover from combined cycle mode to fresh air mode is not provided.

Heat recovery on exhaust gases is done by generating and superheating steam at high pressure (60 bar g at HRSG B.L.).
The HRSG is constituted of the following coils:

- HP superheater (1st section)
- HP superheater (2nd section)
- HP evaporator
- HP economizer
- LP steam drum equipped with degassing section

Demineralized makeup water and condensate return from Refinery are sent to the integrated deaerator (D-202). Water is recirculated in the LP generator E-205 by means of the LP circulation pump P-202 A/B. In case the LP steam self-produced is not enough to cover the deaerator requirements, the excess steam is taken from the LP steam header.
On the contrary should the LP steam production be in excess, the deaerator pressure is increased up to reach a balance.
Part of the boiler feed water from D-202 at a temperature of about 105 °C is pumped by means of pump P-204 to the Refinery MP and HP BFW users.
Boiler feed water is mainly pumped to the HP economizer E-204 by means of BFW pumps (P-201 A/B, one in operation, one spare).
BFW is then delivered to the HP steam drum where saturated HP steam is generated.
The water recirculation is ensured in the HP evaporator coils by the HP circulation pump P-203 A/B.
Level in the HP steam drum is maintained by adjusting the position of the relevant BFW control valves through a three-element logic: steam drum level, steam and feed water flowrates.
These elements, suitably combined, define the set point for boiler feed water flowrate, directly controlled by actuating the BFW control valve.
The saturated steam generated in the HP steam drum is sent to the HP superheating coils E-201, E-202. The desuperheater DS-201, located between the two sections of the superheater, controls the HP steam temperature at HRSG outlet.
HP steam at HRSG outlet is sent to the cogeneration plant HP steam header, except for the fraction necessary for the gas turbine NOx emission reduction that is laminated and desuperheated before GT feeding.

BFW and boiler water quality is controlled by injection of chemicals: oxygen scavenger and corrosion inhibitor injection are provided to protect condensate and boiler feed water lines, while phosphate injection is provided on HP steam drum to avoid scaling.

The blowdown drums (continuous/discontinuous, common to the two trains) are also installed to allow quality control of boiler water. The continuous blowdown is fed from the HP steam drum to the continuous blowdown drum.

Steam fraction from continuous blowdown flashing is recovered to the LP steam system while the remaining liquid fraction is cooled down via machinery cooling water and sent to the Intermittent Blow Down Drum (D-204), where all the other discontinuous blowdowns are discharged as well. Steam fraction from blow down flashing inside the Intermittent Blowdown Drum is discharged to the atmosphere through the relevant vent line while the remaining liquid fraction is sent to the waste water treatment system through the drain line, after mixing with service water, for cooling purposes.

SCR DeNOx will be provided in suitable position between the coils. The system will include the catalyst and injection device but not the ammonia storage system, that will be in common with conventional boiler.
As this system is sensitive to sulphur content in the flue gas, when burning fuel oil undesired reaction may occur leading to the formation of ammonium bisuplhate and the consequent fouling of the downstream coils. Therefore the operation with fuel oil shall be carefully controlled and possibly minimized.

CONVENTIONAL BOILER UNIT

The conventional boiler can be fed either with Refinery fuel gas or with fuel oil, depending on fuels availability and SO_X emission limits.
Fuel oil is pumped to the conventional boiler by the same system described above and composed by pump P-1601 A/B, the exchanger in the exchanger E-1601 A/B and the filter F-1602.
Ambient air is supplied to the boiler by means of the air fan B-401 A/B and preheated in the Ljungstrom exchanger.
Demineralized makeup water and condensate return from Refinery are sent to the deaerator (DA-401). The steam necessary to produce BFW is derived from the LP steam header.
Part of the boiler feed water from the deaerator at a temperature of about 145 °C can be pumped (in case of CCU unit shutdown or maintenance) by means of pump P-402 A/B to the Refinery MP and HP BFW users.
Boiler feed water is also pumped to the conventional boiler steam generator (SG-401) by means of the BFW pump P-401 A/B.

The superheated steam produced by the conventional boiler is sent to the cogeneration plant HP steam header.
SCR DeNOx will be provided in suitable position between the coils. The system will include the catalyst and injection device but not the ammonia storage system, that will be in common with HRSG.
As this system is sensitive to sulphur content in the flue gas, when burning fuel oil undesired reaction may occur leading to the formation of ammonium bisuplhate and the consequent fouling of the downstream coils. Therefore the operation with fuel oil shall be carefully controlled and possibly minimized.

STEAM EXPORT AND POWER GENERATION

Most part of the HP steam is sent to the HP section steam turbine (backpressure type) in order to generate electric power, and then discharged in the Refinery LP header. A controlled extraction from the steam turbine is provided to feed the MP header. Let down and desuperheating stations are provided to feed the Refinery HP header and to back-up if necessary the MP and LP headers.
LP steam for District Heating purposes is derived from LP steam header.

AUXILIARY UNITS

The following auxiliary units are part of the new Cogeneration Power Plant

- Demineralized water system;
- Compressed air system;
- Natural gas and LPG system;
- Refinery Fuel gas and Fuel oil system;
- Ammonia Storage and Handling system;
- District Heating system.

The other utilities necessary for the Plant operation (i.e. compressed air, service water) are imported directly from the Refinery.

UNIT 1200 - DEMINERALIZED WATER SYSTEM

Demi water package shall be designed to provide the water make up to the Cogeneration Power Plant in order to cover the Plant internal consumption and to integrate the portion of exported steam and BFW that is not returned to the Plant as condensate.

The service water is fed to the Demi Water Package, based on ion exchange resins technology. Demi Water is collected into the existing Demi Water Tank and pumped directly to Users.

Unit 1400 – Compressed Air system

A completely new compressed air system shall be designed to cover all the compressed air demand from the new power plant and existing refinery users.
It will be located within the new power plant plot area.
Two new air compressors K-1401 A/B, each one having a design capacity of 3500 Nm^3/h (wet), will be provided. Due to the critical service of instrument air, one of the air compressor shall be steam turbine driven, the other electric motor driven.
An air receiver (D-1401) is installed downstream the air compressor. The total capacity of the air receiver will be adequate to provide the normal compressed air demand for a period of 10 minutes with a decrease of pressure in the receiver (3,5 bar) down to the minimum allowable pressure in the system, in order to handle the automatic start-up for the spare compressor and the safe shutdown of the units in the remote case of failure of both compressors.
A new Air Dryer Package DR-1401 will provide dry air to be used as instrument and plant air. The package will treat 100% of the total instrument air dry demand, having a dew point of -30 °C@ 7,5 barg.
A new drum (D-1402) will be dedicated to the new cogeneration plant to supply air for 10 minutes in case of compressor failure.

Unit 1500 – Natural gas and LPG system

This unit shall treat the fuels to gas turbine in order to be suitable for the burning system.
The natural gas from SNAM network is measured in the metering station before mixing with vaporized LPG in the dedicated mixing drum.
Liquid LPG is pumped by means of LPG transfer pumps P- 1502 A/B (one operating, one spare) from existing LPG storage tank through LPG Coalescer (F-1501) to remove possible water and sodium hydroxide content. Before being sent to the LPG Feed Drum, LPG is measured in the LPG Metering Station (PK-1502). LPG from the feed drum is then pumped to LPG vaporizer V-1501 by LPG Feed Pump P-1501 A/B (one operating and one spare); finally it is superheated in the LPG Heater E-1501 and sent to the mixing drum.
The LPG and natural gas mixture is then filtered and fed to the gas turbine.

Unit 1600 – Refinery Gas and Fuel Oil system

The refinery gas and fuel oil are fed to the conventional boiler and to the postfiring burners of the HRSG.
The Refinery fuel gas first enters into a knock out drum (D-1601) for droplets separation and then fed to the Users.
The new closed loop of Fuel Oil is designed on the base of the requirements of the new Power Plant. In order to comply with the environmental emission limits, the fuel oil type is a low sulphur fuel oil with a maximum sulphur content of 0,3 wt%.
The fuel oil is supplied from existing storage tank and pumped by means of Fuel Oil Pumps (P-1601 A/B) to the new Fuel Oil Heaters E-1601 A/B and the new Fuel Oil Filter (F-1601) before the distribution to the header.
The heaters will warm the fuel oil up to a suitable temperature to have a low viscosity as required by burners.
The strainers (one operating and one spare) will remove the fuel oil from any impurities which could plug the postfiring and conventional boiler burners.
Two dedicated headers are foreseen: one supply header and one return header.
The pressure control valve will keep content the fuel oil pressure at burners and protect the pumps, ensuring a minimum flow.

Unit 1700 – Ammonia Storage and Handling

This unit is designed to store and handle water-ammonia solution that shall be injected into SCR De-NOx systems (X-201, X-401) by means of dosing pumps (P-1701 A/B).
The transportation truck discharge the solution by unloading pumps P-1702A/B to the storage drum (D-1701), whose capacity is 35 m^3.
A bubbler tank (D-1702) on top of the storage drum collects ammonia vapor and quenches it with demi water.
All these equipment are located inside a basin, provided with sump pump to evacuate the solution accidentally poured at ground.

Unit 2000 – District Heating System

This unit is composed by two heat exchangers (E-2001A/B), where LP steam heats the water from 65 °C up to 120 °C. Each heat exchanger is sized to provide 40 MW thermal power, that can operate in paraller to a maximum of 70 MW.
LP condensate is sent to a flash drum (D-2001) to recover LLP steam, while the remaining condensate is sent back to thermal cycle by means of P-2001A/B.
A dedicated expansion drum (D-2002) allows volume variations on water circuit.

Cold water is received from the station outside refinery battery limit, where are located the circulation pumps (supplied by others). Hot water is returned to the same station.

OPERATING MODES

The new Cogeneration Plant will be able to operate in the modes described below.

A. NORMAL OPERATION

The normal operation of the new Cogeneration Power Plant corresponds to the following operating scenarios.

A.1 DISTRICT HEATING NOT *IN OPERATION*

- Gas turbine operating conditio n : full load fed with LPG and/or natural gas
- HRSG steam production : 83 t/h
- Conventional boiler steam production : 48 t/h, adequate to cover the remaining Refinery steam demand and the internal steam consumptions;
- Total steam export to Refinery : 120 t/h
- District Heating System duty : 0 MWt
- BFW export to Refinery : 50 t/h
- Steam turbine load : 40 %

The gas turbine is operated at 100 % load with the relevant HRSG post combustion system preferentially fed by refinery fuel gas.
The conventional boiler is fed by means of the remaining available quantity of refinery fuel gas and by means of fuel oil.

A.2 DISTRICT HEATING IN OPERATION

- Gas turbine operating condition : full load fed with LPG and/or natural gas;
- HRSG steam production : 130 t/h
- Conventional boiler steam production : 77 t/h, adequate to cover the remaining Refinery steam demand and the internal steam consumptions;
- Total steam export to Refinery : 120 t/h

- District Heating System duty : 40 MWt
- BFW export to Refinery : 50 t/h
- Steam turbine load : 100 %

The gas turbine is operated at 100 % load with the relevant HRSG post combustion system preferentially fed by refinery fuel gas.
The conventional boiler is fed by means of the remaining available quantity of refinery fuel gas and by means of fuel oil.

A.3 DISTRICT HEATING IN PEAK OPERATION

- Gas turbine operating condition : full load fed with LPG and/or natural gas;
- HRSG steam production : 130 t/h
- Conventional boiler steam production : 130 t/h, adequate to cover the remaining Refinery steam demand and the internal steam consumptions;
- Total steam export to Refinery : 120 t/h
- District Heating System duty : 66 MWt
- BFW export to Refinery : 50 t/h
- Steam turbine load : 100 %

The gas turbine is operated at 100 % load with the relevant HRSG post combustion system preferentially fed by refinery fuel gas.
The conventional boiler is fed by the remaining available quantity of refinery fuel gas and by fuel oil.

B. HRSG OUT OF OPERATION

The new Cogeneration Plant shall assure 85 t/h steam production during HRSG out of operation. This steam production is adequate to cover the essential Refinery steam consumptions. A steam shedding procedure shall be implemented.
The operating asset in this scenario is the following:

- Gas turbine operating condition : out of service;
- HRSG steam production : 0 t/h
- Conventional boiler steam production : 130 t/h;
- Total steam export to Refinery : 85 t/h
- District Heating Duty : 19 MWt
- Steam turbine load : ~ 40 %

In case of gas turbine failure with consequent loss of steam generation from the HRSG, the conventional boiler covers the minimum Refinery steam requirements and the Cogeneration Plant internal steam consumption and the District Heating system at reduced load.

Being the HP steam generation equal to 62 barg, the steam header hold up assures that during transient period, the HP steam pressure is maintained higher than 43 barg, as per Refinery requirement, during the steam shedding procedure.

After completing the gas turbine shutdown procedure, the HRSG can be purged and isolated with all the necessary safety and operating devices (guillotines) and the fresh air operating mode can be started.
The HRSG steam production in fresh air mode can reach 80 t/h. Considering the production of 130 t/h from the conventional boiler all refinery consumption (120 t/h) and district heating need (up to 40 MWt) will be satisfied.

C. CONVENTIONAL BOILER OUT OF OPERATION

The new Cogeneration Plant shall assure 85 t/h steam production during Conventional Boiler out of operation. This steam production is adequate to cover the essential Refinery steam consumptions. A steam shedding procedure shall be implemented.

The operating asset in this scenario is the following:

- Gas turbine operating condition : full load fed with LPG and/or natural gas;
- HRSG steam production : 130 t/h;
- Conventional boiler steam production : 0 t/h;
- Total steam export to Refinery : 85 t/h
- District Heating Duty : 19 MWt
- Steam turbine load : ~ 40 %

In case of conventional boiler failure the postfiring load can be increased in order to cover the minimum Refinery steam requirements, the Cogeneration Plant internal steam consumption and the District Heating system at reduced load.

Being the HP steam generation equal to 62 barg, the steam header hold up assures that during transient period, the HP steam pressure is maintained higher than 43 barg, as per Refinery requirement, during the steam shedding procedure.

3.0 EQUIPMENT LIST

The list of the main equipment that will be part of the new Cogeneration Power Plant is attached hereinafter.

4.0 MAIN EQUIPMENT FUNCTIONAL SPECIFICATIONS

In order to have a more accurate estimate of investment cost, the functional specifications (attached hereafter) for the following main equipment have been prepared:

- Gas Turbine
- Steam Turbine
- Heat Recovery Steam Generator
- Conventional Boiler

Relevant vendor bids are attached in section J.

5.0 PLANT AREA

The available area for the new Cogeneration Power Plant is located in the south side of the Tamoil Refinery in Cremona, near the area of the existing CTE.
The total area of the Plant cover a surface of 6.600 mq (52,5x125 mt), including the future installation of one gas turbine/HRSG.
The following major equipment/facilities are located inside the perimeter of the Plant:

- one outdoor gas turbine;
- one indoor steam turbine;
- one outdoor heat recovery steam generator;
- one outdoor conventional boiler;
- two outdoor step-up transformers;
- gas compressor package;
- control room;
- electrical room.

The plot plan studied optimizes the location of the equipment in the available area, considering the future expansion of the Plant. Service roads and maintenance areas will be provided.

As for piping interconnecting, tie-in points and routing have been defined.

Relevant drawings are attached to section G.

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	PROJ. NAME	New Cogeneration Plant in Cremona refinery	ISSUED BY	LO	LO	AB		
			CHECKED BY	RD	SA	AP		
	CONTRACT N.		APPROVED BY	RD	RD	RD		

EQUIPMENT LIST
Unit 100 - Gas Turbine

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES							
	PK- 101	**Gas Turbine and Generator Package**							*Including:* Gas Turbine equipped with: - DLN burners - Inlet Guide Vanes Air intake system Lube oil system Hydraulic/pneumatic control system Starting system Fire fighting system Fuel gas system Compressor cleaning system Exhaust gas duct and expansion joint Drainage system Electrical generator and relevant auxiliaries
		GAS TURBINES							
<2>	GT- 101	Gas Turbine		27 MWe					Included in PK-101
		HEAT EXCHANGERS							
		DRUMS							

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	CONTRACT N.		APPROVED BY	RD	RD	RD		

EQUIPMENT LIST
Unit 200 - Heat Recovery Steam Generator

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES							
	PK- 201	**Heat Recovery Steam Generator Packa**	Vertical Forc. circ. Sup. Fired						*Including:* Duct Burners HP steam drum LP steam drum with integrated deaerator HP superheater 2nd section HP superheater 1st section HP evaporator HP economizer LP evaporator HP attemperator Silencer Air Blower Stack SCR deNOx system
	PK- 202	**Phosphates Injection Package**			2.2				*Including:* Phosphates storage drum Phosphates dosing pumps

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	PROJ. NAM	New Cogeneration Plant in Cremona refinery	ISSUED BY	LO	LO	AB		
			CHECKED BY	RD	SA	AP		
	CONTRACT N.		APPROVED BY	RD	RD	RD		

EQUIPMENT LIST
Unit 200 - Heat Recovery Steam Generator

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES (continued)							
	PK- 203	**Oxygen Scavenger Injection Package**			2.2				*Including:* Oxygen scavenger dosing pumps and storag drum
	PK- 204	**Corrosion Inhibitor Injection Package**			2.2				*Including:* Corrosion inhibitor dosing pumps and storage drum
	PK- 205	**Fluids Sampling Package**							
	PK- 206	**Continuous emission monitoring system**							Monitoring of NOx, SOx, CO, O2, H2O
		DRUMS	**Diameter, mm x TT, mm**						
	D- 201	HP steam drum	Horizontal						Included in PK-201
	D- 202	LP steam drum	Horizontal						Included in PK-201 (Equipped with degassing section).
	D- 203	**Continuous Blowdown Drum**	Vertical	1000 x 2000		5.5	160	CS	
	D- 204	**Intermittent Blowdown Drum**	Vertical	1500 x 3500		1.8	100	CS	

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	CONTRACT N.		APPROVED BY	RD	RD	RD		

EQUIPMENT LIST
Unit 200 - Heat Recovery Steam Generator

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		DESUPERHEATERS							
	DS- 201	HP attemperator	Water spray						Included in PK-201
		EXCHANGERS		**Duty, kWt**		**Hot/Cold Side**	**Hot/Cold Side**	**Hot/Cold Side**	
	E- 201	HP superheater 2nd section	Coil						Included in PK-201
	E- 202	HP superheater 1st section	Coil						Included in PK-201
	E- 203	HP evaporator	Coil						Included in PK-201
	E- 204	HP economizer	Coil						Included in PK-201
	E- 205	LP evaporator	Coil						Included in PK-201
	E- 206	**Blowdown Cooler**	Plate	100		5.5 / 5.0	160 / 66	CS	

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	CONTRACT N.		APPROVED BY	RD	RD	RD		

EQUIPMENT LIST

Unit 200 - Heat Recovery Steam Generator

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PUMPS		**Flow x Head**					
	P- 201 A/B	**HP Boiler Feed Water Pump**	Centrifugal	100x815	280	96	135	Casing: CS Impeller: 12% Cr	One spare; electrical motor
	P- 202 A/B	**LP Recirculation Pump**	Centrifugal		11				One spare; electrical motor
	P- 203 A/B	**HP Recirculation Pump**	Centrifugal		110				One spare; electrical motor
	P- 204 A/B	**BFW Pump to users**	Centrifugal	INLET: 62 m3/h IP: 40 m3h x 268 m HP: 22 m3h x 653 m	90	35 80	135 135	Casing: CS Impeller: 12% Cr	Electric motor
		MISCELLANEA							
	SL- 201	Silencer							Included in PK-201
	STK- 201	Stack							Included in PK-201
	B- 201	Air Blower							Included in PK-201
<2>	X - 201	SCR DeNOx package							Included in PK-201

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EQUIPMENT LIST
Unit 300 - Steam Turbine

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES							
	PK- 301	**HP Steam Turbine and Generator Package**							*Including:* Steam turbine Lube oil system Cooling system Idraulic control system Drainage system Seals system Gland steam condenser Electrical generator and relevant auxiliaries
		STEAM TURBINES							
	ST- 301	Steam turbine	backpressure type	23					Included in PK-301

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EQUIPMENT LIST
Unit 300 - Steam Turbine

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		MISCELLANEA							
	X- 301	HP let down and desuperheating station							
	X- 302	MP let down and desuperheating station							
	X- 303	LP let down and desuperheating station							
	X- 304	MP extr. pressure and temperature control							
	X- 305	LP extr. pressure and temperature control							

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EQUIPMENT LIST
Unit 400 - Conventional Boiler System

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES							
	PK-401	**Conventional Boiler**		130 t/h 61 barg 460 °C					*Including:* Air Blower Deaerator BFW Pump Steam SCR deNOx system
	PK-403	**Continuous emission monitoring system**							Monitoring of NOx, SOx, CO, O2, H2O
		AIR BLOWERS							
	B-401 A/B	Air Blower			400				included in PK - 401
		PUMPS		**Flow,m3/hxHead,m**					
	P-401 A/B	Steam Generator BFW Pump	Centrifugal	150x792	400	92	175	Casing: CS Impeller: 12% Cr	included in PK - 401
	P-402 A/B	BFW Pump to users	Centrifugal	INLET: 62 m3/h P: 40 m3h x 236 m HP: 22 m3h x 622m	90	35 78	175 175	Casing: CS Impeller: 12% Cr	Normally not in operation
		DRUMS							
	DA-401	Deaerator							included in PK - 401
		BOILERS							
	SG-401	Steam Generator							included in PK - 401
		MISCELLANEA							
<2>	X - 401	SCR DeNOx package							Included in PK-401

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EQUIPMENT LIST
Unit 1200 - Demineralized Water

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES							
	PK- 1201	**Demineralized Water Package**	Ions exchang	120 m3/h net each					Two lines 120 m3/h each, one spare *Including:* Neutralized blowdown pumps Decarbonator pumps HCl storage tank HCl dosing pumps NaOH storage tank NaOH dosing pumps Cationic exchangers Decarbonator Anionic exchangers Mixed bed exchangers Neutralization tank
		PUMPS		**Flow,m3/hxHead,m**					
	P- 1201 A/B	**Demineralized Water Make Up Pump**	Centrifugal	135 x 50	30	7.0	70	Casing : CS + 6mm CA Impeller: 12% Cr	One spare; electric motors

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EQUIPMENT LIST
Unit 1400 - Compressed Air

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES		**Flow Nm3/h**					
<2>	**PK-1401**	**Compressed Air Package**		3500					Includes: K-1401 A K-1401 B DR-1401
		COMPRESSORS		**Flow Nm3/h**					
<2>	K-1401 A	Air Compressor	Rotary	3500	530				included in PK-1401
<2>	K-1401 B	Air Compressor	Rotary	3500	-				driven by steam turbine - included In PK-1401
		DRUMS		**Diameter, mm x TT, mm**					
<2>	D-1401	Air Receiver	Vertical	3300 x 8500		10	70		
<2>	D-1402	Instrument Air Drum	Vertical	1300 x 3500		10	70		
<2>	DR-1401	Air Drier				10	70		included in PK-1401

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EQUIPMENT LIST
Unit 1500 - Natural Gas and LPG

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES		**Flow**					
	PK- 1501	**Natural Gas Metering Station**		11300 Nm3/h					
<2>	**PK- 1502**	**LPG Metering Station**		15 m3/h					
		COMPRESSORS		**Flow Nm3/h**					
		DRUMS	**Diameter, mm x TT, mm**						
	D-1501	Mixing Drum	Vertical	1000 x 4000		25	130		
	D-1502	Final Separator	Vertical	1000 x 4000		25	130		
	D-1503	LPG feed drum	Vertical	1200 x 4000		11	-20 / 70		
	V-1501	LPG Vaporizer		Duty: 825 kWt		25	130		
		EXCHANGERS							
	E-1501	LPG heater		Duty:255 kWt		25	250		

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	CONTRACT N.		APPROVED BY	RD	RD	RD		

EQUIPMENT LIST
Unit 1500 - Natural Gas and LPG

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		FILTERS	Diameter, mm x TT, mm						
<2>	F-1501	LPG Filter Coalescer		600 x 3000		25	250		
		PUMPS	Flow,m3/h x Head,m						
	P-1501 A/B	LPG Feed Pump	Centrifugal	14 x 265	11	25	70		One spare; electric motors
<2>	P-1502 A/B	LPG Transfer Pump	Centrifugal	14 x 50	2.2	7	70		One spare; electric motors

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EQUIPMENT LIST
Unit 1600 - Refinery Fuel Gas and Fuel Oil

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES							
		COMPRESSORS							
		DRUMS	**Diameter, mm x TT, mm**						
	D-1601	Refinery Fuel Gas K.O. Drum	Vertical	1500 x 3000		8.5	70		
		EXCHANGERS		**Duty, kWt**					
	E-1601 A/B	Fuel Oil Heaters		350		12.0	130		
		FILTERS							
	F-1601	Fuel Oil Filter							
		PUMPS	**Flow,kg/hxHead,bar**						
	P- 1601 A/B	Fuel Oil Pump	Centrifugal	11700 x 10	5.5	12.0	100		One spare; electric motors

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EQUIPMENT LIST

Unit 1700 - Water Ammonia Solution Storage & Handling

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES							
		DRUMS		**Diameter, mm x TT, mm**					
<2>	D-1701	Ammonia Solution Storage	Vertical	2700 x 6500		3.0	100		25% water ammonia solution
<2>	D-1702	Bubbler Tank		400 x 1200		ATM	100		
		EXCHANGERS		**Duty, kWt**					
		PUMPS		**Flow, m3/h x Head, bar**					
<2>	P-1701 A/B	Ammonia Solution Dosing Pumps		0,055 x 5	1				two running & one spare; electric motors
<2>	P-1702 A/B	Unloading Pumps	Centrifugal	30 x 2,6					
<2>	P-1703	Sump Pump	Centrifugal	10 x 2					

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EQUIPMENT LIST

Unit 2000 - District Heating

SYSTEM	ITEM	DESCRIPTION	TYPE	SIZE	Motor rating [kW]	P des [barg]	T des [°C]	Materials	Remarks
		PACKAGES							
		DRUMS	**Diameter, mm x TT, mm**						
<2>	D-2001	D.H. Condensate Flash Drum	Vertical	2600 x 4000		3.0	170		
<2>	D-2002	D.H. Water Expansion Drum	Vertical	2000 x 4300		15.5	150		
		EXCHANGERS	**Duty, MWt x Surface, m2**						
<2>	E-2001 A/B	D.H. Exchanger	S&T	40 x 730		5 (tube 15.5)	180 (tube 150)		
		PUMPS	**Flow,kg/hxHead,bar**						
<2>	P-2001 A/B	D.H. Condensate Return Pump	Centrifugal	69000 x 7	30	10.0	150		One spare; electric motors

CLIENT: TAMOIL REFINERY
LOCATION : CREMONA, ITALY
PROJECT NAME: NEW COGENERATION PLANT IN CREMONA
CONTRACT NO: 1-BD-0238A
UNIT NO: 100
EQUIPMENT NAME: GAS TURBINE AND GENERATOR PACKAGE
EQUIPMENT TAG NO: PK-101

ISSUED BY : A. PALUCCI
CHECKED BY : A. PALUCCI
APPROVED BY : R. DOMENICHINI

Date	Revised Pages	Issued by	Checked by	Approved by
May, 2005	First Issue	A. Palucci	A. Palucci	R. Domenichini

GAS TURBINE AND GENERATOR PACKAGE

PK-101

I N D E X

1.0 INTRODUCTION

Scope of this Functional Specification is the definition of the basic technical requirements for the supply of one Gas Turbine coupled with an electrical generator to be part of a new generation plant to be built in TAMOIL Refinery in Cremona, Italy.

Vendor shall select the Gas Turbine frame so that its nominal electric power output is close to 27 MWe @ 15°C ambient temperature.

Vendor's supply shall include all the items enclosed in this specification as well as any other accessory and additional equipment, which the Vendor deems necessary for the good performance and the smooth, trouble free and safe operation of the package being supplied.

2.0 SCOPE OF SUPPLY

2.1 Description of the Equipment

The Gas Turbine Generator set, equipped with acoustic enclosure suitable for indoor installation in an industrial area, will be fed by Natural Gas (from SNAM distribution network), vaporized LPG or any mixing of the two fuels.
To reduce NOx emissions, the machine shall use steam injection, if DLN burners are not available.
Exhaust gas from Gas Turbine will be discharged to a Heat Recovery Steam Generator (out of scope of supply) without any bypass stack.

This document is a functional specification. As a consequence this scope of supply shall be considered only indicative to satisfy equipment functional requirements of the job. The final scope of supply will be delivered in the material requisition of the Gas Turbine.

2.1.1 MATERIALS

The equipment and materials included in this specification shall be considered as a minimum requirement and Vendor shall recommend any additional feature and/or improvement required for optimum operation of the equipment and for the specified services.
The supply shall fully conform to the local conditions, the available services, and the required guarantees as well as to this specification.

The supply shall include at least the following items for the Gas Turbine Generator set:

A. Mechanical Equipment

Gas Turbine and Generator

1) Heavy duty Gas Turbine engine with DLN burners or steam injection for NOx reduction.
2) Rigid coupling between Gas turbine and relevant Generator;
3) Fuel System (including KO drum, filter and relevant operating/safety devices as PCV and PSV);

4) Lube oil system including oil reservoir, pumps and relevant electric motors, oil coolers, oil purifiers filter, instrumentation, piping, etc. (lube oil system shall be sized to accomplish requirements of both generator and gas turbine itself).
5) Gas turbine compressor on line and off line washing system;
6) Turning gear;
7) Drainage system;
8) Thermal insulation

Ancillary Equipment

1) Air Intake system, complete with air intake silencer, air filtration system, ducts including relevant supporting structures and IGVs;
2) Exhaust gases duct expansion joint between Gas Turbine outlet and the HRSG inlet duct;
3) Acoustic enclosures for Gas Turbine, Generator and relevant auxiliaries suitable for outdoor installation and complete with ventilation system, ducts, normal and emergency lighting, power sockets;
4) Enclosure(s) for packaged electrical compartment and packaged control compartment, complete with heating, air conditioning, normal and emergency lighting, power sockets;
5) Fire Detection and extinguishing equipment for enclosure and ancillary skids. Fire fighting medium shall be CO_2 where applicable;
6) Piping: all lines interconnecting the equipment within Vendor's scope of supply;
7) Base Plate and anchor bolts.

B. Electrical Equipment

1) Electrical Generator, complete of:
   - Brushless exciter with PMG or potential transformer and automatic voltage regulator (AVR);
   - Generator control panel with synchronizing unit;
   - Generator metering and protection system
   - Cooling system;
   - Line CT's inside generator terminal box (if Vendor standard)
   - Star point grounding cubicle with grounding resistor and CT's

2) Static starting system (with relevant starting transformer) or starter motor alternative solution;

3) Electrical distribution boards for GT auxiliaries;

- LV Switchgears (Motor Control Center to supply electrical GT AC auxiliaries);
- Local UPS and relevant distribution panel for GT users, if any;
- Local DC boards completed with battery, rectifier battery charger and relevant distribution panel for GT D.C. auxiliaries: turbine control system included.

4) Power and control cables connecting equipment included in the scope of supply;

C. Instrument, Control and Protection Equipment

1) Packaged Control Compartment to be installed close to the Gas Turbine, including:

- Gas Turbine and Electric Generator control system;
- Gas Turbine/Electric Generator vibration monitoring and alarm system;
- Gas Turbine/Electric Generator temperature monitoring and alarm system;
- Electric Generator protection and metering system;
- Electric Generator Partial Discharge Measurement system;

2) Hydraulic/pneumatic control system;

3) Field instrumentation;

4) Operator workstation to be installed in Main Control Room;

5) All instrument/control cables connecting items included in Vendor's Scope of Supply.

D. General

1) First filling;
2) Spare parts for commissioning and start-up;
3) Any other accessory, ancillary equipment etc. which the Vendor deems necessary for the optimum operation of the package. DC motors shall be complete of starting resistors.
4) Provision off all attachments and equipment (spreader beams, slings etc) for the transportation, handling and installation of the equipment.

Material, equipment, drivers and appurtenances sized shall be fabricated and assembled as far as it is possible, and intended to constitute equipment capable to carry out the specified duty.

Vendor shall be responsible for material and equipment supplied by their sub-suppliers.

2.1.2 SERVICES

1) Process, mechanical, electrical and structural design of the equipment;
2) Design engineering and complete responsibility of Electric Generator coupling;
3) Equipment alignment (preferably through laser alignment technique);
4) Standard shop inspection and tests;
5) Standard site inspection and tests (separate quotation);
6) Transport from workshop to site on foundation (separate quotation);
7) Supervision to erection of the package (separate quotation);
8) Commissioning and start-up supervision (separate quotation);
9) Operators training (separate quotation) ;
10) Performance Test witnessing (separate quotation);

2.2 Documentation

The Vendor shall provide at least the following information:

A. During proposal stage

General

1) Exceptions and clarifications to this Functional Specification.
2) Equipment list;
3) Sub-suppliers list;
4) Delivery time and schedule;
5) Quality plan.
6) Manufacturer's specifications and recommendations for fuel, lubricants, hydraulic fluids, compressed air, cooling water, chemicals, cleaning agents and any other information necessary for operation and maintenance of the supplied equipment.

Performance

7) Performance data including:
   a. Process performances as required in paragraph 4.1;
   b. NOx, CO and Particulate emissions as required in paragraph 4.6;
   c. Utilities consumption;
   d. Electrical consumption;
8) Complete electrical load list,including:
   – Loads to be supplied from emergency AC power supply
   – DC loads (Vendor to state battery autonomy required)
   – consumption, duty cycle and starting sequence of loads fed by emergency power supply;
9) Startup/shutdown procedures and schedules including main parameters transient curves;
10) Equation and/or curves to evaluate Gas Turbine performance for different ambient conditions, fuel characteristics, steam flowrate, gas turbine loads, elevations, GT inlet losses, GT outlet losses, relative humidity, power factors;
11) Degradation curves (heat rate, power output, exhaust gas temperature, exhaust gas flowrate);
12) Octave band sound power level and sound pressure level at one meter from source (guaranteed values);
13) Electric Generator power curve in accordance to CEI EN 60034-3 fig.3;
14) Generator capability diagram (ref. CEI EN 60034-3 fig.2)
15) Generator electrical characteristic (ref. CEI EN 60034-3 fig.2)

16) Conventional generator efficiency and losses curves;
17) Guaranteed figures as required in paragraph 8.0;

Description

18) Detailed description of the supplied equipment including scope of supply and battery limits (with operating and design conditions);
19) Description of the main equipment operation;
20) Control loops/logics description;
21) Summary of Emergency Shutdown signals
22) Control system and safety system description;
23) Exciter & AVR system description;
24) Construction materials;
25) Packing list

Drawing

26) P&IDs showing major control loop, major line size, start-up lines, limits of supply;
27) Lay-out drawing of the proposed system showing main dimensions and weights of the main machines and of the auxiliary equipment;
28) Process flow diagrams;

Reliability Availability and Maitenability

29) Reference list;
30) Availability/Reliability information and recorded data from similar units;
31) Maintenance schedule and maintenance costs;
32) Spare parts list for commissioning and start up
33) Detailed priced spare parts list for two years operation.

B. During contractual stage

1) Installation drawings;
2) All information necessary for the execution of the plant engineering and erection, commissioning and start-up;
3) Instrument and electrical functional logic specifications (including control loops and binary logic diagrams) for package operation to be implemented in the DCS (supplied by Others);

4) Electrical functional and wiring diagrams;
5) Instrument/electrical interconnection and cable list;
6) Hazardous area classification relevant to all release sources included in the package;
7) Performance tests procedure (at least 6 months before the package mechanical completion), complete of guaranteed correction curves and degradation curves;
8) Specified number of sets of Operating and Maintenance manuals (at least 3 months before the package mechanical completion). Operating and Maintenance manuals shall be in Italian language;

2.3 Exclusions

The following parts are excluded from the Vendor's scope of supply:

1) Civil works and civil design;
2) Overhead crane;
3) DCS of the entire plant;
4) Heat Recovery Steam Generators;
5) Utilities production and supply systems;
6) Generator Circuit-Breaker;
7) Step-up transformer;
8) Main bus ducts connecting Generator with Generator Circuit-Breaker and Star Point Cubicle.
9) Power and control cables connecting equipment not included in Vendor's scope of supply.

2.4 Limits of Supply

Combustion Air	:	Air Filter inlet;
Fuel (natural gas or vaporized LPG)	:	Outlet flange of the manual intercept valve at skid B.L.
Steam for NOx abatmnent	:	Inlet flange of stop valve on the Steam Injection skid;
Exhaust Gas	:	Expansion joint outlet;

Machinery Cooling water	:	Single inlet/outlet flanges (distribution within the package supplied by Vendor);
Utilities	:	Block valves on each inlet/outlet line;
Vents to atmosphere	:	Safe location;
Vents to flare	:	Outlet flange of the vent valves;
Drains	:	Outlets of water drain cocks on the gas turbine block and exhaust diffuser;
Flare system	:	All the lines discharging to flare (i.e. PCV, PSV, bleed lines and KO drum bottom outlet) shall be collected to a common header until the Gas Turbine skid.
Base Plates	:	Lower ends of all base plates;

Electrical system:

- Generator : output terminals (line cubicle) for connection to bus duet;
- Low Voltage Switchgears: incoming terminals for 400 V power supply;
- Static starter system : relevant transformer incoming terminals;
- Static starter motor (if any): relevant incoming terminals
- Static exciter : relevant transformer incoming terminals;
- Protection and measurement system): incoming analog signals terminal strips from CT's and PT's (when not included in Vendor scope of supply) outgoing signal terminal strips (only toward equipment not included in Vendor's scope of supply);
- Turbine/generator control/protection panels: incoming power supply terminal strips; outgoing signal terminal strips (only toward equipment not included in Vendor's scope of supply);
- MCC/DC board/UPS : incoming terminals for 400 V power supply.

Instrumentation and control:

Turbine and Generator control panels:	outgoing signal terminal strips (only toward equipment not included in Vendor's scope of supply);
- Instruments:	Infield Junction terminal boxes for Incoming and outgoing instrumentation and control cables from/to the DCS (supplied by others)

The right position of all Battery Limits will be defined later.

2.5 Limits of this Specification

The description and requirements contained in this specification cannot completely cover all the features of the required equipment. Anyway, it has to be clear that equipment and relevant auxiliaries shall be complete of all the accessories necessary for a good operation of the equipment, within the limits of supply listed in paragraph 2.4 and with the exclusions listed in paragraph 2.3.

2.6 Coordination

The Gas Turbine Vendor shall coordinate, expedite and resolve any problems with his sub-suppliers. Vendor shall be responsible for ensuring that all relevant information and documentation is passed on to his sub-suppliers, since all information pertaining to the equipment being supplied by the sub-suppliers may not be necessarily repeated in the relevant section of the requisition.
Gas Turbine Vendor shall supply all the necessary certified data and information required for HRSG design (supplied by Others).

3.0 BASES OF DESIGN

The Gas Turbine and all associated equipment shall be supplied in accorda nce with the following ambient conditions, utilities characteristics and Battery Limit conditions.

3.1 Site Conditions

Reference shall be made to the “Ambient Conditions & Utility Characteristics” enclosed in Attachment A.1

3.2 Fuels

The Gas Turbine shall be able to operate on Natural Gas, vaporized LPG, or any mixed of the two fuels.
For fuel (Natural Gas and LPG) composition and characteristics reference shall be made to the “Ambient Conditions & Utility Characteristics” enclosed in Attachment A.1
Supply temperature of the Natural Gas, vaporized LPG, or any mixed of the two fuels will be in accordance to Vendor requirements; Vendor shall indicate the effects of the fuel supply temperature modification on Gas Turbine performance (efficiency, power output, flue gas temperature and flow rate).

3.3 NO_x Abatement

The Gas Turbine shall be equipped with steam injection for NO_x abatement during fuel operation (Natural Gas, vaporized LPG or any mixed of the two fuels), if DLN burners are not available.

3.4 Utility Characteristics

Reference shall be made to the “Ambient Conditions & Utility Characteristics” enclosed in Attachment A.1

3.5 Battery Limit Conditions

Air Filter Inlet

Pressure drop (Vendor to advise)	mm w.c.	100

Exhaust Gas Outlet

Pressure at Gas Turbine expansion joint outlet	mm w.c.	300

(static back pressure at normal operating conditions:
15 °C ambient temperature, 1013 mbar (a), 75% RU)

Fuel

Natural Gas

Operating Temperature	°C	by Vendor
Operating Pressure	bar	by Vendor

Vaporized LPG

Operating Temperature	°C	by Vendor
Operating Pressure	bar	by Vendor

Note (1) Vendor shall provide the minimum acceptable Natural Gas pressure required for GT operation over the entire load range. As the NG pressure at plant B.L. is borderline for the possible requirement to install a NG Compressor, Vendor shall evaluate possible modifications to its standard supply to lower the required NG pressure. In this case Vendor to provide the relevant extracost by a separate quotation.

Generator terminals

Voltage (Vendor standard)	kV- 50 Hz	by Vendor

Electrical Power

AC Voltage - 50 Hz	400 V ± 5% for LV switchboards; 6000 V ± 5% for motors rated 200 kW or above; 6000 V ± 5% for static starter and exciter transformers.

For utilities operating and design conditions not specified before refer to the “Ambient Conditions & Utility Characteristics enclosed in Attachment A.1

3.6 Noise

All the necessary measures shall be taken to reduce the noise level down to acceptable value in the working area where continuous personnel attendance is required.
Sound emission from each equipment continuously operating shall not exceed a maximum sound pressure level of 85 dB(A) at 1 m (from any point of the Gas Turbine/Generator enclosure, air intake, GT diffuser and from any other equipment included in Vendor's scope of supply).

3.7 Gaseous Emissions

The Power Plant shall comply with the following environmental limits at stack:

NOx : 30 mg/Nm3 @15%O_2 vd
CO : 50 mg/Nm3 @15%O_2 vd

These emission limits shall be met at full load and at reduced loads.

In case the gas turbine cannot meet this emissions either with DLN burners or with steam injetion, the HRSG will be equipped with an SCR system (out of Vendor scope of supply).
In such a case the Vendor shall state the minimum NOx emission reached with DLN burner, if available, or the steam injection required to meet a NOx emission of 250 mg/Nm^3 @15%O_2 vd.

3.8 Operating Philosophy

The Gas Turbine will operate on:

- 100 % natural gas;
- 100 % vaporized LPG;
- any mixture of natural gas and LPG

The Plant operating philosophy shall be based on a continuous operation of the gas turbine for the maximum uninterrupted operation.

Vendor shall design the Gas Turbine, Electrical Generator and all auxiliary equipment to accommodate this operating regime.

4.0 PROCESS DATA

The heavy duty Gas Turbine, suitable for outdoor installation, will discharge the exhaust gas from the machine to a Heat Recovery Steam Generator (out of scope of supply)
The Gas Turbine will be fed with Natural Gas (coming SNAM network), vaporized LPG, or any mixer of the two fuels.

4.1 Performance Data

Gas Turbine performance at different operating conditions for Natural Gas, vaporized LPG and mixed of the two fuels, shall be given by filling in the performance data format enclosed to Attachment A.2.

4.2 Utilities Consumptions

Vendor shall indicate the consumption of the below listed utilities whose characteristics are shown in the paragraph 3.4

Instrument Air	:	....	Nm^3/h (normal and peak)
Plant Air	:	....	Nm^3/h (normal and peak)
Auxiliaries electric power	:	....	kW
Cooling Water	:	……	m^3/h (ΔT by Vendor)
Demi water (for compressor washing)	:	....	m^3/h (normal and design)
Steam injection (if required)	:	……	t/h (pressure by Vendor)

For electric auxiliaries, a complete load list shall be provided for the different operating conditions (normal, cold start-up, shutdown) defining operating and stand-by load. DC load list shall be included.
Loads to be supplied by emergency diesel generator shall be pointed out.
Vendor shall advise the necessity and the consumption of other utilities, not mentioned above, or specify limitations (low/high temperature, etc…) if any.

4.3 Chemicals Requirements

Vendor shall advise the necessity and the consumption of chemicals, if any (compressor washing, etc….)

4.4 Reliability/Availability Information

Vendor shall provide all information necessary for the evaluation of the Equivalent Availability Factor of the supplied equipment/package.
"Equivalent Availability Factor" is the time based method for calculating availability as standardized by the North American Electrical Reliability Council "NERC" and ANSI/IEEE Std 762-1987.

EAF=(PH-FOH-EDOH)/PH

where:

- PH or Period Hours shall be number of hours in a year, equal to 8760 hours.
- FOH or Full Outage Hours shall be the Outage Hours in a period when the equipment was not capable of producing electric power due to Unplanned Maintenance and Planned Maintenance.
- EDOH or Equivalent Derated Outage Hours shall be the Outage Hours in a period when the output of the equipment is derated due to Unplanned Maintenance.

Moreover, Vendor shall indicate the planned maintenance schedule of the supplied equipment showing the following:

- Frequency of the maintenance operation;
- Maintenance operation description;
- Manhours/personnel required for maintenance operation;
- Maintenance estimated cost.

Vendor shall indicate the GT life expenditure, in terms of equivalent hours operation, associated to each GT start-up/shutdown.

4.5 Noise

Vendor shall provide octave band sound power levels at expansion joint outlet for HRSG design emitted by the following components on a steady state operation:

- GT acoustical enclosure emitting inside the turbines building;
- GT electric generator emitting inside the turbines building;

- GT air intake system emitting into the environmental
- GT exhaust emitting into the inlet transition duct to the HRSG;

4.6 Gaseous Emissions

Vendor shall provide NO_x, CO and Particulate emissions for all ambient conditions and GT loads indicated in Attachment A.2.

5.0 OPERATING MODES

5.1 Normal Operation

The Gas Turbine and coupled Generator shall be designed for base load operation, with the plant connected to the external grid.

5.2 Load Rejection (Idle Condition)

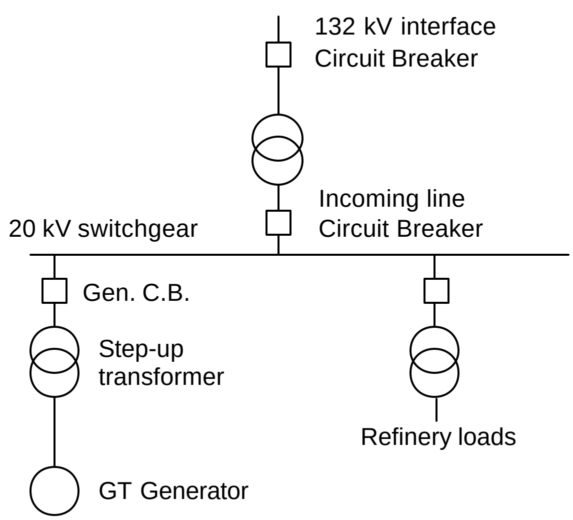
The Gas Turbine and coupled Generator shall be able to withstand a full load rejection maintaining the "full speed no load" condition for indefinite period.

5.3 Island Condition

During Island operation caused by the loss of external grid (when interface 132 kV CB is opened or 20 kV incoming line CB is opened – see follows simplified one line diagram) the Gas Turbine and coupled Generator shall be be able to feed continuosly a plant's load within a minimum house load (auxiliary users of the combined cycle unit) up to maximum GT output (a portion of the internal refinery load).

The gas turbine governor shall be able to change istantaneously from droop to isochronous mode when the 132 kV CB or 20 kV incoming line CB opening ; the Gas Turbine governor shall prevent overspeed after load rejection, starting from any load condition before the CB opening.

In case of internal plant load shedding during a load rejection, when the stady state operating condition are reached, the gas turbine shall be able to take load with an adequate ramp up to its maximum otput power.



Simplified one line diagram

5.4 Operating Flexibility

The Gas Turbine shall be able to operate continuously on Natural Gas, vaporized LPG or any mixer of the two fuels over the whole operating range between 100% load and idle condition.
Vendor shall advise the load operating range corresponding to a full control of exhaust gas temperature by means of IGV's.

5.5 Transient Operation

To allow a continuous and reliable energy production, the Gas Turbine and the coupled Generator shall maintain stable operation during exceptional events, like faults or serious disturbances on external grid, or faults internal to the Plant.

6.0 INSTRUMENTATION AND CONTROL

The field instrumentation and the control automation and protective system will allow the control and monitoring of the gas turbine, as well as its safe management, as required by process operations.
The field instrumentation will use EEx-d or EEx-p method of protection, where required by area classification.
The control automatic and protective system will be microprocessor based and will be based on hierarchically ordered levels.
The design, material, construction, assembly, test and inspection shall be in accordance with the last issue in force for the codes and standards.
Gas Turbine and coupled Generator dedicated control system shall be able to be interfaced with the plant DCS that is fully configured and programmed in accordance with the functional requirements in terms of process control.
Gas Turbine will have its dedicated ESD system, being an integral part of the equipment.
All the blocks that cause a reduction in the power production, affecting the plant reliability factor shall be implemented with a two out of three logic with dedicated sensing elements.

7.0 ELECTRICAL SYSTEM AND SYNCHRONOUS GENERATOR

The following design data shall be applied to the electrical synchronous generator, to its own auxiliary services and to the electrical distribution system of Vendor's package.

Vendor to define the design value in accordance to IEC 60034-3, taking into account the gas turbine performance versus ambient temperature as per table at point 7.1.2. Generator sizing not to limit mechanical power at gas Turbine shaft whichever the ambient temperature and the rated power factor.

Missing data marked with (*) shall be filled-in by Vendor.

7.1 Generator

The generator shall be synchronous, three-phase, round rotor type, cooling system type according to Vendor Standard.

7.1.1 MAIN CHARACTERISTICS

The main characteristics of the synchronous generator shall be:

- Rated power	(*) MVA at 40 °C primary coolant inlet temperature
- Rated voltage	(*) kV± 5% (Vendor std.)
- Rated frequency	50 Hz ± 2%
- Rated power factor (inductive/capacitive)	0.85/0.95
- Short circuit ratio (KC)	≥ 0.4
- Rated speed	3000 r.p.m
- Normal voltage and frequency variations	± 5%; 50 Hz +2%; -2%
- Exceptional voltage and frequency variations	± 5%; 50 Hz +3%; -5%
- Duty service	continuous
- Number of phases	3
- Number of terminals	3 + 3 (for bus duct connection)
- Winding connection	star
- Star point grounding	through high voltage resistance or grounding transformer

- Thermal classification	F
- Temperature rise class	B
- Cooling method (IEC cooling designation)	(*) (Vendor Std)
Stator winding cooling (*)	
- Primary cooling medium	air (x) or water (N.A.)
- Secondary cooling medium	water (x) or air (N.A.)
- Cooling type	direct ( ) or indirect ( )
Rotor winding cooling (*)	
- Primary cooling medium	air (x) or water (N.A.)
- Secondary cooling medium	water (x) or air (N.A.)
- Cooling type	direct ( ) or indirect ( )
Stator/Rotor core cooling (*)	
- Primary cooling medium	air (x) or water (N.A.)
- Secondary cooling medium	water (x) or air (N.A.)
- Number of cooler(s) (sections)	≥4
- Coolers position	Bottom preferred (Vendor Std.)
- Total secondary water flowrate from plant cooling water system	(*) m^3/h
- Max. power output with one cooler section out of service, without exceeding temperature rise class at primary coolant temperature not below 40°C	70% of rated power
- Installation	indoor in acoustic enclosure
- Sound pressure level	≤ 85 dB(A) at 1.0 m (from the enclosure)
- Mechanical protection degree:	(*)
- Overspeed capability	≥120%
- Stator overcurrent capability	≥150% for 30 sec
- Direct axis synchronous reactance	(*) p.u.
- Direct axis transient reactance	(*) p.u.
- Direct axis sub-transient reactance	(*) p.u. (> 0.1 p.u. saturated)
- Direct axis aperiodic time constant	(*) s
- Direct axis transient short circuit time constant	(*) s
- Direct axis sub-transient short circuit time constant	(*) s

- Direct axis transient open circuit time constant (*) s

The generator shall be capable to withstand the following accidental conditions, without suffering any mechanical or electrical damage or dangerous overheating:

– coupling in out-of-phase conditions with phase difference of 120° and 180°;
– asynchronous operation delivering a power equal to 0.75×Pn (Pn = rated power) for 5 seconds;
– unbalanced short circuit at unit step-up transformer HV terminals (rated power = generator MVA; xcc = 13%) cleared in 0.5 s;
– accepting 10% permanent load unbalance.

7.1.2 GENERATOR CAPABILITY

Vendor to fill in the tables here below:

a) Capability at normal operating condition

Ambient Temperature (°C)	**Water Coolant Inlet Temp (°C)**	**Primary Coolant Inlet Temp. (°C)**	**Power Output at Generator Terminal (MW)(**)**	**Generator Efficiency (%)**	**Actual Operating Temperature (°C)**	
					Stator	**Rotor Iron**
-8	10					
15	25					
40	37					

(**) at rated inductive power factor (0.85), rated voltage, rated frequency

b) Capability at maximum admissible IEC temperature consistent with class B temperature rise

Ambient Temperature (°C)	**Water Coolant Inlet Temp. (°C)**	**Primary Coolant Inlet Temp. (°C)**	**Max. Temperature (°C)**		**Generator Capability (MVA) (**)**
			Stator	**Rotor Iron**	
-8	10				
15	25				
40	37				

(**) at rated inductive power factor (0.85), rated voltage, rated frequency

7.1.3 LOSSES

		p.f. =1 (kW)	p.f. =0.85 (kW)
at 100% of rated power	:	*	*
at 75% of rated power	:	*	*
at 50% of rated power	:	*	*
at 25% of rated power	:	*	*

The efficiency at rated voltage and rated power factor shall not be lower than 98.5 %.

7.1.4 INTRUMENTATION

- Stator Winding temperature detectors (RTD)	≥ 4 per, 12 total dual element type, 6 total
- Bearings temperature detectors	dual element type, 1 in oil, 1 in metal for each bearing
- Cooling system monitoring and control	according to Vendor Std
- Seal oil system monitoring and control	according to Vendor Std (minimum requirements at point 7.4.6)
- Water leakage detectors	as necessary (Vendor Std.)
- Vibration monitoring system	common with turbines

All necessary temperature, cooling system and seal oil system (if applicable) monitoring shall be sent to generator or turbine control panel (according to Vendor standard) for alarm and protection purpose.

7.1.5 MECHANICAL CHARACTERISTIC

In case of hydrogen cooling, generator casing shall be sized to withstand explosions caused by an accidental mixture of air and hydrogen (pressure test at 8 bars as a minimum).

Lubricating system of generator shall be common with gas turbine lubricating system (Vendor Std).

Bearings shall be sleeve type; suitable insulation shall be provided to avoid circulating currents.

For cooling system mechanical characteristics see point attachment A.1. “Ambient conditions & Utilities characteristics”.

7.1.6 MATERIALS

- Casing	(*)
- Rotor windings	(*)
- Stator windings	(*)
- Stator winding insulation	(*)
- Rotor	(*)
- Rotor retaining rings	(*)
- Coolers	(*) in accordance with water characteristics

7.1.7 REFERENCE STANDARDS

IEC 60034-1	Rotating electrical machines. Part 1: Rating and performance
IEC 60034-3	rotating electrical machines. Part 3: specific requirements for turbine-type synchronous machines.
IEC 60079	Electrical apparatus for explosive gas atmosphere

7.2 Excitation System

7.2.1 MAIN CHARACTERISTICS

The excitation system shall be static type, fed through a suitable excitation transformer, included in Vendor scope. (The PMG shall provide power supply also in case of short circuit at the generator main terminals or potential transformer (potential transformer type can be accepted according to Vendor standard; in this case the potential transformer shall be included loose in Vendor scope of supply).

The excitation system shall be capable of providing an adequate range of excitation to guarantee a sufficient margin of stability under all steady and transient load conditions and to guarantee that the control will keep the generator running within the acceptable limits of temperature rise and voltage.

When the generator is subjected to a sudden loss of maximum output at rated power factor, the excitation system shall be capable to limit the momentary over voltage to less than 120% of the rated voltage and shall restore the voltage to 2% of the nominal pre-set value within 3 sec.

Moreover the electronic equipment of the excitation system shall be designed to correctly operate with voltage reduction of ac voltage supply equal up to 60% of rated voltage for 1.5 s.

The excitation system shall be capable to sustain the generator fault current for at least 2 s in case of three phase short circuit at high voltage side of step-up Transformer.

Temperature of excitation system shall be monitored, according to Vendor standard

7.2.2 EXCITATION SYSTEM FACILITIES

The excitation system shall provide the following facilities:

One digital Automatic Voltage Regulator (AVR), electronic type, formed of two regulation channels, automatic and manual with automatic change-over device.

- automatic control range	80-120% Vn
- manual control range	0-120% Vn
- Error	± 0.2% of setting value
- settable dead-band including zero as a setting value	
- Positive ceiling voltage	≥ 200% - 2s [(1)]
- Rotor overcurrent	≥ 150% - 10s

The excitation system with automatic voltage regulator shall be equipped with the following further facilities:

- control and regulation, completely digital
- Voltage control
- Power factor control
- Voltage drop compensation up to 80% (negative voltage droop)
- field circuit breaker
- logic system digital type
- Volt/Hertz limiter
- Overexcitation limiter
- Underexcitation limiter
- Stabilising signals
- Field circuit breaker
- Fast de-excitation system
- Signalling and monitoring system (alarm and measurement)
- Local and remote control
- Panel board, free standing, protection degree ≥ IP31
- Cooling system:
- Reference Standard IEC 60034-16

7.3 Static Starter

One static frequency converter shall be provided for the start up of the gas turbine.

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(1) Ceiling voltage according to the requirements as per point 6.2.1

The starter shall be complete of any device necessary for the correct operation.

The electronic equipment of the static starter shall be designed to correctly operate with voltage reduction of ac voltage supply at least equal up to 40% of rated voltage for 0.5 s.

Natural cooling preferred; forced air cooling with 100% redundancy is accepted according to Vendor Std.

The starter transformer necessary to feed the static starter shall be included in scope of supply.

No limitation of number and time interval of restarts shall be present.
Vendor to state the performance of static starter as minimum time required to achieve synchronization

All standard signals for monitoring and protection shall be available, interface with turbine/generator control panel shall be provided. Interface with remote DCS (Supplied by other) shall be provided too, for monitoring purpose only.

7.4 Generator Ancillary

7.4.1 GENERATOR CONTROL SYSTEM

The generator control system shall be interfaced with turbine control system and shall include the control of exciter and AVR and the synchronization functions as described at point 7.4.2.
The generator control system shall be arranged for local and remote command. Interface with remote DCS (supplied by others) shall be provided via serial bus (standard communication protocol shall be selected). Hardwired connection for specific signals (to be specified later) shall be provided too.
A control panel with a synoptic showing typical electric indication shall be included in the Packaged Control Compartment; the synoptic shall show all the synchronizing points provided (see 7.4.2) and allow manual synchronization with double voltmeter and frequency meter.

7.4.2 SYNCHRONIZATION SYSTEM

An automatic synchronizing system, digital type, shall be provided and designed to permit the synchronization of three circuit breakers (132 kV interface CB, 20 kV incoming line CB and 20 kV generator CB).
To this end the facility to receive the different voltage signals shall be foreseen; synchronizing point selection and synchronizing automatic sequence start/stop shall be possible both via generator control panel and via DCS.

The facilities to allow manual synchronizing on each synchronizing point shall be provided too.

7.4.3 METERING AND PROTECTION SYSTEM

Protective relays and transducers shall be of multifunction microprocessor design, PC programmable type.

A single channel of protection with functional redundancy shall be provided.

The following protection functions shall be foreseen:

- 87G: generator differential relay
- 21: under impedance relay
- 46: reverse phase sequence relay
- 24: over-excitation relay
- 40: loss of excitation relay
- 32: reverse power relay
- 64S: stator earth fault relay (both 100% and 95%)
- 59: stator over voltage relay
- 27: stator under voltage relay
- $59U_0$: voltage displacement earth fault relay
- 81: over and under frequency relay
- 64R: rotor earth fault relay
- 60: voltage balance relay
- 50BF: breaker failure over-current relay
- 86B: lockout relays
- 3: trip circuit supervision relay
- 80: auxiliary supply on/off flag relay

7.4.4 PARTIAL DISCHARGE MEASUREMENT SYSTEM (to quote separately)

Partial Discharge Measurement System for the generator shall be used for field and factory measurement and shall be capable for on-line application, with generator in service. Therefore the machine shall be arranged to allow the installation of pick-ups capacitors.
The system shall be of computerised type, composed, at least, by following elements:

- Set of capacitive pick-ups
- Interface unit;
- Processing unit;
- Serial interfaces;
- Portable personal computer with software;
- Calibration unit;
- Cabling and accessories.

Supplier shall state all main characteristics of system proposed, such as bandwidth, resolution time, historical memory capacity.

7.4.5 COOLING SYSTEM

Water coolers shall be complete of:
- intercepting valves, both at water inlet and outlet;
- water flow detectors;
- relief and draining valves;

The exclusion of each cooler (section) shall be possible also with generator in service, and without water flow interruption.

7.4.6 OTHER ACCESSORIES

Moreover, the following accessories shall be provided:
- generator heating resistors;
- brushes and slip rings for excitation system.

7.5 EMC REQUIREMENTS

All the electronic device of the package shall comply with the emission and immunity levels prescribed by the specific standard applicable to the component.

Vendor shall state and motivate in the proposal offer, the deviation respect to the prescribed figures.

It is intended that EMC certificates shall be available at Vendor's shop and submitted on Purchaser's request.

REFERENCE STANDARDS	TEST or MEASUREMENTS	CLASS/TEST LEVEL
EN 55022 EN 55011 EN 61000-3-4 EN 61000-3-5	Conducted emission Harmonics emission Flicker and voltage Fluctuations (°)	class B (group 1) as specified after to be specified by Vendor
EN 55022 EN 55011 IEC 61000-4-2 ENV 50204 IEC 61000-4-3	Radiated emission Electrostatic discharge immunity Radio frequency Electromagnetic field Immunity	class B (group 1) 6 kV contact 8 kV air 10 V/m
IEC 60801-4 IEC 61000-4-4	Electrical fast Transient/burst immunity	Power supply: 2 kV control lines: 2 kV signal lines: 1 kV
ENV 50142 IEC 61000-4-5	Surge immunity	2 kV line/ground 1 kV line/line
ENV 50141 IEC 61000-4-6	Conducted disturbances Induced by radio-frequency Fields immunity	10 V
IEC/EN 61000-4-8	Power frequency magnetic field immunity	30 A/m
IEC/EN 61000-4-9	pulse magnetic field immunity	100 A/m
IEC/EN 61000-4-10	Damped oscillatory Magnetic field	by Vendor
IEC/EN 61000-4-11	voltage dips short interruption	to be defined by Vendor
IEC/EN 61000-4-12	Oscillatory waves Immunity	2 kV (CM) 1 kV (DM)

- voltage dips: 60% 1.5 s; - voltage interruption: 0.3 s.
- Harmonic spectrum: to be stated by Vendor. Flicker: not applicable

7.6 LV switchgear

LV switchgear (LVS) shall be metal clad type, free standing, dead-front, steel structure, for indoor installation, protection degree IP31, TTA type, minimum form 3-a (IEC 60439-1);
For the LVS, Vendor manufacturing standard could be accepted. If necessary, it shall have an emergency bus section, powered from emergency feeder supplied by others, dedicated to the package emergency loads, if any. Automatic change-over to the emergency power supply shall be provided.

Incoming feeders and bus tie shall be equipped with withdrawable circuit breakers. Suitable interlocks shall be provided between the breakers.
Motor feeders shall be equipped with withdrawable circuit-breaker, contactor and thermal relay. Auxiliary circuits of each motor feeder cubicle shall be fed by main power circuit.
Static load outgoing cubicles shall be equipped with withdrawable automatic circuit breaker, moulded case type;

Appropriate spare cubicles not equipped shall be provided (not less than 10%).

7.7 DC System

The DC system shall supply power to the turbine and generator control systems, dc auxiliaries and dc motors. In addition, it shall supply power to the generator protection system.

The DC System voltage level(s) shall be as per Vendor standard.

100% redundancy of batteries and A.C./D.C. rectifiers-battery charges shall be provided.

The DC distribution board(s) shall be preferably formed of two sections separated by a tie-breaker, normally open, each section being supplied from one rectifier and battery branch, the second rectifier being in stand-by (Vendor standard is accepted).

The batteries shall be lead acid type. Each battery shall be able to power the D.C. loads of one D.C. board section for three hours, and any UPS user for one hour (see the next paragraph).
The batteries shall be installed in a dedicated room of the packaged electronic and electrical control compartment, with direct access from outside.

The distribution boards shall be equipped with fixed automatic circuit breakers, two poles type.

7.8 Uninterruptible Power Supply

As far as possible, the use of UPS systems shall be avoided.
In case a UPS system is necessary to supply few particular users, it shall be preferably integrated with the D.C. system. Two 100% redundant inverters with static switches shall be provided, fed by the DC distribution board.
One manual by-pass shall be provided too

The AC distribution panel shall consist of two bus bar sections with tie-breaker. The distribution panel shall be equipped with fixed automatic circuit breakers, two poles type.

The inverters and batteries shall be sized to supply all AC loads (tie-breaker closed) for at least one hour.

7.9 Induction Motors

The induction motors included in the scope of supply shall have the main following characteristics:

- Asynchronous type
- High efficiency
- TEFC type
- Protection degree: motor ≥ IP 55
- Thermal insulation/temperature rise: F/B
- Voltage and frequency variation: Normal condition:
  zone A (as per IEC 60034-1 fig 14.)
  Exceptional conditions:
  zone B[(1)] (as per IEC 60034-1 fig 14.)
- Standards: IEC 60034-1
  IEC 60034-12

Furthermore, motors shall be designed for direct starting at full voltage and for re-acceleration with 100% residual voltage, and for two consecutive starting at 80% of rated voltage.

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(1) In this condition windings temperature shall not exceed 10°C over the temperature rise class B indication

In addition they shall keep in service their mechanical loads when the supply voltage at their terminals is 70% of rated voltage.

All DC motors shall be supplied complete of starting resistors.

7.10 Cabling

Main characteristics shall be:

– Flame retardant	
– Insulation material	Instrument/control: PVC Power: EPR-G7 or XLPE
– Insulation level	Instrument/control: 450/750V Power: 0.6/1 kV
– Conductor material	electrolytic copper
– Standards	IEC 60332-3 IEC 60754-1/2 (for control, instrument and in-board cabling)
– Average length	50 m

Quotation for lengths (per meter) above 50 m is requested

7.11 HAZARDOUS AREA

GT vendor to point out a list of source of release with their grade of release and release rate.

Classification of GT package hazardous areas shall be on Vendor/Manufacturer charge and responsibility; classification of hazardous areas shall be made according to CEI-EN 60079-10. The electrical equipment to be installed in hazardous areas shall be designed and selected in accordance with EN 60079-14 and EN 50014.

GT Manufacturer shall comply with all the European directive 99/92/CE (“Atex 118a” Directive) requirements for improving safety and health protection of workers potentially at risk from explosive atmospheres.

All the supplied equipment and protective systems intended for use in potentially explosive atmospheres and also safety devices, controlling devices and regulating devices intended for use outside potentially explosive atmospheres (but which are required for or contribute to the safe functioning of equipment and protective systems, with respect to the risks of explosion) shall comply to the DPR No. 126 dated March 23, 98 and European directive 94/9/CE ("Atex 100a" Directive).

GT Vendor/Manufacturer bears the CE marking according to European directive 94/9/CE

8.0 GUARANTEED PERFORMANCES

8.1 Reference Conditions

Ambient temperature	:	15	°C
Ambient pressure	:	1013	mbar (a)
Relative humidity	:	75	%
Power factor at generator terminals	:	0.85	lagging
Cooling water supply temperature	:	24	°C
Gas Turbine load	:	100	%
Gas Turbine backpressure (static)	:	300	mm w.c.
Fuel characteristics	:	See para 3.3 and 3.6	

8.2 Guarantee

With reference to the operating conditions stated in paragraph 8.1, Vendor shall guaranteed the following figures:

Power Output at generator terminals:	…….kW (note 1)
Heat rate:	….kJ/kWh (note1)
Exhaust gas flowrate	….kg/h
Exhaust gas temperature	….°C
NO_x emissions (referred to 15 %O_2 vol. dry basis)	….. mg/Nm_3 (note 2)
CO emissions (referred to 15 %O_2 vol. dry basis)	..mg/Nm_3 (note2)
Particulate emissions (referred to 15 %O_2 vol. dry basis)	….kg/h
Noise	= 85 dB(A) at 1m
Auxiliary Consumption	….kW
Steam Consumption (if any)	….kg/h
Reliability at full load over 30 days period	100%

Notes:

1) Guarantee is measured at generator terminals and is net of excitation power and auxiliary consumption normally in operation.

2) Emissions limits to be guaranteed at full load and at reduced loads (at least down to 60 %). Vendor to advise.

8.3 Correction Curves

Vendor shall provide guaranteed correction curves in order to evaluate Gas Turbine and Generator performance at operating conditions different from the reference ones listed at paragraph 0, including correction curves for gas analysis and degradation curves. Guaranteed correction curves to be provided 6 months prior to first firing.

8.4 Gas Turbine Performance and Reliability Test

Performance tests and calculations will be carried out using ASME PTC 22 guidelines. Noise measurements will be carried out in accordance to ISO procedures.
Vendor shall submit a detailed testing procedure to be discussed during detailed engineering and mutually accepted prior to actual testing.
The gas turbine shall also demonstrate to operate continuously at full load during a 30 days reliability test.

ATTACHMENTS

A.1 AMBIENT CONDITIONS & UTILITY CHARACTERISTICS

A.2 PERFORMANCE DATA FORMATS

ATTACHMENT A.1

AMBIENT CONDITIONS & UTILITY CHARACTERISTICS

ATTACHMENT A.2

PERFORMANCE DATA FORMATS

Vendor shall provide all information listed in the following formats (to be filled-in) for both fuel (Natural Gas and vaporized LPG) at full load and reduced load operation.

Table A.2.1 – Full Load Operation with Natural Gas

Site conditions:		**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**
Ambient temperature	°C	-15	0	15	25	40
Ambient pressure	mbar	1013	1013	1013	1013	1013
Ambient relative humidity	%	75	75	75	75	75
Pressure losses:						
Inlet pressure drop	mmwc					
Exhaust gas pressure drop	mmwc				300	
Performances:						
Gas Turbine Load	%	100	100	100	100	100
Shaft Power	kW					
Gross generator output	kW					
Heat consumption (LHV)	MWth					
Heat rate (LHV)	kJ/kWh					
Fuel:						
Type		Nat. Gas	Nat. Gas	Nat. Gas	Nat. Gas	Nat. Gas
Composition & characteristics		See Attach. 1	See Attach. 1	See Attach. 1	See Attach. 1	See Attach. 1
Fuel gas flowrate	t/h					
Fuel pressure at GT B.L.	Bar abs					
Fuel temperature	°C					
Compressor:						
Inlet Guide Vanes Position	%					
Air Flowrate (compressor inlet)	t/h					
Pressure ratio						
NO_x Control						
Type	-	By Vendor	By Vendor	By Vendor	By Vendor	By Vendor
Steam Flowrate (if any)	t/h					
Steam Pressure at GT B.L.	bar abs					
Steam Temperature	°C					
Flue gas:						
Exhaust gas flow	t/h					
Exhaust gas temperature	°C					
Exhaust gas composition:						
Oxygen	% mol					
Water	% mol					
Carbon dioxide	% mol					
Nitrogen	% mol					
Argon	% mol					
NO_x emissions at 15% O_2vd	mg/Nm^3					
CO emissions at 15% O_2vd	mg/Nm^3					
Particulate emissions	kg/h					

Table A.2.2 – Full Load Operation with Vaporized LPG

Site conditions:		**Case 6**	**Case 7**	**Case 8**
Ambient temperature	°C	15	25	40
Ambient pressure	mbar	1013	1013	1013
Ambient relative humidity	%	75	75	75
Pressure losses:				
Inlet pressure drop	mmwc			
Exhaust gas pressure drop	mmwc		300	
Performances:				
Gas Turbine Load	%	100	100	100
Shaft Power	kW			
Gross generator output	kW			
Heat consumption (LHV)	MWth			
Heat rate (LHV)	kJ/kWh			
Fuel:				
Type		Vaporiz. LPG	Vaporiz. LPG	Vaporiz. LPG
Composition & characteristics		See Attach. 1	See Attach. 1	See Attach. 1
Fuel gas flowrate	t/h			
Fuel pressure at GT B.L.	bar			
Fuel temperature	°C			
Compressor:				
Inlet Guide Vanes Position	%			
Air Flowrate (compressor inlet)	t/h			
Pressure ratio				
NO_x Control				
Type	-	By Vendor	By Vendor	By Vendor
Steam Flowrate (if any)	t/h			
Steam Pressure at GT B.L.	Bar abs			
Steam Temperature	°C			
Flue gas:				
Exhaust gas flow	t/h			
Exhaust gas temperature	°C			
Exhaust gas composition:				
Oxygen	% mol			
Water	% mol			
Carbon dioxide	% mol			
Nitrogen	% mol			
Argon	% mol			
NO_x emissions at 15% O_2vd	mg/Nm^3			
CO emissions at 15% O_2vd	mg/Nm^3			
Particulate emissions	kg/h			

Table A.2.3 – Reduced Loads Operation with Natural Gas

Site conditions:		**Case 9**	**Case 10**	**Case 11**
Ambient temperature	°C	15	15	15
Ambient pressure	mbar	1013	1013	1013
Ambient relative humidity	%	75	75	75
Pressure losses:				
Inlet pressure drop	mmwc			
Exhaust gas pressure drop	mmwc			
Performances:				
Gas Turbine Load	%	75	50	25
Shaft Power	kW			
Gross generator output	kW			
Heat consumption (LHV)	MWth			
Heat rate (LHV)	kJ/kWh			
Fuel:				
Type		Nat. Gas	Nat. Gas	Nat. Gas
Composition & characteristics		See Attach. 1	See Attach. 1	See Attach. 1
Fuel gas flowrate	t/h			
Fuel pressure at GT B.L.	Bar abs			
Fuel temperature	°C			
Compressor:				
Inlet Guide Vanes Position	%			
Air Flowrate (compressor inlet)	t/h			
Pressure ratio				
NO_x Control				
Type	-	By Vendor	By Vendor	By Vendor
Steam Flowrate (if any)	t/h			
Steam Pressure at GT B.L.	bar abs			
Steam Temperature	°C			
Flue gas:				
Exhaust gas flow	t/h			
Exhaust gas temperature	°C			
Exhaust gas composition:				
Oxygen	% mol			
Water	% mol			
Carbon dioxide	% mol			
Nitrogen	% mol			
Argon	% mol			
NO_x emissions at 15% O_2vd	mg/Nm^3			
CO emissions at 15% O_2vd	mg/Nm^3			
Particulate emissions	kg/h			

AMBIENT CONDITIONS & UTILITY CHARACTERISTICS

TAMOIL REFINERY, CREMONA (ITALY)	Revision No.: 0
NEW COGENERATION PLANT IN CREMONA REFINERY	Date: May, 2005
	Sheet No. 1 of 14

CLIENT: TAMOIL REFINERY
LOCATION: CREMONA, ITALY
PROJECT NAME: NEW COGENERATION PLANT IN CREMONA
CONTRACT NO: 1-BD-0238A
DOCUMENT NAME: AMBIENT CONDITIONS & UTILITY CHARACTERISTICS

ISSUED BY: A. PALUCCI
CHECKED BY: A. PALUCCI
APPROVED BY: R. DOMENICHINI

Date	Revised Pages	Issued by	Checked by	Approved by
May 2005	First Issue	A. Palucci	A. Palucci	R. Domenichini

INDEX

1.0 INTRODUCTION

Scope of this document is the definition of the ambient conditions and the utility fluids characteristics to be used during the feasibility study activities of a new cogeneration plant that will be built inside the TAMOIL Refinery in Cremona, Italy.

2.0 AMBIENT CONDITIONS

The following data identify the ambient conditions:

Reference Ambient Conditions

Atmospheric Pressure	:	1013 mbar (a)
Ambient Temperature (dry bulb)	:	15 °C
Relative Humidity	:	75 %

Atmospheric Pressure

Minimum	:	735 mmHg
Maximum	:	772 mmHg
Average	:	755 mmHg

Ambient Temperature (dry bulb)

Minimum	:	- 8 °C
Maximum	:	39 °C

Design Temperature

Minimum	:	- 15 °C
Maximum	:	41 °C

Relative Humidity

Average	:	85%
Maximum	:	100%

3.0 UTILITY AND SERVICE FLUIDS CHARACTERISTICS AVAILABLE AT PLANT BATTERY LIMITS

3.1 NATURAL GAS

Natural gas is derived from the SNAM natural gas network. Natural Gas conditions at battery limits are as follows:

OperatingPressure (1) :	15 min ÷20 nominal barg
Operating Temperature :	0÷25 °C
Design Pressure :	
Design Temperature :	

Composition (Typical) (1) :				Reference	min	max
Methane	CH_4	% vol	:	92.597	70.1	99.7
Ethane	C_2H_6	% vol	:	3.455	0.06	8.99
Propane	C_3H_8	% vol	:	0.854	0.01	1.55
Iso-Butane	C_4H_{10}	% vol	:	0.127	0.01	0.21
Normal-Butane	C_4H_{10}	% vol	:	0.185	0.00	0.25
Nitrogen	N_2	% vol	:	2.782	0.11	14.83
Total dry		% vol	:	100		
Water	H_2O	% vol	:	0.015 max.		
Low Heating Value			:	47510 kJ/kg		
MW			:	17.23		

Note (1): assumed values; the minimum operating pressure shall be confirmed by SNAM

3.2 FUEL OIL

	Pressure barg	Temperature °C
Minimum	9.8	90
Normal	10.8	95
Maximum	11.8	105
Mechanical Design		

<u>Analysis</u>

Low heating value	41232	kJ/kg
Density at 15°C	949	kg/m^3
Viscosity at 100°C, cSt		
Viscosity at 50°C, cSt		
Sulfur content	≤ 0.3	% weight
Nitrogen content	0.3	% weight

3.3 REFINERY FUEL GAS

	Pressure barg	Temperature °C
Minimum	3.5	38
Normal	3.5	
Maximum		
Mechanical design	8.5	70

Average composition, % vol.:

H_2	:	72.90
CH_4	:	10.91
C_2H_4	:	0.33
C_2H_6	:	7.03
H_2S	:	0.00
C_3H_6	:	0.36
C_3H_8	:	5.46
C_4H_8	:	0.12
$i\text{-}C_4H_{10}$	:	1.61
$n\text{-}C_4H_{10}$	:	1.03
C_5H_{12}	:	0.22
C_6H_{14}	:	0.03

MW : 9.77
Low Hating Value: 58230 kJ/kg

3.4 LPG

LPG liquid characteristics is as follow:

		Pressure bar g	Temperature °C
Normal	:	8	40
Mechanical Design	:	….	…..

LPG Vaporized Average composition, % vol.:

C_2H_6	:	2.60
C_3H_6	:	2.10
C_3H_8	:	33.81
C_4H_8	:	4.55
i-C_4H_{10}	:	15.87
n-C_4H_{10}	:	37.92
C_5H_{12}	:	3.15
Low Heating Value	:	45916 kJ/kg
MW	:	52.7

3.5 COOLING TOWER

	Pressure barg	Temperature °C
Cooling water supply		
Minimum	4.0	
Normal	4.0	32
Mechanical design	5.0	66
Cooling water return		
Minimum	2.0	

Normal	2.0	38
Maximum		38

3.6 MACHINERY COOLING WATER

For machinery cooling a closed circuit is provided. Demineralized water is charged with corrosion inhibitor and 20% wt. Ethylene Glycol:

Operating pressure	:	4.0	barg
Mechanical design pressure	:	10.0	barg
Maximum user pressure drop	:	1.0	bar

Supply temperature	:		
Normal	:	20	°C
Maximum	:	37	°C

Mechanical design temperature: 70 °C

Maximum temperature difference at users: 6°C

3.7 BOILER FEED WATER

	Pressure barg	Temperature °C
Normal	21	120
Mechanical Design	31	135

3.8 SERVICE WATER (WELL WATER)

	Pressure barg	Temperature °C
Minimum	3.0	
Normal	5.0	30
Mechanical design	10	50

3.9 DEMINERALIZED WATER

Operating pressure	:	4.0	barg
Mechanical design pressure	:	7.0	barg
Operating temperature	:	ambient	°C
Mechanical design temperature	:	50	°C

Characteristics : Demineralized water must satisfy the following limits when analyzed according to ASTM procedures

Parameter	**Unit**	**Limit**	**Procedure**
Total Hardness	°F	0(1)	ASTM D1126
Total Dissolved solids	ppm	= 0.1	ASTM D 1888
pH@25°C$^{(2)}$		6.5÷7.5	ASTM D 1293
Conductivity @ 25°C (2)	µS/cm	= 0.15	ASTM D 1125
Silica (as SiO_2)	mg/l	= 0.02	ASTM D 859
CO_2	mg/l	= 0.01	ASTM D 516
K	mg/l	= 0.01	ASTM D 4191
Fe	mg/l	= 0.01	ASTM D 1068
Cu	mg/l	= 0.01	ASTM D 1688

Notes:
(1) or undetectable by current analytical techniques;
(2) pH and Conductivity measurements shall be made when water is CO_2 free.

3.11 COMPRESSED AIR:

	Pressure barg	Temperature °C
Plant air		
Minimum	5.0	
Normal	6.0	38
Mechanical design	10.5	70

Instrument air

Minimum	3.0	
Normal	3.5	38
Mechanical design	14.7	70
Dew Point at 7.0 barg		- 40 °C

3.12 NITROGEN

Source: Air Liquide Floxal Unit (about 30 m^3 of liquid pure nitrogen is also available).

Operating Temperature	:		°C
Design Temperature	:		°C
Minimum Oper. Pressure	:	8.0	barg
Mechanical design	:	14.7	barg

Composition, % volume

Nitrogen	:	99.5	%
Oxygen	:	0.5	%

3.13 STEAM AND CONDENSATE

Refinery steam and condensate characteristics are the following:

	Pressure barg	Temperature °C
High pressure (HS)		
Minimum (for thermal design)	42.6	430
Normal	43.0	440
Maximum	45.0	450
Mechanical design	50.0	480

	Pressure barg	Temperature °C
Medium pressure (MS)		
Minimum (for thermal design)	9.8	180
Normal	10.8	220
Maximum	12.0	240
Mechanical design	15.0	260
Low pressure (LS)		
Minimum (for thermal design)	3.0	Saturated
Normal	3.5	Saturated
Maximum	3.5	148
Mechanical design	5.0	180
Steam condensate		
(give for each level required)		
Minimum	2.2	--
Normal	2.5	150
Mechanical design	5.0	225
Low Low pressure (LLS)		
Minimum (for thermal design)	0.5	Saturated
Normal	1.2	Saturated
Maximum	1.5	122
Mechanical design	3.0	170

4.0 EXPORT UTILITY

The following utilities are available at plant battery limits to be exported to external users.

4.1 STEAM

HP Steam

Operating Pressure	:	43	barg
Operating temperature	:	440	°C
Steam Quality	:	Superheated	

IP Steam

Operating Pressure	:	11	barg
Operating temperature	:	220	°C
Steam Quality	:	Superheated	

LP Steam

Operating Pressure	:	3.5	barg
Operating temperature	:	148	°C
Steam Quality	:	Saturated	

4.2 BOILER FEED WATER

HP BFW to users

Operating Pressure	:	44	barg
Operating temperature	:	105	°C

MP BFW to users

Operating Pressure	:	12	barg
Operating temperature	:	105	°C

4.3 ELECTRICAL POWER

HV Network	:	132 kV
MV primary distrib. System	:	20 kV
MV secondary distrib. System	:	6 kV
LV primary distrib. System	:	400 Vac – 230 Vac
UPS	:	230 Vac
D.C. for safety & pre-circuit	:	110 Vcc
Motor $\geq$ 200 kW	:	6 kV
Motor < 200 kW	:	400 Vac – 230 Vac
Aux. Circuit	:	110 Vca
Lighting System	:	230 Vac
Frequency	:	50 Hz

CLIENT:	TAMOIL REFINERY
LOCATION :	CREMONA, ITALY
PROJECT NAME:	NEW COGENERATION PLANT IN CREMONA
CONTRACT NO:	1-BD-0238A
UNIT NO:	300
EQUIPMENT NAME:	STEAM TURBINE AND GENERATOR PACKAGE
EQUIPMENT TAG NO:	PK-301

ISSUED BY : A. BEFFANI
CHECKED BY : A. PALUCCI
APPROVED BY : R. DOMENICHINI

Date	**Revised Pages**	**Issued by**	**Checked by**	**Approved by**
June 2005	First Issue	A. Beffani	A. Palucci	R. Domenichini

STEAM TURBINE AND GENERATOR PACKAGE

PK-301

INDEX

1.0 INTRODUCTION

Scope of this Functional Specification is the definition of the basic technical requirements for the supply of one Steam Turbine coupled with an Electrical Generator to be part of a new generation power plant to be built in TAMOIL Refinery in Cremona, Italy.

Vendor's supply shall include all the items enclosed in this specification as well as any other accessory and additional equipment that the Vendor deems necessary for the good performance and the smooth, trouble free and safe operation of the package being supplied.

Vendor shall select the Steam Turbine frame so that its nominal electric power output is close to 23 MWe.

2.0 SCOPE OF SUPPLY

2.1 Description of the Equipment

The Steam Turbine (item ST-301) connected to a generator (item G-301) has the duty to produce electric power and provide steam to be supplied to the adjacent refinery.
The steam turbine shall be backpressure type with intermediate extraction.
It shall be suitable for indoor operation.
The HP superheated steam delivered to the steam turbine is produced both by a HRSG on gas turbine discharge and/or by a conventional boiler at constant pressure (59 bar g).
The IP steam extraction pressure and the LP discharge pressure are to be kept constant.
A bypass system is provided (by others) to route the HP steam to MP and LP steam headers in case of steam turbine out of operation.

2.1.1 Materials

The equipment and materials included in this specification shall be considered as a minimum requirement and Vendor shall recommend any additional feature and or improvement required for optimum operation of the equipment and for the specified services.
They shall be integrated with all those elements that normally are necessary for the operability and safety of the plant, even if these are not expressely mentioned in the specification.
The supply shall include but not be limited to the following main equipment (to be confirmed by Vendor).

A. Mechanical Equipment

Steam Turbine

1. One backpressure Steam Turbine, including stop, check and control valves.
2. Reduction gear and relevant coupling joints (if required).
3. Automatic turning gear (a.c. motor driven and hand operation facilities shall also be provided).
4. Lube and control oil system complete with pumps, electric motors, filters, coolers, oil purifier, instrumentation and piping.
5. Drainage system including valves, attemperators (if any) and piping.

6. Turbine drying system for preservation during long shutdown periods.
7. Thermal insulation.
8. Gland steam system and relevant control valves, related interconnecting piping and attemperators, piping, etc.

Ancillary equipment

1. Structural steel including supporting structures, platform and ladders for access to the equipment, where required for operating requirements.
2. Piping: all lines interconnecting the equipment within Vendor's scope of supply.
3. Acoustic enclosure for Steam Turbine, generator and auxiliaries suitable for indoor installation complete with ventilation system, ducts, power sockets, normal and emergency lighting system.
4. Base plates and anchor bolts.
5. Firefighting system (optional, separate quotation).

B. Electrical equipment

1. Electric Generator coupled to the Steam Turbine, and relevant auxiliaries, complete of:
   - static excitation system with relevant dry type transformer and automatic voltage regulator (AVR);
   - Generator control system (including synchronization system);
   - Generator metering and protection system (separate quotation);
   - Generator cooling system complete with all the required ancillaries.
2. Line cubicle with VT's.
3. Generator CT's for protection and measuring.
4. Star point grounding cubicle.
5. Control and protection cabling: all cables required to interconnect the equipments within Vendor's scope of supply (50m average length shall be considered).
6. Power cabling: direct power connections between excitation transformer and excitation panel and between the excitation panel and the sliprings of the generator.

C. Instrumentation

1. Steam Turbine Governor.
2. Steam Turbine control panels.
3. Safety valves, where required.
4. Field instrumentation.
5. Instruments cabling: all cables interconnecting the equipment within Vendor's scope of supply.
6. Generator partial discharge measurement system (separate quotation).

D. General

1. First filling.
2. Items, motors and auxiliary equipment deemed necessary to satisfy the requirements of this specification. DC motors shall be complete of starting resistors
3. Spare parts for commissioning and start-up.
4. Special tools deemed necessary for installation and ordinary maintenance of the unit including those required for the generator rotor removal.
5. Any other accessory, ancillary equipment etc. which the Vendor deems necessary for the optimum operation of the package.

Material, equipment, drivers and appurtenances shall be sized, fabricated and assembled as far as it is possible, and intended to constitute equipment capable to carry out the duty specified.

2.1.2 Services

The bidder shall provide at least the following services:

1. Process, mechanical, electrical and structural design for the equipment.
2. Design engineering and complete responsibility of coupling with generator.
3. Standard shop inspection and tests.
4. Standard site inspection and tests (separate quotation).
5. Transport from workshop to site on foundation (separate quotation).
6. Supervision to erection.
7. Commissioning and startup supervision (separate quotation).
8. Operators training (separate quotation).

9. Performance test witnessing, including test procedure write-up.

2.2 Documentation

Vendor shall provide at least the following information:

A. During proposal stage

General

A.1. Exceptions and clarifications to this functional specification (if any).

A.2. Equipment list.

A.3. Scheduling and quality plan.

A.4. Sub-suppliers list.

Performance

A.5. Performance data including:
- heat and material balances;
- utilities consumptions;
- electrical consumptions.

A.6. Electrical load list, including
- loads to be supplied from emergency A.C. power supply;
- D.C. loads (Vendor to state the battery autonomy required);
- Consumption, duty cycle and starting sequence of loads fed by emergency power supply.

A.7. Equation and/or correction curves to evaluate the Steam Turbine performance for different inlet steam conditions and different steam exhaust pressure.

A.8. Start up procedures, schedules and main parameters transient curves from:
- Cold conditions;
- Warm conditions;
- Hot conditions.

(Vendor shall define Cold, Warm and Hot conditions).

A.9. Degradation curves.

A.10. Generator capability curves, in accordance with CEI EN 60034-3 fig. 3.

A.11. Generator capability diagram (see CEI EN 60034-3 fig. 2).

A.12. Conventional generator efficiency and losses curves; generator electrical carachteristics.

A.13. Guaranteed figures.

A.14. Noise data (guaranteed values).

Description

A.15. Detailed description of the supplied equipment including scope of supply and battery limits (with operating and design conditions).

A.16. Control Loops/Logics Description.

A.17. Control system and safety system description.

A.18. Summary of Emergency Shutdown signals.

A.19. Exciter and AVR description.

A.20. Construction materials.

A.21. Packing list.

Drawings

A.22. Process flow diagrams.

A.23. P&I diagrams showing major control loops, major line size, start-up lines, limits of supply.

A.24. Layout drawing of the proposed unit showing main dimensions and weights of the main machines and of the auxiliary equipments.

B. During contractual stage

B.1. Installation drawings.

B.2. All information necessary for the execution of the plant engineering and erection, commissioning and start-up.

B.3. Instrument and electrical functional logic specification (including control loops and binary logic diagrams) for package operation to be implemented in the DCS supplied by Others.

B.4. Electrical functional and wiring diagrams.

B.5. Instrument/electrical interconnection and cable list.

B.6. Performance test procedure (at least 6 months before the package mechanical completion).

B.7. Specified number of sets of Operating and Maintenance manuals (at least 3 months before the package mechanical completion). Operating and Maintenance manuals shall be in Italian language.

B.8. As built documents and drawings

Reliability Availability and Mantainability

B.9. Reference List.

B.10. Reliability/availability information. Recorded data from similar units.

B.11. Maintenance schedule and maintenance costs.

B.12. Spare parts list for commissioning and start-up.

B.13. Detailed priced spare part list for two years operation.

2.3 Exclusions

The following parts are excluded from the Vendor's scope of supply:

1. Civil works and civil design.
2. Steam Turbine bypass system.
3. Grounding system.
4. Distribution boards (MCC, DC and UPS) for electrical auxiliaries.
5. All power cables and bus ducts, except the direct power connection between the excitation panel and the sliprings of the generator.
6. Instrument and control cables for interconnection with equipments not included in Vendor's scope of supply.

2.4 Limits of Supply

Mechanical battery limits (refer also to the Schematic Flow Diagram enclosed in Attachment A.2):

HP Steam admission:	Inlet of HP Steam stop valve.
IP Steam extraction:	Outlet flange of the check valve.
LP Steam discharge:	Outlet flange of check valve.
Machinery Cooling Water:	Single inlet/outlet flanges including block valves.
Utilities:	Block valves on each inlet/outlet line.
Base Plates:	Lower ends of all base plates.

The Electrical and Instrument battery limits are:

Generator : output terminals

Excitation transformer	:	MV incoming terminals
Motors	:	power cable terminals
Generator/turbine control panel	:	incoming power supply terminals; outgoing control terminals (only toward equipments not included in Vendor's scope of supply).
Instruments	:	Infield junction terminal boxes for incoming and outgoing instrumentation and control cables from/to the DCS (supplied by others).

2.5 Limits of this Specification

The description and requirements contained in this specification cannot completely cover all the features of the required equipment. Anyway it has to be clear that equipment and relevant auxiliaries shall be complete of all the accessories necessary for a good operation of the equipment, within the limits of supply listed in paragraph 2.4 and with the exclusions listed in paragraph 2.3.

2.6 Coordination

Vendor is the only responsible of the supply, therefore Vendor shall coordinate, expedite and resolve all the problems with his sub-suppliers. Vendor shall be responsible for ensuring that all relevant information and documentation is passed on to his sub-suppliers, since all information pertaining to the equipments being supplied by the sub-suppliers may not be necessarily repeated in the relevant section of the requisition.

3.0 BASES OF DESIGN

The Steam Turbine, the Electrical Generator and all associated equipments shall be supplied in accordance with the following ambient conditions, utility characteristics and battery limits conditions.

3.1 Codes and Standards

The package shall be complied in accordance with the main international standard and codes. All special requirements for steam turbine and electrical generator for refinery services shall be also considered.

3.2 Site Conditions

Reference shall be made to the “Ambient Conditions & Utility Characteristics” enclosed in Attachment A.1

3.3 Utility Characteristics

Reference shall be made to the “Ambient Conditions & Utility Characteristics” enclosed in Attachment A.1.

3.4 team Quality

Vendor shall provide the minimum acceptable quality for HP steam admitted to the machine.

Conductivity (after strong cation exchanger),	µS/cm	....
Silica (SiO2),	ppb	....
Na +K	ppb	....
Fe,	ppb	....
Cu	ppb	....

3.5 Electrical Generator

The rating of the generator shall match the Steam Turbine performance within the complete range of operation with an acceptable margin (not less than 5% at normal operating condition).
The absolute temperature and temperature rise of generator shall never exceed the prescribed values at rated voltage, rated frequency, rated power factor as per paragraph 7.0, whichever are the operating conditions.

3.6 Noise

All the necessary measures will be taken to reduce the noise level down to acceptable values in the working areas where continuous personnel attendance is required.
Sound emission from each component continuously operating shall correspond to a maximum sound pressure level of 85 dB(A) at 1 m from any point of the Steam Turbine and any other equipment included in the scope of supply.
Piping connecting Safety Valves and silencer shall be insulated to reduce sound level at 85 dB(A) at 1 m or at nearest platform.

4.0 PROCESS DATA

4.1 Performance Data

The Steam Turbine is fed with HP steam, whose characteristics are specified in tables 4.1 and 4.2.

Steam Turbine Design Case is shown in Table 4.1. It corresponds to HRSG and Conventional System Boiler operating at 15°C ambient temperature, with steam export for district heating system (winter period).

Steam Turbine Off-Design Case is shown in Table 4.2. It corresponds to the HRSG and Conventional Boiler operating at 15°C ambient temperature, without steam export for district heating system (summer period).

Vendor shall optimise the machine for the steam characteristics and for the back pressure shown in Table 4.1 and 4.2.

Table 4 .1 – Design Case: Steam Turbine Material Balance

Case a. Winter period with air compressor steam turbine driven in operation

Ambient temperature	°C	15
HRSG and Convent. Boiler in operation		postfiring on
HP Steam to steam turbine		
Flowrate	t/h	192
Temperature	°C	460 (1)
Pressure	bar g	59 (1)
IP Steam extraction		
Flowrate	t/h	100 (2)
Temperature	°C	by Vendor
Pressure	bar g	12
LP Steam Discharge		
Flowrate	t/h	92 (2) (3)
Pressure	bar g	4.0
Enthalpy	kJ/kg	By Vendor
Generator Power Output	MWe	By Vendor

Case b. Winter period with air compressor motor driven in operation

Ambient temperature	°C	15
HRSG and Convent. Boiler in operation		postfiring on
HP Steam to steam turbine		
Flowrate	t/h	192
Temperature	°C	460 (1)
Pressure	bar g	59 (1)
IP Steam extraction		
Flowrate	t/h	83 (2)
Temperature	°C	By Vendor
Pressure	bar g	12
LP Steam Discharge		
Flowrate	t/h	109 (2) (3)
Pressure	bar g	4.0
Enthalpy	kJ/kg	By Vendor
Generator Power Output	MWe	By Vendor

Notes:
(1): upstream filters and stop valves
(2): vendor to confirm
(3): vendor to advise the minimum flowrate through LP steam extraction

Table 4.2 – Off-Design Case: Steam Turbine Material Balance

Case a. Summer period with air compressor steam turbine driven in operation

Ambient temperature	°C	15
HRSG and Convent. Boiler in operation		postfiring on
HP Steam to steam turbine		
Flowrate	t/h	103
Temperature	°C	460 (1)
Pressure	bar g	59.0 (1)
IP Steam extraction		
Flowrate	t/h	81 (2)
Temperature	°C	By Vendor
Pressure	bar g	12
LP Steam Discharge		
Flowrate	t/h	22 (2) (3)
Pressure	bar g	4.0
Enthalpy	kJ/kg	By Vendor
Generator Power Output	MWe	By Vendor

Case b. Summer period with air compressor motor driven in operation

Ambient temperature	°C	15
HRSG and Convent. Boiler in operation		postfiring on
HP Steam steam turbine		
Flowrate	t/h	103
Temperature	°C	460 (1)
Pressure	bar g	59.0 (1)
IP Steam extraction		
Flowrate	t/h	64 (2)
Temperature	°C	By Vendor
Pressure	bar g	12
LP Steam Discharge		
Flowrate	t/h	39 (2) (3)
Pressure	bar g	4.0
Enthalpy	kJ/kg	By Vendor
Generator Power Output	MWe	By Vendor

Notes:
(1): upstream filters and stop valves
(2): vendor to confirm
(3): vendor to advise the minimum flowrate through LP steam extraction

4.2 Utilities Consumption

Vendor shall indicate the consumptions of the below listed utilities, whose characteristics are shown in para paragraph 3.2.

Steam (*)	: .... t/h
Instrument Air	: .... Nm3/h (normal peak)
Plant Air	: .... Nm^3/h (normal peak)
Cooling Water (*)	: .... m^3/h (ΔT = by Vendor)
Auxiliary Electric Power	: .... kW

(*) splitted among the various users

For electric auxiliaries a complete load list shall be provided. The emergency power supply as well as the Direct Current power supply requirements shall be provided.
Load to be supplied by emergency diesel generator shall be pointed out.

Vendor shall advise about the necessity and consumption for other utilities not mentioned above, or specify limitation (low/high temperature, etc..) if any.

4.3 Chemical Requirements

Not applicable.

4.4 Reliability/Availability Information

Vendor shall provide all information necessary for the evaluation of the Equivalent Availability Factor of the supplied equipment/package.
"Equivalent Availability Factor" is the time based method for calculating availability as standardized by the North American Electrical Reliability Council "NERC" and ANSI/IEEE Std 762-1987.

EAF=(PH-FOH-EDOH)/PH

where:

- PH or Period Hours shall be number of hours in a year, equal to 8760 hours.
- FOH or Full Outage Hours shall be the Outage Hours in a period when the equipment was not capable of producing electric power due to Unplanned Maintenance and Planned Maintenance.
- EDOH or Equivalent Derated Outage Hours shall be the Outage Hours in a period when the output of the equipment is derated due to Unplanned Maintenance.

Moreover, Vendor shall indicate the planned maintenance schedule of the supplied equipment showing the following:

- Frequency of the maintenance operation;
- Maintenance operation description;
- Manhours/personnel required for maintenance operation;
- Maintenance estimated cost.

Vendor shall indicate the steam turbine life expenditure, in terms of equivalent hours operation, associated to each steam turbine startup/shutdown.

4.5 Gaseous Emissions

Not applicable.

5.0 MECHANICAL DESIGN DATA

5.1 Installation

The installation of the complete package is foreseen indoor.

5.2 Steam Turbine

The piping mechanical design conditions at Steam Turbine battery limits are listed here below:

HP Steam Inlet

- Mechanical design pressure: 70 barg;
- Mechanical design temperature: 510 °C.

IP Steam extraction

- Mechanical design pressure: 15 barg;
- Mechanical design temperature: 325 °C.

LP Steam Exhaust

- Mechanical design pressure: 6.0 barg
- Mechanical design temperature: 220 °C.

6.0 INSTRUMENTATION AND CONTROL SYSTEM

The control logic of the steam turbine must assure, when required, the control of the HP steam pressure upstream the turbine valves as imposed by the process requirements.

The Steam Turbine will normally operate with the inlet HP steam operating pressure at a constant value. The HP superheated steam delivered to the steam turbine is produced both by a HRSG and/or by a conventional boiler.
The HP section Steam Turbine admission valve will be trottled by the pressure controller located on the LP discharge pressure.
The MP section steam turbine admission valve will be controlled by the pressure controller located on the IP steam extraction pressure.

The control valves shall guarantee the safe start up and operation.

The turbine and generator control systems shall be arranged for local and remote operation.

Instrumentation shall be adequate to permit control, supervision, protection and testing of package operation and performance.

Dedicated temporary instrumentation, to be provided by the Vendor, will be used for performance test purposes.

Steam Turbine control system shall include at least the following subsystems:

- operation control providing the following functions:
  - automatic start-up and shutdown sequences;
  - control of the minimum steam pressure through the Steam Turbine admission valves;
  - regulation at Full Speed No Load conditions; furthermore the Steam Turbine shall be able to sustain a full load rejection without shut down (frequency control with generator circuit breaker open);
  - synchronizing facilities;
- temperature and vibration monitoring of turbine and generator
- overspeed protection under no load and emergency conditions.
- interfaces with remote DCS/EMS (supplied by other) for control, trip and supervision.

Steam Turbine and Generator control systems shall be microprocessor type.
For generator control system see points 7.3.1 and 7.3.2.
EMC requirements as per point 7.4.

7.0 ELECTRICAL SYSTEMS AND SYNCHRONOUS GENERATOR

The following design data shall be applied to the electrical generator and its own auxiliary services and to the electrical and instrumentation interconnections among all the equipment included in Vendor scope of supply up their battery limits.

Missing data marked with (*) shall be filled-in by Vendor.

7.1 Generator

The generator shall be synchronous, three-phase, round rotor type.

7.1.1 Main Characteristics

The main characteristics of synchronous generator shall be:

- Reference standards	IEC 60034 -3
- Rated power	(*) MVA at 40 °C primary coolant temperature
- Rated voltage	(*)± 5% Vendor std.
- Rated frequency	50 Hz ± 2%
- Rated power factor (lagging/leading)	0.85 /0.95
- Rated speed	3000 r.p.m
- Voltage and Frequency variations	Vn±5%;50Hz+2%;- 2%(2) Vn±5%;50Hz +3%; -5%(3)
- Duty service	continuous
- Number of phases	3
- Number of terminals	3+3 (cable or bus duct connection) – later
- Winding connection	star
- Star point grounding through high voltage resistance or grounding transformer	
- Thermal classification	F
- Temperature rise class	B
- Cooling method (IEC cooling designation)	(*)………. (Vendor Std)
- Primary Cooling medium:	air

(2) Continuous operation at rated output and rated power factor . Vendor to state max. temperature rise to be expected. See fig. 1 on IEC 60034-3.

(3) Continuous operation at rated output and rated lagging power factor 0.85 for single periods not exceeding 15 minutes, occurring not more than 10 times in a year. Vendor to state max. temp. rise to be expected. See fig.1 on IEC 60034-3

- Secondary Cooling medium	Water
- Type of cooling, rotor/stator	(*)…../(*)…….
- Total water flowrate	(*) …..m3/h
- Number of cooler(s) (sections)	≥ 4 (Vendor Std)
- Coolers position	Bottom preferred (Vendor Std)

- Max. power output with one cooler section out of service (without exceeding temperature rise class at primary coolant temp. below 40 °C) 67% of rated power

- Installation	indoor
- Sound pressure level	≤ 85 dB(A) at 1.0 m
- Mechanical protection degree:	(*)……
- Direct axis synchronous reactance	(*) p.u.
- Direct axis transient reactance	(*) p.u.
- Direct axis sub-transient reactance	(*) p.u. (> 0.1 p.u. saturated)
- Direct axis aperiodic time constant	(*)…… s
- Direct axis sub-transient short circuit time constant	(*)…… s
- Direct axis transient short circuit time constant	(*)……. s
- Direct axis transient open circuit time constant	(*)……. s
- Short circuit ratio (KC)	(*)

7.1.2 Generator Performance

Vendor to fill in the tables indicated below.

Ambient Temperature (°C)	**Water Coolant Inlet Temp (°C)**	**Primary Coolant Inlet Temp. (°C)**	**Power Output at Generator Terminal (MW)(**)**	**Generator Efficiency (%)**	**Actual Operating Temperature (°C)**		
					Stator	**Rotor**	**Iron**
-8	10						
15	25						
40	37						

(**) at rated inductive power factor (0.85), rated voltage, rated frequency

b) Capability at maximum admissible IEC temperature consistent with class B temperature rise

Ambient Temperature (°C)	**Water Coolant Inlet Temp. (°C)**	**Primary Coolant Inlet Temp. (°C)**	**Max. Temperature (°C)**			**Generator Capability (MVA) (**)**
			Stator	**Rotor**	**Iron**	
-8	10					
15	25					
40	37					

(**) at rated inductive power factor (0.85), rated voltage, rated frequency

7.1.3 Losses

Losses at 100% of rated power : (*)…… kW at p.f. = 1
Losses at 100% of rated power : (*)… kW at p.f. = 0.85

The efficiency at rated power output, rated voltage and rated power factor shall exceed 98.5 %.

7.1.4 Instrumentation

At least the following shall be provided:

- Stator Winding temperature detectors (RTD's) dual type to monitor at least six points of stator winding
- Bearings temperature detectors (RTD's): 1 in oil, 1 in metal per bearing
- Vibration monitoring system: common with steam turbine
- Temperature monitoring system, common with steam turbine.

All monitored quantity shall be sent to generator or turbine control panel (according to Vendor standard) for alarm and protection management .

7.1.5 Mechanical Characteristics

- Lubricating system of generator shall be common with steam turbine lubricating system (Vendor Std).

- Coolers shall be complete of:
  - interception valves, both at water inlet and outlet;
  - water flow detectors;
  - relief and draining valves
  - temperature monitoring (according to Vnd. Std.)

The exclusion of each cooler (section) shall be possible also with generator in service, and without water flow interruption.

7.2 Excitation System

7.2. 1 Main Characteristics

The excitation system shall be static type, fed from generator terminals through a suitable excitation transformer, included in Vendor's scope.

The excitation system shall be capable of providing an adequate range of excitation to guarantee a sufficient margin of stability under all steady and transient load conditions and to guarantee that the regulation will keep the generator running within the acceptable limits of temperature rise and voltage.

When the generator is subjected to a sudden loss of maximum output at rated power factor, the excitation system shall be capable to limit the momentary over voltage to less than 120% of the rated voltage and shall restore the voltage to the nominal pre-set value with a tolerance of 2% within 3 sec.

Moreover the electronic equipment of the excitation system shall be designed to correctly operate with voltage reduction of ac voltage supply equal up to 80% of rated voltage (i.e. 20% residual voltage).

The exciter transformer shall be dry type, complete of protection enclosure for installation in electrical room.

Temperature of excitation system shall be monitored, according to Vendor standard

7.2.2 Excitation System Facilities

The excitation system shall provide the following facilities:

- Two digital Automatic Voltage Regulators (AVR), each formed of two regulation channels, automatic and manual (closed-loop controlled operation), with automatic change-over device:
- automatic regulation range — 80-110% V_n
- manual regulation range — 0-120% $I_{e\ rated}$
- regulation error — ±0.2% of setting value
- settable dead-band including zero as setting value
- Positive ceiling voltage — ≥ 200% - 2s [(1)]
- Rotor overcurrent — ≥ 150% - 10s
- Voltage regulation
- Power factor/reactive power regulation
- Voltage drop compensation up to 80% of the transformer voltage drop.
- Volt/Hertz limiter
- Overexcitation / Underexcitation limiter[(2)]
- Stabilising signals
- Fast de-excitation system
- Signalling and monitoring system (alarm and measurement)
- Local and remote control
- Panel board, free standing, protection degree ≥ IP31
- Cooling system: natural cooling preferred; Vendor standard accepted. If forced cooling is necessary, 100% redundancy shall be ensured.

(1) The excitation system shall be capable to force the exciter ceiling voltage for at least 2 s in case of three phase short circuit at high voltage side of step-up Transformer (rated power = generator MVA; Xcc=13%).

2) Over/underexcitation limits shall allow automatic voltage regulation with in the margin of the capability curve.

7.3 Generator Ancillary

7.3.1 Generator Control System

The generator control system shall control the exciter, AVR and shall be interfaced with the turbine control system.
It shall also include synchronising facility.
The generator control system shall be arranged for local and remote command. Interface with remote DCS (supplied by others) shall be provided via serial bus (standard communication protocol shall be selected). Hardwired connection for specific signals (to be specified later) shall be provided too.
A synoptic with typical electric indication shall be included in the generator control system. The synoptic shall also allow manual synchronisation with double voltmeter and frequencymeter.

7.3.2 Automatic Synchronization System

An automatic synchronising system shall be provided.
It shall be digital type. Synchronising automatic sequence start/stop shall be possible both locally and via DCS.

7.3.3 Protection System

Protective relays shall be of multifunction microprocessor design, PC programmable type.

Two redundant protection channels shall be provided. Each channel shall be self-sufficient so that the generator remains in service protected by one channel in case of failure of the other channel.
Main and back up protective functions of each channel shall be performed by different CPU's.

For each channel, the following protection functions shall be foreseen:

- 87G: generator differential relay
- 21: under impedance relay
- 46: reverse phase sequence relay
- 24: over-excitation relay
- 78: out of step relay
- 40: loss of excitation relay
- 32: reverse power relay
- 37: under power relay
- 64S: stator earth fault relay (both 100% and 95%)

- 59: stator over voltage relay
- 27: stator under voltage relay
- 59U $_0$: voltage displacement earth fault relay
- 81: over and under frequency relay
- 64R: rotor earth fault relay
- 60: voltage ba lance relay
- 50BF: breaker failure overcurrent relay
- 86B: lockout relays
- 3: trip circuit supervision relay
- 80: auxiliary supply on/off flag relay

7.3.4 Partial Discharge Measurement System (option)

Partial Discharge Measurement System for the generator shall be used for field and factory measurement and shall be capable for on-line application, with generator in service. Therefore the machine shall be arranged to allow the installation of pick-ups capacitors.
The system shall be of computerised type, composed, at least, by following elements:

- Set of capacitive pick-ups
- Interface unit;
- Processing unit;
- Serial interfaces;
- Portable personal computer with software;
- Calibration unit;
- Cabling and accessories.

Supplier shall state all main characteristics of system proposed, such as bandwidth, resolution time, historical memory capacity.

7.3.5 Other Accessories

Moreover, the following accessories shall be provided:

- generator heating resistors;
- brushes and slip rings for excitation system.

7.4 EMC Requirements

All the electronic equipment of the package shall comply with the emission and immunity levels prescribed in the following table.

Vendor shall state and motivate in the proposal offer, the deviation respect to the prescribed figures.

It is intended that EMC certificates shall be available at Vendor's shop and submitted on Purchaser's request.

REFERENCE STANDARDS	TEST or MEASUREMENTS	CLASS/TEST LEVEL
EN 55022	Conducted emission	
EN 55011		(group 1)
EN 61000-3-4	Harmonics emission	by Vendor
EN 61000-3-5	Flicker	by Vendor
EN 55022 EN 55011	Radiated emission	class B (group 1)
IEC 61000-4-2	Electrostatic discharge immunity	6 kV contact 8 kV air
ENV 50204 IEC 61000-4-3	Radio frequency Electromagnetic field Immunity	10 V/m
IEC 60801-4 IEC 61000-4-4	Electrical fast Transient/burst immunity	Power supply: 2 kV control lines: 2 kV signal lines: 1 kV
ENV 50142 IEC 61000-4-5	Surge immunity	2 kV line/ground 1 kV line/line

REFERENCE STANDARDS	TEST or MEASUREMENTS	CLASS/TEST LEVEL
ENV 50141 IEC 61000-4-6	Conducted disturbances Induced by radio-frequency Fields immunity	10 V
IEC/EN 61000-4-8	Power frequency magnetic field immunity	30 A/m
IEC/EN 61000-4-9	pulse magnetic field immunity	100 A/m
IEC/EN 61000-4-10	Damped oscillatory Magnetic field	by Vendor
IEC/EN 61000-4-11	voltage dips short interruption	to be defined by Vendor
IEC/EN 61000-4-12	Oscillatory waves Immunity	2 kV (CM) 1 kV (DM)

7.5 Induction Motors

7.5.1 Main Characteristics

The induction motors included in the scope of supply shall have the main following characteristics:

- Asynchronous type
- High efficiency
- TEFC type
- Protection degree motor: ≥ IP 54
  terminal boxes: ≥ IP 55
- Thermal insulation/temperature rise F/B
- Voltage and frequency variation Normal condition:
  zone A (as per IEC 60034-1 fig 14.)
  Exceptional conditions:
  zone B [1] (as per IEC 60034-1 fig 14.)
- Reference standards IEC 60034 series

Furthermore, motors shall be designed for direct starting at full voltage and for re-acceleration with 100% residual voltage, and for two consecutive starting at 80% of rated voltage.
In addition they shall keep in service their mechanical loads when the supply voltage at their terminals is 70% of rated voltage for 0.5 sec.
All DC motors shall be supplied complete of starting resistors.

[1] In this condition windings temperature shall not exceed 10°C over the temperature rise class B indication

7.6 Cabling

Main characteristics shall be:

- Flame retardant (safety circuits: flame resistant)
- Insulation material EPR or XLPE
- Instrumentation/control cables insulation level 0.6/1 kV
- Conductor material electrolytic copper
- Shielding:
  - copper braided mesh
  - covering percentage ≥ 85%
  - cross-section ≥ 10 mm^2
  - a single shield for each couple of 4-20 mA and RTD signal

Reference standards IEC 60332 – 3 for power cables
IEC60754-1/2 for control instrument and on-board cables.

- Average length 50 m
- Quotation in Euro/meter for length above 50 m to be provided by Vendor.

8.0 PERFORMANCE GUARANTEES

8.1 Reference Conditions

Atmospheric pressure	1013 mbar
Ambient temperature:	15 °C
Relative Humidity:	75 %
Steam Turbine performance data:	see Table 4.1 and Table 4.2
Cooling water supply temperature:	25 °C
Power factor:	0.85 lagging

8.2 Guarantees

The following performances at the reference conditions listed in para. 8.1 shall be guaranteed by Vendor:

- Generator power ouput : ………… kW
- Auxiliaries consumption : ………… kW
- Noise : < 85dB(A) indoor
- Operating reliability : 99%

Furthermore, the Manufacturer shall guarantee that equipment supplied and all parts thereof shall be suitable for the intended use and free from defects in material and workmanship defects due to design.

8.3 Correction Curves

Vendor shall provide correction curves in order to evaluate the package performances at operating conditions different from the reference ones listed at para 8.1.

8.4 Steam Turbine Performance Test

Steam turbine performance tests and calculations shall be done using ASME PTC 6 guidelines. Noise measurements will be carried out in accordance to ISO procedures.
Vendor shall submit a detailed testing procedure to be discussed during detailed engineering and mutually accepted prior to actual testing.

ATTACHMENT A.1

AMBIENT CONDITIONS & UTILITY CHARACTERISTICS

CLIENT: TAMOIL
LOCATION: CREMONA – ITALY
PROJECT NAME: NEW COGENERATION PLANT
CONTRACT NO:
UNIT NAME: HEAT RECOVERY STEAM GENERATOR

ISSUED BY : A. BATTAGLIA
Checked by : A. BATTAGLIA
APPROVED BY : R. DOMENICHINI

Date	Revised Pages	Issued by	Checked by	Approved by
May 2005	First issue	A. Battaglia	A. Battaglia	R. DOMENICHINI

HEAT RECOVERY STEAM GENERATOR

INDEX

HEAT RECOVERY STEAM GENERATOR

1. INTRODUCTION

Scope of this functional specification is the definition of the technical requirements for the supply of one (1) Heat Recovery Steam Generator (HRSG) equipped with Postfiring System to be installed downstream a 25 MWe gas turbine (GT) for the Combined Cycle Power Plant to be erected in the Tamoil refinery in Cremona (Italy).

Vendor's supply shall include all the items enclosed in this specification as well as any other accessory and additional equipment the Vendor deems necessary for the good performance and the smooth, trouble free and safe operation of the package being supplied.

2. SCOPE OF SUPPLY

2.1. DESCRIPTION OF THE EQUIPMENT

The HRSG shall be designed for outdoor installation, will be fed by the exhaust gases coming from the Gas Turbine firing Natural Gas and/or vaporized LPG. **HRSG shall be vertical forced circulation type or horizontal natural circulation type. The area available for the HRSG insallation is 40x20 meters. Vendor shall define in the offer the boiler proposed type**. HRSG shall be equipped with burners Low NOx type for supplementary firing suitable to operate with Refinery Gas and/or Distillate Oil.

The HRSG shall be single pressure, and shall provide superheated steam for steam turbine. Degassing section shall be integrated in the HRSG.

The HRSG is suitable to generate and to superheat steam at high pressure (60 barg at HRSG B.L.) and it is constituted of the following coils (from the bottom to the top):

- HP superheater (1^{st} section)
- HP superheater (2^{nd} section)
- HP evaporator
- HP economizer
- LP steam drum (feedwater tank) equipped with degassing section

Exhaust gases enthalpy is increased by firing additional fuel in the post-combustion in line section, then enter the HRSG, flow counter current the above listed steam/water coils and finally they are discharged to atmosphere at a temperature of 115 °C through the stack when firing Natural Gas. The HRSG stack shall be equipped with silencer.

The HRSG shall be equipped with SCR system assuring a NOx emission level not exceeding 30 mg/Nm^3 at 15% O_2 dry gases.

When gas turbine is out of service or under maintenance a guillotine installed on the gas turbine's outlet duct isolates the HRSG from GT allowing the HRSG operation in fresh air mode while the air fan supplies the necessary combustion air.

Demineralized makeup water and condensate return from Refinery are sent to the integrated deaerator. Water is recirculated in the LP generator by means of the LP circulation pump (only for vertical boiler solution, in any case the pump is out of HRSG vendor scope of supply). In case the LP steam self produced is not enough to cover the degassing needs the excess steam is taken from the LP steam header, on the contrary if LP steam production is in excess the LP section pressure is increased up to reach the equilibrium.

Vendor shall verify in which operation conditions (if any) it is necessary to by-pass the LP generator in order to avoid any acid dew point phenomena.

Boiler Feed Water for HP services is taken from the LP steam drum (feedwater tank) and delivered to the relevant sections/users by means of dedicated HP boiler feed water pumps (out of scope of supply). The BFW enters the HRSG at the temperature of 120°C.

HP Boiler Feed Water flows through the HP Economizer coils and feeds the HP Steam Drum. Level is maintained by adjusting the position of the relevant BFW control valve (out of scope of supply) through a three variables control logic.

HP Boiler Water is recirculated in the HP generator by means of the HP circulation pump (only for vertical boiler solution, in any case the pump is out of HRSG vendor scope of supply).

During start-up phase, or in case of high level in the HP Steam Drum, an overflow valve discharges the excess of water to the continuous blowdown tank (out of scope of supply).

HP Steam Drum operating pressure is sliding, according to ambient conditions and Combined Cycle load. The normal operating pressure is 62,5 barg. The steam turbine admission valves (out of scope of supply) adjust their stroke to maintain the HP Steam Drum operating pressure above a minimum value (30 barg, vendor to confirm).

Generated HP steam is superheated in the HP Superheater coils and sent to the HP section of a Steam Turbine (out of scope of supply).

To control the maximum value of the HP superheated steam final temperature (465°C), a desuperheating station, located between HP superheater coils, has to be provided by vendor.

Cooling medium is HP BFW taken on the HP BFW pumps discharge and adjusted through a dedicated temperature control valve.

During start-up phase, or in case of high level in the LP Steam Drum, an overflow valve discharges the excess of water to the continuous blowdown drum (out of scope of supply).

Continuous HP and LP blow-down flowrates are adjusted by means of dedicated angle valves (out of scope of supply) and they are sent to a dedicated blow-down drum (out of scope of supply).

Intermittent HP and LP blow-down flowrates are adjusted by means of dedicated angle valves (out of scope of supply) and sent to a dedicated atmospheric blow-down drum together with the possible overflows coming from the Steam Drums (out of scope of supply).

This drum (the atmospheric blow-down drum) also collects the blowdown coming from the continuous blow-down drum.

2.2. DESCRIPTION OF SUPPLY

2.2.1. MATERIALS

Scope of supply shall include, but not limited to, the items listed in the following.

Vendor shall integrate them with all those elements that normally are necessary for the operability, maintenance and safety of the equipment, even if these are not expressly mentioned in the specification.

1) HP superheater coils;
2) HP evaporator coil;
3) HP 1st and 2nd economizer coils;
4) LP evaporator coil;
5) HP steam drum with double stage internals;
6) LP steam drum with internals;
7) Deaerator with spry nozzles, baffle plates, steam extraction system, etc.
8) Intermediate HP steam water spray desuperheater with relevant water spray control valve;
9) Safety valves on Steam Drums, at Superheaters and relevant silencers according to local regulations requirements;
10) Dual Fuel (Refinery fuel gas and/or fuel oil) Post-firing system including main burners sets, pilots, electrical ignitors, flame monitoring system and local panel for burners start up and shut down;
11) Air fan suppling the necessary combustion air to the above post firing system;
12) Fuel piping and intruments (skid mounted) including block and vent valves and relevant control valves, safety valves, local instruments, field instrumentation and transmitters;

13) Burner Management System;

14) Retractable type sootblowers elecrtric motor driven, with valves for the steam distribution and for condensate draining, local control panel and platform for the operation and maintenance of the sootblowers (vendor shall define the sootblowers quantity in order to assure the tubes cleaning).

15) Drains network collecting all drains of the package to ground level;

16) Internal casing insulation and lining;

17) All exhaust gas ducting from Gas Turbine expansion joint outlet to HRSG inlet and from HRSG outlet to the relevant stack.

18) Stack up to 60m elevation, equipped with silencer, ladders, stairs, flue gas sampling points platforms for flue gas pick-up and analysis. The stack shall be sized to take in charge the flue gases coming from the conventional boiler of the plant;

19) SCR system including catalist, relevant anchoring/supporting system, facilities for catalis removal and all piping for chemicals distribution. **In order to have one type of catalist in the plant, the supplier shall accept to finalize the catalist selection toghether with the supplier of the conventional boiler.**

- Valves, filters, drains and vents within the limits of supply;
- Piping connecting equipment included in the scope of supply;
- All vents with relevant double valves and piping to safe location;
- Shell structure-supporting equipment.

2.2.2. SERVICES

Vendor shall provide at least the following services:

20) Design, engineering and procurement;

21) Delivery Materials Free on Board (FOB);

22) Erection supervision;

23) Precommissioning, commissioning and start-up assistance and supervision;

24) Operators Training;

25) Performance Test witnessing and test procedure write up;

26) Refractory dry-out (if required);

27) Chemical cleaning and boiler conservation, including equipment, chemical and specific waste water treatment after cleaning.

2.3. DOCUMENTATION

Not applicable at this stage of the project.

2.4. EXCLUSIONS

The following items are specifically excluded from the scope of supply:

1) Boiler Feed Water pumps and relevant drivers;
2) HP and LP circulation pumps and relevant drivers;
3) HP and LP Steam Drums level control valves and associated piping;
4) HP and LP Steam Drums overflow control valves;
5) HP and LP continuous blowdown valves;
6) HP and LP intermittent blowdown valve;
7) Field instrumentation on steam/water side;
8) Chemical injection system;
9) Continuous/intermittent blow-down drums;
10) Civil works: only foundation loads and underground network information are required;
11) Control room and control room instrumentation;
12) Wiring between junction boxes and control room;
13) Electrical power systems and lighting;
14) Main earthing grid;
15) Utilities supply;
16) Piping outside HRSG battery limits;
17) Pipe rack;
18) Final painting;
19) Piping and drums thermal insulation;
20) Fire fighting system;
21) Expansion joint between Gas Turbine and HRSG inlet duct;
22) Flue gas continuos monitoring system;

2.5. LIMITS OF SUPPLY

Limits of supply are shown on the Schematic Flow Diagram attached to the end of this Functional Specification (Attachment A.1).

- HP Steam:	- stop/check valve outlet flange on HP superheated steam line to Steam Turbine;
- LP Steam:	- stop/check valve inlet flange on Deaerator
- HP Boiler Feed Water:	- block valve inlet flange on the HP economizer inlet line;
	- block valve inlet flange on HP BFW line to spray water control valve.
- LP Boiler Feed Water:	- block valve inlet flange on the LP Evaporator inlet line;
- Condensate:	- block valve on Deaerator inlet flange
- HP overflow:	block valve outlet flange.
- LP overflow:	block valve outlet flange.
- Each Fuel for postfiring:	block valve inlet flange on fuel skid (postfiring).
- Flue gas:	GT expansion joint outlet;
- Chemicals injection:	Double valves on HP and LP Steam Drums.
- Chemicals injection for SCR:	inlet flange on the chemicals distribution lines
- Continuous blow-down:	Double valves on HP and LP Steam Drums.
- Steam & air for sootblowers:	connections to the sootblowers; main distributing valve and drain valve are supplied loose.
- Intermittent blow-down:	Double valves on HP and LP Steam Drums.
- Vents:	Safe location.
- Fluid sampling:	Double valves on the line connections.
- Instrument Air:	Users;
- Drains:	Outlet flanges of the drain manifolds.
- Instrument cables:	Junction boxes included in scope of supply.
- Tracing System:	Tracing cables junction boxes.

- Safety valves:	- Steam: silencers outlet at safe locations;
	- Water: outlet flanges of the drain manifolds.

2.6. LIMITS OF THIS SPECIFICATION

The description and requirements contained in this specification cannot completely cover the required equipment. Anyway, it has to be clear that equipment and relevant auxiliaries shall be complete of all the accessories necessary to a good operation of the equipment, within the limits of supply listed on paragraph 2.5 and with the exclusions listed on paragraph 2.4.

2.7. COORDINATION

The HRSGs Vendor shall coordinate, expedite and resolve any problems with his sub-suppliers. Vendor shall be responsible for ensuring that all relevant information and documentation is passed on to his sub-suppliers, since all information pertaining to the equipment being supplied by the sub-suppliers may not be necessarily repeated in the relevant section of the requisition.

3. BASIS OF DESIGN

The mechanical design, materials, fabrication and testing of the HRSG and relevant auxiliary equipment, shall be supplied in accordance with the following ambient conditions, utilities characteristics and Battery Limit conditions.

3.1. CODES AND STANDARDS

The package shall be in accordance with the main International Standard and Codes.
All local regulations should be also considered whenever applicable and if more stringent.

3.2. REFERENCE AMBIENT CONDITIONS

Reference shall be made to the “Ambient Conditions & Utility Characteristics” enclosed in Attachment A.1

3.3. UTILITIES CHARACTERISTIC

Reference shall be made to the “Ambient Conditions & Utility Characteristics” enclosed in Attachment A.1

3.4. DESIGN DATA

3.4.1. GAS TURBINE EXHAUST GASES

The **preliminary** characteristics of the exhaust gases coming from the Gas Turbine at different fuel are listed in the following table. All data relevant to Gas Turbine is at full load and 300 mm H_2O HRSG backpressure.

		Natural Gas	LPG
Ambient Temperature	°C	15	15
Ambient Pressure	Mbar	1013	1013
Gas Turbine Load	%	100	100
Exhaust Gas Temperature	°C	488	488
Exhaust Gas Flowrate	t/h	453.9	454.5
NOx	mg/Nm^3 at 15% O_2 vol.	86	133.5
CO	mg/Nm^3 at 15% O_2 vol	31	31
Composition			
N_2	%vol	72.96	72.76
Ar	%vol	0.94	0.93
O_2	%vol	14.00	13.83
CO_2	%vol	2.80	2.87
H_2O	%vol	9.30	9.66

Vendor shall indicate the maximum flue gas thermal gradient (increasing/decreasing) allowable for the supplied HRSG during Gas Turbine transients.

3.4.2. FUELS FOR POST-FIRING

Refinery Gas and Distillate Oil shall be completely burnt in all operating conditions. Reference shall be made to the "Ambient Conditions & Utility Characteristics" enclosed in Attachment A.1

3.4.3. BOILER FEED WATER CHARACTERISTICS AND CONDITIONS

Reference shall be made to the "Ambient Conditions & Utility Characteristics" enclosed in Attachment A.1

3.4.4. STEAM PURITY

Water carryover in the HP steam shall be lower than 0.05% at HRSG battery limits.

The quality of steam, obtained with boiling water at the minimum conditions required by ABMA for the considered HP operating pressures shall be as follow:

Conductivity,	µS/cm	<0.2
Silica (SiO_2),	ppb	<20
Sodium (Na),	ppb	<5
Total Iron (Fe),	ppb	<20
Total Copper (Cu)	ppb	<1

3.4.5. BLOW-DOWN

HP and LP Continuous Blow-down (% steam production)

- Normal	%	0.5
- Design	%	5

HP and LP Intermittent Blow-down

- Design	%	10

3.4.6. STEAM DRUMS

In case of low HRSG load, operating pressures are kept above the following minimum value (Vendor to advise) necessary to satisfy steam Users and to have a good steam/water separation in the steam drums:

– HP steam drum: 30 barg (Vendor to advise);

3.4.7. DUCT BURNERS SYSTEM

The post-firing system shall be designed in order to comply with the following guidelines.

Design

The burners design shall consist of a burner frame, suitable to be mounted in the HRSG duct with integrated burner elements, with suitable devices assuring a reliable operation without any maintenance inside the duct over a great number of years, according to Vendor experience.
Each burner element shall be provided with a gas/electric ignition burner and two self-checking U.V. scanners.
The ignition burners shall be gas/electric, using the gas turbine exhaust gases as combustion air.

The postfiring System shall be able to accept both Refinery Gas and Distillate Oil as feed fuels.

Emissions

The burners and the SCR shall be selected in order to meet the followings NO_x emission level:

NO_x at 15% O_2 dry gases, mg/Nm^3: 30
The turn-down required for the burners is the following:
Minimum turn down ratio shall be 15:1.

3.4.8. STACK

Stack height	60 m
Min flue gas velocity at discharge	15 m/s

3.4.9. PRESSURE LOSSES

The HRSG shall be sized for a maximum static pressure drop (flue gas side) of 300 mm H_2O at HRSG/Turbine Battery Limits with the GT exhaust gas characteristics in paragraph 3.4 for 15 °C ambient temperature.

3.5. NOISE

All the necessary measures will be taken to reduce the noise level down to acceptable values in the working areas where continuous personnel attendance is required.

Sound emission from each component continuously operating shall correspond to a maximum sound pressure level of 85 dB(A) at 1 m away and 1.5 m high.

The spring loaded safety valves and the start-up vents shall be silenced and their sound level shall be reduced to 85 dB(A) at 1 m or at the nearest platform. The same value of 85 dB(A) at 1 m shall be applied to the equipment not in continuous operation.

Piping connecting PSV and silencer shall be noise-isolated to reduce sound level at 85 dB(A) at 1 m or at the nearest platform.

The silencer of the stack shall be designed in order to achieve the more stringent of following limits:

- a sound pressure of 85 dB(A) at the top of the stack at 90° from the vertical axis and one meter distance from the stack edge.
- a sound pressure of 30 dB(A), due to chimney exaust, at 450 metres distance the more stringent.

4. PROCESS DATA

4.1. HRSG PERFORMANCE DATA

Table 4.1 shows the performance data of the HRSG for the following cases:

- 15°C ambient temperature, GT base load, Post firing System firing Natural Gas;
- 15°C ambient temperature, GT base load, Post firing System firing distillate (**for this case the vendor has to maximize the steam production**);
- 15°C ambient temperature, GT off (**fresch air operation**), Post firing System firing Refinery gas;
- 15°C ambient temperature, GT base load, Post firing System off (**pure recovery operation**);

The performance data are based on the Gas Turbine exhaust gases and to the fuels for post-firing composition listed at Paragraph 3.4.

Vendor shall optimize the HRSG design on the case “A” and confirm the performances in the other cases.

Table 4.1 – Expected Battery Limits Conditions for HRSG

Case		**A (NOC)**	**B**	**C**	**D**
Ambient Temperature	°C	15	15	15	15
Gas Turbine Fuel	-	Natural Gas	Natural Gas	-	Natural Gas
Gas Turbine Load	-	100%	100%	-	100%
Gas Turbine exhaust					
- Flowrate	t/h	453.9	453.9	-	453.9
- Temperature	°C	488	488	-	488
Post Firing					
-Fuel		Ref. Gas	Distillate	Ref. Gas	-
HP steam to Steam Turbine					
- Flowrate	t/h	130	Max	80	70
- Temperature	°C	465	465	465	465
- Pressure at HRSG outlet	barg	62	62	62	62

4.2. UTILITIES CONSUMPTION

Vendor shall indicate required utilities and the relevant consumption. Utilities characteristics and design/operating conditions are at para. 3.3.

4.3. CHEMICAL REQUIREMENTS

Vendor shall indicate the type of chemicals, the relevant consumptions for all equipment included in their scope of supply.

4.4. RELIABILITY/AVAILABILITY INFORMATION

Not applicable in this phase.

5. MECHANICAL DESIGN DATA

All ducts, drums and tube bundles shall be designed to accept without any problem sudden modification of the temperature of the flue gas coming from the relevant Gas Turbine. This could occur in case of load rejection from full load, when the Gas turbine is immediately put at full speed no load.
Vendor shall indicate maximum allowable thermal gradient for flue gases during the operating gas turbine transients.

5.1. DUCTS

Ductwork from Gas Turbine Expansion joint outlet to HRSG transition duct, HRSG transition duct, supplementary firing duct (with dual feed fuel Ref. Gas/distillate), and HRSG duct to the stack and stack it self are included in scope of supply.
This ductwork system includes support structures, insulation and access doors.
The inlet transition duct shall be designed with a suitable geometry to ensure uniform flue gas distribution, according to Vendor experience.

5.2. CASING

The HRSG and the HRSG casing shall be designed for outdoor installation.
The HRSG casing shall be designed for an internal pressure of +500/-100.
The tube bundles shall be contained inside the HRSG casing flue gas-tight steel plate made with a minimum thickness of 6 mm, all welded and internally insulated.
The maximum temperature of Gas Turbine flue gases at HRSG inlet to be used for the mechanical design of the supports is 700 °C (preliminary).

5.3. DRUMS

The steam drums shall be designed according to local codes and ASME Pressure Vessel Code (Section I for Power Boilers, Section VIII for Unfired Pressure Vessels).
The HRSG drums shall be sized in order to have the following hold-up times between normal operating level and minimum acceptable level at the maximum steam productions:

- HP steam drum: minutes 5
- LP steam drum: minutes 7

Steam drums shall be equipped with double stage internals in order to assure the steam quality indicated at para 3.4.4.
The corrosion allowance of the steam drums shall be 3 mm minimum.

The minimum requested design pressures (Vendor to advise) are:

- HP steam drum: barg 68
- LP steam drum: barg 5.9

5.4. POSTFIRING SYSTEM

The postfiring system will be sized to produce the steam flowrate shown on the paragraph using Refinary Gas or Distillate Oil. Lower NOx emissions shall constitute a preferable title in the selection of the system. The required turn down 1:10 with all burners in operation.
Burners shall be provided with igniter, continuous pilot and UV flame detector.
The pilot shall use the same postfiring fuel.

5.5. TUBE BUNDLES

The various tube bundles shall be designed according to local codes and ASME Pressure Vessel Code (Section I for Power Boilers, Section VIII for Unfired Pressure Vessels). All tube bundles shall be drainable.

5.6. THERMAL INSULATION

The HRSG casing shall be internally insulated.
The insulation shall be designed to minimize heat losses and for personnel protection. The design conditions for the calculation of the insulation thickness are the following:

- External casing temperature: °C 60 max
- Ambient temperature: °C 41
- Wind velocity: m/s 0

Personal protection shall be provided for piping and equipment containing fluids at temperature higher than 60°C.

5.7. STACK

The HRSG shall be equipped with a stack designed and built according to the codes in force, having the following minimum characteristics:

- stack height: 60 m;

- single wall steel structure;
- equipped with silencer, stairs, ladders, platforms for flue gas pick-up and analysis, flue gas sampling points. **An external shell (about 5.5x3.2 m) shall convey both the stacks, from HRSG and from the conventional boiler (about 1.9 m dia);**
- arranged for aeronautical lights installation.

6. INSTRUMENTATION AND CONTROL SYSTEM

6.1. INTRODUCTION

This chapter describes the main HRSG logics for Safety and Control.
Instrumentation shall be adequate to permit control, supervision, protection and testing of package operation and performance.
Dedicated instrumentation will be used for performance test purposes.

6.2. SAFETY AND INTERLOCK SYSTEM

HRSG safety system, based on digital signals, shall assure that the Unit must be safely operable under any condition. The system shall consist in a programmed sequence of interlock alarms and lockouts. The safety interlocks are foreseen to prevent a not correct operating sequence especially during the start-up and shutdown phases. The lockouts with the relevant alarms are foreseen to assure the protection of the HRSG in case of failure or not safe operating conditions. Actions required to carry back the HRSG in the safe operating condition or to shutdown it, in case these conditions are not reached, shall be automatically performed without any operator action.
Burners Management System control philosophy shall be developed by Vendor and submited for approval.
The HRSG safety system is based on the following preliminary conditions (Vendor to advise):

- Cause: Very low level in HP/LP Steam Drum
- Action: Post firing shutdown
  Gas turbine shutdown

- Cause: Very high level in HP/LP the Steam Drum
- Action: Steam Turbine shutdown

- Cause Very high flue gas temperature downstream auxiliary burners
- Action Post firing shutdown

- Cause: Very high flue gas pressure at the HRSG casing inlet
- Action: Post firing shutdown
  Gas Turbine shutdown

- Cause: Very high temperature of the HP Superheated steam

- Action: Post firing shutdown
  Gas Turbine shutdown

- Cause: Very high pressure in the Steam drums
- Action: Post firing shutdown

- Cause Control room panel push button (emergency)
- Action Post firing shutdown

- Cause Local panel push button (emergency)
- Action Post firing shutdown

- Cause Very low fuel pressure
- Action Post firing shutdown

- Cause Flame failure
- Action Post firing shutdown

6.3. CONTROL SYSTEM

This paragraph gives a general guideline for the main control loops.
Vendor is requested to comment the control philosophy and provide on these bases the final scheme for approval.

6.3.1. STEAM DRUMS PRESSURE CONTROL

Steam drums operating pressure is slightly variable (sliding) according to the cycle load, as it is superimposed by the downstream steam turbine (steam turbine inlet valves normally fully open), within the range allowed by the HRSG steam drums design.
In case of low HRSG load, operating pressures are kept above a minimum value (Vendor to advise) necessary to have a good steam/water separation in the steam drums:

- HP steam drum: 30 barg
- LP steam drum: 1.5 barg

The pressure control is performed by throttling the relevant Steam Turbine admission valves (out of scope of supply).

During startup phases dedicated motor operated valves (out of scope of supply) located downstream HP superheater coil vent to the atmosphere, through dedicated silencers, a part of the generated steam.

6.3.2. STEAM TEMPERATURE CONTROL

The final HP superheated steam temperature shall be controlled within the fixed limits (temperature of the steam sent to HP section of steam turbine: 465°C maximum) by two elements cascade-type control loops, acting on the opening of the relevant water spray control valves (out of scope of supply).
The measured value of the superheated steam final temperature compared with the set point in a controller (primary) defines the set-point for the temperature controller (secondary), located downstream the attemperator, modulating the spray water control valve (out of scope of supply).

6.3.3. STEAM DRUMS LEVEL CONTROL

Water levels in the HP and LP steam drums are maintained by trimming the water flowrate by means of a dedicated control valve (out of scope of supply).
In order to have a two out of three voting logic, the level transmitters (out of scope of supply) must be three for each drum; the measured level values are properly corrected on the basis of temperature signal coming from the transmitters (out of scope of supply) placed on the steam drums.
HP steam drum level is controlled by a three elements control logic:

- liquid level inside steam drum;
- steam flowrate;
- boiler feed water flowrate.

These elements, properly combined, are used to provide proper set which determines the position of the control valve on the BFW feed line.
The LP drum level is controlled by a single element control logic (Vendor to advise) trimming the hot condensate flowrate entering in the LP steam drum degassing facilities.

In case of high level in the HP and LP steam drums, dedicated overflow control valves (out of scope of supply) will discharge the excess of liquid into an atmospheric overflow recovery tank (out of scope of supply).

6.3.4. POST FIRING CONTROL

The flowrate of fuel is controlled by the plant master controller that acts on the fuel control valve.
The flue gas temperature controller overrides the master controller to limit the flue gas temperature up to a limit defined by the vendor.

7. ELECTRICAL MOTORS

Electrical motors shall be asynchronous type, for outdoor installation, capable of supplying fans or other mechanical loads as required by the need of the plant.

They shall be high efficiency type.

Thermal insulation/temperature rise class shall be F/B. Motors shall be TEFC type, protection degree not less than IP54.

Electrical motors below 200kW shall be fed at 400V, above 200 kW shall be fed at 6 kV voltage level.

The asynchronous motors shall be sized for direct starting at full voltage and for reacceleration with 100% residual voltage, even in the case of out of phase reclosing. Attention shall be paid to mechanical stresses at coupling between motor and driven load.

Motors shall be designed for two consecutive hot starting at 80% of rated voltage. In addition, they shall keep in service their mechanical loads when the supply voltage at their terminals is 70% of rated voltage.

Motors shall be capable of supporting 20% overspeed without danger of mechanical failure.

8. GUARANTEED PERFORMANCES

Fuels for post firing	see paragraph 3.4.2
BFW characteristics	see paragraph 3.4.3

8.1. WARRANTY PERIOD

Vendor shall warrant for materials, equipment and workmanship for a period of two (2) years operation from the date of taking-over.

8.2. REFERENCE CONDITIONS

Atmospheric pressure:	1013	mbar
Ambient temperature:	15	°C
Relative humidity:	75	%
GT load:	100	%
GT exhaust gases	see paragraph 3.4.1	

8.3. HRSG PERFORMANCES

Vendor shall guarantee, at the reference conditions listed in paragraph 8.2, the performance specified in Table 4.1 in the cases A, B, C and D.
Guaranties shall be given taking into account the loss of the flue gas to atmosphere through the guillotine. Vendor to advise.

8.4. STEAM PURITY

Vendor shall guarantee the steam purity specified in paragraph 3.4.4.

8.5. HRSG PRESSURE LOSSES

Vendor shall guarantee the pressure losses for flue gas side specified in paragraph 3.4.9.

8.6. UTILITIES CONSUMPTION

Not applicable.

8.7. NOISE

Vendor shall guarantee limits shown at para 3.5

8.8. CORRECTION CURVES

Vendor shall provide correction curves in order to evaluate the HRSG performances at operating conditions different from the reference ones listed at paragraph 8.2, in particular at different flue gas flow rates and temperatures.

8.9. HRSG PERFORMANCE TEST

Vendor shall submit a detailed testing procedure to be discussed during detailed engineering and mutually agreed prior to actual testing.

Attachments

A.1 AMBIENT CONDITIONS & UTILITY CHARACTERISTICS

CLIENT: TAMOIL REFINERY
LOCATION : CREMONA, ITALY
PROJECT NAME: NEW COGENERATION PLANT IN CREMONA
CONTRACT NO: 1-BD-0238A
UNIT NO: 400
EQUIPMENT NAME: CONVENTIONAL BOILER
EQUIPMENT TAG NO: PK-401

ISSUED BY : A. PALUCCI
Checked by : A. BATTAGLIA
APPROVED BY : R. DOMENICHINI

Date	Revised Pages	Issued by	Checked by	Approved by
June 2005	First issue	A. Palucci	A. Battaglia	R. DOMENICHINI

CONVENTIONAL BOILER

INDEX

ATTACHMENTS

CONVENTIONAL BOILER

PK-401

1. INTRODUCTION

The scope of this functional specification is the definition of the technical requirements for the supply of one (1) Conventional Boiler for a new Cogeneration Plant to be erected in the TAMOIL Refinery in Cremona (Italy).

Vendor's supply shall include all the items enclosed in this specification as well as any other accessory and additional equipment the Vendor deems necessary for the good performance and the smooth, trouble free and safe operation of the package being supplied.

Vendor is free to offer its standard Boiler design to reduce package cost, provided that the supply is able to meet with the process requirements included in this Functional Specification.

2. SCOPE OF SUPPLY

2.1. DESCRIPTION OF THE EQUIPMENT

The Conventional Boiler shall be suitable for outdoor installation, it shall be natural circulation type. The Auxiliary Boiler shall be water tube type with pressurized combustion chamber; it shall be equipped with burners Low NOx type suitable to operate with Refinery Fuel Gas and/or Fuel Oil.

Shop-assembled boiler will be preferred.

The Conventional Boiler shall provide superheated steam for steam turbine. The degassing section (**to be quoted as an option**) shall be installed on the top of the boiler supported by the boiler structure; degassing section shall be fed by the LP steam of the new power plant.

The Conventional Boiler is suitable to generate and to superheat steam at high pressure (60 barg at boiler B.L.) and it is constituted of the following sections:

- superheater;
- water tube steam generator;
- HP economizer (complete of inlet and outlet headers);

Exhaust gases are discharged to atmosphere at a temperature of to be defined by Vendor through the stack when firing Natural Gas and/or Fuel Oil. The Conventional Boiler stack shall be equipped with silencer.

The Conventional Boiler shall be equipped with SCR system assuring a NOx emission level not exceeding 80 mg/Nm^3 at 3% O_2 dry gases.

Boiler Feed Water will be supplied by dedicated boiler feed water pumps (out of scope of supply) from the deaerator but installed on the top of boiler supported by the boiler structure. The BFW is heated in the economizer before entering the Steam Drum and delivered to the relevant sections/users by means of dedicated HP boiler feed water pumps (out of scope of supply). The BFW enters the Auxiliary Boiler at the temperature of 120°C (preliminary value to be confirmed by Vendor).

Boiler Feed Water flows through the Economizer coils and feeds the HP Steam Drum. The liquid level is maintained by adjusting the BFW flowrate through the dedicated control valve through a three variables control logic.

HP Boiler Feed Water circulates naturally through the tube steam generator between steam and water drums.

During start-up phase, or in case of high level in the Steam Drum, an overflow valve discharges the excess water to a continuous blowdown drum (out of scope of supply).

The Conventional Boiler will operate to maintain constant the steam pressure at superheated outlet. The normal operating pressure is 60 barg.

Steam is superheated in the Superheater coils and delivered to the HP header to be sent to the Steam Turbine (out of scope of supply).

To control the HP superheated steam final temperature to a maximum of (465°C), a desuperheating station, located between HP superheater coils, has to be provided by vendor.

The attemperating water shall be BFW taken on the BFW pumps discharge (out of scope of supply). The water flow shall be adjusted through a dedicated temperature control valve.

Continuous blow-down flowrate is adjusted by means of dedicated angle valve and it is sent to a dedicated blow-down drum (out of scope of supply).

Intermittent blow-down flowrate is adjusted by means of dedicated angle valve and sent to a dedicated atmospheric blow-down drum (out of scope of supply) together with the possible overflows coming from the Steam Drum.

The atmospheric blow-down drum also collects the blowdown coming from the continuous blow-down drum.

2.2. DESCRIPTION OF SUPPLY

2.2.1. MATERIALS

The Conventional Boiler shall be installed outdoor and the scope of supply shall include, but not limited to, the items listed in the following.

Vendor shall integrate them with all those elements that normally are necessary for the operability, maintenance and safety of the equipment, even if these are not expressly mentioned in the specification.

1) economizer (complete of inlet and outlet headers);
2) water tube steam generator;
3) steam/water drums;
4) all internal water and steam pipes and headers;

5) Dual Fuel (Refinery fuel gas and fuel oil) firing system, including:
   - main isolation valves inside of boiler area
   - Refinery fuel gas/fuel oil low NOx burners system including main burner's sets and pilots
   - Electric ignition and flame detection installation (n. 2 flame detectors per burner)
   - Pipework and valve stations inside the boiler area
   - Burner management system (BMS)
   - Ignition and cooling air fans with motors
   - flame monitoring system and local panel for burners start up and shut down

6) Comburent air fan complete with asynchronous three-phase electric motor;

7) Intermediate steam water spray desuperheater with relevant water spray control valve;

8) Safety valves on Steam Drums, at Superheater and relevant silencers according to local regulations requirements. Safety valves, start up valves and silencers shall be equipped with blow-off pipes;

9) Fuels piping and relative supports, intruments (skid mounted) including block and vent valves and relevant control valves, safety valves, local instruments, field instrumentation and transmitters;

10) Piping and relative supports included in the system;

11) Retractable type sootblowers electric motor driven, with relevant piping and valves for the steam distribution and for condensate draining, local control panel and platform for the operation and maintenance of the sootblowers (vendor shall define the sootblowers quantity in order to assure the tubes cleaning).

12) Drains network collecting all drains of the package to ground level, the network shall include all necessary drains, purges, vents and blowdown pipes including valves concentrated at valve group (double block valve);

13) Sound-proofing system where necessary;

14) Refractory setting, including:
   - Moduled refractory lining and shaped fire bricks in the area of the burners, accessdoors and peepholes, etc.

- Furnace moduled refractory
- Casing, frame and supports (buckstays, tie bars, stiffeners and pipe damps)
- One complete set of doors and peepholes necessary for access, inspection and supervision including service air nozzles connection piping;

15) Gas duct from boiler outlet to stack flange complete with expansion joint.

16) All necessary mechanical components not included in the skids for connection among the supplied skids;

17) Provisions (with relevant valves) for continuous chemicals monitoring and sampling of the feedwater, boiler water and steam;

18) Stack up to 60m elevation, equipped with silencer, ladders, stairs, flue gas sampling points platforms for flue gas pick-up and analysis. The stack shall be convoyed in an enclosure common to the HRSG (out of Vendor scope of supply);

19) SCR system including catalyst, relevant anchoring/supporting system, facilities for catalyst removal and all piping for chemicals distribution. **In order to have one type of catalyst in the plant, the supplier shall accept to finalize the catalyst selection together with the supplier of the HRSG.**

20) Piping, boiler and drums Manual insulation

21) Steam Drum level control valve

22) Vent control valve at superheater outlet

23) Control valve actuators

24) Level gauges required by applicable codes

25) Fields instrumentation (elements and transmitters)

26) Fuel Oil atomization system (if required)

27) Fuel piping and instruments (skid mounted) including block and vent valves and relevant control valves

28) Gas ducting with air flow measurements

29) Wiring between instrumentation and junction boxes

30) Expansion joints, fitting, flanger and appurtenances

31) Flanged connection for chemical cleaning

32) Sampling connection with double valve

33) Spool pieces for temporary instrumentation used for Boiler evaluation during performance test, according to the procedure issued by the Vendor and approved by Customer.

34) Spare parts for commissiong and start-up

35) Special tools necessary for the maintenance and operation of the equipment supplied (if any).

36) Valves, filters, drains and vents within the limits of supply;

37) Piping connecting equipment included in the scope of supply;

38) All vents with relevant double valves and piping to safe location;

39) Shell structure-supporting equipment;

40) Thermal insulation.

41) Deaerator with spray nozzle, baffle plates, steam extraction system, etc. **(optional)**

2.2.2. SERVICES

Vendor shall provide at least the following services:

42) Design, engineering and procurement;

43) Delivery Materials Free on Board (FOB);

44) Site supervision;

45) CE marking;

46) Erection and erection supervision (separate quotation)

47) Precommissioning, commissioning and start-up assistance and supervision;

48) Operators Training;

49) Performance Test witnessing and test procedure write up;

50) Refractory dry-out;

51) Special tools for erection and maintenance;

52) Chemical cleaning and boiler conservation, including equipment, chemical and specific waste water treatment after cleaning.

2.3. DOCUMENTATION

The Bidder shall provide at least the following information.

A. Proposal Phase

1) Exceptions and clarifications to the Functional Specification;

2) Detailed description of the supplied equipment including scope of supply;

3) Constructability study;

4) Process flow diagram;

5) Performance data including;

6) Octave band sound power level and sound pressure level at one meter from any source (guaranteed figures);

7) Heat transfer surfaces, materials and mechanical characteristics of the various coils;

8) Dimensions, thickness, materials and characteristics of the Steam Drum and Water Drum;

9) General arrangement of the Boiler;

10) Description of the start-up sequences and start-up curves (from cold, warm and hot conditions). Description of the shutdown sequences;

11) Execution program (schedule);

12) Sub-supplier list;

13) Quality control program either of Supplier and Sub-supplier;

14) Reference list;

15) Reliability/availability information;

16) Maintenance schedule, manpower required and costs;

17) Interface drawings;

18) Complete electrical load list;

19) FAN and motor data sheets;

20) One Line Diagram for a.c. and d.c. power circuits, including metering and protective relaying;

21) Electrical equipment layout and dimensions drawings;

B. Contractual Phase

1) P&IDs showing major control loops, alarms, signals, valves, major lines size, start-up lines, drains, vents, limits of supply;

2) Boiler data sheets;

3) Burners data sheets;

4) Safety valves data sheets;

5) Silencer data sheets;

6) Field instrumentation data sheets;

7) Control valves data sheets;

8) Summary of emergency shutdown signals;

9) Instrument and electrical functional logic specification (including control loops and binary logic diagrams) for package operation to be implemented (by Others) in the plant control system (out of scope of supply);

10) Electrical functional and wiring diagrams;

11) Execution program;

12) Installation drawings;

13) Foundation loads;

14) Weights, volumes, degree of prefabrication and erection sequence. In order to minimize the field operation the maximum degree of prefabrication is required;

15) Specified number of sets of Operating Manuals;

16) Quality control program;

17) Maintenance manuals;

18) Chemical cleaning procedure;

19) Start-up procedure;

20) Performance test procedure;

21) Interconnecting and cable list;

22) Mechanical catalogue;

23) Certificates, licenses, patents (if any).

2.4. EXCLUSIONS

The following items are specifically excluded from the scope of supply:

1) Boiler Feed Water pumps and relevant drivers;
2) Chemical injection system;
3) Continuous/intermittent blow-down drums;
4) Civil works: only foundation loads and underground network information are required;
5) Control room and control room instrumentation;

6) Power cables from FAN output terminals to motor terminals and from transformer terminals to FAN switchgear (all relevant to FD fans)

7) Control cables connecting equipment not included in Vendor's scope of supply

8) Wiring between junction boxes and control room;

9) Electrical power systems and lighting;

10) Main earthing grid;

11) Utilities supply;

12) Piping outside Auxiliary Boiler battery limits;

13) Pipe rack;

14) Final painting;

15) Fire fighting system;

16) Flue gas continuos monitoring system;

2.5. LIMITS OF SUPPLY

Limits of supply are shown in the following:

- HP Steam:	- stop/check valve outlet flange on HP superheated steam line to Steam Turbine;
- LP Steam:	- stop/check valve outlet flange on Deareator
- HP Boiler Feed Water:	- block valve inlet flange on the HP economizer inlet line;
	- block valve inlet flange on HP BFW line to spray water control valve.
- HP Boiler Feed Water:	- stop/check valve outlet flange on Deareator
- Condensate:	- block valve on dearator inlet flange
- HP overflow:	block valve outlet flange.
- LP overflow:	block valve outlet flange.
- Each Fuel for firing sys.:	block valve inlet flange on fuel skid.
- Chemicals injection:	Double valves on HP and LP Steam Drums.
- Chemicals injection for SCR:	inlet flange on the chemicals distribution lines
- Continuous blow-down:	Double valves on HP and LP Steam Drum.
- Steam & air for sootblowers:	connections to the sootblowers; main distributing valve and drain valve are supplied loose.

- Intermittent blow-down:	Double valves on HP and LP Steam Drums.
- Vents:	Safe location.
- Fluid sampling:	Double valves on the line connections.
- Instrument Air:	Users;
- Drains:	Outlet flanges of the drain manifolds.
- Instrument cables:	Junction boxes included in scope of supply.
- Tracing System:	Tracing cables junction boxes.
- Safety valves:	- Steam: silencers outlet at safe locations; - Water: outlet flanges of the drain manifolds.

2.6. LIMITS OF THIS SPECIFICATION

The description and requirements contained in this specification cannot completely cover the required equipment. Anyway, it has to be clear that equipment and relevant auxiliaries shall be complete of all the accessories necessary to a good operation of the equipment, within the limits of supply listed on paragraph 2.5 and with the exclusions listed on paragraph 2.4.

2.7. COORDINATION

The Conventional Boiler Vendor shall coordinate, expedite and resolve any problems with his sub-suppliers. Vendor shall be responsible for ensuring that all relevant information and documentation is passed on to his sub-suppliers, since all information pertaining to the equipment being supplied by the sub-suppliers may not be necessarily repeated in the relevant section of the requisition.

3. BASES OF DESIGN

The mechanical design, materials, fabrication and testing of the Conventional Boiler and relevant auxiliary equipment, shall be supplied in accordance with the following ambient conditions, utilities characteristics and Battery Limit conditions.
The Supplier shall design all the accessories and systems for mounting and dismounting the main components (burners, valves etc.) in order to allow an easy maintenance of them.

3.1. CODES AND STANDARDS

The package shall be in accordance with the main International Standard and Codes. All special requirements for conventional boiler for refinery service shall be also considered.
All local regulations should be also considered whenever applicable and if more stringent.

3.2. REFERENCE AMBIENT CONDITIONS

Reference shall be made to the "Ambient Conditions & Utility Characteristics" enclosed in Attachment A.1

3.3. UTILITIES CHARACTERISTIC

Reference shall be made to the "Ambient Conditio ns & Utility Characteristics" enclosed in Attachment A.1

3.4. PREFABRICATION

The auxiliary boiler shall be manufactured in order to reach the highest prefabrication level and to minimize the erection time at site.

Shop-assembled boiler will be preferred.

3.5. DESIGN DATA

3.5.1. FUELS FOR FIRING SYSTEM

Refinery Gas and Fuel Oil shall be completely burnt in all operating conditions. Reference shall be made to the "Ambient Conditions & Utility Characteristics" enclosed in Attachment A.1

3.5.2. BOILER FEED WATER CHARACTERISTICS AND CONDITIONS

Reference shall be made to the "Ambient Conditions & Utility Characteristics" enclosed in Attachment A.1.
The Vendor shall confirm that the BFW characteristics are acceptable.

3.5.3. STEAM PURITY

Water carryover in the HP steam shall be bwer than 0.05% at Conventional Boiler battery limits.

The quality of steam, obtained with boiling water at the minimum conditions required by ABMA for the considered HP operating pressures shall be as follow:

Conductivity,	µS/cm	<0.2
Silica (SiO_2),	ppb	<20
Sodium (Na),	ppb	<5
Total Iron (Fe),	ppb	<20
Total Copper (Cu)	ppb	<1
Cl	ppb	<5

3.5.4. BLOW-DOWN

HP Continuous Blow-down (% steam production)

- Normal	%	0.5
- Design	%	5

HP Intermittent Blow-down

- Design	%	10

3.5.5. BURNERS SYSTEM

The firing system shall be designed in order to comply with the following guidelines.

Design

The firing equipment shall be designed to operate with Refinery Gas and/or Fuel oil. The firing system ignition equipment shall be designed to provide reliable ignition of the burners. Provision shall be provided to prevent the admission of the fuel gas to the boiler in the event of loss flame and from the purging of fuels lines for burner maintenance
Each burner shall be provided with a gas/electric ignition burner and two self-checking U.V. scanners.
Burners shall be low Nox type; preferably they shall be of multiple lances.
Burners shall be in number to cover all the required functioning field.
The combustion chamber shall be sized in order to avoid flame contact with its walls.
Firing equipment shall be complete of air box and air registers.

Emissions

The burners (firing refinery gas and/or fuel oil) shall be selected in order to confirm the NOx emission level and to meet the following CO and Particulate limits.

- CO: 100 mg/Nm^3 @ 3% O_2 dry gas
- Particulate: 30 mg/Nm^3 @ 3% O_2 dry gas

SCR shall be selected in order to meet the followings NO_x emission level:

- NO_x : 80 mg/Nm^3 @ 3% O_2 dry gas

The minimum turn-down ratio required for the burners shall be 10:1.

3.5.6. STACK

Stack height	60 m
Min flue gas velocity at discharge	18 m/s

3.5.7. AIR FAN

The combustion air fan shall be centrifugal and fixed speed type. It shall be selected (together with its electrical motor) in order to assure the right air flowrate to the burners considering the different pressure drops of the air-gas system at different boiler loads. The fan suction shall be equipped with a radial blade type capacity and head regulation device motor actuated (inlet vane control).

3.6. NOISE

All the necessary measures will be taken to reduce the noise level down to acceptable values in the working areas where continuous personnel attendance is required.

Sound emission from each component continuously operating shall correspond to a maximum sound pressure level of 85 dB(A) at 1 m away and 1.5 m high. The spring loaded safety valves and the start-up vents shall be silenced and their sound level shall be reduced to 85 dB(A) at 1 m or at the nearest platform. The same value of 85 dB(A) at 1 m shall be applied to the equipment not in continuous operation.

Piping connecting PSV and silencer shall be noise-isolated to reduce sound level at 85 dB(A) at 1 m or at the nearest platform.

The silencer of the stack shall be designed in order to achieve the more stringent of following limits:

- a sound pressure of 85 dB(A) at the top of the stack at 90° from the vertical axis and one meter distance from the stack edge.
- a sound pressure of 30 dB(A), due to chimney exaust, at 450 metres distance the more stringent.

4. PROCESS DATA

4.1. CONVENTIONAL BOILER PERFORMANCE DATA

Data for the Conventional Boiler Operation are shown in Table 4.1:

The Vendor shall complete the data in Table 4.1 for case 1 to 6 for all fuels (Refinery Gas and Fuel Oil).

As an alternative, the Vendor may furnish standard data sheets provided that these cover at least the parameters in Table 4.1.

Table 4.1 – Boiler Performance Summary

Fuel		**Refinery Fuel Gas**			**Refinery Fuel Oil**		
Case Description	-	**1** ***Design*** ***100%***	**2** ***NOC*** ***50%***	**3** ***Minimum Steaming Rate By Vendor***	**4** ***Design*** ***100%***	**5** ***NOC*** ***50%***	**6** ***Minimum Steaming Rate By Vendor***
Steam Generated	t/h	***130***	***65***		***130***	***65***	
Blowdown	t/h						
Pressure at Boiler BL	barg	***60***	***60***	***60***	***60***	***60***	***60***
Superheater outlet temp	°C	465	465	465	465	465	465
Boiler drum pressure	barg						
Feedwater temperature	°C	120°C	120°C	120°C	120°C	120°C	120°C
Economizer outlet temp	°C						
Temp of air entering unit	°C	15	15	15	15	15	15
Temp of gas leaving furnace	°C						
Temp of gas leaving boiler	°C						
Temp of gas leaving economizer	°C						
Flue gas recirculation	%						
Excess air at boiler bank	%						
Air entering unit	kg/h						
Wet gas leaving unit	kg/h						
Gas side ΔP – superheater	mbar						
Gas side ΔP - boiler bank	mbar						
Gas side ΔP – economizer	mbar						
Gas side ΔP – flues	mbar						
Gas side ΔP – damper	mbar						
Air side ΔP – ducts	mbar						
Air side ΔP – burner	mbar						
Air side ΔP – flow measure	mbar						
Air & gas side ΔP – total	mbar						
Heat input	MW						
Fuel Fired	kg/hr						
Furnace Liberation	MW/m^3						
Furnace Heat Release (EPRS)	MW/m^2						
Furnace Heat Release (ABMA)	MW/m^2						
Efficiency (LHV)	%						

4.2. UTILITIES CONSUMPTION

Vendor shall indicate required utilities and the relevant consumption. Utilities characteristics and design/operating conditions are at para. 3.3.

4.3. CHEMICAL REQUIREMENTS

Vendor shall indicate the type of chemicals, the relevant consumptions for all equipment included in their scope of supply.

4.4. RELIABILITY/AVAILABILITY INFORMATION

Not applicable in this phase.

5. MECHANICAL DESIGN DATA

All ducts, drums and tube bundles shall be designed to accept without any problem sudden modification of the heat fired in the combustin chamber. Vendor shall indicate maximum allowable load during operating transients.

5.1. DUCTS, CASING, THERMAL INSULATION

The Conventional Boiler shall be designed for outdoor installation. It shall be completely clothed with a stiffened aluminium sheet casing in order to assure a perfect preservation of the insulation and of the boiler itself.
The insulation material shall be asbestos free.
Ductwork from economizer to boiler, and from boiler to the stack and stack it self are included in scope of supply.
This ductwork system includes support structures, insulation, peeping doors (enough to observe combustion chamber and tube frames conditions during the boiler operation), and access doors.
Explosion-proof doors or other openings in combustion chamber to prevent detonations of the fuel air mixture are forbidden.

5.2. DRUMS

The steam drums shall be designed according to local codes.
The Conventional Boiler drums shall be sized in order to have the following hold-up times between normal operating level and minimum acceptable level at the maximum steam productions:

- HP steam drum: minutes 5

- LP steam drum: minutes 7
  (the hold up for LP steam drum shall be calculated considering the stream to refinery users equal to 50 t/h)

HP steam drum shall be equipped with double stage internals in order to assure the steam quality indicated at para 3.5.3.
The corrosion allowance of the steam drums shall be 3 mm minimum.

The minimum requested design pressures (Vendor to advise) are:
- HP steam drum: barg 68

5.3. COMBUSTION SYSTEM

Burners shall be able to burn Refinary Gas and/or Fuel Oil. Burners shall be low Nox type. Burners nozzles shall be stainless steel made.
The required turn down 1:10 with all burners in operation.
Burners shall be provided with igniter, continuous pilot and UV flame detector.

5.4. TUBE BUNDLES

The various tube bundles shall be designed according to local codes and ASME Pressure Vessel Code (Section I for Power Boilers, Section VIII for Unfired Pressure Vessels). All tube bundles shall be drainable.

5.5. THERMAL INSULATION

The Boiler shall be externally insulated.
The insulation shall be designed to minimize heat losses and for personnel protection. The design conditions for the calculation of the insulation thickness are the following:

- External casing temperature: °C 60 max
- Ambient temperature: °C 41
- Wind velocity: m/s 0

Personal protection shall be provided for piping and equipment containing fluids at temperature higher than 60°C.

5.6. STACK

The Conventional Boiler shall be equipped with a stack designed and built according to the codes in force, having the following minimum characteristics:

- stack height: 60 m;
- single wall steel structure;
- equipped with silencer, stairs, ladders, platforms for flue gas pick-up and analysis, flue gas sampling points. **An external shell (about 5.5x3.2 m, installed on the HRSG) shall convey both the stacks, from HRSG and from the Conventional boiler;**

6. INSTRUMENTATION AND CONTROL SYSTEM

6.1. INTRODUCTION

This chapter describes the main Conventional Boiler logics for Safety and Control.
Instrumentation shall be adequate to permit control, supervision, protection and testing of package operation and performance.
Dedicated field instrumentation will be used for performance test purposes, as indicated by the Vendor in the "Performance Test Procedure".

6.2. SAFETY AND INTERLOCK SYSTEM

Conventional Boiler safety system, based on digital signals, shall assure that the package must be safely operable under any condition. The system shall consist in a programmed sequence of interlock alarms and lockouts. The safety interlocks are provided to prevent a not correct operating sequence especially during the start-up and shutdown phases. The lockouts with the relevant alarms are provided to assure the protection of the Conventional Boiler in case of failure or not safe operating conditions. Actions required to carry back the Conventional Boiler in the safe operating condition or to shutdown it, in case these conditions are not reached, shall be automatically performed without any operator action.
Burners Management System control philosophy shall be developed by Vendor and submited for approval.
The Conventional Boiler safety system is based on the following preliminary signals (Vendor to advise); which action will be to shut down the firing system:

- Very low level in HP Steam Drum
- Very high level in HP the Steam Drum
- Very high temperature of the HP Superheated steam
- Very high pressure in the Steam drum
- Control room panel push button (emergency)
- Very high gas temperature
- Local panel push button (emergency)
- Very low fuel pressure
- Flame failure

The automation system shall satisfy local rules requirements and NFPA 8501 and NFPA 8502 norms.

6.3. CONTROL SYSTEM

This paragraph gives a general guideline for the main control loops.
Vendor is requested to comment the control philosophy and provide on these bases the final scheme for approval.

6.3.1. STEAM DRUMS PRESSURE CONTROL

The boiler is connected to the steam header operating at constant pressure. Superheated steam pressure at boiler battery limits will be maintained at 60 barg by acting on burners.

During start-up phases or in case of very high pressure, steam will be vented to atmosphere through a dedicated control valve and silencer located downstream of the superheated.

6.3.2. STEAM TEMPERATURE CONTROL

The final HP superheated steam temperature shall be controlled within the fixed limits (temperature of the steam sent to HP section of steam turbine: 465°C maximum) by two elements cascade-type control loops, acting on the opening of the relevant water spray control valves.
The measured value of the superheated steam final temperature compared with the set point in a controller (primary) defines the set-point for the temperature controller (secondary), located downstream the attemperator, modulating the spray water control valve.

6.3.3. STEAM DRUM LEVEL CONTROL

Water level in the HP steam drum ise maintained by controlling the water flowrate by means of a dedicated control valve.
In order to have a two out of three voting logic, the level transmitters must be three for each drum; the measured level values are properly corrected on the basis of temperature signal coming from the transmitters placed on the steam drums.

HP steam drum level is controlled by a three elements control logic:

- liquid level inside steam drum;
- steam flowrate;
- boiler feed water flowrate.

These elements, properly combined, are used to provide proper set which determines the position of the control valve on the BFW feed line.

In case of high level in the HP steam drum, dedicated overflow control valve will discharge the excess of liquid into an atmospheric overflow recovery tank (out of scope of supply).

6.3.4. FIRING SYSTEM CONTROL

The flowrate of fuel is controlled by the plant master controller that acts on the fuel control valve.
The combustion chamber temperature controller overrides the master controller to limit the combustion chamber temperature up to a limit defined by the vendor.

7. ELECTRICAL MOTORS

Electrical motors shall be asynchronous type, for outdoor installation, capable of supplying fans or other mechanical loads as required by the need of the plant.

They shall be high efficiency type.

Thermal insulation/temperature rise class shall be F/B. Motors shall be TEFC type, protection degree not less than IP54.

Electrical motors below 200kW shall be fed at 400V, above 200 kW shall be fed at 6 kV voltage level.

The asynchronous motors shall be sized for direct starting at full voltage and for reacceleration with 100% residual voltage, even in the case of out of phase reclosing. Attention shall be paid to mechanical stresses at coupling between motor and driven load.

Motors shall be designed for two consecutive hot starting at 80% of rated voltage. In addition, they shall keep in service their mechanical loads when the supply voltage at their terminals is 70% of rated voltage.

Motors shall be capable of supporting 20% overspeed without danger of mechanical failure.

8. GUARANTEED PERFORMANCES

8.1. WARRANTY PERIOD

Vendor shall warrant for materials, equipment and workmanship for a period of two (2) years operation from the date of taking-over.

8.2. REFERENCE CONDITIONS

Atmospheric pressure:	1013	mbar
Ambient temperature:	15	°C
Relative humidity:	75	%
Auxiliary Boiler load:	100	%
Fuels (Ref. Gas & Fuel Oil):	Reference shall be made to the “Ambient Conditions & Utility Characteristics” enclosed in Attachment A.1	

8.3. BOILER PERFORMANCES

Vendor shall guarantee, at the reference conditions listed in paragraph 8.2, the performance specified in Table 4.1 in the cases A, B, and C.

8.4. STEAM PURITY

Vendor shall guarantee the steam purity specified in paragraph 3.5.3.

8.5. EMISSIONS

Vendor shall guarantee the emissions specified in paragraph 3.5.5

8.6. NOISE

Vendor shall guarantee limits shown at para 3.6

8.7. CORRECTION CURVES

Vendor shall provide correction curves in order to evaluate the Conventional Boiler performances at operating conditions different from the reference ones listed at paragraph 8.2.

8.8. CONVENTIONAL BOILER PERFORMANCE TEST

The performance tests and calculation shall be done using the ASME or British standard guidelines for Testing Boilers.

Attachments

A.1 AMBIENT CONDITIONS & UTILITY CHARACTERISTICS

SECTION C

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PLANT PERFORMANCES

1.0 PLANT PERFORMANCES

The expected performances of the new Cogeneration Power Plant operating in normal condition are evaluated for the following cases:

- Table C1.1: Expected Plant Performances in normal operation with GT burning 100% natural gas
- Table C1.2: Expected Plant Performances in normal operation with GT burning 100% LPG;
- Table C1.3: Expected Plant Performances in normal operation with GT burning 100% natural gas and District Heating system in operation;
- Table C1.4: Expected Plant Performances in normal operation with GT burning 100% LPG and District Heating system in operation.

The performances are calculated at the "reference ambient conditions" listed in Section B, para. 1.1.

The gas turbine performance data for 100% natural gas considered for the expected Plant overall performances evaluation have been provided by General Electric and are hereinafter summarized for sake of clarity:

- Electric power output : 27460 kW
- Heat Rate : 12340 kJ/kWh
- Exhaust flowrate : 453.9 t/h
- Exhaust temperature : 483.3 °C
- Steam injection flowrate : 7611 kg/h

The gas turbine performance data for 100% LPG considered for the expected Plant overall performances evaluation have been provided by General Electric and are hereinafter summarized for sake of clarity:

- Electric power output : 27100 kW
- Heat Rate : 12350 kJ/kWh
- Exhaust flowrate : 454 t/h
- Exhaust temperature : 484 °C
- Steam injection flowrate : 7688 kg/h

The HRSG post combustion system is preferentially fed by refinery fuel gas.
The conventional boiler is fed by means of the remaining available quantity of refinery fuel gas and by means of fuel oil.

The auxiliaries consumption of the New Cogeneration Power Plant operating with 100% natural gas and 100% LPG are summarized in the following tables:

- Table C1.3: Electrical consumption;
- Table C1.4: Utilities requirements;
- Table C1.5: Internal steam consumption;

Table C.1.3
Electrical consumption

		100% NATURAL GAS	100% LPG
POWER ISLAND			
Unit 100	kW	130	130
Unit 200	kW	447	447
Unit 300	kW	50	50
Unit 400	kW	563	563
AUXILIARY UNITS			
Unit 1200	kW	31	31
Unit 1500	kW	6	6
Unit 1600	kW	3	3
Unit 1700	kW	2	2
Unit 2000	kW	15	15
MISCELLANEA			
Instruments, el. system losses		70	70
TOTAL CONSUMPTION	**KW**	**1330**	**1330**

Table C.1.4
Utilities requirements

		100% NATURAL GAS	100% LPG
TOWER COOLING WATER			
- Flowrate	m^3/h	300	300
- Delta T	°C	6	6
SERVICE WATER (1)			
- Flowrate	m^3/h	130	130
COMPRESSED AIR			
- Flowrate	Nm^3/h	100	100

(1) 50 t/h are returned to the new Cogeneration Power Plant as steam condensate from Refinery Users.

Table C.1.5
Internal steam consumption

		100% NATURAL GAS	**100% LPG**
Degassing LP steam:	t/h	15.0	15.5
LP steam to Fuel Oil heater	t/h	0.2	0.2
LP steam to LPG vaporizer	t/h	0.0	1.4
Steam for GT injection	t/h	7.6	7.7
MP steam air compressor ST (*)	t/h	18.0	18.0
MP steam to LPG heater	t/h	0.0	0.4

(*) only in case of failure of motor driven air compressor

2.0 HEAT & MATERIAL BALANCES

The Heat and Material balances for the new Cogeneration Power Plant in the above described operating conditions are attached.

- Table C2.1:Expected Heat and Material balance with GT burning 100% natural gas and District Heating System not in operation;
- Table C2.2:Expected Heat and Material balance with GT burning 100% LPG District Heating System not in operation.
- Table C2.3:Expected Heat and Material balance with GT burning 100% natural gas and District Heating System in operation.
- Table C2.4:Expected Heat and Material balance with GT burning 100% LPG and District Heating System in operation.

3.0 ENVIRONMENTAL PERFORMANCES

3.1 GASEOUS EMISSIONS

EMISSIONS LIMITS

The emission limits for each equipment are listed in the following Tables. The values considered for postcombustion burners are estimated and burners shall be confirmed by Vendors.

Table 3.1
Gas Turbine Emissions
mg/Nm^3@15%O_2 vol.

FUEL	NATURAL GAS	LPG
NO_x	86	133.6
CO	13	13
Particulate	Negl.	Negl.

Table 3.2
Postcombustion System
g/GJ (LHV)

FUEL	FUEL GAS	FUEL OIL
NO_x	45	80
CO	50	80
Particulate	Negl.	10

Table 3.3
Conventional Boiler
mg/Nm^3@3%O_2 vol.

FUEL	FUEL GAS	FUEL OIL
NO_x	150	370
CO	100	100
Particulate	Negl.	50

Table 3.4
Expected Stack Emissions

	HRSG	Conventional boiler
NO_x	30 mg/Nm^3@15%O_2 vol.	80 mg/Nm^3@3%O_2 vol.
CO	50 mg/Nm^3@15%O_2 vol.	100 mg/Nm^3@3%O_2 vol.

EXPECTED EMISSIONS	**100% NG**		**100% LPG**	
	Normal Operat.	**District Heating**	**Normal Operat.**	**District Heating**
	kg/h	**kg/h**	**kg/h**	**kg/h**
NOx emissions from GT	25	25	38.4	38.4
NOx emissions from Postfiring	3.8	3.8	3.7	3.7
NOx emissions from Conventional Boiler	14.3	19.9	14.2	19.6
Total NO_x emissions at stack outlet (after SCR)	**14.3**	**19.9**	**14.2**	**19.6**
SOx emissions from GT SOx emissions from Postfiring	Negl. Negl.	Negl. Negl.	Negl. Negl.	Negl. Negl.
SOx emissions from Conventional Boiler	19.7	53.3	19.1	53.0
Total SO_x emissions at stack outlet [(a)]	**19.7**	**53.3**	**19.1**	**53.0**
CO emissions from GT	3.6	3.6	3.7	3.7
CO emissions from Postfiring	4.2	4.2	4.1	4.1
CO emissions from Conventional Boiler	4.0	11.0	4.3	10.5
Total CO emissions at stack outlet	**11.8**	**18.8**	**12.1**	**18.3**
Particulate emissions from GT	Negl.	Negl.	Negl.	Negl.
Particulate emissions from Postfiring	Negl.	Negl.	Negl.	Negl.
Particulate emissions from Conventional Boiler	1.84	5.36	1.92	5.33
Total particulate emissions at stack outlet	**1.84**	**5.36**	**1.92**	**5.33**

a) SO_X emisssions calculated on Fuel Oil with sulphur content 0.3 % wt.

Herebelow are shown the values declared in the "Perizia Giurata".

GUARANTEED EMISSIONS (kg/h)	**Normal Operat.**	**District Heating**
Total **NO_x** emissions at stack outlet (after SCR)	**16.2**	**21.0**
Total **SOx** emissions at stack outlet	**24.2**	**53.2**
Total **CO** emissions at stack outlet	**19.0**	**24.5**
Total **particulate** emissions at stack outlet	**2.7**	**5.8**

3.2 LIQUID EFFLUENTS

The expected liquid effluents of the new Cogeneration Power Plant are the following:

- clean rain water;
- de-oiled water;
- treated sanitary water.
- chemical water.

CLEAN RAIN WATER

Rain water from clean areas are directly discharged to the final receiver.
HRSG blowdown and drains, as well as sampling system drains are also collected directly to the final receiver.

POTENTIALLY OILY WATER

Potentially oily waste water are sent to the existing Waste Water System.

SANITARY WATER

Sanitary waste water will be discharged in the existing sewer.

CHEMICAL WATER

The following streams will be discharged in the existing chemical sewer.:

- Washing water from gas turbine package
- Neutralised eluates from demineralisation unit

3.3 SOLID WASTES

No solid waste is produced by the new Cogeneration Power Plant.

3.4 NOISE

The new Cogeneration Power Plant will be designed to respect the noise limits and the requirements, imposed by Italian Laws.
All equipment is specified such that the sound pressure level, at all locations, is to be 85 dB(A) at a distance of 1 meter from the equipment or from any acoustic attenuation unit fitted.

FOSTER WHEELER ITALIANA

TAMOIL REFINERY NEW COGENERATION POWER PLANT

Expected Performances, 100% Natural Gas (Table C1.1)

UNIT CONFIGURATION	GT, HRSG, Conventional boiler, backpressure ST
OPERATING MODE	Full load

AMBIENT CONDITIONS

Temperature	°C	15
Relative Humidity	%	75

GT CHARACTERISTICS

Type	GE - MS5001PA
Fuel Type	Natural Gas
GT Load	100%

Natural Gas Low Heating Value	kJ/kg	47510
Fuel Consumption	kg/h	7132
Fuel Thermal Input	MWt	94.1
Heat Rate	kJ/kWh	12340
Electric power at gen. Terminals	**MWe**	**27.5**
Exhaust gas flowrate	t/h	453.9
Exhaust gas temperature	°C	483.3
Steam injection for NOx reduction	kg/h	7611

HRSG CHARACTERISTICS

Refinery Fuel Gas Low Heating Value	kJ/kg	54817
Fuel Gas Consumption	kg/h	1530
Fuel Thermal Input	MWt	23.3
Duct Burner Exit Temperature	°C	635
Exhaust Gas Outlet Temperature	°C	115

GENERATED STEAM

Steam generation pressure	bara	63.5
Steam flowrate at HRSG outlet	t/h	82.7
Steam pressure at HRSG outlet	bara	62.0
Steam temperature at HRSG outlet	°C	465

CONVENTIONAL BOILER CHARACTERISTICS

Refinery Fuel Gas Low Heating Value	kJ/kg	54817
Fuel Gas Consumption (90% LHV eff.)	kg/h	190.0
Fuel Gas Thermal Input	MWt	2.9
Fuel Oil Low Heating Value	kJ/kg	41232
Fuel Oil Consumption (90% LHV eff.)	kg/h	3280
Fuel Oil Thermal Input	MWt	37.6

GENERATED STEAM

Steam flowrate at boiler outlet	t/h	48.3
Steam pressure at boiler outlet	bara	62.0
Steam temperature at boiler outlet	°C	460

STEAM TURBINE CHARACTERISTICS

HP section inlet flowrate	t/h	117.5
HP section inlet pressure	bara	60.0
HP section inlet temperature	°C	460
LP section outlet flowrate	t/h	35.7
LP section outlet pressure	bara	5.5
LP section outlet temperature	°C	247
Steam Turbine Power Output	**MWe**	**9.8**

OVERALL PERFORMANCES

Steam export to Refinery	t/h	120.0
MP steam to air compressor	t/h	0.0
BFW export to Refinery	t/h	50.0
Internal steam cons. to deaerators	t/h	13.9
Condensate return from Refinery	t/h	50.0

Gross Electrical Power Output	MWe	37.3
Auxiliary Electrical Consumptions	MWe	1.33
Net Electrical Power Output	**MWe**	**36.0**
Total thermal input	MWt	157.9
Net Electrical Efficiency	**%**	**22.8**

Thermal Power Output	**MWt**	**100.3**
Net Thermal Efficiency	**%**	**63.5**

Overall Efficiency	**%**	**86.3**

FOSTER WHEELER ITALIANA

TAMOIL REFINERY NEW COGENERATION POWER PLANT

Expected Performances, 100% LPG (Table C1.2)

UNIT CONFIGURATION	GT, HRSG, Conventional boiler, backpressure ST		
OPERATING MODE	Full load		
AMBIENT CONDITIONS	Temperature	°C	15
	Relative Humidity	%	75
GT CHARACTERISTICS	Type	GE - MS5001PA	
	Fuel Type	LPG	
	GT Load	100%	
	LPG Low Heating Value	kJ/kg	45967
	Fuel Consumption	kg/h	7281
	Fuel Thermal Input	MWt	93.0
	Heat Rate	kJ/kWh	12350
	Electric power at gen. Terminals	**MWe**	**27.1**
	Exhaust gas flowrate	t/h	454.0
	Exhaust gas temperature	°C	484
	Steam injection for NOx reduction	kg/h	7688
HRSG CHARACTERISTICS	Refinery Fuel Gas Low Heating Value	kJ/kg	54817
	Fuel Gas Consumption	kg/h	1491
	Fuel Thermal Input	MWt	22.7
	Duct Burner Exit Temperature	°C	630
	Exhaust Gas Outlet Temperature	°C	115
GENERATED STEAM	Steam generation pressure	bara	63.5
	Steam flowrate at HRSG outlet	t/h	82.7
	Steam pressure at HRSG outlet	bara	62.0
	Steam temperature at HRSG outlet	°C	465
CONVENTIONAL BOILER CHARACTERISTICS	Refinery Fuel Gas Low Heating Value	kJ/kg	54817
	Fuel Gas Consumption (90% LHV eff.)	kg/h	229.0
	Fuel Gas Thermal Input	MWt	3.5
	Fuel Oil Low Heating Value	kJ/kg	41232
	Fuel Oil Consumption (90% LHV eff.)	kg/h	3184
	Fuel Oil Thermal Input	MWt	36.5
GENERATED STEAM	Steam flowrate at boiler outlet	t/h	47.7
	Steam pressure at boiler outlet	bara	62.0
	Steam temperature at boiler outlet	°C	460
STEAM TURBINE CHARACTERISTICS	HP section inlet flowrate	t/h	116.9
	HP section inlet pressure	bara	60.0
	HP section inlet temperature	°C	460
	LP section outlet flowrate	t/h	35.1
	LP section outlet pressure	bara	5.5
	LP section outlet temperature	°C	247
	Steam Turbine Power Output	**MWe**	**9.8**
OVERALL PERFORMANCES	Steam export to Refinery	t/h	120.0
	MP steam to air compressor	t/h	0.0
	BFW export to Refinery	t/h	50.0
	Internal steam cons. to deaerators	t/h	13.4
	Condensate return from Refinery	t/h	50.0
	Gross Electrical Power Output	MWe	36.9
	Auxiliary Electrical Consumptions	MWe	1.33
	Net Electrical Power Output	**MWe**	**35.6**
	Total thermal input	MWt	155.6
	Net Electrical Efficiency	**%**	**22.9**
	Thermal Power Output	**MWt**	**100.3**
	Net Thermal Efficiency	**%**	**64.4**
	Overall Efficiency	**%**	**87.3**

FOSTER WHEELER

TAMOIL REFINERY NEW COGENERATION POWER PLANT

Expected Performances, 100% Natural Gas, D.H. (Table C.1.3)

UNIT CONFIGURATION	GT, HRSG, Conventional boiler, backpressure ST and District Heating		
OPERATING MODE	Full load		
AMBIENT CONDITIONS	Temperature	°C	15
	Relative Humidity	%	75
GT CHARACTERISTICS	Type	GE - MS5001PA	
	Fuel Type	Natural Gas	
	GT Load	100%	
	Natural Gas Low Heating Value	kJ/kg	47510
	Fuel Consumption	kg/h	7132
	Fuel Thermal Input	MWt	94.1
	Heat Rate	kJ/kWh	12340
	Electric power at gen. Terminals	**MWe**	**27.5**
	Exhaust gas flowrate	t/h	453.9
	Exhaust gas temperature	°C	483.3
	Steam injection for NOx reduction	kg/h	7611
HRSG CHARACTERISTICS	Refinery Fuel Gas Low Heating Value	kJ/kg	54817
	Fuel Gas Consumption	kg/h	1530
	Fuel Thermal Input	MWt	23.3
	Duct Burner Exit Temperature	°C	635
	Exhaust Gas Outlet Temperature	°C	115
GENERATED STEAM	Steam generation pressure	bara	63.5
	Steam flowrate at HRSG outlet	t/h	82.7
	Steam pressure at HRSG outlet	bara	62.0
	Steam temperature at HRSG outlet	°C	465
CONVENTIONAL BOILER CHARACTERISTICS	Refinery Fuel Gas Low Heating Value	kJ/kg	54817
	Fuel Gas Consumption (90% LHV eff.)	kg/h	190.0
	Fuel Gas Thermal Input	MWt	2.9
	Fuel Oil Low Heating Value	kJ/kg	41232
	Fuel Oil Consumption (90% LHV eff.)	kg/h	8890
	Fuel Oil Thermal Input	MWt	101.8
GENERATED STEAM	Steam flowrate at boiler outlet	t/h	125.0
	Steam pressure at boiler outlet	bara	62.0
	Steam temperature at boiler outlet	°C	460
STEAM TURBINE CHARACTERISTICS	HP section inlet flowrate	t/h	19195.0
	HP section inlet pressure	bara	60.0
	HP section inlet temperature	°C	460
	LP section outlet flowrate	t/h	111.0
	LP section outlet pressure	bara	5.5
	LP section outlet temperature	°C	187
	Steam Turbine Power Output	**MWe**	**22.8**
OVERALL PERFORMANCES	Steam export to Refinery	t/h	120.0
	MP steam to air compressor	t/h	0.0
	BFW export to Refinery	t/h	50.0
	Internal steam cons. to deaerators	t/h	28.6
	Condensate return from Refinery	t/h	50.0
DISTRICT HEATING	LP steam flowrate	t/h	61.0
	LP steam pressure	bara	4.5
	Net Electrical Power Output	°C	148
	District Heating Duty	**MWt**	**40.0**
	Condensate return from B.L.	t/h	61.0
	Gross Electrical Power Output	MWe	50.3
	Auxiliary Electrical Consumptions	MWe	1.33
	Net Electrical Power Output	**MWe**	**49.0**
	Total thermal input	MWt	222.1
	Net Electrical Efficiency	**%**	**22.0**
	Thermal Power Output	**MWt**	**136.3**
	Net Thermal Efficiency	**%**	**61.3**
	Overall Efficiency	**%**	**83.4**

FOSTER WHEELER

TAMOIL REFINERY NEW COGENERATION POWER PLANT

Expected Performances, 100% LPG, D.H. (Table C.1.4)

UNIT CONFIGURATION	GT, HRSG, Conventional boiler, backpressure ST and District Heating		
OPERATING MODE	Full load		
AMBIENT CONDITIONS	Temperature	°C	15
	Relative Humidity	%	75
GT CHARACTERISTICS	Type	GE - MS5001PA	
	Fuel Type	LPG	
	GT Load	100%	
	Natural Gas Low Heating Value	kJ/kg	45967
	Fuel Consumption	kg/h	7281
	Fuel Thermal Input	MWt	93.0
	Heat Rate	kJ/kWh	12350
	Electric power at gen. Terminals	**MWe**	**27.1**
	Exhaust gas flowrate	t/h	454.0
	Exhaust gas temperature	°C	484
	Steam injection for NOx reduction	kg/h	7688
HRSG CHARACTERISTICS	Refinery Fuel Gas Low Heating Value	kJ/kg	54817
	Fuel Gas Consumption	kg/h	1491
	Fuel Thermal Input	MWt	22.7
	Duct Burner Exit Temperature	°C	630
	Exhaust Gas Outlet Temperature	°C	115
GENERATED STEAM	Steam generation pressure	bara	63.5
	Steam flowrate at HRSG outlet	t/h	82.7
	Steam pressure at HRSG outlet	bara	62.0
	Steam temperature at HRSG outlet	°C	465
CONVENTIONAL BOILER CHARACTERISTICS	Refinery Fuel Gas Low Heating Value	kJ/kg	54817
	Fuel Gas Consumption (90% LHV eff.)	kg/h	229.0
	Fuel Gas Thermal Input	MWt	3.5
	Fuel Oil Low Heating Value	kJ/kg	41232
	Fuel Oil Consumption (90% LHV eff.)	kg/h	8839
	Fuel Oil Thermal Input	MWt	101.2
GENERATED STEAM	Steam flowrate at boiler outlet	t/h	125.0
	Steam pressure at boiler outlet	bara	62.0
	Steam temperature at boiler outlet	°C	465
STEAM TURBINE CHARACTERISTICS	HP section inlet flowrate	t/h	194.0
	HP section inlet pressure	bara	60.0
	HP section inlet temperature	°C	460
	LP section outlet flowrate	t/h	111.0
	LP section outlet pressure	bara	5.5
	LP section outlet temperature	°C	187
	Steam Turbine Power Output	**MWe**	**22.7**
OVERALL PERFORMANCES	Steam export to Refinery	t/h	120.0
	MP steam to air compressor	t/h	0.0
	BFW export to Refinery	t/h	50.0
	Internal steam cons. to deaerators	t/h	28.0
	Condensate return from Refinery	t/h	50.0
DISTRICT HEATING	LP steam flowrate	t/h	61.0
	LP steam pressure	bara	4.5
	LP steam temperature	°C	148
	District Heating Duty	**MWt**	**40.0**
	Condensate return from B.L.	t/h	61.0
	Gross Electrical Power Output	MWe	49.8
	Auxiliary Electrical Consumptions	MWe	1.33
	Net Electrical Power Output	**MWe**	**48.5**
	Total thermal input	MWt	220.4
	Net Electrical Efficiency	**%**	**22.0**
	Thermal Power Output	**MWt**	**136.3**
	Net Thermal Efficiency	**%**	**61.8**
	Overall Efficiency	**%**	**83.8**

FOSTER WHEELER

NEW COGENERATION PLANT IN CREMONA REFINERY

HEAT & MATERIAL BALANCE

Table C 2.1

CLIENT:	TAMOIL			**PROJECT No. :**	**MODEL:** CREMONA
LOCATION :	CREMONA				**CASE :** 100% NG
PROJECT NAME:	New Cogeneration Plant In Cremona Refinery			**DESCRIPTION**	**100% NG**
REVISION	**0**	**1**	**2**	Amb. temp.	15 °C
DATE	Aug 04	Jun 05		Rel. umidity	75%
ORIGINAL.BY	LO	AB		Partial Load	100%
CHECKED.BY	SA	AP			
APPROVED BY	RD	RD			

N°	STREAM DESCRIPTION	FLOW-RATE [kg/h]	TEMPERATURE [°C]	PRESSURE [bar a]	ENTHALPY [kJ/kg]
A	FUEL GAS TO GAS TURBINE	7132	40	20.7	-
B	FUEL OIL TO POST FIRING SYSTEM	0	105	12.0	-
C	REFINERY FUEL GAS TO POST FIRING SYSTEM	1530	38	4.5	-
D	FUEL OIL TO CONVENTIONAL BOILER	3280	105	12.0	-
E	REFINERY FUEL GAS TO CONVENTIONAL BOILER	190	38	4.5	-
F	HRSG EXHAUST GASES	455530	115	atm	-

NOTES :

Natural Gas LHV:	47510 kJ/kg
Fuel Oil LHV:	41232 kJ/kg
Fuel Gas LHV:	54817 kJ/kg
LPG LHV:	45967 kJ/kg

FOSTER WHEELER

NEW COGENERATION PLANT IN CREMONA REFINERY

HEAT & MATERIAL BALANCE

Table C 2.1

CLIENT:	TAMOIL			**PROJECT No. :**	**MODEL:** CREMONA
LOCATION :	CREMONA				**CASE :** 100% NG
PROJECT NAME:	New Cogeneration Plant In Cremona Refinery			**DESCRIPTION**	**100% NG**
REVISION	**0**	**1**	**2**	Amb. temp.	15 °C
DATE	Aug 04	Jun 05		Rel. umidity	75%
ORIGINAL.BY	LO	AB		Partial Load	100%
CHECKED.BY	SA	AP			
APPROVED BY	RD	RD			

N°	STREAM DESCRIPTION	FLOW-RATE [kg/h]	TEMPERATURE [°C]	PRESSURE [bar a]	ENTHALPY [kJ/kg]
1	DEMINERALIZED WATER MAKEUP TO HRSG	104255	20	2.5	84
2	CONDENSATE RETURN TO HRSG	33333	100	2.5	419
3	LP STEAM TO HRSG INTEGRATED DEAERATOR	6322	150	4.5	2748
4	BFW TO HRSG HP BFW PUMP	93782	105	1.2	439
5	IP BFW TO USERS	32000	105	13.0	441
6	HP BFW TO USERS	18000	105	45.0	445
7	HP GENERATED STEAM	80084	279	63.5	2781
8	HP SUPERHEATED STEAM	82717	460	60.0	3327
9	DEMINERALIZED WATER TO CONVENTIONAL BOILER DEAERATOR	24157	20	4.2	84
10	CONDENSATE RETURN TO CONVENTIONAL BOILER	16667	100	4.2	419
11	LP STEAM TO CONVENTIONAL BOILER DEAERATOR	7636	150	4.5	2748
12	BFW TO CONVENTIONAL BOILER BFW PUMP	48260	145	4.2	610
13	CONVENTIONAL BOILER SUPERHEATED STEAM	48260	460	60.0	3327
14	HP STEAM TO STEAM TURBINE	117489	460	60.0	3327
15	HP STEAM EXPORT	7000	440	44.0	3303
16	IP STEAM EXTRACTION	88000	220	12.0	2865
17	STEAM TURBINE DISCHARGE	38959	148	4.5	2743
18	GT STEAM INJECTION	7611	250	21.0	2898

NOTES :

FOSTER WHEELER

NEW COGENERATION PLANT IN CREMONA REFINERY

HEAT & MATERIAL BALANCE

Table C 2.2

CLIENT:	TAMOIL			**PROJECT No. :**	**MODEL:** CREMONA
LOCATION :	CREMONA				**CASE :** 100% LPG
PROJECT NAME:	New Cogeneration Plant In Cremona Refinery			**DESCRIPTION**	**100% LPG**
REVISION	**0**	**1**	**2**	Amb. temp.	15 °C
DATE	Aug 04	Jun 05		Rel. umidity	75%
ORIGINAL.BY	LO	AB		Partial Load	100%
CHECKED.BY	SA	AP			
APPROVED BY	RD	RD			

N°	STREAM DESCRIPTION	FLOW-RATE [kg/h]	TEMPERATURE [°C]	PRESSURE [bar a]	ENTHALPY [kJ/kg]
A	FUEL GAS TO GAS TURBINE	7281	145	20.7	-
B	FUEL OIL TO POST FIRING SYSTEM	0	105	12.0	-
C	REFINERY FUEL GAS TO POST FIRING SYSTEM	1491	38	4.5	-
D	FUEL OIL TO CONVENTIONAL BOILER	3184	105	12.0	-
E	REFINERY FUEL GAS TO CONVENTIONAL BOILER	229	38	4.5	-
F	HRSG EXHAUST GASES	455491	115	atm	-

NOTES :

Natural Gas LHV:	47510 kJ/kg
Fuel Oil LHV:	41232 kJ/kg
Fuel Gas LHV:	54817 kJ/kg
LPG LHV:	45967 kJ/kg

FOSTER WHEELER

NEW COGENERATION PLANT IN CREMONA REFINERY

HEAT & MATERIAL BALANCE

Table C 2.2

CLIENT:	TAMOIL			**PROJECT No. :**	**MODEL:** CREMONA
LOCATION :	CREMONA				**CASE :** 100% LPG
PROJECT NAME:	New Cogeneration Plant In Cremona Refinery			**DESCRIPTION**	**100% LPG**
REVISION	**0**	**1**	**2**	Amb. temp.	15 °C
DATE	Aug 04	Jun 05		Rel. umidity	75%
ORIGINAL.BY	LO	AB		Partial Load	100%
CHECKED.BY	SA	AP			
APPROVED BY	RD	RD			

N°	STREAM DESCRIPTION	FLOW-RATE [kg/h]	TEMPERATURE [°C]	PRESSURE [bar a]	ENTHALPY [kJ/kg]
1	DEMINERALIZED WATER MAKEUP TO HRSG	104782	20	2.5	84
2	CONDENSATE RETURN TO HRSG	33333	100	2.5	419
3	LP STEAM TO HRSG INTEGRATED DEAERATOR	5850	150	4.5	2748
4	BFW TO HRSG HP BFW PUMP	93761	105	1.2	439
5	IP BFW TO USERS	32000	105	13.0	441
6	HP BFW TO USERS	18000	105	45.0	445
7	HP GENERATED STEAM	80084	279	63.5	2781
8	HP SUPERHEATED STEAM	82717	460	60.0	3327
9	DEMINERALIZED WATER TO CONVENTIONAL BOILER DEAERATOR	23716	20	4.2	84
10	CONDENSATE RETURN TO CONVENTIONAL BOILER	16667	100	4.2	419
11	LP STEAM TO CONVENTIONAL BOILER DEAERATOR	7528	150	4.5	2748
12	BFW TO CONVENTIONAL BOILER BFW PUMP	47710	145	4.2	610
13	CONVENTIONAL BOILER SUPERHEATED STEAM	47705	460	60.0	3327
14	HP STEAM TO STEAM TURBINE	116942	460	60.0	3327
15	HP STEAM EXPORT	7000	440	44.0	3303
16	IP STEAM EXTRACTION	88000	220	12.0	2865
17	STEAM TURBINE DISCHARGE	38378	148	4.5	2743
18	GT STEAM INJECTION	7688	250	21.0	2898

NOTES :

FOSTER WHEELER

NEW COGENERATION PLANT IN CREMONA REFINERY

HEAT & MATERIAL BALANCE

Table C 2.3

CLIENT:	TAMOIL			**PROJECT No. :**		**MODEL:** CREMONA
LOCATION :	CREMONA					**CASE :** 100% NG + DH
PROJECT NAME:	New Cogeneration Plant In Cremona Refinery			**DESCRIPTION**	**100% NG + District Heating**	
REVISION	**0**	**1**	**2**	Amb. temp.	15 °C	
DATE	Aug 04	Jun 05		Rel. umidity	75%	
ORIGINAL.BY	LO	AB		Partial Load	100%	
CHECKED.BY	SA	AP				
APPROVED BY	RD	RD				

N°	STREAM DESCRIPTION	FLOW-RATE [kg/h]	TEMPERATURE [°C]	PRESSURE [bar a]	ENTHALPY [kJ/kg]
A	FUEL GAS TO GAS TURBINE	7132	40	20.7	-
B	FUEL OIL TO POST FIRING SYSTEM	0	105	12.0	-
C	REFINERY FUEL GAS TO POST FIRING SYSTEM	1530	38	4.5	-
D	FUEL OIL TO CONVENTIONAL BOILER	8890	105	12.0	-
E	REFINERY FUEL GAS TO CONVENTIONAL BOILER	190	38	4.5	-
F	HRSG EXHAUST GASES	455530	115	atm	-

NOTES :

Natural Gas LHV:	47510 kJ/kg
Fuel Oil LHV:	41232 kJ/kg
Fuel Gas LHV:	54817 kJ/kg
LPG LHV:	45967 kJ/kg

FOSTER WHEELER

NEW COGENERATION PLANT IN CREMONA REFINERY

HEAT & MATERIAL BALANCE

Table C 2.3

CLIENT:	TAMOIL			**PROJECT No. :**	**MODEL:** CREMONA
LOCATION :	CREMONA				**CASE :** 100% NG + DH
PROJECT NAME:	New Cogeneration Plant In Cremona Refinery			**DESCRIPTION**	**100% NG + District Heating**
REVISION	**0**	**1**	**2**	Amb. temp.	15 °C
DATE	Aug 04	Jun 05		Rel. umidity	75%
ORIGINAL.BY	LO	AB		Partial Load	100%
CHECKED.BY	SA	AP			
APPROVED BY	RD	RD			

N°	STREAM DESCRIPTION	FLOW-RATE [kg/h]	TEMPERATURE [°C]	PRESSURE [bar a]	ENTHALPY [kJ/kg]
1	DEMINERALIZED WATER MAKEUP TO HRSG	103374	20	2.5	84
2	CONDENSATE RETURN TO HRSG	33333	100	2.5	419
3	LP STEAM TO HRSG INTEGRATED DEAERATOR	6188	150	4.5	2748
4	BFW TO HRSG HP BFW PUMP	92728	105	1.2	439
5	IP BFW TO USERS	32000	105	13.0	441
6	HP BFW TO USERS	18000	105	45.0	445
7	HP GENERATED STEAM	80084	279	63.5	2781
8	HP SUPERHEATED STEAM	82717	460	60.0	3327
9	DEMINERALIZED WATER TO CONVENTIONAL BOILER DEAERATOR	86071	20	4.2	84
10	CONDENSATE RETURN TO CONVENTIONAL BOILER	16667	100	4.2	419
11	LP STEAM TO CONVENTIONAL BOILER DEAERATOR	22878	150	4.5	2748
12	BFW TO CONVENTIONAL BOILER BFW PUMP	125415	145	4.2	610
13	CONVENTIONAL BOILER SUPERHEATED STEAM	125415	460	60.0	3327
14	HP STEAM TO STEAM TURBINE	194668	460	60.0	3327
15	HP STEAM EXPORT	7000	440	44.0	3303
16	IP STEAM EXTRACTION	88000	220	12.0	2865
17	STEAM TURBINE DISCHARGE	54070	148	4.5	2743
18	GT STEAM INJECTION	7611	250	21.0	2898

NOTES :

FOSTER WHEELER

NEW COGENERATION PLANT IN CREMONA REFINERY

HEAT & MATERIAL BALANCE

Table C 2.4

CLIENT:	TAMOIL			**PROJECT No. :**	**MODEL:** CREMONA
LOCATION :	CREMONA				**CASE :** 100% LPG + DH
PROJECT NAME:	New Cogeneration Plant In Cremona Refinery			**DESCRIPTION**	**100% LPG + District Heating**
REVISION	**0**	**1**	**2**	Amb. temp.	15 °C
DATE	Aug 04	Jun 05		Rel. umidity	75%
ORIGINAL.BY	LO	AB		Partial Load	100%
CHECKED.BY	SA	AP			
APPROVED BY	RD	RD			

N°	STREAM DESCRIPTION	FLOW-RATE [kg/h]	TEMPERATURE [°C]	PRESSURE [bar a]	ENTHALPY [kJ/kg]
A	FUEL GAS TO GAS TURBINE	7281	145	20.7	-
B	FUEL OIL TO POST FIRING SYSTEM	0	105	12.0	-
C	REFINERY FUEL GAS TO POST FIRING SYSTEM	1491	38	4.5	-
D	FUEL OIL TO CONVENTIONAL BOILER	8839	105	12.0	-
E	REFINERY FUEL GAS TO CONVENTIONAL BOILER	229	38	4.5	-
F	HRSG EXHAUST GASES	455491	115	atm	-

NOTES :

Natural Gas LHV:	47510 kJ/kg
Fuel Oil LHV:	41232 kJ/kg
Fuel Gas LHV:	54817 kJ/kg
LPG LHV:	45967 kJ/kg

FOSTER WHEELER	NEW COGENERATION PLANT IN CREMONA REFINERY	HEAT & MATERIAL BALANCE Table C 2.4

CLIENT:	TAMOIL			**PROJECT No. :**	**MODEL:** CREMONA
LOCATION :	CREMONA				**CASE :** 100% LPG + DH
PROJECT NAME:	New Cogeneration Plant In Cremona Refinery			**DESCRIPTION**	**100% LPG + District Heating**
REVISION	**0**	**1**	**2**	Amb. temp.	15 °C
DATE	Aug 04	Jun 05		Rel. umidity	75%
ORIGINAL.BY	LO	AB		Partial Load	100%
CHECKED.BY	SA	AP			
APPROVED BY	RD	RD			

N°	STREAM DESCRIPTION	FLOW-RATE [kg/h]	TEMPERATURE [°C]	PRESSURE [bar a]	ENTHALPY [kJ/kg]
1	DEMINERALIZED WATER MAKEUP TO HRSG	103880	20	2.5	84
2	CONDENSATE RETURN TO HRSG	33333	100	2.5	419
3	LP STEAM TO HRSG INTEGRATED DEAERATOR	5712	150	4.5	2748
4	BFW TO HRSG HP BFW PUMP	92719	105	1.2	439
5	IP BFW TO USERS	32000	105	13.0	441
6	HP BFW TO USERS	18000	105	45.0	445
7	HP GENERATED STEAM	80084	279	63.5	2781
8	HP SUPERHEATED STEAM	82717	460	60.0	3327
9	DEMINERALIZED WATER TO CONVENTIONAL BOILER DEAERATOR	85653	20	4.2	84
10	CONDENSATE RETURN TO CONVENTIONAL BOILER	16667	100	4.2	419
11	LP STEAM TO CONVENTIONAL BOILER DEAERATOR	22775	150	4.5	2748
12	BFW TO CONVENTIONAL BOILER BFW PUMP	124895	145	4.2	610
13	CONVENTIONAL BOILER SUPERHEATED STEAM	124856	460	60.0	3327
14	HP STEAM TO STEAM TURBINE	194094	460	60.0	3327
15	HP STEAM EXPORT	7000	440	44.0	3303
16	IP STEAM EXTRACTION	88000	220	12.0	2865
17	STEAM TURBINE DISCHARGE	53488	148	4.5	2743
18	GT STEAM INJECTION	7688	250	21.0	2898

NOTES :

SECTION D

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ELECTRICAL SYSTEM

1.0 ELECTRICAL SYSTEM DESIGN

1.1 INTRODUCTION

This document is relevant to the electrical system of the new cogeneration plant to be installed in the Tamoil Refinery of Cremona and also to the partial upgrading of the existing refinery's electrical system to be realized for the integration between the new cogeneration plant and the refinery itself.

This document shall be read in conjunction with "Key One Line Diagram" doc. FWI no. BD0238A-0-73-001 rev. A

This document specifies the main requirements for the design of the electrical system of the new unit and for the modification of the existing electrical system and provides electrical characteristics of the main components of the electrical network.

1.2 LAWS & REGULATION

Electrical systems, machinery and components shall be designed, manufactured, inspected, installed and tested in accordance with the national and European standards (CEI, EN – CENELEC and IEC standard), API standards (where applicable) and country laws.

1.3 MAIN DESIGN CRITERIA

The electrical system of the cogeneration power plant shall be designed in order to:

- supply the refinery loads;
- deliver the exceeding power to the 132 kV National grid.
- operate during normal operating condition in synchronism with the 132 kV National grid;
- supply the refinery loads and the cogeneration unit auxiliary loads when disconnected from the National Grid (Island operation);
- supply the refinery loads from the National Grid when the cogeneration plant is out of service;
- allow the start-up of the power plant from 132 kV National grid.

2.0 ELECTRICAL SYSTEM DESCRIPTION

2.1 COGENERATION POWER PLANT

The new cogeneration power plant shall consist of two generators G-101 and G-301 respectively rated 31.7 MVA and 26.6 MVA, and coupled to the gas turbine GT 101 and to the steam turbine ST 301.

The power generated by the two synchronous machines shall be delivered to the refinery loads through a new refinery's 20 kV main distribution switchgear. The exceeding power shall be delivered to the HV national grid via the new station transformers 20/132 kV, 45 MVA each rated.

The user loads of the cogeneration power plant shall be mainly fed at two different voltage levels:

- 6 kV - for supplying motors exceeding 200kW.
- 0,4 kV - for motors rated up to 200 kW and other small LV loads.

The distribution network of the cogeneration power plant shall mainly consist of a new 6kV switchgear (6kV-QMT-A-CCCP) and new LV distribution system; both MV and LV distribution system shall be designed on the basis of secondary selective scheme.

The new 6kV switchgear shall be fed from two different sources; it shall be fed from the new 20 kV main distribution switchgear, through a new unit auxiliary transformer T-101, and/or an adequate feeder from the new 6kV switchgear "6kV-QMT-A-REF" of the refinery.

The LV users shall be supplied by a new 0.4 kV Power Motor Control Centers that shall be fed from three different power sources; two of these shall be realized by means of new unit auxiliary transformers "UAT-102" and "UAT-103" (supplied them selves by the new 6 kV switchgear), while the other shall be realized by means of an adequate feeder from the new 0.4 kV refinery emergency loads bus bar of the new Power Center "PMCC-A-REF".

The essential loads of the cogeneration power plant shall be fed from dedicated direct current system, uninterrupted power system or from the essential bus bar of the new 0.4 kV Power Motor Control Center "PMCC-101" (fed from the existing emergency diesel generator through the new emergency transformer "T-EM" via the new "PMCC-A-REF), depending on their power, voltage and on the maximum time that loss of supply can be tolerated.

2.2 INTEGRATION BETWEEN NEW COGENERATION PLANT AND REFINERY ELECTRICAL SYSTEM – UPGRADING OF THE EXISTING ELECTRICAL NETWORK

The electrical system of the new cogeneration power plant shall be strictly integrated on different levels with the refinery electrical system as shown on the attached "key one line diagram" FWI dwg no. BD0238A-0-73-001 rev. A.

To ensure that integration it's necessary to realize partial upgrade of the existing refinery's electrical system; in particular the following areas shall be involved:

- existing 132 kV switchyard
- existing 15 kV substations ("cabina NORD" and "cabina A)
- existing 6kV substations (mainly "cabina B" and "cabina B Enel").

Upgrade of the refinery's electrical system shall mainly consists of:

- realization of new connection with the existing 132 kV switchyard
- realization of new MV primary distribution with new voltage level (20 kV instead of 15 kV) and a new main distribution switchgear;
- partial upgrade of the existing 6 kV secondary distribution system
- Reutilization of the existing emergency diesel generator "DGE"
- reutilisation of the existing generator "TG4".

2.2.1 EXISTING 132 KV SWITCHYARD

The existing 132 kV switchyard is constituted by two transformer bays and one interconnection bay with AEM Cremona existing switchyard.

Transformer bays are equipped with HV circuit breaker while the interconnection bay is only equipped with disconnecting switch.

All the existing equipment are obsolete except for the two HV circuit breakers that have been replaced recently; some of those equipment are sized on the basis of the existing transformer rated power (10 MVA); they are not suitable for the new power ampacity required by the refinery (up to 45 MVA) and therefore shall be replaced.

Furthermore to replace the existing equipment without causing a complete refinery shut down it is strictly necessary to extend the switchyard (installation of a new 132 kV transformer bay) prior to put out of service one of the two existing 132 kV transformer bays (the other transformer bay could be abandoned or could be reutilized in case of cogeneration plant enlargement).

To increase the availability of the 132 kV system and/or to replace the existing equipment of the interconnection bay if they are not suitable for the new current ampacity (to be investigated by AEM Cremona), an additional interconnection bay shall be arranged between the refinery's switchyard and AEM's switchyard (it is also necessary to arrange a new interconnection bay on AEM switchyard side - to be investigated and quoted by AEM Cremona).
This enlargement could also be required in case of future enlargement of the cogeneration plant due to a greater power (approx. 30÷35 MVA) to be delivered to the external network.

2.2.2 MV PRIMARY DISTRIBUTION SYSTEM OF REFINERY

Nowadays the refinery MV primary distribution system is mainly constituted by the existing 15 kV switchgears QM-NORD and QM-A, respectively located in the existing substation "CABINA NORD" and substation "CABINA A".
The ratings of these two existing switchgears are not compatible with the new required current ampacity required by refinery and short circuit ampacity; as a consequence a new primary distribution switchgear has to be foreseen. Furthermore new MV primary distribution system voltage level has to be selected (20 kV instead of 15 kV) to allow selection of market-standardized equipment.

The new 20 kV switchgear shall be installed in the electrical room of the new building of the cogeneration plant.

The new GT's Generator and ST's Generator shall be connected to the new 20 kV switchgear by means of dedicated step-up transformers.

The new 20 kV switchgear shall be connected to the existing 132 kV switchyard by means of two new station transformers "ST-101" and "ST-102", to be installed near the new building of the cogeneration plant.
The existing station transformers TR1 and TR2 are not suitable to supply the whole refinery load (nowadays about 30 MVA while the rated power of the existing transformer is 10 MVA) even if they are operating together in parallel. The new station transformers shall be sized each one in order to feed, according to secondary selective scheme the existing and future (it is considered a load increase of about 10 MVA) refinery load demand when the power plant is out of service.

The new station transformers shall be located in the cogeneration plant area and shall be connected to the 132 kV switchyard by means of 132 kV extruded cables, directly buried.

Some of the existing 15/6 kV distribution transformers, supplied by the existing 15 kV switchgears QM-NORD and QM-A, shall be replaced with new ones due to new 20 kV voltage level.

These transformers are the following:

- TR-R, 2500 kVA, 15/04. kV (nowadays is supplying substation “CABINA R”)
- 6TR1, 6000 kVA, 15/6 kV (nowadays is supplying CCR plant)
- 6TR2, 2000 kVA, 15/0.4 kV (nowadays is supplying CCR plant)
- TF-1, 6000 kVA, 15/6 kV (nowadays is supplying substation “CABINA F”)

To replace 6TR1 and 6 TR2 a complete refinery shut down has to be planned (expected outage ~ 3÷5 days)

2.2.3 MV SECONDARY DISTRIBUTION SYSTEM OF REFINERY

Nowadays the refinery MV secondary distribution system is mainly constituted by the following existing 6 kV switchgears:

- QM-B and QM-B ENEL installed into the existing substation “CABINA B”
- QM-F installed into the existing substation “CABINA F”
- QM-F1A installed into the existing substation “CABINA F1A”
- QM-CCR installed into the existing substation “CABINA P”

All the existing steam turbine generators (TG1÷TG4) are connected to switchgear QM-B; when the new cogeneration plant will be in service the existing generators will be stopped except for TG4 that will remain in service (the existing TG4 steam turbine will use recovery steam coming from the existing Visbreaker).

All the existing 6 kV switchgears are obsolete and can’t allow future refinery expansion. Therefore some parts of the existing 6 kV system shall be upgraded as mentioned below.

A new 6 kV switchgear “QM-A-REF” is to be provided replacing the existings QM-B and QM-B ENEL to fed the existing utilities (i.e. common utilities like as cooling tower and/or refinery utilities) that will remain in service after dismounting of the existing power plant.

The new 6 kV switchgear “QM-A-REF” shall be constituted by three bus bar sections, bus bar A, bus bar B and essential/emergency bus bar with two tie breakers.

The new 6 kV switchgear shall be fed during normal operating condition from two new power transformers T-101 and T-102 (fed by the new 20 kV switchgear) and from the existing TG4 generator (connected to the essential bus bar section). During normal operating condition one of the two tie breakers remains open to realize a secondary selective scheme. Automatic transfer slow type shall be foreseen to ensure that, in case of loss of one power supply to the bus bars, all the users shall be fed from the other bus bar.
During emergency condition (i.e. general black-out) both tie breakers will be automatically opened and the essential/emergency bus bar will be automatically supplied from the the existing emergency diesel generator (to be reconnect to the new 6 kV switchgear).

The new 6 kV "QM-A-REF" switchgear shall supply the existing users and the substations that were supplied before from the existing "QM-B" and "QM-B ENEL" switchgears (only users and substations that still remain in service after existing power plant dismounting).
For these purposes new above ground cable connections shall be foreseen replacing the existing ones; no splice joints on the existing cables have to be considered because all the existing cables are directly buried and therefore a long refinery outage is expected (about 15÷20 day for splice joints respect to 3÷5 day necessary for the connection of the new cables).

The following new 6 kV cable connections shall be provided coming from the new 6 kV "QM-A-REF" switchgear will be:

- cable connection up to existing "cabina M"
- cable connection up to existing "cabina C"
- cable connection up to existing "cabina O"
- cable connection up to existing "cabina K"
- cable connection up to existing "cabina L"
- cable connection up to existing "cabina H"
- cable connection up to existing "cabina N-HDS"
- cable connection up to existing "cabina N-DWX"
- cable connection up to existing "cabina deposito"
- cable connection up to existing "cabina G"
- cable connection up to existing "cabina D"
- cable connection up to existing "cabina E"
- cable connections up to existing cooling towers fans

New cable connections shall be also provided for the follows:

- cable connection up to new air compressor(s)
- cable connections up to existing TG4 generator
- cable connections up to existing emergency diesel generator

2.2.4 LV DISTRIBUTION SYSTEM OF REFINERY

No upgrade of refinery LV distribution system is necessary except for:

- a new 0.4kV PC (PMCC-A REF) to be provided for feeding the LV auxiliaries and LV distribution panels nowadays supplied by the existing 0.4 kV PC installed in the existing substation "Cabina B". The new PC shall also be provided to feeding, from the emergency bus bar section, the LV emergency loads;
- a new UPS to be provided for feeding all the existing workstations of the refinery control system and the new ones to be provided for the new cogeneration plant.

The new 0.4 kV "PMCC-A-REF" shall be constituted by three bus-bar sections, bus bar A, bus bar B and emergency bus bar, fed respectively from the LV windings of three new power transformers T-103, T-104 and T-EM via a secondary selective scheme. During normal operating condition one of the two tie breakers remains open to realize a secondary selective scheme. Automatic transfer slow type shall be foreseen to ensure that, in case of loss of one power supply to the bus bars, all the users shall be fed from the other bus bar.
During emergency condition (i.e. general black-out) both tie breakers will be automatically opened and the emergency bus bar section will be automatically supplied from the the existing emergency diesel generator via the new emergency transformer T-EM.

The new UPS shall be located in the new control room to be located outside the cogeneration area. The new UPS unit shall be constituted of two redundant rectifiers, two batteries, two inverters, an emergency static switch and one distribution board with two distribution sections. The new UPS shall be supplied from the new 0.4 kV PMCC-A REF.

2.2.5 EMERGENCY DISTRIBUTION SYSTEM

A new essential/emergency electrical network shall be foreseen feed by the existing emergency diesel generator.
The existing emergency diesel generator shall be directly connected to the essential/emergency bus bar section of the new 6 kV kV "QM-A-REF" switchgear that provides power supply to the emergency bus bar section of the ne 0.4 kV "PMCC-A REF" by means of a dedicated new 6/0.4 kV power transformer (T-EM). The new emergency network will be used both for the new cogeneration plant essential services and refinery essential services.

2.3 UPGRADE OF THE REFINERY'S ELECTRICAL EQUIPMENT NOT INVOLVED IN THE NEW COGENERATION POWER PLANT PROJECT

What follows shown possible further upgrading of the existing refinery electrical distribution network that could be executed during the refinery shut down planned for the integration with the new cogeneration plant. This upgrade is not related to the new cogeneration plant but could be performed since the existing switchgears of the refinery distribution network are obsolete.
The final decision is under Refinery responsibility.

As shown on the attached "key one line diagram" FWI dwg no. BD0238A-0-73-001 rev. A, the areas where it could be necessary to replace the existing switchgears are:

- existing substation "Cabina P" (replacement of one 6 kV switchgear and one 0.4 kV switchgear has to be considered);
- existing substation "Cabina F" (replacement of one 6 kV switchgear has to be considered);
- existing substation "Cabina F1A" (replacement of one 6 kV switchgear has to be considered and installation of a new 20/6 kV power transformer is necessary);

For the upgrade of the existing "cabina P", feeding CCR that is one of the most important plants of the whole refinery, two different solutions are possible:

- minimum solution: replacement of the two switchgears only;
- optimum solution: replacement of the two switchgears and installation of two additional power transformers in order to realize a secondary selective scheme (complete feeding redundancy).

The first solution has been considered in the investment cost estimation (attached to this document); the second solution requires deep investigation to check available space for the additional transformers.

3.0 MAIN ELECTRICAL COMPONENTS

The sizing and quantities of the electrical equipment and components, as indicated in the following sections, shall be intended as preliminary.

3.1 132 kV AIR INSULATED SWITCHYARD

The enlargement of the existing 132 kV switchyard shall consist of:

- one new transformer bay constituted by one three pole disconnecting switch (three column type) with earthing blades, one three pole circuit breaker and three single pole current transformers;
- extension of the existing tube type bus bar system and installation of a new bus bar three pole disconnecting switch (three column type)
- one new interconnection bay constituted by one three pole disconnecting switch (three column type) with earthing blades and three single pole potential transformers;

The main characteristics of AIS equipment shall be:

- Rated/Maximum voltage 132/145 kV kV
- Rated lightning impulse withstand voltage 650 kV
- Rated power frequency withstand voltage 275 kV
- Rated short time withstand current 31.5 kA –1s
- Rated peak withstand current 80 kA
- Rated bus bars current 1250 A

3.2 STATION TRANSFORMERS (ST-101, ST-201)

The main characteristics of the station transformers shall be:

- rated power (reference value) 35/45 MVA
- three phase
- oil immersed type
- cooling ONAN/ONAF
- rated voltage 132/20 kV
- maximum voltage 145/24 kV
- rated lightning impulse withstand voltage 650/125 kV
- Short duration power frequency withstand voltage 275/50 kV

- on-load tap-changer on HV winding ±8×1.25%
- winding connection Ynd11
- winding insulation not-uniform
- short circuit impedance 10 %

3.3 20 kV QMT-A Switchgear

The 20 kV distribution switchgear shall include at least the following functional units:

- 2 generator incoming units each one equipped with withdrawable circuit breaker;
- 2 transformer incoming units each one equipped with withdrawable circuit breaker;
- 1 tie breaker unit equipped with withdrawable circuit breaker;
- 9 transformer feeder units each one equipped with withdrawable circuit breaker.
- 6 not-equipped spare feeder units.

The main characteristics of the switchgear shall be:

- Rated voltage 24 kV
- Rated lightning impulse withstand voltage 125 kV
- Rated power frequency withstand voltage 50 kV
- Rated short time withstand current 31.5 kA –1s
- Rated peak withstand current 63 kA
- internal arc withstand current 31.5 kA –0.5s
- Rated current 2500 A

3.4 GAS TURBINE GENERATOR BAY

The gas turbine generator-transformer bays shall include one three phase synchronous generator (G-101), line cubicle (with surge arrester, surge capacitor, protection and measuring transformers), neutral and grounding cubicle, non segregated phase bus duct and one unit step-up transformer (UT-101).
The HV terminal of the step up transformer shall be connected to the 20 kV switchgear through a cable line of adequate size.

The generator bay shall be composed of:

3.4.1 GAS TURBINE UNIT STEP-UP TRANSFORMERS (UT-101)

The characteristics of the transformer shall be:

- rated power (reference value) 31 MVA
- three phase
- oil immersed type
- cooling ONAF
- rated voltage 11/20 kV
- maximum voltage 17,5/24 kV
- rated lightning impulse withstand voltage 95/125 kV
- Short duration power frequency withstand voltage 38/50 kV
- off-load tap-changer on HV winding $\pm 2 \times 2.5\%$
- winding connection dY
- winding insulation uniform
- short circuit impedance 7 %

3.4.2 GAS TURBINE GENERATOR BUS DUCT

The three-phase bus-duct system, non-segregated phase type, for outdoor installation, shall be used for interconnecting the following equipment:

- Generator (G-101)
- Unit step-up transformer (UT-101)

The following ratings shall apply to all sections of the buses:

- rated/maximum voltage 11/17,5 kV
- operating voltage 11 kV

• rated power frequency withstand voltage	38 kV
• rated lighting impulse voltage	95 kV
• carrying current at 15°C ambient temperature.	2000 A

3.4.3 GAS TURBINE GENERATOR (G-101)

The synchronous three-phase generator, driven by gas turbines, shall comply with the following characteristics:

• rated output (according to GTG package offer)	31.7 MVA (*)
• rate power factor (inductive/capacitive)	0.85/0.95
• rated voltage	11 kV±5% (*)
• rated frequency	50Hz±2%
• rated speed	1500 r.p.m. (*)
• service type	continuous
• stator connection	star
• thermal insulation	F
• temperature rise	B

(*) referred to GTG's offer

3.5 STEAM TURBINE GENERATOR BAY

The steam turbine generator-transformer bays shall include one three phase synchronous generator (G-301), line cubicle (with surge arrester, surge capacitor, protection and measuring transformers), neutral and grounding cubicle and one unit step-up transformer (UT-301). The connection of the generator to the step-up transformer shall be realised by means of MV cables.

The HV terminals of the step up transformer shall be connected to the 20 kV switchgear through a cable line.

The generator bay shall be composed of:

3.5.1 STEAM TURBINE UNIT STEP-UP TRANSFORMERS (UT-301)

The characteristics of the transformer shall be:

• rated power (reference value)	28 MVA
• three phase	
• oil immersed type	

- cooling ONAF
- rated voltage 11/20 kV
- maximum voltage 17,5/24 kV
- rated lightning impulse withstand voltage 95/ 125 kV
- Short duration power frequency withstand voltage 38/ 50 kV
- off-load tap-changer on HV winding $\pm 2 \times 2.5\%$
- winding connection dY
- winding insulation uniform
- short circuit impedance 7%
- standards IEC-60076

3.5.2 Steam Turbine Generator (G-301)

The synchronous three-phase generator, G-301, driven by steam turbine, shall comply with the following characteristics:

- rated output 26.6 MVA (*)
- rated power factor (inductive/capacitive) 0.85/0.95
- rated voltage 11 kV ± 5% (*)
- rated frequency 50 Hz ± 2%
- rated speed 1500 r.p.m. (*)
- service type continuous
- stator connection star
- thermal insulation F
- temperature rise B
- standards IEC60034-1,60034-3.

(*) referred to STG’s offer

3.6 COGENERATION PLANT AUXILIARY DISTRIBUTIO N SYSTEM

Cogeneration & combined cycle auxiliary loads shall be fed by MV/LV distribution/utilization system.

The auxiliary system shall be composed of:

3.6.1 UNIT AUXILIARY TRANSFORMER (UAT-101)

One Auxiliary Transformer, two windings, named UAT-101, shall be connected to the 20 kV switchgear.

The characteristics of the transformer shall be:

• rated power	3.2/4 MVA
• three phase	
• oil immersed type	
• cooling	ONAN/ONAF
• rated voltage	20/6,3 kV
• maximum voltage	24/7,2 kV
• rated lightning impulse withstand voltage	125/60 kV
• Short duration power frequency withstand voltage	50/20 kV
• off-load tap-changer on HV winding	$\pm$ 2$\times$2.5%
• winding connection	D yn11
• winding insulation	uniform
• short circuit impedance	6 % ref to 4MVA

3.6.2 6 KV SWITCHGEAR

The 6 kV switchgear, named QMT-A-CCCP, shall be three phase with two bus bar sections and one bus tie breaker. An automatic transfer, slow type, shall be provided.

The 6 kV distribution switchgear shall include at least the following functional units:

- 1 line incoming unit equipped with withdrawable circuit breaker;
- 1 transformer incoming unit equipped with withdrawable circuit breaker;
- 1 tie breaker unit equipped with withdrawable circuit breaker;
- 6 motor feeder units each one equipped with withdrawable fuse-contactor;
- 2 transformer feeder units each one equipped with withdrawable circuit breaker.
- 2 not-equipped spare feeder units.

The main characteristics of the switchgear shall be:

• Rated voltage	7,2 kV
• Rated lightning impulse withstand voltage	60 kV
• Rated power frequency withstand voltage	20 kV
• Rated short time withstand current	40 kA –1s
• Rated peak withstand current	100 kA
• internal arc withstand current	40 kA – 0.5s
• Rated busbars current	600 A

3.6.3 UNIT AUXILIARY TRANSFORMERS (UAT-102 AND UAT-103)

Two Auxiliary Transformers, two windings, named UAT-102 and UAT-103, shall be connected to the 6 kV switchgear.

The characteristics of the transformers shall be:

• rated power (reference value)	1 MVA
• three phase	
• oil immersed type	
• cooling	ONAN
• rated voltage	6/0,42 kV
• maximum voltage	7,2/1,1 kV
• rated lightning impulse withstand voltage	60/- kV
• Short duration power frequency withstand voltage	20/3 kV
• off-load tap-changer on HV winding	$\pm 2 \times 2.5\%$
• winding connection	Dyn11
• winding insulation	uniform
• short circuit impedance	5 %

3.6.4 LV SWITCHGEARS

The LV switchgear, named PMCC-101, shall be three phase plus neutral, with three bus bar sections (two normal and one essential services bus bar) and two bus tie breakers. An automatic transfer, slow type, shall be provided.

The PMCC-101 shall include :

- 2 transformer incoming units each one equipped with withdrawable circuit breaker;
- 2 bus tie breaker each one units equipped with withdrawable circuit breaker;
- outgoing units (in appropriate number) equipped with fixed circuit breaker to feed secondary LV switchgears (MCC for GT loads, MCC for ST loads, etc);
- withdrawable motor starter units (in appropriate number) to supply induction motors (above 75kW);
- not-equipped spare units.

The main characteristic of PMCC-101 shall be:

- rated maximum voltage 400/690V
- rated bus current 2000A
- rated short time withstand current 50 kA
- rated peak withstand current 110 kA

Appropriate number of Secondary LV switchgears in MCC's arrangement shall be provided for the supply of motors <75kW.

Each secondary switchgear shall include :

- one incoming cubicles from PMCC-101 equipped with three phase on-load disconnecting switch;
- withdrawable motor starter units, as required;
- static load outgoing units, as required.

The main electrical characteristics shall be:

- Rated apparent power 400/690V
- bus-bar rated current according to load
- rated short time withstand current (1s) 50kA
- rated peak withstand current 100kA

3.6.5 EMERGENCY NETWORK

The emergency power supply shall be fed from the Refinery Emergency Network via a dedicated LV feeder. This feeder shall supply the essential and vital loads in case of lack of the main power supply.
The black-start of the power plant shall not be foreseen.

3.6.6 DC AND UPS SYSTEMS

The 110 V d.c. system shall consist of two lead-acid batteries, two battery charger rectifiers and one distribution board, made of two different sections, which provides supply to control and monitoring system and to protective relay systems.

The UPS section shall consist of two inverters connected to the 110 Vdc distribution board, two emergency static switches and one distribution board, made of two different sections, to supply, at 230 V - 50 Hz, instrument, control and regulation devices of the new cogeneration Plant.
A by-pass circuit, complete of insulating transformer and stabilizer, shall be fed from the essential bus-bar of the PMCC-101.

3.7 REFINERY DISTRIBUTION SYSTEM

3.7.1 POWER TRANSFORMERS T-101 AND T-102

The main characteristics of the transformers shall be:

• rated power	16/20 MVA
• three phase	
• oil immersed type	
• cooling	ONAN/ONAF
• rated voltage	20/6,3 kV
• maximum voltage	24/7,2 kV
• rated lightning impulse withstand voltage	125/60 kV
• Short duration power frequency withstand voltage	50/20 kV
• off-load tap-changer on HV winding	±2×2.5%
• winding connection	Dyn11
• winding insulation	uniform
• short circuit impedance	7 % ref to 20 MVA

3.7.2 POWER TRANSFORMER TR-R NEW

The characteristics of the transformer shall be:

• rated power	2.5 MVA
• three phase	
• oil immersed type	
• cooling	ONAN
• rated voltage	6/0.42 kV
• maximum voltage	7,2/1,1 kV
• rated lightning impulse withstand voltage	60/- kV
• Short duration power frequency withstand voltage	20/3 kV
• off-load tap-changer on HV winding	±2×2.5%
• winding connection	Dyn11
• winding insulation	uniform
• short circuit impedance	6%

3.7.3 POWER TRANSFORMER 6TR-1 NEW

The main characteristics of the transformer shall be:

• rated power	6 MVA
• three phase	
• oil immersed type	
• cooling	ONAN
• rated voltage	20/6,3 kV
• maximum voltage	24/7,2 kV
• rated lightning impulse withstand voltage	125/60 kV
• Short duration power frequency withstand voltage	50/20 kV
• off-load tap-changer on HV winding	±2×2.5%
• winding connection	Dyn11
• winding insulation	uniform
• short circuit impedance	7%

3.7.4 POWER TRANSFORMER 6TR-2 NEW

The characteristics of the transformer shall be:

• rated power	2 MVA
• three phase	
• oil immersed type	
• cooling	ONAN
• rated voltage	6/0,42 kV
• maximum voltage	7,2/1,1 kV
• rated lightning impulse withstand voltage	60/- kV
• Short duration power frequency withstand voltage	20/3 kV
• off-load tap-changer on HV winding	±2×2.5%
• winding connection	Dyn11
• winding insulation	uniform
• short circuit impedance	6%

3.7.5 POWER TRANSFORMER TF-1 NEW AND TF-1A NEW

The main characteristics of the transformer shall be:

• rated power	6 MVA
• three phase	
• oil immersed type	
• cooling	ONAN
• rated voltage	20/6,3 kV
• maximum voltage	24/7,2 kV
• rated lightning impulse withstand voltage	125/60 kV
• Short duration power frequency withstand voltage	50/20 kV
• off-load tap-changer on HV winding	$\pm 2 \times 2.5\%$
• winding connection	Dyn11
• winding insulation	uniform
• short circuit impedance	7%

3.7.6 6 KV SWITCHGEAR

The 6 kV switchgear, named QM-A-REF, shall be three phase with three bus bar sections and two bus tie breakers. An automatic transfer, slow type, shall be provided.

The 6 kV distribution switchgear shall include at least the following functional units:

- 2 transformer incoming units each one equipped with withdrawable circuit breaker;
- 2 generator incoming units each one equipped with withdrawable circuit breaker;
- 2 tie breaker units each one equipped with withdrawable circuit breaker;
- 6 motor feeder units each one equipped with withdrawable fuse-contactor;
- 3 transformer feeder units each one equipped with withdrawable circuit breaker.
- 6 not-equipped spare feeder units.

The main characteristics of the switchgear shall be:

• Rated voltage	7,2 kV
• Rated lightning impulse withstand voltage	60 kV
• Rated power frequency withstand voltage	20 kV
• Rated short time withstand current	40 kA –1s
• Rated peak withstand current	100 kA

- internal arc withstand current 40 kA-0.5 s
- Rated busbars current 3150 A

3.7.7 REFINERY AUXILIARY TRANSFORMERS (T-103, T-104 AND T-EM)

Three auxiliary Transformers, two windings, shall be connected to the new 6 kV switchgear.

The characteristics of the transformers shall be:

- rated power (reference value) 2.5 MVA
- three phase
- oil immersed type
- cooling ONAN
- rated voltage 6/0,42 kV
- maximum voltage 7,2/1,1 kV
- rated lightning impulse withstand voltage 60/- kV
- Short duration power frequency withstand voltage 20/3 kV
- off-load tap-changer on HV winding ±2×2.5%
- winding connection Dyn11
- winding insulation uniform
- short circuit impedance 6 %

3.7.8 LV SWITCHGEAR

The LV switchgear, named PMCC-A-REF, shall be three phase plus neutral.

LV Switchgear named PMCC-A-REFshall have three bus bar sections and two tie breakers. An automatic transfer, slow type, shall be provided.

The PMCC- A-REF shall include :

- 3 transformer incoming units each one equipped with withdrawable circuit breaker;
- 2 bus tie breaker units each one equipped with withdrawable circuit breaker;
- outgoing units (in appropriate number) equipped with fixed circuit breaker to feed secondary LV switchgears;
- withdrawable motor starter units (in appropriate number) to supply induction motors (above 75kW);
- Not-equipped spare units.

The main characteristic of the new PMCC-A-REF shall be:

• rated maximum voltage	400/690V
• rated bus current	4000A
• rated short time withstand current	50 kA
• rated peak withstand current	110 kA

3.7.9 UPS SYSTEM FOR THE NEW CONTROL ROOM (TO BE LOCATED OUTSIDE NEW COGENERATION PLANT AREA)

The 230 Va.c. UPS shall consist of two rectifiers/battery chargers, two lead-acid batteries, two inverters connected, two emergency static switches and one distribution boards, made of two different 230 V – 50 Hz sections.
A by-pass circuit, complete of insulating transformer and stabilizer, shall be fed from the emergency bus-bar section of the new PMCC-A-REF.

4.0 SINGLE LINE DIAGRAM

The single line diagram of the whole cogeneration plant and refinery plant is shown on the attached “KEY ONE LINE DIAGRAM” FWI dwg no. BD0238A-0-73-001 rev. A.

SECTION E

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INSTRUMENT & AUTOMATION

1.0 SYSTEM DESCRIPTION

The scope of this document is to define the minimum requirements of the Distributed Control system to be installed for the new Cogeneration Plant in the TAMOIL Refinery in Cremona (Italy), as main process unit control system.

1.1 GENERAL DESCRIPTION OF THE CONTROL SYSTEM

The Control System of the new cogeneration plant shall be characterized by architecture with several functionally and hierarchically ordered levels as listed below.

- Level 0: this is the lowest level of the hierarchically ordered System structure. It regards all the field instruments like sensors, initiator and actuator.

- Level 1: this is the intermediate level of the hierarchically ordered structure of the System. It regards all the System equipment dedicated to Control, Automation, and Data Acquisition functions.

- Level 2: this level regards the System equipment having the function of HUMAN-MACHINE interface. Level 2 is the control and supervisory level of the Plant.

- Level 3: this is the level dedicated to administrative, management and communication purposes - Advanced Control, Plant Optimization and Energy Management System.

The Control System shall be based on modules for the control and acquisition of data by microprocessor and equipped with resident software to carry out the analogical control algorithms, the logical and sequential control functions, the functions of acquisition/sending of analogical and digital signals and the protection functions as well as historical recording and trend analysis.

Field instrumentation (e.g. transmitters, control valve positioners, MOV actuators, etc) shall be connected to DCS by means of hardwired I/O using 4-20 mA signal transmission, voltage free contacts, 24/110 VDC powered signals.
The same philosophy shall be used for interfacing MV and LV Motor Control Centers.

The same philosophy shall be used for interfacing MV and LV Motor Control Centers.

Specific Level 1 equipment shall be provided for Gas Turbine, Steam Turbine, Electrical Generators and Electrical High Voltage and Medium Voltage primary distribution system of the whole plant.

A dedicated BMS/ESD integrated system (Safety PLC based) shall be provided for the new Cogeneration Plant protection purposes, mainly dedicated to HRSG shutdown interlocks and burners management.

The control modules and work stations (Lev. 2) shall be connected by a data communication system enabling the Operator to monitor and operate the whole Cogeneration Plant.

The principal control modules or systems, as well as the control systems that belong to package units (Gas Turbine, Steam Turbine, Electric Systems, etc.) will include redundancy in all the devices/connections that are critic for the control and safety of the plant.

In particular the redundancy criteria can be applied to the following:

- Power supply modules
- Multi-function processors
- Communication modules
- Communication buses
- I/O cards of closed control loops

The BMS/ESD system will be in accordance with the criteria defined in the IEC-61508.

In case of failure of the main connection bus or any other equipment, the transfer on the back-up bus or unit shall occur automatically, without interruption of the operations and without requiring interventions of the operator.

The Operator interface shall be unique. It means that he shall have the possibility to monitor and operate the whole Cogeneration Plant from any operator station; anyway dedicated workstations, for remote supervision of the GTG Set and STG

Set, shall be installed, linked to the DCS workstations by means of high speed redundant links (i.e. OPC protocol).

The Operator interface shall be implemented through interactive work stations equipped with data display console, keyboard and printer and shall be able to manage the supervision, control, graphic presentation, alarm, message, diagnostic functions in a Windows-based environment adopting a Client-Server architecture.

An engineering Work Station, dedicated to the configuration of the System and the implementation/modification of the user software, shall be also provided.

The Control system shall also communicate (at lev.3), through appropriate interface modules, with external computers and/or data communications standard network (e.g. existing refinery control system) . In particular an Energy Management System will be connected to the plant DCS; this system will be configured to provide the following:

- planning of the production/consumption rates of the plant (planning module);
- cost calculation (production, estimation, consumptive) and cost calculation for fuel gas and energy invoicing (cost evaluation module);

A performance plant evaluation module will be also integrated to compare the expected performances in the actual operating conditions with the actual performances as to warn the Plant Supervisor about the inefficiency of the operation and about the specific areas determining this inefficiency.

The performances will be calculated for the following areas:

- complete plant
- gas turbine
- steam turbine and thermal cycle
- boiler
- feed water circuit
- main pumps and fans
- electrical system

1.2 GENERAL REQUIREMENTS FOR THE CONTROL SYSTEM

The Control system shall be designed giving the utmost consideration to its reliability, in particular the selection of the electronic components and the individual entities forming the system shall be particularly accurate, considering a continuous operating time of 2 years.

The Control system shall be of modular construction and easily expandible; the module typology shall take into consideration the need of interchangeability and storage cost reduction.

A minimum of 25% spare capacity shall be available within the control system (i.e. installed spares). This includes field terminations, I/O, system and field power capacity, etc.

Processor utilization shall be no more than 70%.

An additional 20% spare (i.e. unused) space shall be available within all cabinets for future expansion.

The Control system must be capable of supporting the entire Cogeneration Plant process units, which will have a large number of basic instruments and controllers. Speed of response for both control functions and human-machine interface should not be degraded under any conditions (such as alarm overload) since this is a relatively fast-responding process. Multiple local area networks are allowed provided that the overall functionality is satisfied.

The loop execution time, considered as the sum of input reading, algorithm processing, output updating shall be selectable per loop within a range from 0.1 to 1 sec.

The Control system should have some type of ability to continue operation, without upsets, during single point failure of critical controllers (identification of controllers being critical will occur during detailed engineering).

The Control system should provide various levels of password and/or key protection to allow for different levels of authorization when maintenance is being performed; separate passwords for configuration and debugging activities are required.

The Control system should support standardized communication protocols. Specific read/write communication module with the Emergency Shut down System is required. It has to be able to transfer from the ESD system to the DCS the first out alarms.

The Control system shall ensure the following execution time (execution time: the sum of input reading at input card level, data transfer to central processor controller performing algorithms and managing data transfer to output card, output writing to output card terminals):

at Level 1 (time between the moment when a signal changes in value and the moment when the controller takes the consequent action and the output signal is sent):

- slow loops 1 sec.
- fast loops 0.5 sec.
- very fast loops (critical) 0.10 to 0.25 sec.
- logic control (MOV's, motors, ecc.) 0.5 sec.
- sequence 0.5 sec.
- ESD interlocks 0.25 sec.
- very fast logics (i.e. motor reacceleration) 0.10 to 0.20 sec.

In any case, the basic processing cycle shall be selectable at system configuration time.

At Level 2, (time elapsing between the change of value or state of an input of a I/O card at Lev. 1 and the moment when the same information is available to the operator at Level 2 at the video or printer):

- operator command 2 sec.
- alarm on VDU further to change 2 sec.
- change given on VDU 2 sec.

The display changing time further to operator request shall be shorter than 2 seconds.

1.3 SPECIFIC REQUIREMENTS FOR THE EMERGENCY SHUT DOWN SYSTEM (ESD)

An Emergency Shutdown System shall be provided to automatically shutdown a component, system, or the Cogeneration Plant in a safe and controlled manner in the event of abnormal operating conditions which could cause permanent damage to the Cogeneration Plant, or endanger human safety.

The design of the ESD shall be based on a fault tolerant and fail-safe PLC according to IEC 61508/61511 Ads. All critical inputs whose failure, if present, will cause major loss of plant performance, shall be triplicated and voted on a "2 out of 3" logic. Anyway the protection system fails to the condition which would normally protect the Plant and Persons.

Segregation from DCS instrumentation shall be provided so that failures into non-protective systems shall not impact protective system functionality or safety.

The ESD shall be interfaced with DCS and other controllers through suitable soft redundant link, to exchange non-critical signals. Critical signals shall be in any case exchanged through hardwired connections.

GT/ST packages will have their dedicated ESD systems, being integral part of respective control systems.

The ESD system will also operate as Burner Management System (BMS) for the Heat Recovery Steam Generator.

1.4 GENERAL CRITERIA FOR PACKAGE CONTROL SYSTEMS

Dedicated controllers different from the DCS can be present in the Plant and they perform control, supervision and protection activities of their own subsystems/packages (i.e. the Power Block, BMS/ESD, Demi package).

The DCS will take care of the integration of the various subsystems according to the following criteria:

- The DCS will be connected to the dedicated controllers by means of hardwired and/or serial connections (according to safety and reliability requirements).
- The informations exchanged between DCS and dedicated controllers will be limited to monitoring the packages status and main process variables; commands/informations/permissives from DCS to local controllers will be limited to the ones related to macro sequences (i.e. start-up/shut-down sequences) and trip purposes; these signals will be internally processed by the local controllers in order to reach the requested operating condition without any further DCS processing activity.
- The DCS operator stations will foresee mimic pages for the global monitoring of the packages. For each package controlled by a dedicated governor, some mimic pages (less than the ones available on the package operator workstation) will be developed to give the operator an overview of the behavior of the subsystem and to allow the input of the most important commands. The supervision and the operator interface of each package is fully demanded to its dedicated local control panel.
- The DCS engineering station will be only used to modify the configuration of the resident software. From this station there will be no possibility to modify the control algorithms, interlock, sequential control functions proper of the package. The configuration of each package controller is fully demanded to its dedicated engineering workstation.

1.5 GENERAL CRITERIA FOR INSTRUMENTION SYSTEM DESIGN

All single measuring elements foreseen for the controllers shall be coupled with a local instrument.

All important indicators should be achieved with other instruments foreseen close-by in the Cogeneration Plant or with suitable connections for portable instruments (typically TW).

Single detector/instrument for indication purpose shall be provided.

Electronic transmitters will be SMART type (HART protocol), 4-20 mA.

For control and alarm purposes a single detector will be normally provided; redundant analog input cards will be used for closed control loops based on a single field electronic transmitter.

Two detectors shall be installed in case of possible difficult and/or uncertainty in the measuring or in case of critical measure. In this case one detecting element is the master one (the operator may select the element assumed as master) and performs the control. The second element, the spare one, automatically substitute the master one through a dedicated logic in case of failure/bad quality reading. An alarm is foreseen in case of failure of a single element. The two transmitters shall be connected to different input cards not redundant.

Redundant analog output cards will be used for all closed control loops.

Trip initiators shall be dedicated instruments. Trips shall be initiated by a 2 out of 3 voting logic whenever they could cause the shutdown of the Cogeneration Plant, the shutdown of equipment that could be permanently damaged in case of shutdown or they could be subject to detection difficulties making the trip signal not reliable. All other trips initiators shall be single. As base case control valves will not be used as trip actuators. However control valves that are not a potential cause of the malfunction initiating the trip sequence can be used for trip purposes.
The use of process switches will be avoided, maximizing the use of electronic transmitters.

2.0 CONTROL SYSTEM ARCHITECTURE

The control system architecture is shown in the attached drawing hereafter.

3.0 NEW CONTROL ROOM

A new building will host the new control room to serve both the new cogeneration unit and the refinery units.

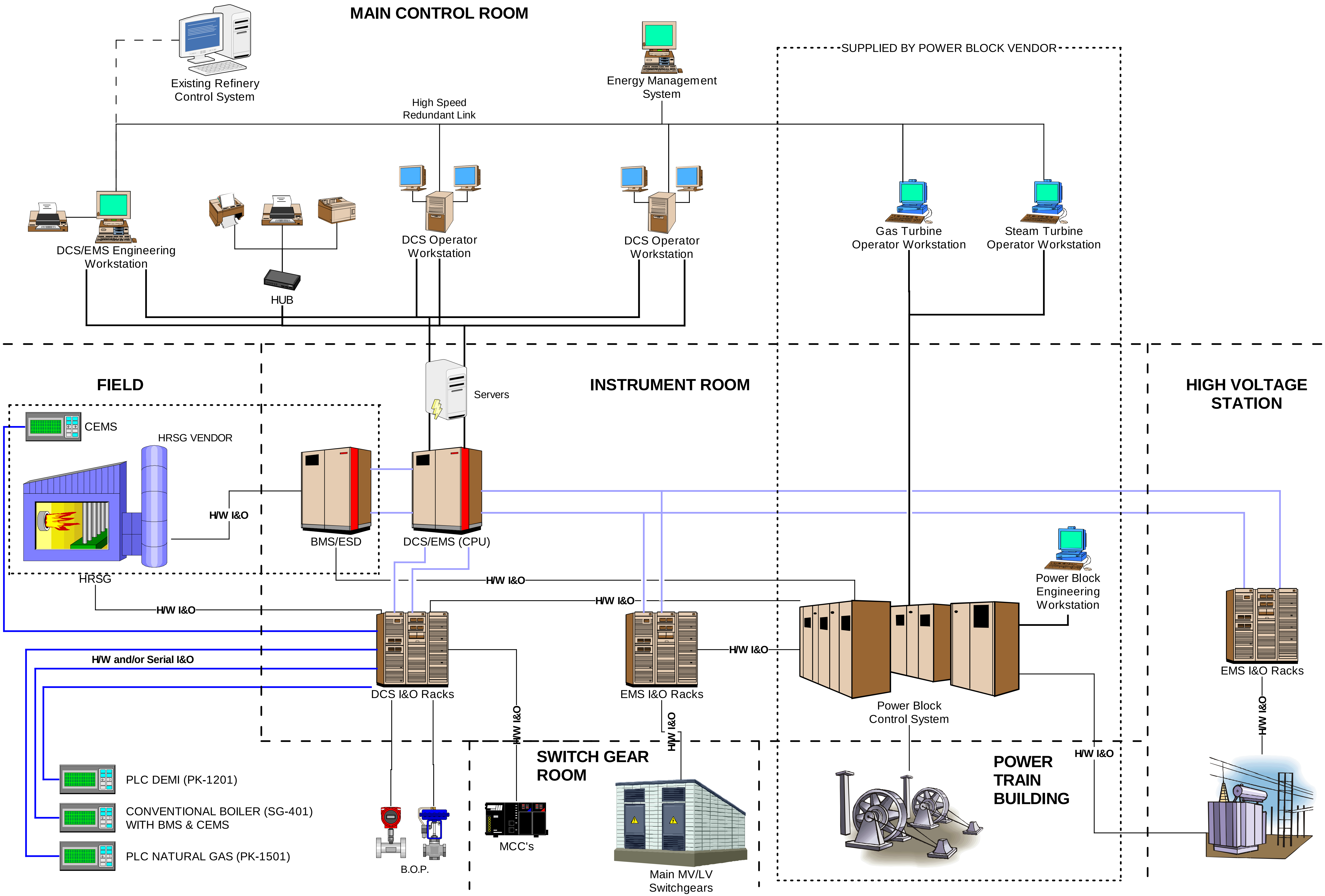
The building will have at ground floor:

- control room, with floating floor, 10 m x 15 m
- electrical room, with floating floor, 5 m x 5 m
- engineering room, with floating floor, to host engineering workstation for software configuration and printers, 5 m x 5 m
- offices for shift supervisor and chief

and at first floor:

- meeting room
- offices
- HVAC room
- UPS room, with floating floor
- toilettes

Design of control room will be made during detailed engineering phase, since at the moment it is not clear if the existing control bays can be reused.


MAIN CONTROL ROOM
Existing Refinery Control System
Energy Management System
SUPPLIED BY POWER BLOCK VENDOR
High Speed Redundant Link
DCS/EMS Engineering Workstation
HUB
DCS Operator Workstation
DCS Operator Workstation
Gas Turbine Operator Workstation
Steam Turbine Operator Workstation
FIELD
INSTRUMENT ROOM
HIGH VOLTAGE STATION
Servers
CEMS
HRSG VENDOR
H/W I&O
BMS/ESD
DCS/EMS (CPU)
HRSG
H/W I&O
H/W I&O
H/W I&O
Power Block Engineering Workstation
H/W and/or Serial I&O
DCS I&O Racks
EMS I&O Racks
H/W I&O
Power Block Control System
EMS I&O Racks
H/W I&O
H/W I&O
H/W I&O
SWITCH GEAR ROOM
POWER TRAIN BUILDING
H/W I&O
PLC DEMI (PK-1201)
CONVENTIONAL BOILER (SG-401) WITH BMS & CEMS
PLC NATURAL GAS (PK-1501)
B.O.P.
MCC's
Main MV/LV Switchgears

SECTION F

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CIVIL WORKS

1. BUILDINGS

Scope of this paragraph is to describe the general and functional requirements for the new Industrial and Civil Buildings of the New Cogeneration Plant site in Cremona Refinery (CR), to be used for their design under the architectural and layout point of view.
This description covers the following new buildings:

- Technical building (Steam Turbine and auxiliaries, and electrical room building).
- New control room building;
- New Air compressors building;
- New demi water treatment building.

1.1 GENERAL

The buildings shall be supplied complete with all the facilities needed for their correct, comfortable and safe use, such as the electrical distribution system, the HVAC (where required), the potable/service water distribution system, the sanitary sewer system the fire fighting system, and so on.
The ventilation system of the buildings, with reference to the air collecting and distribution ducts, may be included in the scope of supply.

1.2 TECHNICAL BUILDING

Reference shall be made to DWG. N. BH0238A-0-01-001 attached to section G.
The Technical building shall be placed in the north side of the area of the new Power Plant and shall be divided in two functional parts:

- Steam Turbine and auxiliaries building;
- Electrical room building.

1.2.1 STEAM TURBINE AND AUXILIARIES BUILDING

The structure of the turbines building shall be made in prefabricated reinforced concrete, and external walls will be realized using prefabricated concrete reinforced panels.
Metal stairs, ladders and one bridge-crane for maintenance operations shall be provided.
The building shall include a ventilation system to guarantee proper operating indoor temperature.
The approximative building dimensions will be the following:

- length : 25 m
- width : 10 m
- height : 12 m

<u>The final size of the building and the final position of all the auxiliaries will be in according to the selected turbines supplier.</u>

1.2.2 ELECTRICAL ROOM BUILDING

This part of building consists of two floor levels, and will be realized in prefabricated reinforced concrete structure, with external walls and roof in prefabricated concrete reinforced panels.
The electrical low voltage room, the electrical medium voltage room and the battery room will be located at el. 2 m, above the lower cable room.
The instrument room will be located at el. 7,8 m (room height 4,2 m), above the electrical low voltage room and the battery room.
The building shall include a system to guarantee proper indoor temperature.
The approximative building dimensions will be the following:

M.V. ELECTRICAL ROOM:

- length : 30,8 m
- width : 10,2 m
- height: 5,8 m (elevation from 2,00 m to 7,8 m)

L.V. ELECTRICAL ROOM:

- length : 19,8 m
- width : 10,2 m

BATTERY ROOM:

- length : 9,4 m
- width : 5,4 m

1.3 NEW CONTROL ROOM BUILDING

Reference shall be made to DWG. N. BH0238A-0-01-001 attached to section G.
The new Control room building shall be placed in the south side of the existing C.T.E. area and shall consist of two floor levels.
This building shall be realized in prefabricated reinforced concrete structure, with external walls and roof on prefabricated reiforced concrete panels.
The new Control Room and the annexes technical offices will be located at el. 1m above refinery ground floor , while the UPS room, the HVAC room, offices and W.C. will be located at the second floor, at el. 5m.
The control room building shall be completed with all the provisions for continuous presence of employees.
The approx building dimensions will be the following:

- length : 32 m
- width : 13 m
- height : 10 m

1.4 NEW AIR COMPRESSORS BUILDING

Reference shall be made to DWG. N. BH0238A-0-01-001 attached to section G.
The structure shall be made by painted steel, walls will be realized using metal sandwich deadening panels (shelter type). The air compressors building, after the dismantling of the existing Diesel Generator, shall be located in the south side of the existing C.T.E. building. The new air compressors building shall be naturally ventilated by grids.
A bridge crane or hoist shall be provided for the maintenance operations.
The approx building dimensions will be the following:

- length : 12 m
- width : 10 m
- height : 6 m

1.5 NEW DEMI WATER TREATMENT BUILDING

Reference shall be made to DWG. N. BH0238A-0-01-001 attached to section G.
The structure shall be made by painted steel, walls will be realized using metal corrugated panels (shelter type). The demi water building shall be located in the south-east corner of the existing C.T.E. area.
The new demi water building shall be naturally ventilated by grids.
Chemicals collecting basins shall be built by reinforced concrete adjacent the demi water building.
The approx building dimensions will be the following:

- length : 18 m
- width : 11,5 m
- height : 8 m

2. ASSESSMENT OF EXISTING FOUNDATIONS

FWI has evaluated the possibility to re-use the foundations of structures and equipment existing in the area of the new cogeneration plant.

On the basis of the information gathered from the Refinery technicians during a site survey – notwithstanding the lack of detailed drawings – FWI has analyzed the impact of new equipment/structures loads on the existing foundations.
The result of this preliminary study is that the re-use of the existing foundations is not possible from both technical and economic point of view.

New foundations shall hence be realized for new buildings and equipment, after total removal of existing underground structures (such as foundations, cable trenches, sewers, etc.) and complete land reclaiming. These activities of soil preparation shall be performed by Tamoil.

Moreover, in light of the future expansion of the cogeneration plant and in order to gain space for a better design and routing of the pipes (AG/UG) FWI recommends to reclaim the whole area, including the space for the future second gas turbine and HRSG train.

SECTION G

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DRAWINGS

Attached to this section are the following drawings:

- Process Flow Diagrams:
  - Thermal Cycle BD0238A-0-50-101 rev. A
  - Auxiliary Units BD0238A-1-50-102 rev. A

- General Plot Plan BD0238A-0-01-001 rev. A

- Piping Interconnecting BD0238A-0-01-002 rev. A

- Key One Line Diagram BD0238A-0-73-001 rev. A

A	JUN 05	FIRST ISSUE	S.F.			
REV.	DATE	DESCRIPTION	DRAW	BY	CHD	APP.

REVISIONS

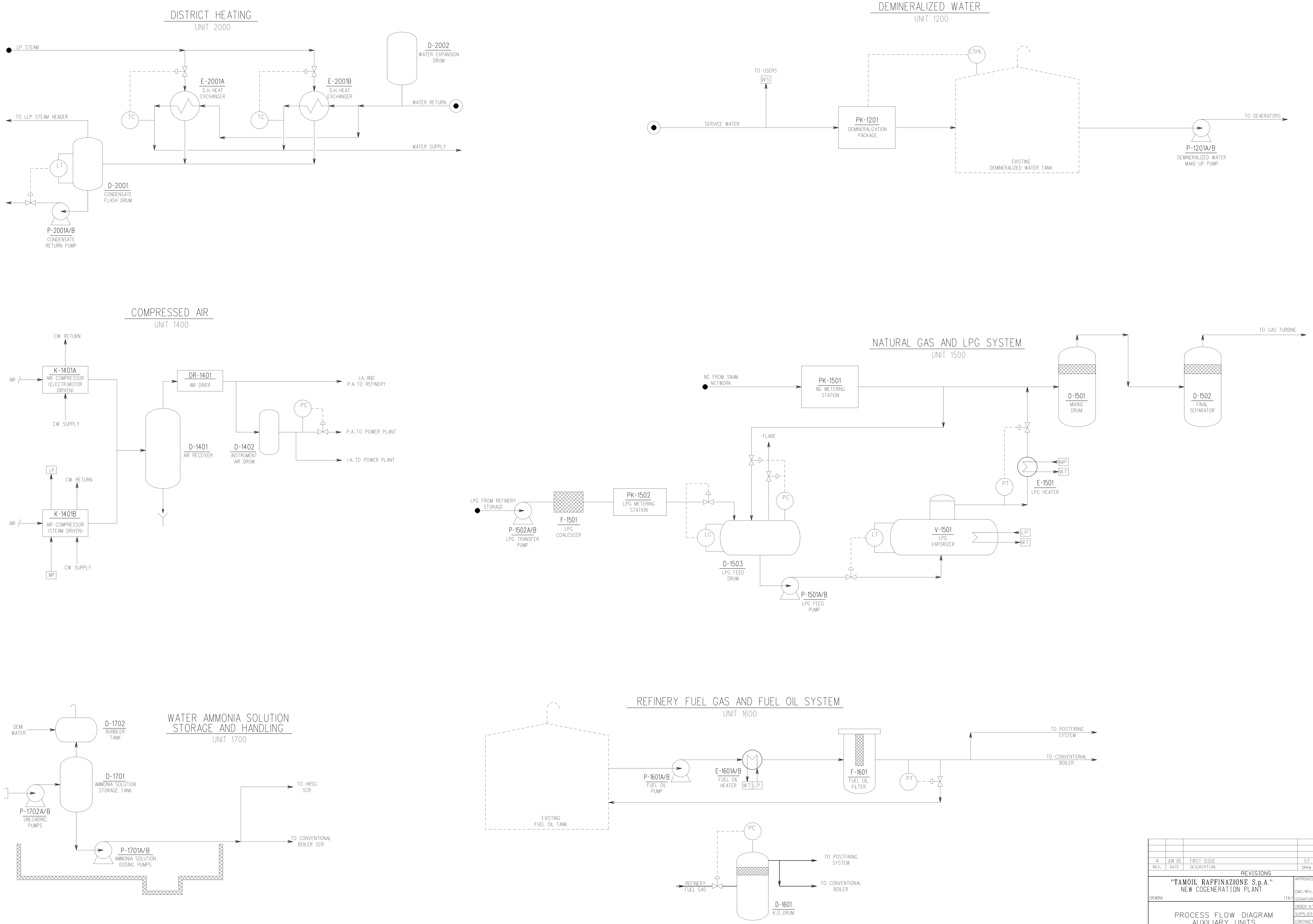
"TAMOIL RAFFINAZIONE S.p.A."
NEW COGENERATION PLANT
CREMONA ITALY

APPROVED FOR CONSTRUCTION
DWG. REV. DATE
SIGNATURE
ORDER N°
SUPPLIER
CONTRACT N° 1-BD-0238A
FRAME N°

PROCESS FLOW DIAGRAM
THERMAL CYCLE

FOSTER WHEELER

CLIENT DWG N° SCALE
SHEET OF
FWI DWG N° BD0238A-0-50-101 REV. A
SHEET OF
CAD FILE NAME



REV.	DATE	DESCRIPTION	DRAW	BY	CHD	APP.
A	JUN 05	FIRST ISSUE	S.F.			

REVISIONS

"TAMOIL RAFFINAZIONE S.p.A."
NEW COGENERATION PLANT

CREMONA ITALY

APPROVED FOR CONSTRUCTION
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ORDER N°
SUPPLIER
CONTRACT N° 1-BD-0238A
FRAME N°

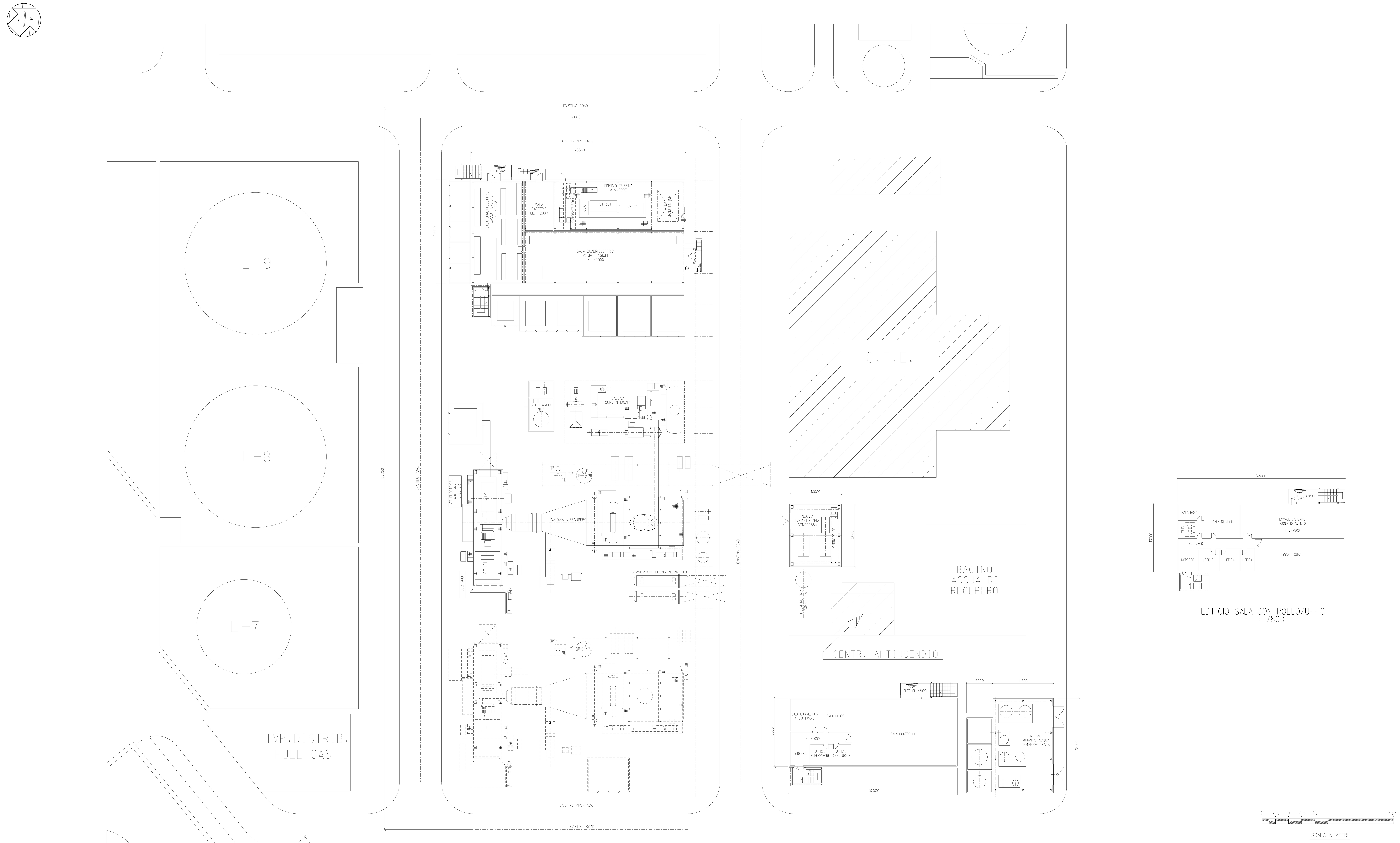
PROCESS FLOW DIAGRAM
AUXILIARY UNITS

FOSTER WHEELER

CLIENT DWG N° SCALE
SHEET OF

FWI DWG N° BD0238A-0-50-102 REV. A
SHEET OF

CAD FILE NAME



REV.	DATE	DESCRIPTION	DRAW	BY	CHD	APP.
A	GIU 05	PRIMA EMISSIONE	S.F.			

REVISIONS

"TAMOIL RAFFINAZIONE S.p.A."
NEW COGENERATION PLANT
CREMONA ITALY

APPROVED FOR CONSTRUCTION
DWG. REV. DATE
SIGNATURE

PLANIMETRIA GENERALE

ORDER N°
SUPPLIER
CONTRACT N° 1-BD-0238A
FRAME N°
CLIENT DWG N°
SHEET OF
SCALE 1:250

FOSTER WHEELER

FWI DWG N° BD0238A-0-01-001
SHEET OF
REV. A

CAD FILE NAME

TIE-IN N°	DESCRIZIONE	LUNGHEZZA TUBAZIONE	DIAMETRO TUBAZIONE	SCHEDULA & MATERIALE	Barg/°C
1	GPL	900 mt	3''	BA51	10/70
2	FUEL OIL (ALIMENTAZIONE)	230 mt	3''	AA51	15/150
3	FUEL OIL (RITORNO)	230 mt	2''	AA51	15/150
4	REFINERY FUEL GAS	240 mt	6''	AA51	8,5/70
5	COOLING TOWER WATER (MCW)	200 mt	6''	AA53	5,0/66
6	SERVICE WATER	280 mt	8''	AA53	10/50
7	POTABLE WATER	200 mt	2''	AC21	7/50
8	AZOTO	200 mt	2''	AA21	14,7/60
9	CONDENSATE	160 mt	6''	AA23	5,0/225
10	DEMI WATER	250 mt	6''	SS304L sch. 105	7,0/50
11	HP STEAM	90 mt	8''	DD21	50/480
12	MP STEAM	130 mt	18''	BA23	15/260
13	LP STEAM	180 mt	12''	AA23	5,0/180
14	HP BOILER FEED WATER	80 mt	3''	DA21	50/150
15	MP BOILER FEED WATER	80 mt	4''	BA23	20/120
16	ARIA STRUMENTIED IMPIANTI	80 mt	2''	AC21/AA21	14,7/70
17	METANO DA RETE SNAM	1350 mt	6''	BA22	25/60
18	ACQUA TELERISCALDAM.(ALIMENTAZ.)	800 mt	18''	AA51	15/150
19	ACQUA TELERISCALDAM.(RITORNO)	800 mt	18''	AA51	15/150
20	FOGNA ACIDA	200 mt		AA53	

REV.	DATE	DESCRIPTION	DRAW	BY	CHD	APP.
A	GIU 05	PRIMA EMISSIONE	S.F.			

REVISIONS

"TAMOIL RAFFINAZIONE S.p.A."
NEW COGENERATION PLANT

CREMONA ITALY

APPROVED FOR CONSTRUCTION

DWG.REV. DATE

SIGNATURE

PLANIMETRIA GENERALE PIPING INTERCONNECTING

ORDER N°

SUPPLIER

CONTRACT N° 1-BD-0238A

FRAME N°

CLIENT DWG N°

SHEET OF

SCALE 1:1000

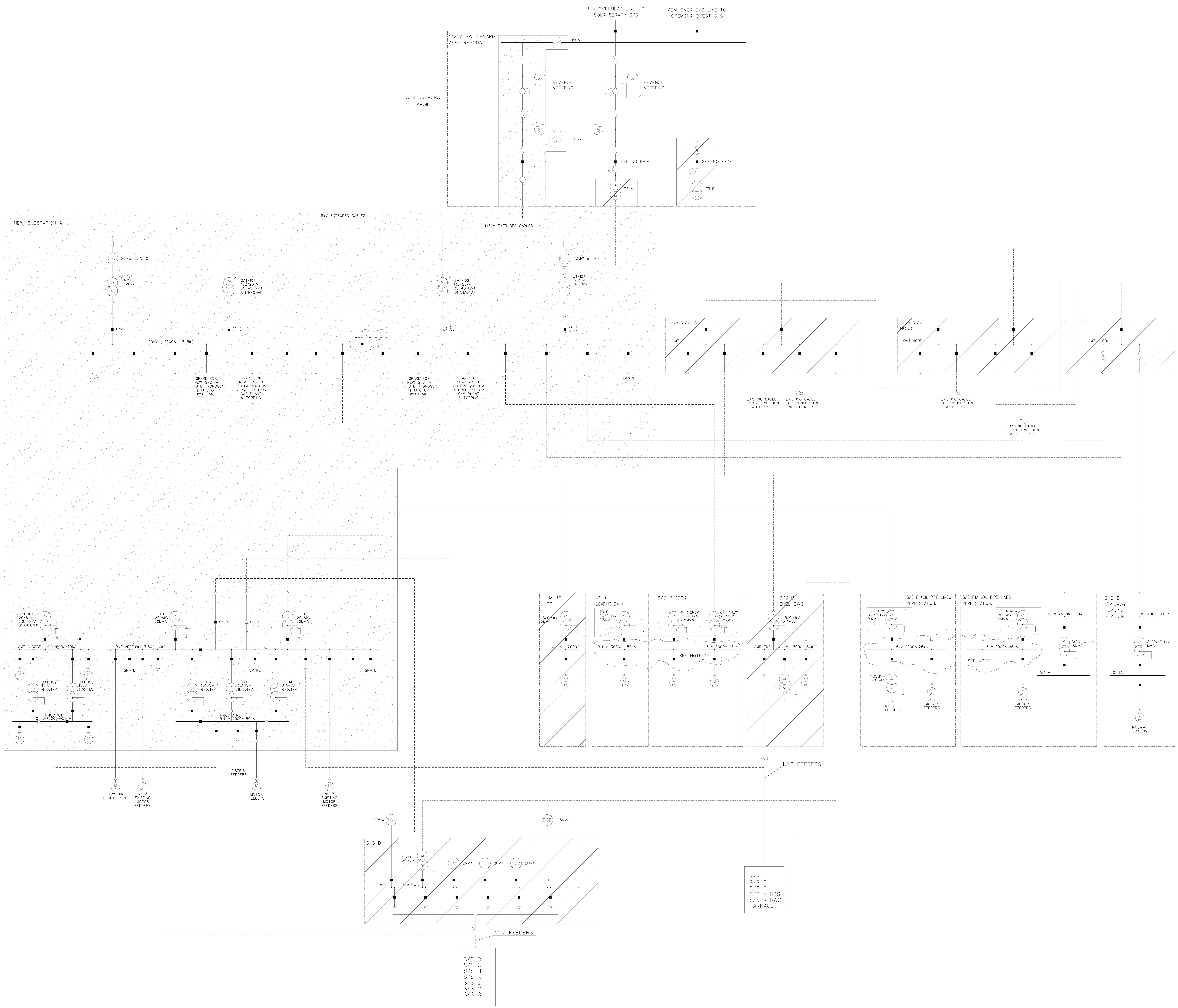
FWI DWG N° BD0238A-0-01-002

REV. A

SHEET OF

FOSTER WHEELER

CAD FILE NAME



LEGEND

CIRCUIT BREAKER "NORMALLY CLOSED/NORMALLY OPEN"

- CIRCUIT BREAKERS POSITION ARE INDICATED IN NORMAL OPERATING CONDITION

(S) CIRCUIT BREAKER WITH SINCRONIZATION FACILITIES

NEW EQUIPMENT

EXISTING EQUIPMENT TO BE ABANDONED

EQUIPMENT NOT SHADOWED IS EXISTING OR INCLUDED IN COGENERATION PORTION.

EXISTING CABLES

EXISTING CABLES TO BE ABANDONED

NEW CABLES

NOTES

1)THE EXISTING 3150A 132kV CIRCUIT BREAKER WILL BE REUSED. CT, VT AND DISCONNECTOR WILL BE PURCHASED NEW.

2)THE BUS TIE HAS TO REMAIN ALWAYS IN CLOSED POSITION. CAN BE OPERATED AT NO VOLTAGE AND FOR MAINTENANCE OPERATION ONLY.

3)TO BE REUSED FOR THE FUTURE 2nd GTG CONNECTION.

4)UPGRADE OF THE REFINERY'S ELECTRICAL EQUIPMENT NOT INVOLVED IN THE NEW COGENERATION POWER PLANT PROJECT

REV.	DATE	DESCRIPTION	DRAW	BY	CHD	APP.
A	JUN 05	FIRST ISSUE	S.F.			

REVISIONS

"TAMOIL RAFFINAZIONE S.p.A."
NEW COGENERATION PLANT
CREMONA ITALY

APPROVED FOR CONSTRUCTION
DWG. REV. DATE
SIGNATURE

KEY ONE LINE DIAGRAM

ORDER N°
SUPPLIER
CONTRACT N° 1-BD-0238A
FRAME N°
CLIENT DWG N°
SHEET OF
SCALE

FOSTER WHEELER

FWI DWG N° BD0238A-0-73-001
REV. A
SHEET OF

CAD FILE NAME

Allegato 2

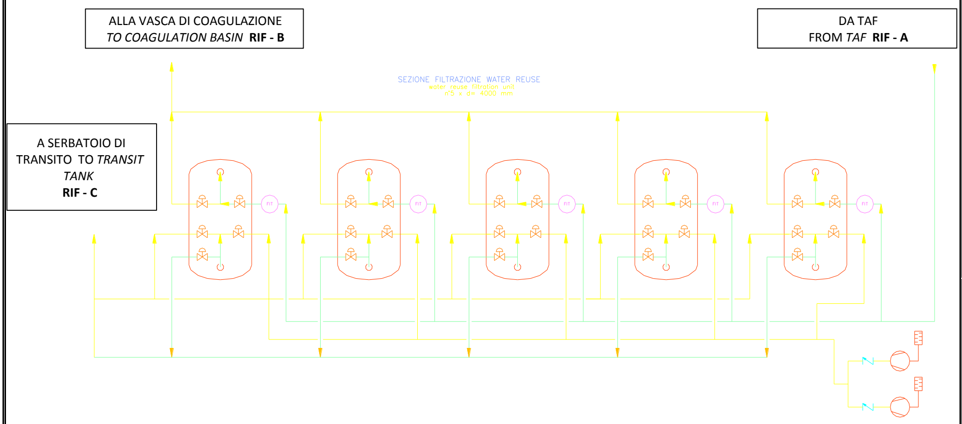
Studio di fattibilità per il riutilizzo delle acque reflue

Il presente Allegato 2 è costituito dalla seguente documentazione tecnica:

- Relazione Tecnica
- Schema a Blocchi e Bilancio Materiale Generale
- Schema a Blocchi e Bilancio Materiale Sezione
- Schema di Processo
- Plot Plan
- Caratteristiche apparecchiature

TAMOIL RAFFINERIA DI CREMONA	Cliente/Client	TAMOIL RAFFINAZIONE S.p.A	BERNARDINELLO ENGINEERING
	Località/Place	CREMONA	
	Impianto/Plant	WWTP - WHITE WATER TREATMENT PROCESS	
	Doc. PEB No.		

Commessa/Job	I08/001		
Doc.BE No.	I08_001_004NTE		
Page	4	of	6



NAMES	UNITS OF MEASURE	RIF - A	RIF - B	RIF - C				
SST	mg/l	N.D.	<5	N.D.				
pH	-	6-8	6-8	6-8				
THC	mg/l	<0.5	<0.5	<0.5				
COD	mgO2/l	<20	<50	<20				
BOD	mgO2/l	<7	<17	<7				
AMMONIA	mg/l	<2	<2	<2				
SULPHIDES	mg/l	<0.1	<0.1	<0.1				
PHENOLS	mg/l	N.D.	N.D.	N.D.				
NITRATES	mg/l	<5	<5	<5				
CHLORIDES	mg/l	<1	50	<1				
FLOW RATE (AVR.)	m3/h	450	25	425				
FLOW RATE (MAX.)	m3/h	594	33	561				
PRESSURE	bar	3	0	2				
TEMPERATURE	°C	15-25	15-25	15-25				

NOTES:
Filtration rate (average) = 7.2 m/h (with 5 working filters)
Filtration rate (design) = 9.5 m/h (with 5 working filters)
Filtration rate (average) = 8.9 m/h (with 4 working filters)
Filtration rate (design) = 11.8 m/h (with 4 working filters)
Filtration bed thickness = 2m

INDICE STRUMENTI - *Strumental index*

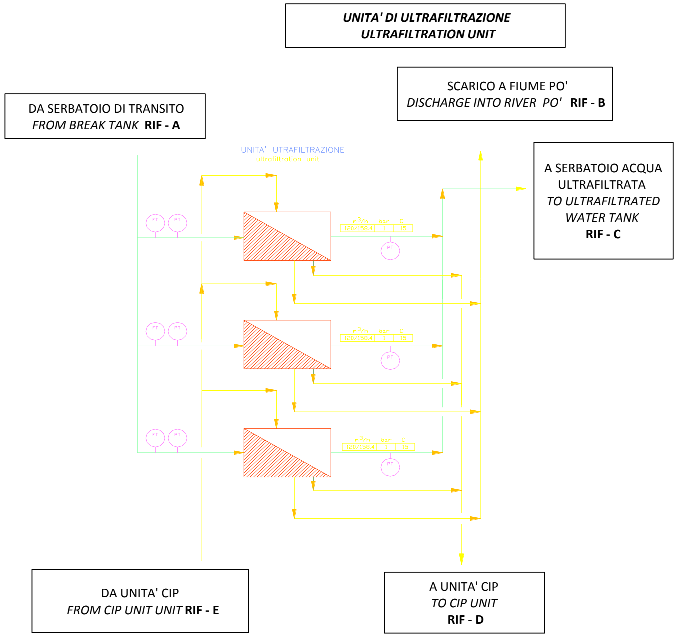
FIT	TRASMETTITORE DI PORTATA - *Flow trasmitter*	

FILTRAZIONE DI RIUTILIZZO ACQUA - *WATER REUSE FILTRATION UNIT*

BERNARDINELLO ENGINEERING

Rev	Data/Date	Descrizione/Description	Compilato/Compiled	Controllato/Checked	Approvato/Approved
0	06/02/2008	BOZZA/DRAFT	PICELLO	ROSSI	CARRARO

TAMOIL RAFFINERIA DI CREMONA	Cliente/Client	TAMOIL RAFFINAZIONE S.p.A	BERNARDINELLO ENGINEERING	Commessa/Job	I08/001
	Località/Place	CREMONA		Doc.BE No.	I08_001_004NTE
	Impianto/Plant	WWTP - WHITE WATER TREATMENT PROCESS			
	Doc. PEB No.			Page	5 of 6



NAMES	UNITS OF MEASURE	RIF - A	RIF - B	RIF - C	RIF - D	RIF - E		
SST	mg/l	<0.01	<5	N.D.	-	-		
pH	-	6-8	6-8	6-8	-	-		
THC	mg/l	<5	<0.5	<0.5	-	-		
COD	mgO2/l	<20	<20	<20	-	-		
BOD	mgO2/l	<7	<7	<7	-	-		
AMMONIA	mg/l	<2	<2	<2	-	-		
SULPHIDES	mg/l	<0.1	<0.1	<0.1	-	-		
PHENOLS	mg/l	N.D.	N.D.	N.D.	-	-		
NITRATES	mg/l	<1	<5	<5	-	-		
CHLORIDES	mg/l	50	50	50	-	-		
FLOW RATE (AVR.)	m3/h	425	65	360	-	-		
FLOW RATE (MAX.)	m3/h	561	85.8	475.2	-	-		
PRESSURE	bar	2	1	1	-	-		
TEMPERATURE	°C	15-25	15-25	15-25	-	-		

NOTES:

Dead-end working

Effective membrane surface = 50m2

Fibers internal diameter = 0.9mm

Fiber pores diameter = about 0.02um

Cut-off molecular weight = 80 - 150 kDa

Membrane composition = PES(M)

Housing composition = PVC

INDICE STRUMENTI - *Strumental index*

PT	TRASMETTITORE DI PRESSIONE	*- Pressure transmitter*	
PI	MANOMETRO	*- Pressure gauges*	

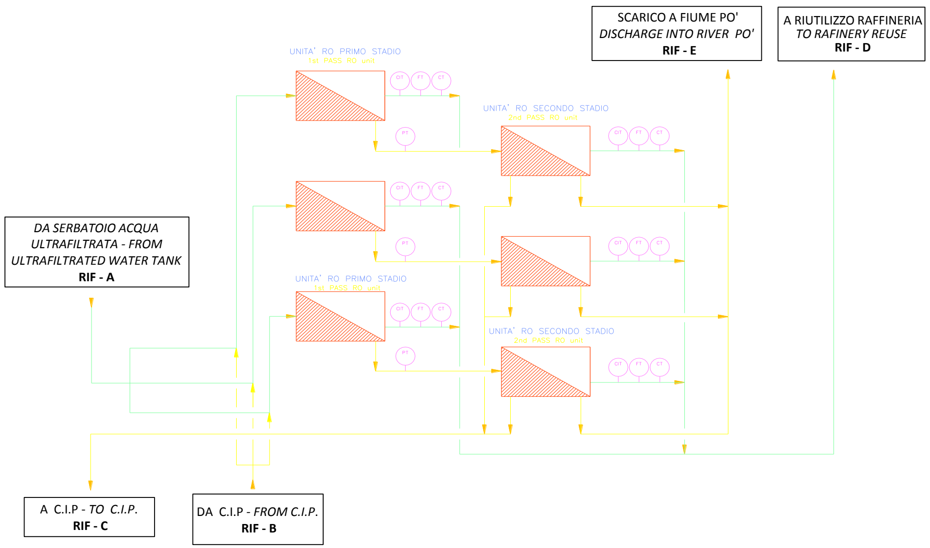
UNITA' DI ULTRAFILTRAZIONE - *ULTRAFILTRATION UNIT*

BERNARDINELLO ENGINEERING

0	06/02/2008	BOZZA/DRAFT	PICELLO	ROSSI	CARRARO
Rev	**Data/Date**	**Descrizione/Description**	**Compilato/Compiled**	**Controllato/Checked**	**Approvato/Approved**

RAFFINERIA DI CREMONA	Cliente/Client	TAMOIL RAFFINAZIONE S.p.A		Commessa/Job	I08/001
	Località/Place	CREMONA		Doc.BE No.	I08_001_004NTE
	Impianto/Plant	WWTP - WHITE WATER TREATMENT PROCESS			
	Doc. PEB No.			Page	6 of 6

UNITA' RO PRIMO E SECONDO STADIO
1ST AND 2ND PASS RO UNITS



NAMES	UNITS OF MEASURE	RIF - A	RIF - B	RIF - C	RIF - D	RIF - E		
SST	mg/l	N.D.	-	-	N.D.	<5		
pH	-	6-8	-	-	6-8	6-8		
THC	mg/l	<0.5	-	-	<0.1	<0.5		
COD	mgO2/l	<20	-	-	N.D.	<50		
BOD	mgO2/l	<7	-	-	N.D.	<17		
AMMONIA	mg/l	<2	-	-	<2	<2		
SULPHIDES	mg/l	<0.1	-	-	<0.1	<0.1		
PHENOLS	mg/l	N.D.	-	-	N.D.	N.D.		
NITRATES	mg/l	<5	-	-	<1	<5		
CHLORIDES	mg/l	50	-	-	<1	84		
FLOW RATE (AVR.)	m3/h	360	-	-	110	250		
FLOW RATE (MAX.)	m3/h	475	-	-	145,2	330		
PRESSURE	bar	11	-	-	0,5	0,5		
TEMPERATURE	°C	15-25	-	-	15-25	15-25		

NOTES:
Total recovery = 70%

INDICE STRUMENTI - *Strumental index*

FT	TRASMETTITORE DI PORTATA	*- Flow trasmitter*	
PI	MANOMETRO	*- Pressure gauges*	
PT	TRASMETTITORE DI PRESSIONE	*- Pressure transmitter*	
CIT	TRASMETTITORE DI CONDUCIBILITA'	*- Conducibilty trasmitter*	

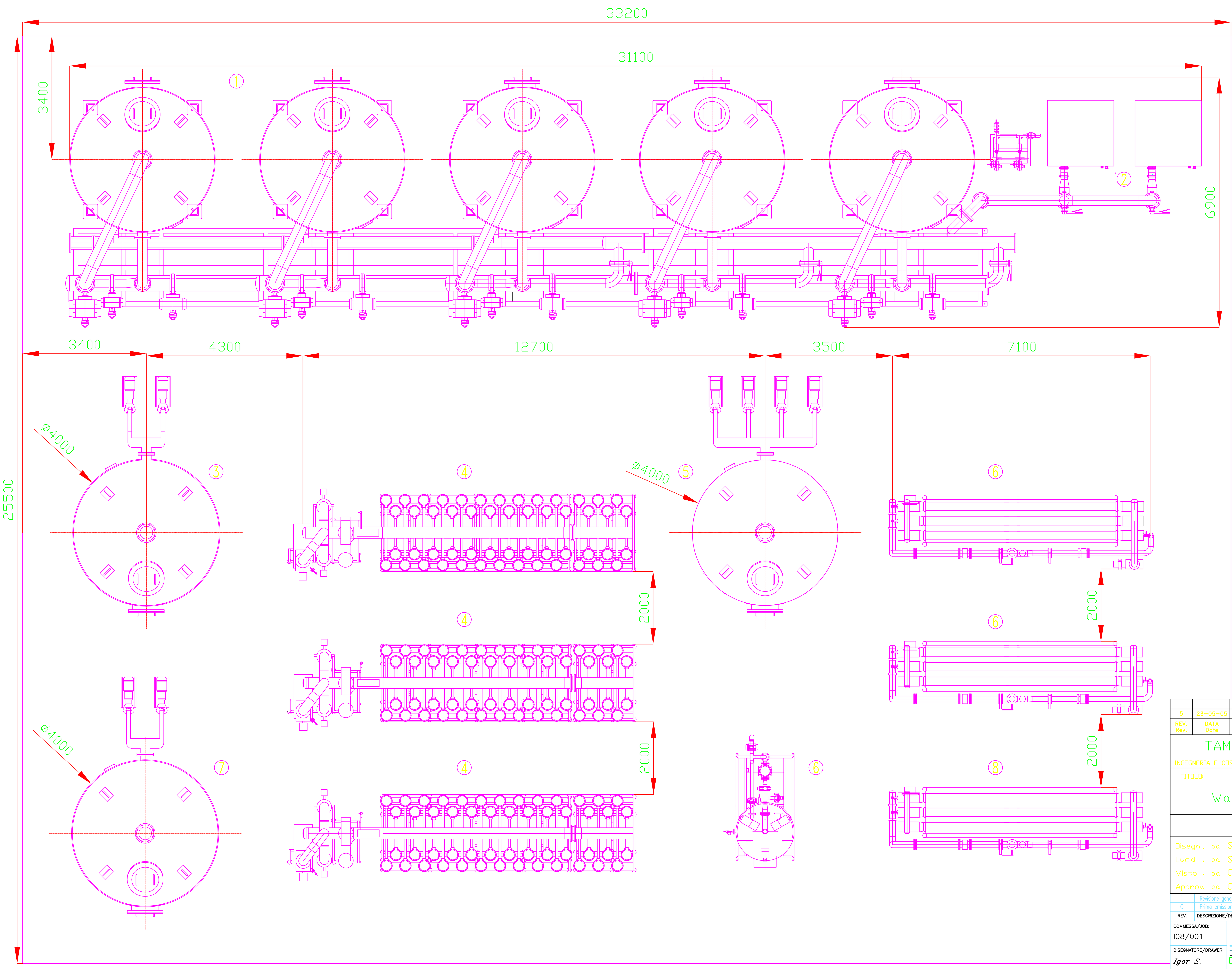
UNITA' RO PRIMO E SECONDO STADIO - *1ST AND 2ND PASS RO UNITS*

0	06/02/2008	BOZZA/DRAFT	PICELLO	ROSSI	CARRARO
Rev	**Data/Date**	**Descrizione/Description**	**Compilato/Compiled**	**Controllato/Checked**	**Approvato/Approved**

CARATTERISTICHE EQUIPAGGIAMENTI TRATTAMENTO ACQUE BIANCHE E WATER REUSE

Equipment characteristics white water treatment and water reuse

0	06/02/2008	PRIMA EMISSIONE / FIRST EMISSION	PICELLO	ROSSI	CARRARO
Rev	**Data/Date**	**Descrizione/Description**	**Compilato/Compiled**	**Controllato/Checked**	**Approvato/Approved**



LEGENDA/legend	
1	FILTRI QUARZITE PIROLUSITE quarzite pyrolusite filters
2	SOFFIATORI LAVAGGIO washing blowers
3	SERBATOIO ACQUA FILTRATA filtrated water tank
4	ULTRAFILTRAZIONE ultrafiltration
5	SERBATOIO ACQUA ULTRAFILTRATA ultrafiltrated water tank
6	OSMOSI INVERSA reverse osmosis
7	SERBATOIO STOCCAGIO ACQUA TRATATA storage treated water tank
8	UNITA C.I.P. C.I.P. unit

REV. Rev.	DATA Date	DESCRIZIONE Description	DISEGN. Draft.	CONTR. Check'd	APPROV. Appr'd	STATO REV. Rev. Status
5	23-05-05	REVISIONE GENERALE	SITECNE	C.NEVI	C.NEVI	

TAMOIL RAFFINAZIONE S.p.A

INGEGNERIA E COSTRUZIONE — RAFFINERIA DI CREMONA

TITOLO: WWTP - CUP
Water reuse plant lay-out

Disegn. da SITECNE Data 23-05-05
Lucid. da SITECNE Data 23-05-05
Visto. da C.NEVI Data 20-05-05
Approv. da C.NEVI Data 20-05-05

SCALA 1 : 50

E-12-8378

Rev. 5

REV.	DESCRIZIONE/DESCRIPTION	DATA/DATE:	FIRMA/SIGNATURE:
1	Revisione generale / General revision	28.02.2008	A. Rossi
0	Prima emissione / First emission	21.02.2008	Igor S.

COMMESSA/JOB: 108/001

DISEGNATORE/DRAWER: Igor S.

VISTO/APPROVED:

SCALA/SCALE: 1:50

DATA/DATE: 20/02/2008

BERNARDINELLO ENGINEERING Cadoneghe (PD) ITALY

OGGETTO/OBJECT: WWTP
Water reuse plant lay-out

COMMITTENTE/CUSTOMER: TAMOIL S.P.A.

SOSTITUITO DA / REPLACED BY

SOSTITUISCE IL / IN REPLACEMENT OF

DIS. N° 3258-E2

A1

RELAZIONE TECNICA

IMPIANTO

WATER REUSE (WR)

Rev.	Descrizione	Data	Redatto	Controllato	Approvato
0	Prima emissione	22/02/2008	Carraro	Rossi	Bernardinello

1.1.1 Water reuse

L'impianto di *"Water Reuse"* verrà alimentato con l'acqua trattata dall'impianto TAF. E' prevista la possibilità riutilizzare anche le acque in uscita dall'impianto di trattamento delle acque bianche.

Le acque del TAF giungeranno quindi in una sezione di filtrazione, per la rimozione di eventuali tracce di metalli (ferro e manganese) o di solidi sospesi.

Le acque di lavaggio dei filtri saranno convogliate in ingresso alla sezione di trattamento delle acque bianche.

L'acqua filtrata sarà inviata in un serbatoio di transito, che potrà accogliere anche le acque bianche trattate.

Tramite pompe dedicate l'acqua filtrata alimenterà le unità di ultrafiltrazione (3 in parallelo).

L'ultrafiltrazione è un processo di separazione solido-liquido di tipo fisico; a differenza dei sistemi tradizionali di filtrazione in pressione o a gravità (nei quali la filtrazione è di tipo "normale"), l'ultrafiltrazione su membrane è processo di filtrazione di tipo tangenziale.

Convenzionalmente il processo di ultrafiltrazione ha un grado di filtrazione compreso tra 0,01 e 0,1 μm.

Per definizione operativa si definiscono "solidi sospesi" tutti i solidi di dimensioni superiori a 0,45 μm.

Le sostanze, o particelle, "colloidali" sono definibili invece come sostanze solide disperse in un liquido (in questo caso l'acqua), aventi dimensioni variabili nell'intervallo 0,10 - 1 μm

E’ chiaro quindi che sulla base di quanto esposto l’ultrafiltrazione è potenzialmente in grado di rimuovere i solidi sospesi e i solidi di natura colloidale presenti in soluzione acquosa.

L’ultrafiltrazione da questo punto di vista rappresenta il miglior pretrattamento possibile a monte di un successivo stadio di demineralizzazione su osmosi inversa.

Tutte le sostanze disciolte (sostanze in soluzione e non in sospensione) non vengono trattenute dalle membrane di ultrafiltrazione.

La dimensione dei pori delle membrane permette la separazione, oltre ai colloidi e ai solidi di natura inorganica, anche dei batteri, dei virus, e di alcune molecole organiche aventi dimensioni maggiori dei pori delle membrane utilizzate.

In figura 4 è rappresentato un tipico “spettro di filtrazione”.

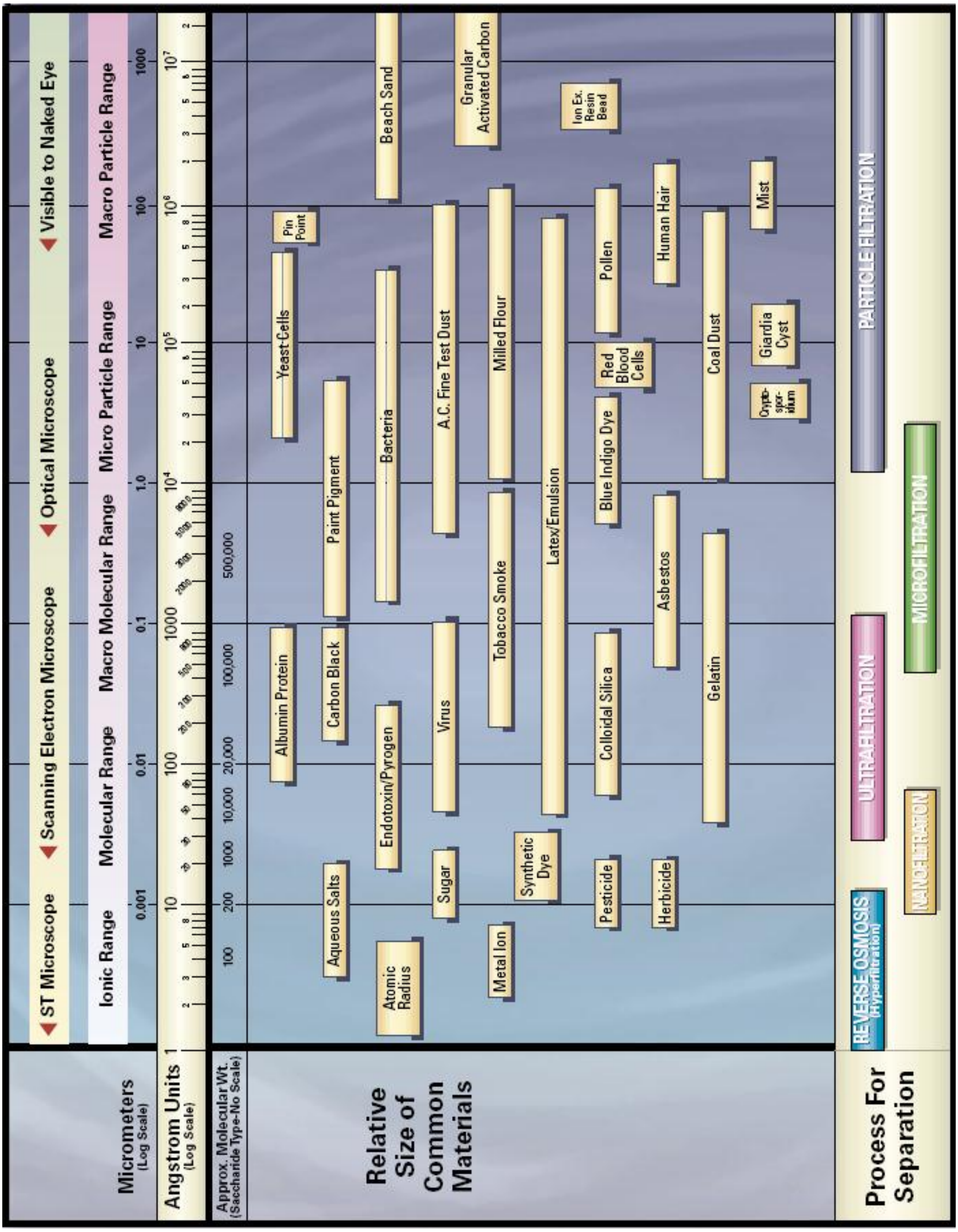


Figura 4 – Spettro di filtrazione convenzionale

Il concentrato dell'ultrafiltrazione, contenente quindi i colloidi trattenuti durante la fase di lavoro, sarà inviato allo scarico.

L'acqua ultrafiltrata sarà stoccata in un serbatoio dedicato dal quale preleveranno le pompe della sezione di osmosi inversa.

Il permeato dell'osmosi, stoccato i un serbatoio di transito, sarà inviato tramite pompe dedicate a monte del collettore di distribuzione dell'acqua di servizio, azzerando il prelievo idrico dai pozzi esistenti.

Il concentrato dell'impianto di osmosi inversa sarà inviato allo scarico nel recettore finale.

Le acque prodotte durante i lavaggi periodici o provenienti dalle sanificazioni delle membrane UF o RO saranno scaricate in fogna bianca per essere adeguatamente trattate.

Tabella 7 - Composizione chimica acqua industriale (pozzi)/acqua da water reuse

Parametro	***U.M.***	***Acqua di pozzo (Media)***	***Acqua da WR (Media)***
Conducibilità	µS/cm	512	ca. 30
pH		7,5	6,5 – 7,5
Cloruri	mg/l Cl	19,8	< 5
Solfati	mg/l SO_4	6,2	< 1
Calcio	mg/l Ca	63,9	< 0,5
Magnesio	mg/l Mg	13,1	< 0,1
Sodio	mg/l Na	24,7	< 2
Potassio	mg/l K	3,4	<0,1
Durezza tot	mg/l $CaCO_3$	256	< 0,5
Alcalinità	mg/l $CaCO_3$	265	< 5
Nitrati	mg/l NO_3	0,9	< 0,5
Ammoniaca	mg/l NH_4	1,5	< 0,01
Ossidabilità (Kubel)	mg/l O_2	1,7	<1

1.2 Effetti del recupero idrico

L’acqua recuperata dall’impianto di water reuse, avente caratteristiche chimico-fisiche di cui alla tabella precedente 6.1. Sarà riutilizzata per l’alimentazione delle seguenti unità di processo:

- Alimentazione nuovi impianti demineralizzazione CTE (nuova centrale termoelettrica)
- Reintegro torri evaporative si stabilimento
- Desalter
- Altre utenze di processo

L’utilizzo di acqua da water reuse comporterà una serie di vantaggi tangibili al funzionamento e alle performance della nuova sezione di demineralizzazione della centrale termica e al funzionamento e al bilancio idrico delle torri evaporative.

Alimentando gli impianti di demineralizzazione con l’acqua da water reuse, basati su processo a scambio ionico, si aumenterà di fatto di almeno un fattore 10 la resa ciclica delle nuove linee installate (per resa ciclica si intende il volume di acqua demineralizzata prodotta tra una rigenerazione e la successiva).

Questo fatto comporterà una proporzionale riduzione dei rigeneranti utilizzati per la “riattivazione” delle resine (acido cloridrico e idrossido di sodio), e una diminuzione degli eluati da neutralizzare ed inviare allo scarico nel recettore finale (diminuzione consistente del quantitativo ponderale di cloruri scaricato nel recettore finale rispetto alla situazione attuale – circa -70%).

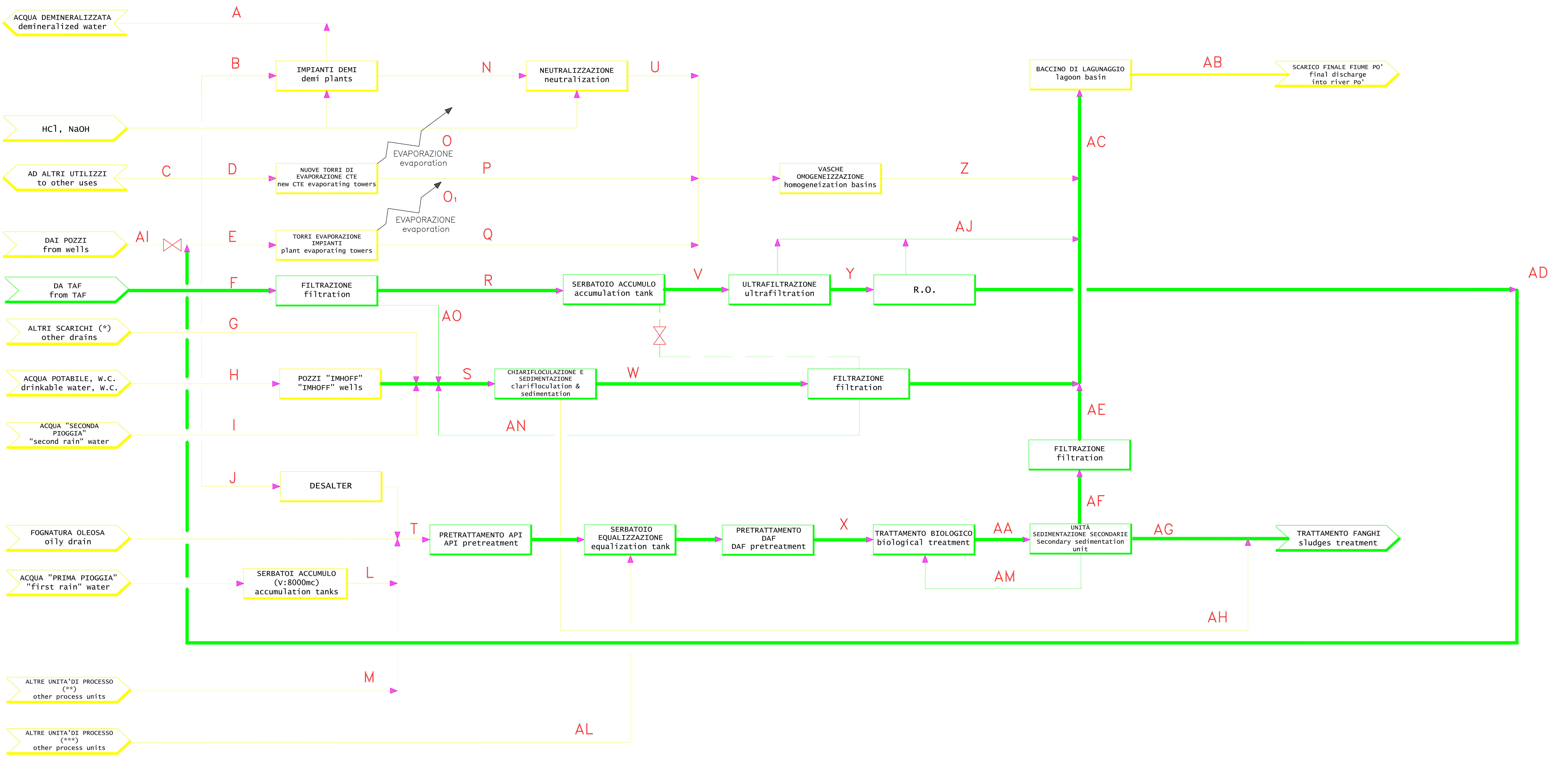
Per quanto concerne le acque di raffreddamento, alimentando la torre evaporativa con acqua osmotizzata da water reuse verranno aumentati drasticamente i cicli di concentrazione (da 3 ad un numero maggiore di 10 volte). Verrà quindi ridotto il volume di acqua di spurgo e conseguentemente il volume di acqua da reintegrare.

Come conseguenza diretta, verrà drasticamente ridotto (stimiamo inferiore al 5% dell'attuale) il dosaggio dell'agente disperdente (antincrostante) e del prodotto per la correzione del valore di pH.

E' probabile anche una riduzione (non quantificabile) del prodotto biocida attualmente utilizzato.

Stream	A	B	C	D	E	F	G	H	I	J	L	M	N	O	O1	P	Q	R	S	T
Temperatura (°C)						15–25												15–25	15–25	30–40
COD (mgO2/L)						<20												<20		300
BOD (mgO2/L)						<7												<7		100
Ammoniaca (mg/L)						<2												<2		35
Solfuri (mg/L)						<0.1												<0.1		13
Fenoli (mg/L)						n.d.												n.d.		2
Nitrati (mg/L)						<5												<5		7
THC (mg/L)						<0.5			1		20					0.1	0.1	<0.5	10.00	160
Cloruri (mg/L)		19,8	19,8	1,5	19,8	<0.05	121	25	5	25	5	617	730			11.3	59.5	<0.05	58.6	43
SOA (mg/L)						<0.01	4.11		0.2	5	1	8.88		0.04	0.04	0.04	0.04	<0.01	2.00	3
SST (mg/L)							20.53			50		318								100
pH	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8
Portata (m3/h)	119.6	123.6	18.5	35	45.1	450	29	6	35	27.8	15	34.4	4	30.3	30.1	4.7	15	425	100.0	84

Stream	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AL	AM	AN	AO
Temperatura (°C)	15–25	15–25	15–25	30–40	15–25	15–25	30–40	15–25	30–40	15–25	30–40	30–40	30–40	15–25	15–25	15–25	15–25	30–40	15–25	15–25
COD (mgO2/L)		<20	<50	200	<20		70		<70	<20	<70	70		<20	<20	<20		70	<20	<20
BOD (mgO2/L)		<7	<17	66	<7				<20		<20	<20						<20		
Ammoniaca (mg/L)		<2	<2	35	<2		<5		<5		<5	<5						<5		
Solfuri (mg/L)		<0.1	<0.1	1	<0.1		<0.5		<0.5		<0.5	<0.5						<0.5		
Fenoli (mg/L)		n.d.	n.d.	2	n.d.		<0.1		<0.1		<0.1	<0.1						<0.1		
Nitrati (mg/L)		<5	<5	10	<5		15		15		15	15						15		
THC (mg/L)		<0.5	<1	1	<0.5	0.09	<1	0,25	<0.5		<0.5	<1						<1		
Cloruri (mg/L)	730	<0.05	50	43	50	126	43	281	43		43	43						43		
SOA (mg/L)		<0.01	<0.01	0.5	<0.01	0.04	<0.1	0,03	<0.1		<0.1	<0.1						<0.1		
SST (mg/L)				20					<10		<10	<25						<25		
pH	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8	6–8
Portata (m3/h)	4	425	89	95	360	23.7	159	366.7	366.7	250.0	84	86	9	1	0.0	175	17	64	5	25



(*) = TROPPO PIENO VASCA CTE, DRENAGGI SERBATOI
Overload CTE basin, Tank's drainage

(**) = DRENAGGI: SERBATOI GREGGIO, UNITA' IMPIANTI E RECUPERO IDROCARBURI IMPIANTO API
Drainages: Oil tanks, plant units and API hydrocarbons recovery plant

(***) = DA ISPESSITORE SD-5, SERBATOIO S-3
From thickener SD-5, S-3 tank

NUOVE LINEE DI PROCESSO / new process lines

NUOVI PROCESSI DI TRATTAMENTO UNITARI / new unitary treatment processes

BY-PASS

DOCUMENTI DI RIFERIMENTO/ Reference documents

DWG N.	DESCRIZIONE / Description
3258-B1	WWTP – PFD – TRATTAMENTO ACQUE OLEOSE/ oily water treatment
3258-B2	WWTP – PFD – TRATTAMENTO FANGHI / sludge treatment
3258-B3	WWTP – PFD – TRATTAMENTO ACQUE BIANCHE / white water treatment
3258-B4	WWTP – BILANCIO MASSA TRATTAMENTO ACQUE OLEOSE / Mass balance oily water
3258-B5	WWTP – BILANCIO MASSA TRATTAMENTO FANGHI / Mass balance sludges
3258-B6	WWTP – BILANCIO MASSA ACQUE BIANCHE / Mass balance white water
3258-B7	BILANCIO MASSA COMPLESSIVO / Total mass balance

REV.	DESCRIZIONE/DESCRIPTION	DATA/DATE:	FIRMA/SIGNATURE:
3			
2			
1	Revisione generale / General revision	28.02.2008	A. Rossi
0	Prima emissione / First emission	21.02.2008	A. Rossi

COMMESSA/JOB: I08/001

DISEGNATORE/DRAWER: A. Rossi

VISTO/APPROVED:

SCALA/SCALE: 1:1

DATA/DATE: 19-02-2008

BERNARDINELLO ENGINEERING Cadoneghe (PD) ITALY

OGGETTO/OBJECT: WWTP
General mass balance

COMMITTENTE/CUSTOMER: TAMOIL RAFFINAZIONE

SOSTITUITO DA REPLACED BY

SOSTITUISCE IL IN REPLACEMENT OF

DIS. N° 3258-B7

Stream	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q
Temperatura/Temparature (°C)	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25	15-25
COD (mgO2/l)	<50	<50	<20	<50	<50	<50	<50	<20	<20	<20	n.d.	<20	<20	<20	
*BOD5 (mgO2/l)	<17	<17	<7	<17	<17	<17	<17	<7	<7	<7	n.d.	<7	<7	<7	
Ammoniaca/Ammonia (mg NH4/l)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	
Solfuri/Sulphide (mgH2S/l)	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	
Fenoli/Phenols (mg/l)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	
Nitrati/NItrate (mgNO3/l)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<1	<5	<5	<5	
THC (mg/l)	2	<1	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5	<0,1	<0,5	<0,5	<0,5	
Cloruri/Cloride (mg/l)	50	50	50	50	50	50	84	50	50	50	<1	<1	<1	<1	
SOA (mg/l)	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	
SST (mg/l)	200	30	<5	<5	<5	<5	<5	<5	n.d.	n.d.	n.d.				
pH (mg/l)	6-8	6-8	6-8	6-8	6-8	6-8	6-8	6-8	6-8	6-8	6-8	6-8	6-8	6-8	
Portate/Flow rates (m3/h)	90.0	89.0	89.0	1.0	5.0	30.0	264.0	425.0	360.0	360.0	250.0	450.0	25.0	425.0	

* BOD=1/3COD

n.d. = non determinabile/no determinable

DOCUMENTI DI RIFERIMENTO/ Reference documents

DWG N.	DESCRIZIONE / Description
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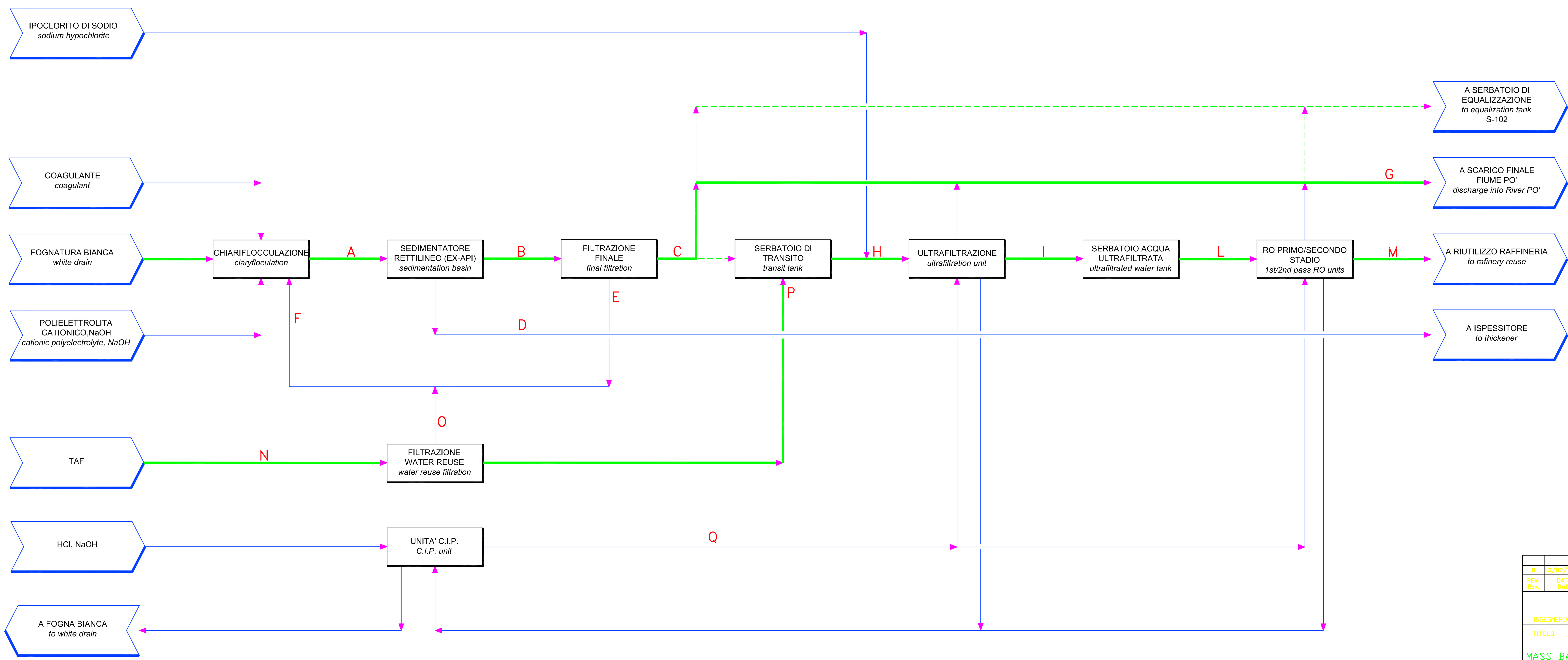
3258-B3	WWTP – TRATTAMENTO ACQUE BIANCHE / white water treatment
3258-B4	WWTP – BILANCIO MASSA TRATTAMENTO ACQUE OLEOSE / Mass balance oily water
3258-B5	WWTP – BILANCIO MASSA TRATTAMENTO FANGHI / Mass balance sludges
3258-B6	WWTP – BILANCIO MASSA ACQUE BIANCHE / Mass balance white water
3258-B7	BILANCIO MASSA COMPLESSIVO / Total mass balance



LINEA PRINCIPALE DI PROCESSO
Primary process line

PROCESSI DI TRATTAMENTO UNITARI
Unitary treatment processes

BY-PASS

LINEA FANGHI
Sludges line

0	13/02/2008	PRIMA EMISSIONE PER COMMENTI	PICELLO	CARRARO	CARRARO	
REV. Rev.	DATA Date	DESCRIZIONE Description	DISEGN. Draft.	CONTR. Check'd	APPROV. Appr'd	STATO REV. Rev. Status

TAMOIL RAFFINAZIONE S.p.A

INGEGNERIA E COSTRUZIONE — RAFFINERIA DI CREMONA

TITOLO: CUP – CREMONA UPGRADE PROJECT

MASS BALANCE WHITE WATER TREATMENT AND WATER REUSE

Disegn. da -- Data 15-02-08
Lucid. da -- Data 15-02-08
Visto. da -- Data 15-02-08
Approv. da -- Data 15-02-08

SCALA 1 : 1

E-xxxxx

Rev. 0

REV.	DESCRIZIONE/DESCRIPTION	DATA/DATE:	FIRMA/SIGNATURE:
7			
6			
5			
4			
3			
2			
1	Revisione generale / General revision	28.02.2008	A. Rossi
0	Prima emissione / First emission	21.02.2008	A. Carraro

COMMESSA/JOB: 108/001

DISEGNATORE/DRAWER: PICELLO

VISTO/APPROVED:

SCALA/SCALE: 1:1

DATA/DATE: 21.02.2008

BERNARDINELLO ENGINEERING — Cadoneghe (PD) ITALY

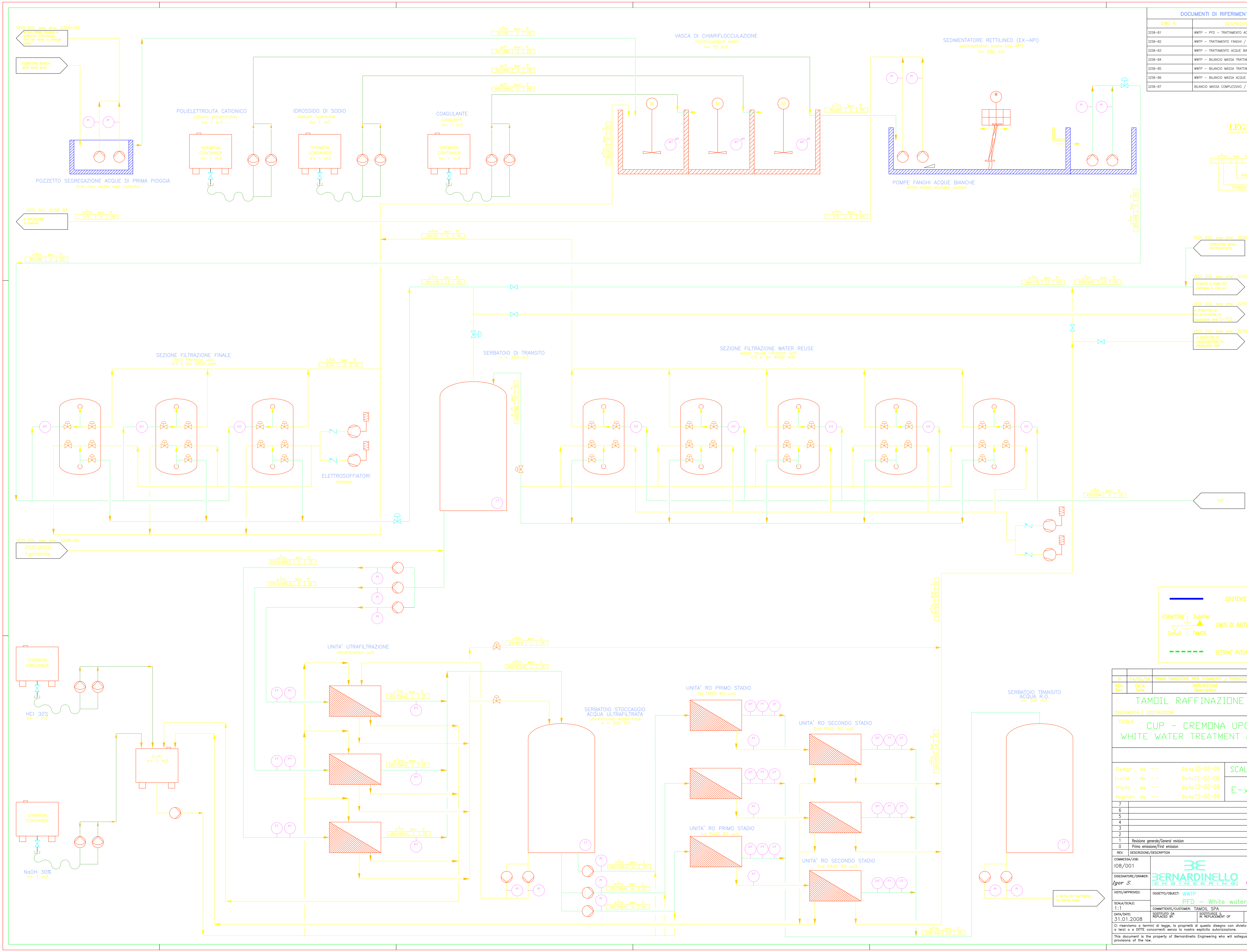
OGGETTO/OBJECT: WWTP White water & Water reuse
Diagram scheme & Mass balance

COMMITTENTE/CUSTOMER: TAMOIL SPA

SOSTITUITO DA / REPLACED BY — SOSTITUISCE IL / IN REPLACEMENT OF

DIS. N° 3258-B6

A0



DOCUMENTI DI RIFERIMENTO/ Reference documents

DWG N.	DESCRIZIONE / Description
3258-B1	WWTP – PFD – TRATTAMENTO ACQUE OLEOSE/ oily water treatment
3258-B2	WWTP – TRATTAMENTO FANGHI / sludge treatment
3258-B3	WWTP – TRATTAMENTO ACQUE BIANCHE / white water treatment
3258-B4	WWTP – BILANCIO MASSA TRATTAMENTO ACQUE OLEOSE / Mass balance oily water
3258-B5	WWTP – BILANCIO MASSA TRATTAMENTO FANGHI / Mass balance sludges
3258-B6	WWTP – BILANCIO MASSA ACQUE BIANCHE / Mass balance white water
3258-B7	BILANCIO MASSA COMPLESSIVO / Total mass balance

LEGENDA/Legend

ESISTENTE / existing

FORNITORE | Supplier — Tamoil | TAMOIL — LIMITI DI BATTERIA / design battery limits

SEZIONE FUTURA / future

REV. Rev.	DATA Date	DESCRIZIONE Description	DISEGN. Draft.	CONTR. Check'd	APPROV. Appr'd	STATO REV. Rev. Status
0	14/02/08	PRIMA EMISSIONE PER COMMENTI / FORNOTE	--	--	--	

TAMOIL RAFFINAZIONE S.p.A

INGEGNERIA E COSTRUZIONE — RAFFINERIA DI CREMONA

TITOLO: CUP – CREMONA UPGRADE PROJECT
WHITE WATER TREATMENT AND WATER REUSE

Disegn. da -- Data 15-02-08
Lucid. da -- Data 15-02-08
Visto. da -- Data 15-02-08
Approv. da -- Data 15-02-08

SCALA 1 : 1

E-xxxxx

Rev. 0

REV.	DESCRIZIONE/DESCRIPTION	DATA/DATE:	FIRMA/SIGNATURE:
7			
6			
5			
4			
3			
2			
1	Revisione generale/General revision	28.02.2008	A. Rossi
0	Prima emissione/First emission	21.02.2008	A. Carraro

COMMESSA/JOB: I08/001

DISEGNATORE/DRAWER: Igor S.

BERNARDINELLO ENGINEERING — Cadoneghe (PD) ITALY

VISTO/APPROVED:

OGGETTO/OBJECT: WWTP
PFD – White water treatment & Water reuse

SCALA/SCALE: 1:1

COMMITTENTE/CUSTOMER: TAMOIL SPA

DATA/DATE: 31.01.2008

SOSTITUITO DA REPLACED BY

SOSTITUISCE IL IN REPLACEMENT OF

DIS. N° 3258-B3

A0

Composizione Fuel Gas - Caratterizzazioni analitiche Dicembre 2010

	Codice	H2S	COS	CO	CH4	CO2	H2	Ossigeno + Argon	Azoto	C2 come etano	C3 come propano	C4 come n-butano	C5 come n-pentano	C6 e C6+ come n-esano	Σ % C (W)	PCS (MJ/kg)	PCI (MJ/kg)
01-dic-10	1018677	0,0001	<0,0001	0,0173	30,51	0,11976	53,76	<0,01	0,43437	4,88	5,03	4,13	0,82	0,31	71,52	59,23	53,13
02-dic-10	1018729	0,0001	<0,0001	0,0477	24,16	0,10692	62,84	<0,01	0,3380	3,86	4,37	3,23	0,76	0,29	69,13	62,00	55,36
03-dic-10	1018820	0,0009	<0,0001	0,0335	33,47	0,0570	55,48	<0,01	0,39431	3,59	3,97	2,04	0,66	0,30	69,62	61,25	54,71
04-dic-10	1018874	0,0004	<0,0001	<0,0001	20,43	0,4150	67,40	<0,01	0,66648	3,19	4,58	2,64	0,58	0,11	66,03	62,67	55,77
06-dic-10	1019028	0,0004	<0,0001	<0,0001	25,34	0,39623	63,00	<0,01	0,72423	3,81	4,01	2,08	0,53	0,12	66,50	61,96	55,17
07-dic-10	1019029	0,0001	<0,0001	0,0015	20,63	0,18464	66,49	<0,01	0,54305	3,74	4,69	2,29	1,33	0,11	67,60	62,65	55,85
09-dic-10	1019090	0,0105	<0,0001	<0,0001	2,40	0,09772	80,90	<0,01	0,19239	3,14	6,22	5,82	1,07	0,15	67,84	64,72	57,73
10-dic-10	1019261	0,0010	<0,0001	<0,0001	28,88	0,3808	58,31	<0,01	0,9668	4,32	4,39	2,05	0,58	0,12	67,55	60,29	53,80
11-dic-10	1019353	0,0153	<0,0001	<0,0001	28,57	0,31632	58,52	<0,01	0,63363	4,02	4,46	2,53	0,79	0,14	68,66	60,57	54,10
13-dic-10	1019356	0,0168	<0,0001	<0,0001	26,89	0,11673	62,74	<0,01	0,36134	2,51	4,18	2,37	0,68	0,14	67,90	63,02	56,13
14-dic-10	1019520	0,0202	<0,0001	<0,0001	25,88	0,18953	63,35	<0,01	0,50374	2,96	4,37	2,04	0,57	0,13	67,16	62,92	56,01
15-dic-10	1019523	0,0158	<0,0001	<0,0001	9,36	0,1350	82,18	<0,01	0,30755	2,53	2,56	2,45	0,39	0,07	59,43	72,24	63,58
16-dic-10	1019681	<0,0001	<0,0001	<0,0001	92,10	0,46968	0,65	<0,01	1,02678	4,66	0,81	0,24	0,04	0,01	73,67	53,66	48,33
17-dic-10	1019683	<0,0001	<0,0001	<0,0001	92,91	0,48991	<0,001	<0,01	1,15528	4,36	0,81	0,23	0,04	0,01	73,53	53,48	48,17
18-dic-10	1019820	<0,0001	<0,0001	<0,0001	93,19	1,2930	0,002	<0,01	0,0030	4,41	0,82	0,23	0,04	0,01	73,96	53,39	48,09
20-dic-10	1019822	<0,0001	<0,0001	<0,0001	92,39	1,2900	0,003	<0,01	0,18658	5,07	0,79	0,21	0,04	0,01	73,80	53,21	47,93
21-dic-10	1019930	<0,0001	<0,0001	<0,0001	92,97	1,35258	<0,001	<0,01	0,00407	4,56	0,83	0,23	0,04	0,01	73,91	53,30	48,01
22-dic-10	1020054	<0,0001	<0,0001	<0,0001	92,40	1,15394	0,002	<0,01	0,08692	5,33	0,78	0,21	0,04	0,01	74,09	53,47	48,17
23-dic-10	1020061	0,0003	0,00241	<0,0001	92,29	1,1900	0,00202	<0,01	0,06453	5,43	0,77	0,20	0,04	0,01	74,08	53,44	48,14
24-dic-10	1020095	0,0008	0,0081	<0,0001	91,16	1,73476	0,00298	<0,01	0,63082	4,92	1,14	0,33	0,06	0,02	72,86	52,17	47,01
27-dic-10	1020125	<0,0001	0,0150	<0,0001	90,94	1,69441	0,004	<0,01	0,85919	4,98	1,10	0,33	0,06	0,02	72,63	52,02	46,88
28-dic-10	1020221	<0,0001	<0,0001	<0,0001	89,26	2,26135	0,006	<0,01	1,0259	5,61	1,30	0,42	0,09	0,02	71,99	51,12	46,08
29-dic-10	1020368	0,0198	<0,0001	0,6565	76,17	1,4093	0,006	<0,01	1,1360	4,91	2,78	11,38	1,51	0,01	75,59	50,62	45,99
30-dic-10	1020399	0,0101	<0,0001	0,00955	9,98	0,47841	82,59	<0,01	0,06417	2,01	2,68	1,51	0,30	0,37	57,98	72,65	63,82
31-dic-10	1100027	0,0130	<0,0001	0,00079	22,55	0,52922	69,24	<0,01	1,18881	2,89	2,02	1,03	0,35	0,19	60,42	64,62	57,08

Composizione Fuel Gas - Caratterizzazioni analitiche Novembre 2010

Data	Codice	H_2S	COS	CO	CH_4	CO_2	H_2	Ossigeno + Argon	Azoto	C2 come etano	C3 come propano	C4 come n-butano	C5 come n-pentano	C6 e C6+ come n-esano	Σ % C (W)	PCS (MJ/kg)	PCI (MJ/kg)
02-nov-10	1016735	0,0002	<0,0001	0,0725	32,70	0,08738	53,75	<0,01	0,52251	4,38	4,67	2,64	0,76	0,42	70,54	59,84	53,58
03-nov-10	1016768	0,0015	<0,0001	0,0491	33,18	0,0830	54,12	<0,01	0,39972	4,23	4,44	2,46	0,66	0,37	70,40	60,37	54,01
04-nov-10	1016874	0,0004	<0,0001	0,0714	29,33	0,08378	55,92	<0,01	0,49686	4,50	5,31	3,17	0,73	0,39	70,68	59,91	53,66
05-nov-10	1016973	0,0004	<0,0001	0,0548	33,31	0,07934	52,94	<0,01	0,4740	4,59	4,65	2,67	0,81	0,42	70,87	59,72	53,49
06-nov-10	1017035	0,0036	<0,0001	0,0156	30,21	0,07093	58,26	<0,01	0,27729	4,31	3,71	2,02	0,68	0,46	69,45	61,87	55,23
08-nov-10	1017036	0,0031	<0,0001	0,0457	25,51	0,4500	58,54	<0,01	0,80128	4,82	5,39	3,07	0,93	0,45	69,38	59,09	52,91
09-nov-10	1017132	0,0027	<0,0001	0,0496	34,43	0,20519	51,51	<0,01	0,50838	4,60	4,93	2,55	0,82	0,38	70,86	59,16	53,01
10-nov-10	1017231	0,0031	<0,0001	0,0406	31,66	0,08405	54,24	<0,01	0,43452	4,36	5,17	2,80	0,82	0,39	70,89	59,86	53,62
11-nov-10	1017308	0,0027	<0,0001	0,0504	33,51	0,09828	52,27	<0,01	0,42479	4,67	5,19	2,66	0,76	0,37	71,13	59,53	53,35
12-nov-10	1017448	0,0005	<0,0001	0,0127	27,49	0,06494	58,98	<0,01	0,25025	5,57	4,34	2,14	0,67	0,48	69,95	61,57	55,02
13-nov-10	1017594	0,0025	<0,0001	0,0771	25,21	0,51918	55,21	<0,01	0,81555	6,34	7,11	3,29	0,98	0,46	70,76	57,68	51,80
15-nov-10	1017595	0,0011	<0,0001	0,0486	30,47	0,36073	53,93	<0,01	0,74445	5,09	5,38	2,78	0,81	0,37	70,17	58,73	52,62
16-nov-10	1017666	0,0006	<0,0001	0,0153	24,15	0,2300	63,39	<0,01	0,5460	3,89	4,12	2,59	0,73	0,35	67,95	61,98	55,28
17-nov-10	1017789	0,0011	<0,0001	0,0156	31,22	0,09286	57,48	<0,01	0,4209	3,45	3,97	2,34	0,69	0,33	69,32	61,43	54,85
18-nov-10	1017802	0,0011	<0,0001	0,0412	35,80	0,09311	50,97	<0,01	0,54333	3,99	4,33	3,12	0,76	0,37	71,00	59,31	53,14
19-nov-10	1017981	0,0008	<0,0001	0,0531	28,11	0,09315	57,79	<0,01	0,47229	4,31	4,95	3,09	0,75	0,38	70,20	60,46	54,11
20-nov-10	1017990	0,0008	<0,0001	0,0164	31,24	0,1030	55,59	<0,01	0,42013	3,84	4,51	3,22	0,71	0,34	70,46	60,31	53,98
22-nov-10	1017992	0,0005	<0,0001	0,1658	27,12	0,08674	60,28	<0,01	0,34735	3,33	4,40	3,15	0,74	0,39	69,52	61,36	54,83
23-nov-10	1018065	0,0015	<0,0001	0,0457	26,76	0,25122	59,06	<0,01	0,70586	4,70	4,00	3,41	0,72	0,34	69,15	60,20	53,83
24-nov-10	1018170	0,0003	<0,0001	0,0141	28,77	0,10114	59,11	<0,01	0,33647	3,65	4,62	2,39	0,69	0,31	69,45	61,62	55,03
25-nov-10	1018265	0,0003	<0,0001	0,0182	25,18	0,40876	58,57	<0,01	0,5440	4,72	5,20	4,22	0,80	0,34	70,22	59,29	53,12
26-nov-10	1018362	0,0002	<0,0001	0,0165	27,92	0,47051	55,87	<0,01	0,54608	5,09	5,06	3,84	0,83	0,35	70,43	58,81	52,71
27-nov-10	1018423	0,0006	<0,0001	0,0626	28,92	0,11523	57,87	<0,01	0,50573	5,38	2,90	2,89	0,96	0,39	69,58	60,81	54,36
29-nov-10	1018475	0,0005	<0,0001	0,5171	34,70	0,12364	49,77	<0,01	0,43259	5,15	5,00	2,93	0,98	0,39	71,45	58,35	52,36

Composizione Fuel Oil - Caratterizzazione Dicembre 2010 (densità, % Zolfo, T°C trasferimento)

	DATA TRASFERIM.	SERBATOIO PROVEN.	SERBATOIO CONSUMI INTERNI	DENSITA' [tons/mc]	%S [%wt]	TEMPER. °C
DICEMBRE	03/12/2010	B17	Ci7	0,962	0,400	39
	08/12/2010	B14	Ci6	0,961	0,390	47
	14/12/2010	B14	Ci7	0,961	0,390	46
	17/12/2010	B14	Ci6	0,961	0,390	51
	24/12/2010	B14	Ci7	0,961	0,390	50
	28/12/2010	B14	Ci6	0,961	0,390	50
	30/12/2011	B16	Ci7	0,960	0,380	48

Composizione Fuel Oil - Caratterizzazione Novembre 2010 (densità, % Zolfo, T°C trasferimento)

	DATA TRASFERIM.	SERBATOIO PROVEN.	SERBATOIO CONSUMI INTERNI	DENSITA' [tons/mc]	%S [%wt]	TEMPER. °C
NOVEMBRE	02/11/2010	B17	Ci7	0,961	0,380	46
	05/11/2010	B17	Ci6	0,961	0,380	42
	08/11/2010	B17	Ci7	0,960	0,380	46
	12/11/2010	B17	Ci6	0,960	0,380	45
	18/11/2010	B17	Ci7	0,962	0,400	49
	22/11/2010	B17	Ci6	0,962	0,400	47
	25/11/2010	B17	Ci7	0,962	0,400	39
	30/11/2010	B17	Ci6	0,962	0,400	39

Caratterizzazione Gasolio - Nov_Dic 2010			
Data	**Densità**	**Serbatoio provenienza**	**Zolfo**
	t/mc		*ppm*
24-ago	0,8319	F5	5,0

Il 24 agosto è stato effettuato l'ultimo trasferimento di gasolio a consumi interni per il DGE dal serbatoio F5
I dati di densità e zolfo sono pertanto rappresentativi del gasolio c.i. consumato nei mesi di novembre e dicembre

Allegato 3

Report mensile quantità e qualità dei combustibili utilizzati

Il presente allegato riporta i report mensili relativi ai consumi di combustibile della Raffineria riferiti ai mesi di novembre e dicembre 2010. Per ciascun combustibile utilizzato si riportano inoltre i risultati delle determinazioni analitiche effettuate negli stessi mesi di riferimento.

Combustibili Dicembre 2010

	Massa *kg*
Fuel gas [1]	3.960.542
Fuel oil	3.984.595
Gasolio	232

(1) *di cui gas naturale pari a 2.313.896 kg*
Gas incondensabili e metano di integrazione vengono miscelati in una polmone prima di essere inviati ai forni di processo. Le analisi di caratterizzazione e le misure di portata vengono effettuate sulla miscela di fuel gas effettivamente bruciata.

Combustibili Novembre 2010

	Massa *kg*
Fuel gas [(1)]	7.282.694
Fuel oil	4.615.264
Gasolio	286

(1) *di cui gas naturale pari a 2.770.959 kg*
Gas incondensabili e metano di integrazione vengono miscelati in una polmone prima di essere inviati ai forni di processo. Le analisi di caratterizzazione e le misure di portata vengono effettuate sulla miscela di fuel gas effettivamente bruciata.

Allegato 4

Rapporti di intervento tecnico installazione analizzatori della rete di monitoraggio qualità dell’aria

VERBALE DI AVVENUTA CONSEGNA, INSTALLAZIONE E MESSA IN SERVIZIO DELLA FORNITURA

Luogo: Cremona   Data: 27.07.2010

INDIVIDUAZIONE DELLA FORNITURA

Committente: Tamoil Raffinazione S.p.A.

Fornitore: Project Automation S.p.A.

Riferimento ordine Tamoil Raffinazione S.p.A.: N° A 2010-888 del 19.05.2010

Importo ordine: € 51.548,00 + IVA

Oggetto dell'ordine: Fornitura, installazione e messa in servizio di un analizzatore a polveri sottili a doppio canale, presso la stazione fissa di monitoraggio ambientale sita in Cremona Via Cadorna, gestita da Arpa Lombardia dipartimento di Cremona.

****

VERBALE DI AVVENUTA CONSEGNA, INSTALLAZIONE E MESSA IN SERVIZIO DELLA FORNITURA

A seguito delle verifiche effettuate a campo si certifica l'avvenuta consegna, installazione e messa in servizio di un analizzatore a polveri sottili a doppio canale, (Fai Instruments Swam Dual Channel) presso la stazione fissa di monitoraggio ambientale sita in Cremona Via Fatebenefratelli, gestita da Arpa Lombardia dipartimento di Cremona. A seguito di accordi tra Arpa Cremona e Tamoil è stata variata la stazione di destinazione dell'apparecchiatura che inizialmente era quella di Via Cadorna.

La ditta Project Automation può emettere la fattura di € 49.000,00 + IVA prevista alla consegna di quanto previsto alla Voce 1 dell'ordine, come meglio dettagliato al punto 1 dell'allegato N°1 all'ordine.

Tamoil Raffinazione S.p.A.
Sig. Diego Guercilena

Project Automation S.p.A.
Sig. Rodolfo Gaiardelli

ORION	RAPPORTO DI INTERVENTO TECNICO	MODULO 09.05.3 Copia per Orion

RAPPORTO DI INTERVENTO TECNICO

Cliente	Località
TAMOIL	VIA FATEBENEFRATELLI (CR)
	Commessa 210045

Persona da contattare SIG. BESSI

Tipo di prestazione	☐ contratto di manutenzione	☐ intervento ordinario	☐ intervento straordinario
	☐ su chiamata	☐ a consuntivo	☐ intervento correttivo
	☑ messa in servizio	☐ altro	☐ in garanzia
Tipo di analisi	☐ emissioni	☑ immissioni	☐ acqua
Tipo di impianto	☐ armadio	☐ stazione fissa	☐ stazione mobile
	☐ stazione meteo	☑ analizzatore	☐ altro

DATA	ORE LAVORO	ORE VIAGGIO		KM EFFETTUATI		NOTE
		andata	ritorno	andata	ritorno	
08/11/10	6	3	3	300	300	

DESCRIZIONE DEL LAVORO SVOLTO

Installato analizzatore NH_3 e ~~verifica~~ implementato sul sistema di acquisizione della cabina. Verificato uscite analogiche, tarature automatiche e allarmi. L'analizzatore è correttamente funzionante in ogni sua parte.

Q.TÀ	CODICE MATERIALI UTILIZZATI

APPARECCHIATURE RITIRATE:

FIRMA TECNICO Matteo Pi[illegible]

TIMBRO E FIRMA DEL CLIENTE Anello Bosi

ORION S.r.l. Automazione per Industria ed Ecologia
Via A. Volta, n° 25/b
35030 Veggiano - Padova - Italia
Tel. 049 9006911 r.a. - Fax 049 9006939
P. IVA 02149470284
www.orion–srl.it - E-mail: info@orion–srl.it

ORION	RAPPORTO DI INTERVENTO TECNICO	MODULO 09.05.3 Copia per Orion

RAPPORTO DI INTERVENTO TECNICO

Cliente	Località
TAMOIL	CREMONA
	Commessa 210045

Persona da contattare SIG. BESSI

Tipo di prestazione	[ ] contratto di manutenzione	[ ] intervento ordinario	[ ] intervento straordinario
	[ ] su chiamata	[ ] a consuntivo	[ ] intervento correttivo
	[x] messa in servizio	[ ] altro	[ ] in garanzia
Tipo di analisi	[ ] emissioni	[x] immissioni	[ ] acqua
Tipo di impianto	[ ] armadio	[x] stazione fissa	[ ] stazione mobile
	[ ] stazione meteo	[ ] analizzatore	[ ] altro

DATA	ORE LAVORO	ORE VIAGGIO andata	ORE VIAGGIO ritorno	KM EFFETTUATI andata	KM EFFETTUATI ritorno	NOTE
22/12/10	2	2	2	180	180	

DESCRIZIONE DEL LAVORO SVOLTO

Installato analizzatore NH_3 e verificato uscite analogiche e l'analizzatore è correttamente collegato al sistema e funzionante

Q.TÀ	CODICE MATERIALI UTILIZZATI

APPARECCHIATURE RITIRATE:

FIRMA TECNICO	TIMBRO E FIRMA DEL CLIENTE
Matteo Bianco	x ARPA. Arnaldo Bessi

ORION S.r.l. Automazione per Industria ed Ecologia
Via A. Volta, n° 25/b
35030 Veggiano - Padova - Italia
Tel. 049 9006911 r.a. - Fax 049 9006939
P. IVA 02149470284

ORION	RAPPORTO DI INTERVENTO TECNICO	MODULO 09.05.3 Copia per Orion

RAPPORTO DI INTERVENTO TECNICO

Cliente	Località
TAMOIL	CREMONA
	Commessa 210045

Persona da contattare

Tipo di prestazione	☐ contratto di manutenzione	☐ intervento ordinario	☐ intervento straordinario
	☐ su chiamata	☐ a consuntivo	☐ intervento correttivo
	☒ messa in servizio	☐ altro	☐ in garanzia
Tipo di analisi	☐ emissioni	☒ immissioni	☐ acqua
Tipo di impianto	☐ armadio	☒ stazione fissa	☐ stazione mobile
	☐ stazione meteo	☐ analizzatore	☐ altro

DATA	ORE LAVORO	ORE VIAGGIO		KM EFFETTUATI		NOTE
		andata	ritorno	andata	ritorno	
30/08/10	8	2	2	180	180	
31/08/10	8	2		180		
01/09/10	6		2		180	

DESCRIZIONE DEL LAVORO SVOLTO

Eseguito installazione EDA su cabine di Piazza Cadorna e Fatebene Fratelli, Installato analizzatore SO_2 su piazza Cadorna. Installato centro presso laboratorio Tamoil ed eseguito prove di scarico dati e configurate le cabine per lo scarico automatico.

Q.TÀ	CODICE MATERIALI UTILIZZATI

APPARECCHIATURE RITIRATE:

FIRMA TECNICO Mattia Bravo
Rodolfo Zambelli

TIMBRO E FIRMA DEL CLIENTE

ORION S.r.l. Automazione per Industria ed Ecologia
Via A. Volta, n° 25/b
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PRO MEMORIA PER L'ACQUISTO DI STRUMENTAZIONE DA INSERIRE NELLE CABINE DI MONITORAGGIO DELLA QUALITÀ DELL'ARIA NEL COMUNE DI CREMONA

Versione del 02/12/2009

SUGGERIMENTI CAPITOLATO DI ACQUISTO

- L'ordine di acquisto deve comprendere l'allestimento della cabina e della messa in opera della relativa strumentazione. ARPA ha chiesto sia prevista la presenza di suo personale al collaudo definitivo.
- Il contratto di acquisto deve prevedere anche i materiali (parti di ricambio, consumabili ed utensili) necessari alla manutenzione ordinaria e preventiva della stazione sino al completamento dell'intero periodo di garanzia, che avrà decorso dalla data di collaudo definitivo e durare minima 2 anni.
- Specificare che durante tutto il periodo di garanzia eventuali richieste d'intervento per guasti o malfunzionamenti potranno essere effettuate direttamente da ARPA Lombardia (a cui sarà assegnata la gestione con apposita convenzione) con comunicazione scritta (anche via e-mail o Fax) al Fornitore e p.c. a TAMOIL.
- Gli interventi in garanzia dovranno essere eseguiti con la modalità e tempistica tipica dei contratti di manutenzione di ARPA Lombardia, qui di seguito descritte:
  - intervento "on-site" entro 16 ore lavorative (2 giorni) dalla chiamata per la verifica dell'entità del guasto ed eventuale contestuale risoluzione dello stesso;
  - riparazione definitiva del guasto entro 40 ore lavorative (5 giorni) dall'apertura della chiamata.
  - installazione, a cura ed onere del Fornitore, di apparecchiatura sostitutiva, di pari livello e funzionalità, se la riparazione dello strumento richieda periodi di fuori servizio superiori alle 5 giornate lavorative; in ogni caso il ripristino dello strumento originario dovrà avvenire entro giornate lavorative successive al primo intervento "on-site"; esaurito tale termine lo strumento sarà in qualsiasi caso classificato come "irreparabile" e il Fornitore dovrà provvedere alla sua immediata sostituzione con apparecchiatura nuova, nella medesima configurazione operativa. Le spese saranno a totale carico del Fornitore. Sulla nuova apparecchiatura installata la garanzia avrà decorso "ex-novo " dalla nuova installazione e collaudo. Il fornitore provvederà altresì al reintegro dei materiali e dei ricambi sin lì utilizzati per la manutenzione ordinaria sull'apparecchiatura soggetta a rottura.

GESTIONE DATI

La convenzione deve prevedere che dati prodotti dagli analizzatori siano acquisiti direttamente da ARPA mediante linea telefonica/modem o rete informatica con le seguenti modalità: il COD (Centro Operativo Dipartimentale), collocato presso il Dipartimento ARPA di Cremona, acquisirà i dati dalla stazione di Spinadesco mediante chiamate periodiche automatiche, tipicamente orarie, od occasionali secondo necessità.

Al momento il COD gestisce le proprie stazioni mediante due applicativi (EDA-Centro di Orion srl e Eco-manager di Project Automation spa) che dialogano con le stazioni della rete fissa di qualità dell'aria di ARPA mediante propri protocolli e modalità. E' quindi importante che il data-logger/PC di stazione che concentra i dati forniti dagli analizzatori e gestisce la comunicazione con il COD sia compatibile con gli applicativi summenzionati in dotazione ad ARPA.

In caso contrario si dovrà provvedere all'implementazione presso il COD e nella stazione periferica di adeguati programmi e tools che consentano l'acquisizione di tutti i dati richiesti in modo trasparente dal sistema ARPA.

In questo caso ARPA chiede che le modalità (procedure) ed soprattutto, il tracciato record utilizzati per l'inserimento dati al COD, siano "in chiaro" (resi disponibili i file sorgenti delle utility non commerciali) e dettagliatamente descritti e documentati in apposito manuale, anche per evitare successivi problemi di incompatibilità fra software.

Nella convenzione deve essere precisato che ogni giorno lavorativo ARPA provvederà alla validazione dei dati sino alla giornata precedente. Il report di questi dati sarà inserito nel Bollettino giornaliero assieme a quelli di tutte le altre stazioni gestite da ARPA e inviato ai destinatari.

TAMOIL potrebbe dotarsi di un proprio sistema di interrogazione dei dati forniti dalla strumentazione della cabina in tempo reale. ARPA chiede che tale sistema dovrà permettere solo la lettura dei dati e nessuna opzioni di manipolazione o controllo della strumentazione.

ACQUISTO STRUMENTAZIONE

La società TAMOIL acquisterà la strumentazione elencata qui sotto, da collocarsi nelle stazioni di Piazza Cadorna e di via Fatebenefratelli a Cremona. ARPA resterà proprietaria delle cabine e delle attrezzature accessorie, mantenendo quindi a proprio carico gli oneri amministrativi e di utenza elettrica e telefonica delle due postazioni.

Con apposita convenzione TAMOIL contribuirà alla gestione della stazione di Cadorna, mentre la gestione della strumentazione collocata a Zaist sarà totalmente a carico di ARPA. Dal canone annuo di gestione della stazione sono esclusi i costi delle campagne di speciazione per metalli o IPA sul particolato atmosferico, PM10 e/o, PM2,5 e/o deposizioni che sono conteggiati una tantum.

Aggiornamento dotazione strumentale stazione Piazza Cadorna a Cremona

Strumentazione	**Attuale ARPA Cadorna**	**Ancora da ARPA Cadorna**	**Nuova da Tamoil Cadorna**
Datalogger di stazione	X	-	X
Generatore "aria zero"	X	X	-
Diluitore statico	X	X	-
SO2	X	-	X
BTX	X	-	X
CO	X	X	-
NOx	X	X	-
O3	X	-	-
PM10	-	-	X
PM 2,5	-	-	X

Aggiornamento dotazione strumentale stazione via Fatebenefratelli, Quartiere Zaist, a Cremona

Strumentazione	**Attuale ARPA Zaist**	**Ancora da ARPA Zaist**	**Nuova da Tamoil Zaist**
Datalogger di stazione	X	X	X
Generatore "aria zero"	X	X	-
Diluitore statico	X	X	-
Stazione meteo	X	X	-
Analizzatore SO2	X	X	-
BTX	-	-	X
CO	X	X	-
NOx	X	-	-
NOx + NH3	-	-	X
O3	X	X	-
PM10	X	-	-
PM 2,5	-	-	X

Nel seguito sono indicate in dettaglio le caratteristiche della strumentazione più idonea per l'allestimento delle stazioni. Per ogni strumento sono altresì indicati gli accessori necessaria rendere gli analizzatori pienamente operativi. Sono altresì presenti alcune valutazioni, peraltro formulate in maniera estremamente sintetica, utili a meglio comprendere le ragioni delle scelte fatte. Si tratta di considerazioni comunque suscettibili di integrazione e discussione anche in funzione dell'acquisizione di nuove informazioni.

Data_logger stazione	
Modello suggerito: EDA-2000 Eco-Monitor	**Fornitore:** Thermo Scientific – distribuito da ORION srl (Veggiano - PD) Project Automation- (Viale Elvezia42 – MONZA)
Requisiti di minimi: Almeno 16 ingressi analogici 0-10 V (espandibili a 32) Almeno 16 uscite analogici 0-10 V Almeno 16 ingressi Digitali (espandibile a 32) Almeno 16 uscite Digitali Almeno 1 ingresso counter Possibilità (Hw e Sw) di gestione strumenti e acquisizione dati via seriale (RS232) e/o connessione rete ethernet locale. Programma di memorizzazione dati istantanei con frequenza configurabile/calcolo medie orarie; memorizzazione dati calibrazione, eventi allarme stazione/strumentali Configurazione e gestione strumenti; visualizzazione sinottica misure e attività in corso Interfaccia con COD dipartimentale ARPA per invio DIRETTO dati e telecontrollo di gestione.	

Analizzatore SO2	
Modello suggerito: TE43i	**Produttore - Fornitore:** Thermo Scientific – distribuito da ORION srl (Veggiano - PD)
Requisiti minimi: Specifiche tecniche conformi ai requisiti previsti dalla normativa	
Specifiche di acquisto B = Alimentazione 220Vac – 50 Hz P = Sorgente Span interna a permeazione (fornetto + sorgente[#]) con allestimento valvole Sample/Cal - Zero/Span S = Kicker idrocarburi – (allestimento standard) A = Uscite/ingressi segnale – configurazione standard B = Maniglie e alette fissaggio – allestimento rack standard EIA Lo strumento in questa configurazione ha il seguente codice d'ordine: ***43i - B P S A B***	
Altre opzioni/accessori: • Guide estensibili per installazione a rack 19" • Estensione guide (per rack "lungo") • Manuale d'Uso in Lingua Italiana • [#] se non ricompreso nell'allestimento previsto: Tubo a permeazione (tipo Wafer) SO2 (Flusso emissivo 150 ± 5% ng/min - per una conc. indicativa finale span 100÷130 ppb di SO2- con flusso di 0,4÷0,5 l/min) • Filtri : 47 mm/ 2µm in teflon Pall-Gellman cod. 66155, n.100 pz (1 conf)	

Analizzatore BTX	
Modello suggerito: GC955 serie 600	**Produttore - Distributore:** SynTech - SARTEC
Requisiti minimi: Specifiche tecniche conformi ai requisiti previsti dalla normativa	

Altre opzioni/accessori:

- Riduttore pressione doppio stadio (acciaio inox) - Uscita stadio finale 10 Bar (o secondo richiesta costruttore) - Attacco Azoto - raccordo uscita 6mm (1/4") linea CARRIER GAS
- Riduttore pressione doppio stadio (acciaio inox) - Uscita stadio finale 10 Bar (o secondo richiesta costruttore) - Attacco Azoto - raccordo uscita 6mm (1/4") linea di Servizio per movimentazione valvola 10 vie. (*In alternativa si può utilizzare un compressore oil-less, riducendo il consumo di gas-carrier, altrimenti notevole).*
- Riduttore pressione doppio stadio (acciaio inox) - Uscita stadio finale 2,5 Bar - Attacco Azoto - raccordo uscita 6mm (1/4") con valvola regolazione micrometrica (per miscele taratura)
- Eventuali raccordi e riduzioni per ingressi pneumatici 1/8" a bordo strumento
- Manuale d'uso in lingua italiana
- Filtri : 47 mm/ 2um in teflon Pall-Gellman cod.66155 n.100 pz (1 conf)
- Portafiltri 47mm (per SYNTECH con raccordi per linee da 3mm o 1/8 pollice

Analizzatore NOx + NH3	
Modello suggerito: TE17i	**Produttore - Fornitore:** Thermo Scientific – distribuito da ORION srl (Veggiano - PD)
Requisiti minimi: Specifiche tecniche conformi ai requisiti previsti dalla normativa	

Specifiche di acquisto

B = Alimentazione 220Vac – 50 Hz
Z = allestimento valvole Sample/cal - Zero/span
P = Essiccatore aria ozono a permeazione (Permapure)
A = Uscite/ingressi segnale – configurazione standard
B = Maniglie e alette fissaggio – allestimento rack standard EIA

Lo strumento in questa configurazione ha il seguente codice d'ordine: ***17i - B Z P A B***

Altre opzioni/accessori:

- Guide estensibili per installazione a rack 19"
- Estensione guide (per rack "lungo")
- Manuale d'Uso in Lingua Italiana
- Riduttore pressione doppio stadio acciaio inox - Uscita stadio finale 2,5 Bar - Attacco Azoto - raccordo uscita 6mm (1/4")
- Filtri : 47 mm/ 2um in teflon Pall-Gellman cod.66155 n.100 pz (1 conf)

Analizzatore PM10 e PM 2,5

Sono da preferire apparecchiature con sistema di misura ad attenuazione beta. Per poter effettuare anche campagne di speciazione e/o verifiche sulle misure con confronto col metodo gravimetrico è necessario adottare analizzatori a filtro singolo anziché a nastro continuo.
La versione "dual channel" ha un doppio canale di aspirazione e può campionare e misurare in contemporanea due frazioni PM10 e PM2,5.

Modello suggerito:	**Fornitore:**
OPSIS mod. SM200 FAI mod. 8 SWAM 5a monitor FAI mod. 8SWAM 5a dual channel monitor	SARTEC srl Milano FAI Instruments, Via Aurora, 15 - 00013 Fonte Nuova (RM)

Requisiti minimi:
Specifiche tecniche conformi ai requisiti previsti dalla normativa

Accessori aggiuntivi (comuni per entrambi gli apparecchi)

- N. 1 Testa prelievo per diametro PM10 in versione Europea (2,3 m3/h)
- N. 1 Testa prelievo per diametro PM2,5 in versione Europea (2,3 m3/h)
- N. 1 Testa prelievo per diametro PM10 in versione US-EPA (1,0 m3/h)
- N. 1 Testa prelievo per diametro PM2,5 in versione US-EPA (1,0 m3/h)
- N. 100 supporti porta filtri per membrane filtranti diam. 47mm
- Doppia dotazione contenitori carico-scarico (4 unità[*])
- per la versione SWAM Dual prevedere dotazione tripla (6 unità[**])

[*] OPSIS - Chiedere se sono disponibili caricatori da 50, altrimenti prevedere 3 contenitori standard da 40 + 1 da 80 per singola apparecchiature. FAI - Chiedere se sono disponibili caricatori da 50, altrimenti prevedere 2 contenitori standard da 36 + 2 da 72 per singola apparecchiature
[**] Per la versione Dual solo caricatori da 72.

- Filtri (per ciascun analizzatore; per lo SWAM doppio canale raddoppiare le quantità):
- 47 mm/ 2um in teflon con anello (verificare compatibilità) Pall_Gellman cod.R2P2047 n.250 pz
- 47 mm/ 2um in Borosilicato Teflon Coated (fiberfilm) Pall_Gellman cod.7212 n.250 pz
- 47 mm/ 0,45um Esteri/Nitrato/Acetato di Cellulosa (Advantec cod.C045A047A) n.250 pz

Opsis - *Per i filtri in teflon necessario il prefiltro altrimenti il sistema non lo vede bene quando fa il bianco.*
FAI - *Utilizza un filtro per misure di riferimento – complicazione se si cambia tipo di filtro (sia materiale che porosità).*

Altre opzioni/accessori:

- Manuale d'uso in lingua italiana

Documento di trasporto (D.P.R. 14 agosto 1996, 472 art.1) N. 470 data 31/08/2010

MITTENTE	DESTINATARIO	
TAMOIL RAFFINAZIONE S.p.A. P.le Caduti del Lavoro, 30 - 26100 CREMONA Cap. Soc. € 234.000.000 Casella Postale, 136 - Tel. 0372/5591 - Fax 0372/412567 www.tamoil.it Codice Fiscale e numero di iscrizione al Registro Imprese di Cremona 01029270194 R.E.A. di Cremona n. 129514 Part. IVA 01029270194	Ditta e Cod. Fiscale	ARPA LOMBARDIA
	Indirizzo Sede	PIAZZA CADORNA 26100 - CREMONA
	Indirizzo del Luogo di dest.	IDEM

Da compilare in alternativa						
A	il trasporto avrà inizio alle ore 9.00 del giorno 1/9/10		A CURA DEL ☐ mittente ☐ destinatario		Firma del conducente	
B	VETTORE SAEAS RICERCHE	INDIRIZZO ZONA INDUSTRIALE MACCHIAREDDU ASSEMINI	DATA 01/09/10	ORA RITIRO 09.	FIRMA	

QUANTITÁ	DESCRIZIONE DEI BENI (Natura e qualità)
NR. 01	GASCROMATROGRAFO GC 955
NR. 02	BOMBOLE GAS CAMPIONE
NR. 02	RIDUTTORI DI PRESSIONE

CAUSALE DEL TRASPORTO	PORTO
INSTALLAZIONE	FRANCO
	KG. 20

ANNOTAZIONI - VARIAZIONI	Data.
	FIRMA DEL DESTINATARIO

CR 147

VETTORE

Saras Ricerche e Tecnologie SpA
Società unipersonale appartenente
al Gruppo Saras

Unità Commerciale
Galleria De Cristoforis, 1
20122 Milano
Tel: 02.48002137; Fax: 02.7737801

SEZ. OPERATIONS & MAINTENANCE
SEZ. ING. AUTOMAZIONE

Sede Legale
Traversa 2^ Strada Est
I-09032 Assemini – CA
Tel.: 070.24638.1; Fax: 070.24638242

Stabilimenti e Laboratori
Traversa 2^ Strada Est
I-09032 Assemini – CA
Tel.: 070.24638.1; Fax: 070.24638242

Traversa C, 5^ Strada Ovest
I-09032 Assemini – CA
Tel.: 070.2464200; Fax: 070.2464230

RAPPORTO DI COLLAUDO SAT (SITE ACCEPTANCE TEST)

SITE ACCEPTANCE TEST REPORT

N° / *NO.*		DEL / *DATED:*	02/09/2010

PROGETTO / *PROJECT*	
CLIENTE / *CUSTOMER*	TAMOIL (CREMONA)
N° ORDINE / *CONTRACT NO.*	A2010889 DEL 19/05/2010
N° COMMESSA / *JOB NO.*	2010923-COM10
LUOGO / *LOCATION*	CABINA ANALISI SITA IN PIAZZA CADORNA CREMONA
C/O FORNITORE / *C/O SUBCONTRACTOR*	

TIPO DI TEST / *TYPE OF TEST*	PARZIALE / *PARTIAL*		FINALE / *FINAL*	X

DESCRIZIONE / *DESCRIPTION:*

Installazione e messa in servizio GC955 Sn. 2429

DOCUMENTI DI RIFERIMENTO / *REFERENCE DOCUMENTS:*	
Specifica di Collaudo N° / Test spec No .	N.A.
Altri documenti / *Other docs.*	N.A.

Lavoro completato in accordo al contratto / *Works completed according to the contract*	~~YES~~	NO
Collaudi completati come da spec – vedi All. 1 / *Test completed according to spec – see Att. 1*	YES	NO
Difetti e/o problemi riscontrati – vedi All. 2 / Defect and/or failure – see Att. 2	YES	~~NO~~
Azioni correttive completate entro il / Corrective actions completed by:		
Inizio periodo di garanzia / *Guarantee period start date*	02/09/2010	

A SEGUITO DEL COLLAUDO ESEGUITO IL CLIENTE DICHIARA DI ACCETTARE LA FORNITURA

FOLLOWING THE EXECUTION OF THE SAT CUSTOMER ACCEPTS THE SUPPLY

NOTE / *REMARKS:*

Strumento installato presso cabina analisi sita in piazza Cadorna a Cremona, gestita da ARPA Lombardia

SARAS RICERCHE E TECNOLOGIE		CLIENTE / *CUSTOMER*
RC	RDC	

RAPPORTO DI COLLAUDO SAT (SITE ACCEPTANCE TEST) *SITE ACCEPTANCE TEST REPORT*			
N° /*No.*		DEL /*DATED:*	

ALLEGATO 1 / ATTACHMENT 1
VERIFICHE ESEGUITO DURANTE IL SAT / VERIFICATION EXECUTED DURING THE SAT

#	Descrizione / *Desctiption*	SRT	Customer
1	Verifica fornitura, integrità e completezza		
2	Installazione strumento su rack		
3	Posa linea di campionamento e filtro, posa linea carrier gas, posa linea calibrazione		
4	Connessione strumento alla bombola carrier gas		
5	Connessione strumento a span box, connessione alla bombola di calibrazione		
6	Verifica assenza perdite		
7	Connessione dello strumento al data logger		
8	Accensione dello strumento		
9	Verifica regolare funzionamento del PC e del sistema operativo		
10	Verifica regolare funzionamento del programma GC955		
11	Avvio ciclo di analisi e verifica regolare svolgimento dello stesso: temperatura oven, temperatura camera di preconcentrazione, flusso ecc.		
12	Verifica stabilità dello strumento		
13	Verifica delle uscite analogiche e relativa comunicazione con il data logger		
14	Calibrazione		
15	Verifica stabilità della calibrazione		
16	Breve corso di formazione al personale addetto		

LE ATTIVITÀ DI VERIFICA SONO STATE EFFETTUATE IN ACCORDO ALLA SPECIFICA DI COLLAUDO

SARAS RICERCHE E TECNOLOGIE		CLIENTE / *CUSTOMER*
RC	RDC	

Saras Ricerche e Tecnologie SpA
Società unipersonale appartenente
al Gruppo Saras

RAPPORTO DI COLLAUDO SAT (SITE ACCEPTANCE TEST) *SITE ACCEPTANCE TEST REPORT*			
N° /*No.*		DEL /*DATED:*	

ALLEGATO 2 / ATTACHMENT 2
DIFETTI E PROBLEMI RISCONTRATI / DEFECT AND/OR FAILURE

#	Descrizione Difetti/Problemi ed Azione Correttive da Eseguire (AC)	AC entro il	AC cura di	Verificata il	Verificata da

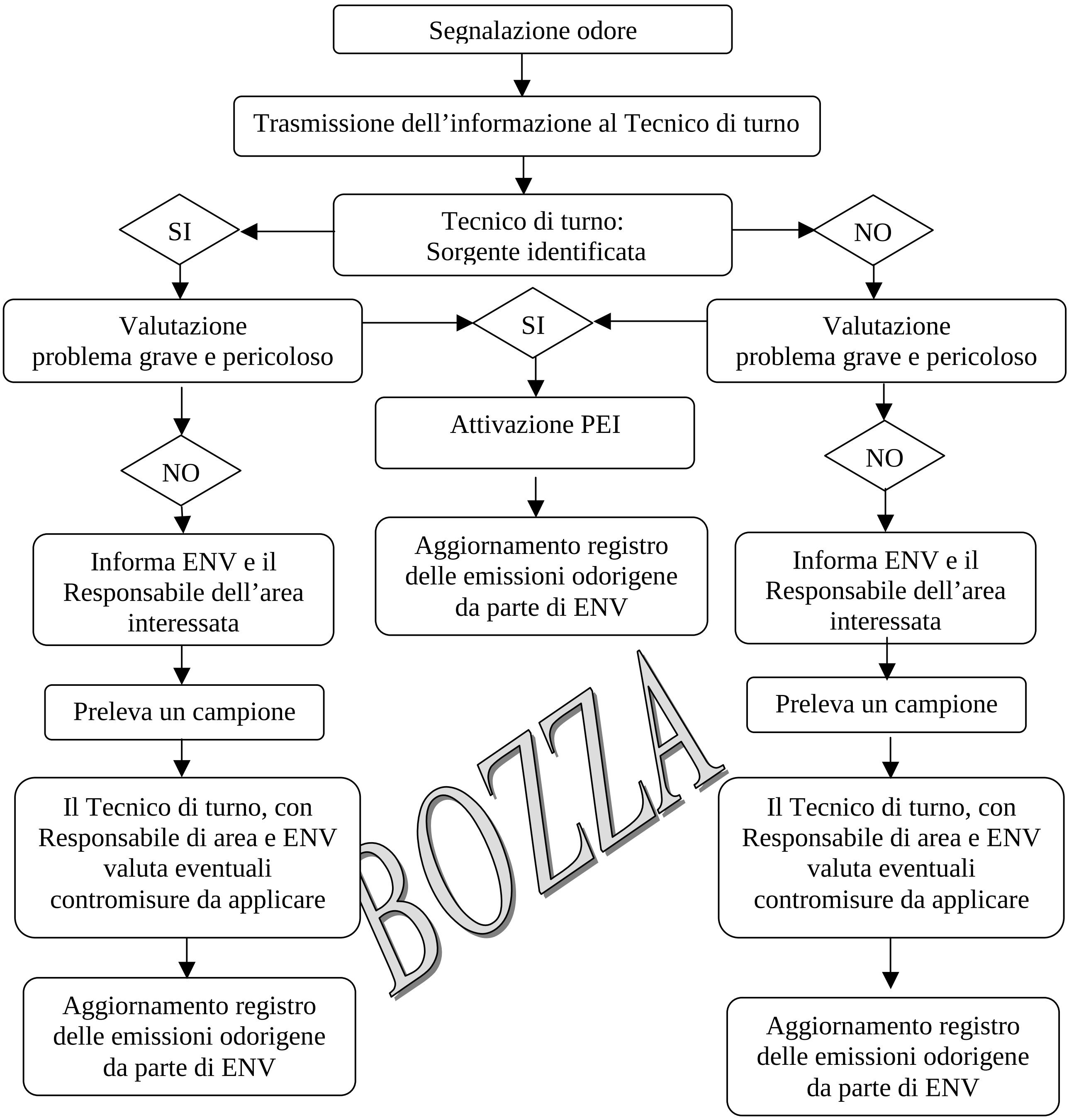
SARAS RICERCHE E TECNOLOGIE		CLIENTE / *CUSTOMER*
RC	RDC	

Allegato 5

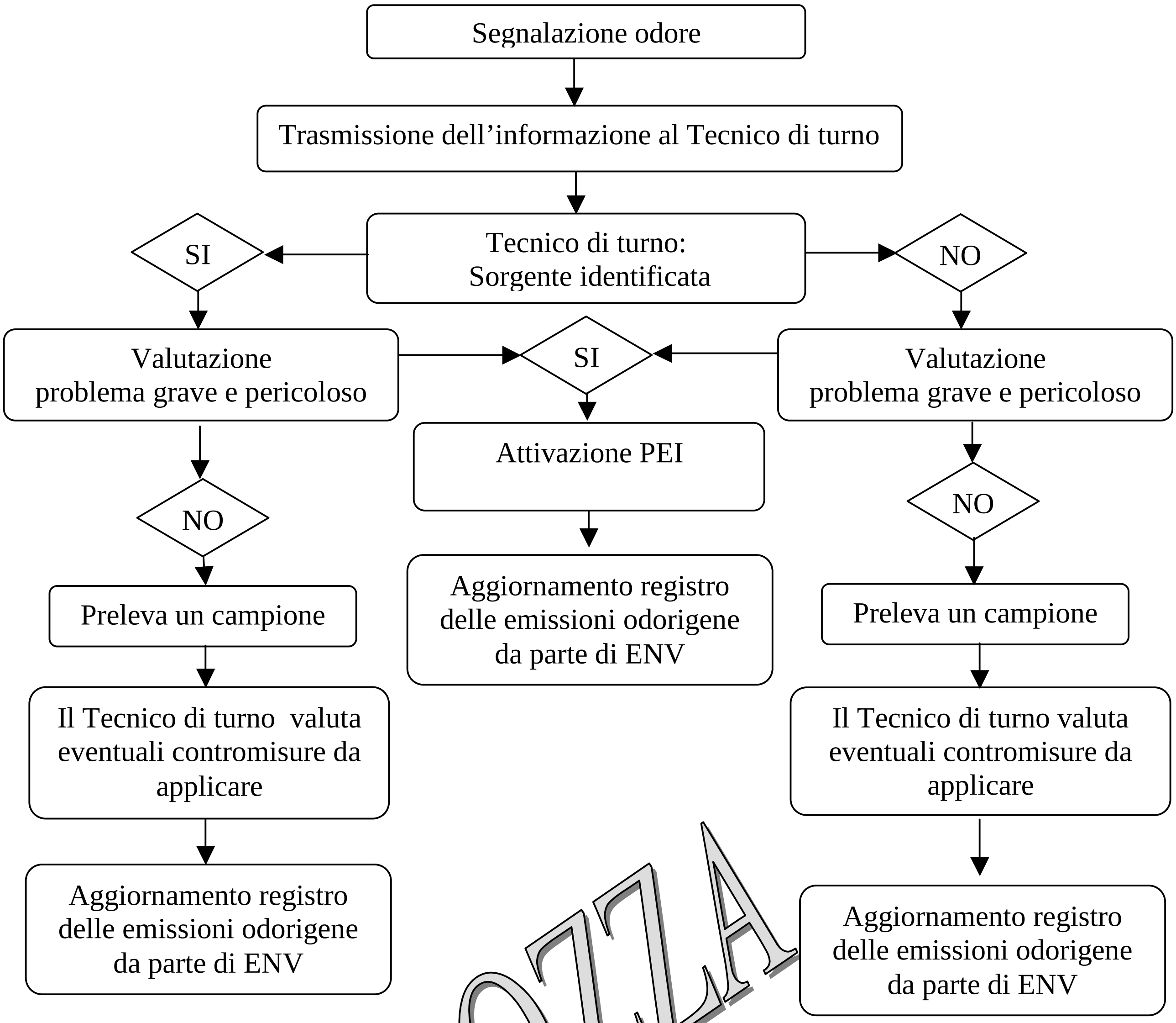
Procedura operativa monitoraggio emissioni odorigene

Procedura in caso di chiamata interna/esterna

CASO 1: Durante le ore di lavoro



CASO 2: Al di fuori delle ore di lavoro



BOZZA

Codice	Titolo	Ed.	Rev.	Data	Pagina
Mod. 1	**Registro delle segnalazioni odorigene**	**1**	**0**	**21/10/2010**	**1 di 1**

N°	Data	Ora	Tipo di segnalazione[1]	Soggetto segnalante	Società di appartenenza[2]	Area interessata dalla segnalazione	Possibile sorgente di odore	Unità di processo attive al momento della segnalazione	Unità di processo non attive al momento della segnalazione	Spedizione o ricevimento di prodotti/grezzo	Operazioni di manutenzione in atto	Dati meteo	Misure di attenuazione	Apertura Non Conformità	Note

TIPOLOGIA DI DOCUMENTO	CODICE	PAGINA
Procedura Operativa	**POA 09**	Pag. 1 di 6
TITOLO	**EDIZIONE**	**DATA**
Monitoraggio emissioni odorigene	01	21-10-10
SISTEMA DI APPARTENENZA	**REVISIONE**	**DATA**
Sistema di Gestione Ambientale	00	21-10-10

TAMOIL RAFFINAZIONE S.p.A.
CREMONA

SISTEMA DI GESTIONE AMBIENTALE

MONITORAGGIO EMISSIONI ODORIGENE

BOZZA

Ed.	Rev.	Data	Motivazione	Redazione	Verifica	Approvazione
01	00	21-10-10	Prima edizione della Procedura Operativa	RSGA	RDSGA	Alta Direzione

INDICE

1. RIFERIMENTI

Documentazione del Sistema di Gestione Ambientale

- POA 04 Gestione emissioni atmosferiche
- MSGA Manuale del Sistema di Gestione Ambientale

Documentazione di riferimento

- Autorizzazione integrata Ambientale (AIA) U.prot DVA-DEC-2010-0000368 del 06/07/2010
- Norma UNI EN 13725:2004 "Qualità dell'aria – Determinazione della concentrazione di odore mediante olfattometria dinamica"

2. SCOPO

Scopo della seguente procedura è di definire e regolamentare le modalità di gestione e monitoraggio delle emissioni atmosferiche per quanto concerne il comparto odori al fine di garantire che queste emissioni siano adeguatamente individuate, caratterizzate e monitorate.

3. CAMPO DI APPLICAZIONE

La presente procedura viene applicata all' attività produttiva della Raffineria che può avere come effetto un'emissione in atmosfera di sostanze odorigene.

4. DEFINIZIONI

- Emissione atmosferica: Corrente gassosa continua e/o discontinua proveniente da una sorgente puntuale o diffusa.
- Gas odorigeno: Gas che contiene odoranti.
- Odore: Attributo organolettico percepibile dall'organo olfattivo annusando determinate sostanze volatili.
- Sorgenti diffuse: Sorgenti con dimensioni definite (per la maggior parte sorgenti aerali) che non hanno un flusso definito di affluente gassoso.
- Sorgente puntiforme (convogliata): Sorgente fissa discreta di emissione dei gas di scarico nell'atmosfera attraverso condotti canalizzati di dimensioni definite e portata dell'aria.

5. ALLEGATI E MODULI

POA 09 All. A	Segnalazioni – Schema di Flusso delle informazioni
POA 09 Mod. 1	Registro delle segnalazioni

6. MODALITA' OPERATIVE

6.2. Generalità

Le emissioni atmosferiche della Raffineria possono essere suddivise in due tipologie:

- Emissioni convogliate, provenienti dai camini dei forni degli impianti e degli impianti recupero vapori (VRU) del carico autobotti e ferrocisterne;
- Emissioni diffuse, provenienti dagli impianti, dagli stoccaggi, dalle vasche di trattamento effluenti e dalle operazioni di caricamento.

La planimetria con l'ubicazione dei punti di emissione odorigena è disponibile presso Engineering.

6.3. Attività di monitoraggio

Questa attività si suddivide in due tipologie di monitoraggio:

- Programmato
- Su segnalazione

6.3.1 Monitoraggio programmato

Il monitoraggio viene effettuato con cadenza semestrale di cui uno nel periodo estivo tra maggio e settembre.

Per tale attività ci si può avvalere di una società esterna qualificata.

Il monitoraggio è suddiviso nelle seguenti fasi:

- Fase 1

Durante tale fase vengono individuate le possibili sorgenti di odore sulla base della valutazione dei seguenti dati:

- Dati relativi ai cicli produttivi, quantità di materie prime/prodotti finiti/intermedi utilizzati nel ciclo produttivo e le relative schede di sicurezza, eventuali sottoprodotti di reazione chimica.

- Analisi chimiche eseguite sulle emissioni gassose convogliate e diffuse con dati relativi alle concentrazioni e quantità orarie emesse.

- Dati caratteristici dei camini di espulsione degli inquinanti (portate, temperature, altezze, ecc).

- Dati riguardanti eventuali impianti di recupero vapori con le relative schede tecniche impiantistiche (rese di abbattimento, tempi di contatto, ecc).

Successivamente vengono individuati i possibili punti di ricaduta.

Alle sorgenti sopra individuate con le modalità indicate, vengono aggiunte eventuali sorgenti definite a seguito di segnalazioni registrate secondo la presente procedura.

- **Fase 2**

Al fine di identificare la tipologia delle sostanze che potrebbero provocare le molestie olfattive, si prevede l'esecuzione di campionamenti nelle postazioni significative individuate in Fase 1.

Viene eseguito uno screening quali-quantitativo per determinare le concentrazioni dei composti in grado di generare molestie olfattive mediante prelievo dell'aria in "canister" e successiva analisi in gas massa (GC-MS) secondo il metodo EPA TO15.

Durante l'esecuzione dei prelievi delle sostanze sopra riportate vengono eseguite delle misure olfattometriche mediante la norma UNI EN 13725:2004, per correlare l'intensità odorimetrica con la concentrazione dei marker presenti.

Durante i monitoraggi vengono monitorati in continuo i parametri meteo climatici (velocità e direzione del vento, temperatura e umidità dell'aria, la pressione atmosferica).

- Fase 3

Successivamente, nei potenziali punti di ricaduta vengono eseguite analisi olfattometriche secondo la norma UNI EN 13725:2004 e le analisi chimiche secondo il metodo EPA TO15. In questo modo oltre ad avere la misurazione della "noia olfattiva" in unità olfattometriche per metro cubo sarà possibile evidenziare la presenza di marker chimici individuati nella fase precedente.

Si prevede di eseguire le misure sopra riportate nei punti piu' significativi; le analisi dovranno essere effettuate sia quando le molestie olfattive sono percepibili che quando non lo sono.

In fase di discussione dei dati ottenuti, vengono inoltre riportate tutte le indicazioni utili relative a fattori esterni, quali : la presenza di eventuali ulteriori non previste fonti emissive, l'intensità del traffico veicolare, ecc.

Le analisi di cui sopra sono completate con una valutazione organolettica (giudizio di gradevolezza/sgradevolezza) dei campioni prelevati. Tale valutazione è effettuata da esaminatori di un laboratorio esterno.

- **Fase 4**

Sulla base dei risultati vengono programmati i possibili interventi di mitigazione per il contenimento dell'eventuale impatto olfattivo ed eventuali modifiche alle frequenze di monitoraggio.

I report delle campagne di monitoraggio vengono archiviati presso ENV.

6.3.2 Monitoraggio su segnalazione

Le attività di monitoraggio possono essere attivate in concomitanza di segnalazioni provenienti sia dall'interno che dall'esterno della Raffineria, secondo le seguenti modalità.

6.3.2.1 Segnalazioni interne

Le segnalazioni interne possono essere effettuate dal personale Tamoil o da Imprese operanti in Raffineria che, in presenza di emissioni odorigene anomale, devono avvisare il Tecnico di Turno comunicando il luogo della segnalazione e la possibile sorgente di odore (se individuata).

Se il Tecnico di Turno individua che l' emissione odorigena è correlata ad una situazione di pericolo gestisce l' evento secondo quanto previsto dal Piano di Emergenza Interno (PEI).

Nel caso il Tecnico di Turno non rilevi una situazione di pericolosità, avvisa ENV e il Responsabile dell'area oggetto di segnalazione e immediatamente preleva un campione d'aria nel punto individuato come possibile sorgente, utilizzando il kit di prelievo in dotazione, secondo le linee guida della norma UNI EN 13725:2004, per la successiva consegna al laboratorio esterno di analisi.

Contemporaneamente il Tecnico di turno, in collaborazione con il Responsabile dell'area oggetto di segnalazione ed ENV, valuta la necessità d' attuare le misure atte a diminuire l'emissione odorigena.

6.3.2.2 Segnalazioni esterne

Nel caso di segnalazioni esterne scritte o telefoniche, quando si verifica che la sorgente di odore è localizzata all'interno della Raffineria, il Tecnico di turno preleva un campione d'aria nel punto individuato come possibile sorgente, utilizzando il kit di prelievo in dotazione, secondo le linee guida della norma UNI EN 13725:2004, per la successiva consegna al laboratorio esterno di analisi.

Contemporaneamente il Tecnico di turno, in collaborazione con il Responsabile dell'area oggetto di segnalazione ed ENV, valuta la necessità d' attuare le misure atte a diminuire l'emissione odorigena.

Nel caso di intervento delle Autorità di controllo, si consente l'accesso per procedere alle necessarie verifiche. Per accedere alla Raffineria gli organi di controllo saranno accompagnati da ENV (durante le ore di lavoro) e dal Tecnico di turno.

Se richiesto dalle Autorità viene prelevato un campione, con le stesse modalità sopra descritte, anche all'esterno delle Raffineria.

6.3.2.3 Registro delle segnalazioni odorigene

Presso ENV viene aggiornato e conservato il registro delle segnalazioni odorigene che raccoglie tutte le informazioni riguardanti sia segnalazioni interne che esterne (Mod. 1).

E' cura di ENV valutare eventuali misure di mitigazione e apertura di una non conformità come da paragrafo 5.3. del MSGA. Viene inoltre valutata l'eventuale necessità di modifiche alle frequenze dei monitoraggi programmati.

6.4. Rapporto annuale

Annualmente viene inviato all'Ente di Controllo un rapporto in cui sono indicate le sorgenti individuate di sostanze odorigene e le contromisure implementate per il contenimento degli odori.

7. COMUNICAZIONI ESTERNE

Per comunicazioni di Tamoil Raffinazione S.p.A. con l'esterno in occasione di segnalazioni viene attuato quanto indicato nel Manuale del Sistema di Gestione Ambientale (MSGA) paragrafo 4.3.2.

Allegato 6

Procedura operativa monitoraggio emissioni fuggitive

BOZZA

Codice	Titolo	Ed.	Rev.	Data	Pagina
POA08 Mod. 1	FREQUENZE DEI MONITORAGGI E TEMPI DI INTERVENTO DEL PROGRAMMA LDAR	1	0	21/10/2010	1 di 1

COMPONENTE	FREQUENZA MONITORAGGIO	ATTIVITA' DI MONITORAGGIO	TEMPI DI INTERVENTO	CAUSE DI VARIAZIONE TEMPI INTERVENTO	VARIAZIONE TEMPI INTERVENTO
Tipologia	Periodicità	TIPOLOGIA	Giorni	Giorni	Giorni
1/3 di tutti componenti	Annuale	FID	Inizio:Entro 5 gg lavorativi da individuazione perdita. Fine:Entro 15 gg da inizio intervento	Emissione sostanza Cancerogena (Benzene)	Inizio: immediato dopo individuazione perdita.
2/3 di tutti componenti	Annuale	OGI	Inizio:Entro 5 gg lavorativi da individuazione perdita. Fine:Entro 15 gg da inizio intervento	Emissione sostanza Cancerogena (Benzene)	Inizio: immediato dopo individuazione perdita.
Punti difficili da raggiungere	Biennale	OGI	Inizio:Entro 5 gg lavorativi da individuazione perdita. Fine:Entro 15 gg da inizio intervento	Emissione sostanza Cancerogena (Benzene)	Inizio: immediato dopo individuazione perdita.
Valvole di sicurezza (dopo rilasci)	Immediata	FID	Inizio:Entro 5 gg lavorativi da individuazione perdita. Fine:Entro 15 gg da inizio intervento	Emissione sostanza Cancerogena (Benzene)	Inizio: immediato dopo individuazione perdita.
Componenti con perdita visibile	Immediata	FID	Inizio:Entro 5 gg lavorativi da individuazione perdita. Fine:Entro 15 gg da inizio intervento	Emissione sostanza Cancerogena (Benzene)	Inizio: immediato dopo individuazione perdita.
Componente sottoposto a manutenzione - riparazione	Entro 1 mese dalla data di fine lavori	FID	Inizio:Entro 5 gg lavorativi da individuazione perdita. Fine:Entro 15 gg da inizio intervento	Emissione sostanza Cancerogena (Benzene)	Inizio: immediato dopo individuazione perdita.

TIPOLOGIA DI DOCUMENTO	CODICE	PAGINA
Procedura Operativa	**POA 08**	Pag. 1 di 7
TITOLO	**EDIZIONE**	**DATA**
Monitoraggio emissioni fuggitive	01	21-10-10
SISTEMA DI APPARTENENZA	**REVISIONE**	**DATA**
Sistema di Gestione Ambientale	00	21-10-10

TAMOIL RAFFINAZIONE S.p.A.
CREMONA

SISTEMA DI GESTIONE AMBIENTALE

MONITORAGGIO EMISSIONI FUGGITIVE

BOZZA

Ed.	Rev.	Data	Motivazione	Redazione	Verifica	Approvazione
01	00	21-10-10	Prima edizione della Procedura Operativa	RSGA	RDSGA	Alta Direzione

INDICE

0. RIFERIMENTI

Documentazione del Sistema di Gestione Ambientale

- POA 04 Gestione emissioni atmosferiche;
- MSGA Manuale del Sistema di Gestione Ambientale;

Documentazione di Raffineria

- Istruzione Operativa IO MAN 1000

Documentazione di riferimento

- Autorizzazione integrata Ambientale (AIA) U.prot DVA-DEC-2010-0000368 del 06/07/2010
- EPA Method 21 (protocollo EPA 453/95);
- Decreto 29 gennaio 2007 Emanazione di linee guida per l'individuazione e l'utilizzazione delle migliori tecniche disponibili, in materia di raffinerie, per le attività elencate nell'allegato I del decreto legislativo 18 febbraio 2005, n. 59;
- UNI EN 15446: Emissioni da fughe e diffuse relative ai settori industriali Misurazione delle emissioni da fughe di composti gassosi provenienti da perdite da attrezzature e tubazioni.

1. SCOPO

Scopo della presente procedura è definire e regolamentare le modalità di monitoraggio e gestione delle emissioni atmosferiche di natura diffusa/fuggitiva prodotte dalla Raffineria, attribuire le relative responsabilità ed uniformare i comportamenti del personale proprio e dei Terzi, al fine di garantire che i composti organici volatili (VOC) siano caratterizzati, monitorati e controllati e che le eventuali fonti di origine siano adeguatamente gestite.

2. CAMPO DI APPLICAZIONE

La presente procedura viene applicata alle attività di Raffineria che possono avere come effetto un’emissione in atmosfera di natura diffusa/fuggitiva.

Tamoil Raffinazione S.p.A. implementa il sistema di LDAR “Leak Detection and Repair” per monitorare e minimizzare le emissioni fuggitive dei Composti Organici Volatili.

3. DEFINIZIONI

Componenti normalmente raggiungibili: valvola, flangia, raccordo, pompa raggiungibili dall’operatore con lo strumento utilizzato per la misurazione delle VOC, senza l’ausilio di scale mobili, piattaforme semoventi o altri sistemi di sollevamento.

Emettitore cronico: componente per cui la perdita è pari o superiore a soglia emissiva limite, per due volte su quattro consecutive campagne di monitoraggio.

Emissione: corrente gassosa continua e/o discontinua, proveniente da una sorgente puntuale (punto di emissione/camino), contenente uno o più inquinanti.

FERP: Fuggitive Emissions Reduction Program, software di catalogazione delle sorgenti emissive classificate per tipo di componente, tipologia dello stream, e dati relativi alla procedura di LDAR.

FID: rivelatore a ionizzazione di fiamma, FID (Flame Ionization Detector), strumento di misurazione utilizzato per il rilevamento gascromatografico degli idrocarburi.

Impianto: unità operativa nella quale avviene una fase definita delle attività di raffineria.

LDAR: acronimo di Leak Detection And Repair

OGI: tecnica ispettiva remota con telecamera ad infrarossi IR camera sensibile alla lunghezza d'onda tipica degli idrocarburi (Optical Gas Imaging).

Perdita: emissione fuggitiva da un componente (emettitore), con una concentrazione di VOC superiore alla soglia emissiva limite.

Punto di emissione: sorgente puntuale che dà origine ad emissione in atmosfera.

Soglia emissiva limite: soglia al di sopra della quale è obbligatorio procedere alla riparazione dei componenti oggetto dell'emissione fuggitiva. le prescrizioni AIA fissano tale limite a 10.000 ppm_{volume} espressi come CH4.

VOC: Volatile Organic Compounds, composti organici volatili.

4. ALLEGATI E MODULI

POA08 Mod.1	Tabella frequenze di monitoraggio

5. MODALITA' OPERATIVE

5.1 GENERALITÀ

Le emissioni atmosferiche, di tipo fuggitivo, della Raffineria, possono pervenire dalle seguenti aree impiantistiche:

- Area Impianti di produzione;
- Area Movimentazione (carico prodotti in uscita).

I componenti maggiormente critici dal punto di vista delle perdite e pertanto oggetto di monitoraggio sono: flange, valvole, compressori, elementi inizio/fine linea, tenute dei serbatoi e pompe.
Tamoil Raffinazione SpA implementa il sistema di monitoraggio di tali componenti, tramite la tecnica LDAR.
LDAR si sviluppa nelle seguenti fasi:

1) Individuazione di tutti componenti interessati dal monitoraggio secondo indicazioni EPA metodo 21;
2) misure strumentali in campo delle perdite sui componenti secondo indicazioni EPA metodo 21;
3) interventi di manutenzione mirati sui componenti fuori soglia emissiva limite;
4) misure strumentali per verificare i componenti oggetto degli interventi della fase precedente;
5) calcolo delle VOC totali di Raffineria.

Nell'ambito della prima fase il censimento coinvolge tutti i componenti delle linee di processo o di aree ausiliarie che sono state aggregate in cinque gruppi principali ed in sottogruppo GAS o LIGHT LIQUID (LL) a seconda della fase dello stream (sono stati seguiti i criteri di classificazione della EPA453/95). Viene compilato un inventario (database) dei componenti, localizzandoli all'interno di un'identificabile linea di processo ed un P&I e associando a ciascuno il valore misurato in campo.

Questo inventario è disponibile all'interno di un software denominato FERP, all'interno del quale i componenti sono raggruppati sulla base dell'impianto di appartenenza.
FERP è predisposto per essere interpellabile con query di verifica dei seguenti argomenti:

- data di inserimento del componente nel programma LDAR;
- data di inizio / fine della riparazione o data di slittamento della stessa con motivazione;
- numero dei monitoraggi realizzati nel trimestre;
- numero di componenti monitorati al giorno da ogni tecnico coinvolto nel programma;
- calcolo dei tempi trascorsi tra due monitoraggi consecutivi su ogni componente;
- numero di riparazioni fatte oltre i tempi consentiti;
- altre informazioni utili per la gestione del programma;

Il sistema è in dotazione ai seguenti reparti:

- HSE;
- Processes and Technology;
- Maintenance, Engineering and I.T.

5.2 ATTIVITÀ DI MONITORAGGIO

Con le tempistiche definite nel Mod.1 della presente procedura, ENV provvede ad organizzare, incaricando una ditta esterna specializzata tramite contratto, le campagne di monitoraggio specifiche per la ricerca delle perdite dai vari componenti.
Tali campagne vengono condotte per ogni impianto di Raffineria, su tutti i componenti normalmente raggiungibili, utilizzando rilevatore FID e/o OGI.
Il primo sistema, di tipo quantitativo, attribuisce, mediante misurazione effettuata in campo dall'operatore della ditta incaricata, un valore in ppm$_{volume}$, ad ogni componente. Questi valori vengono successivamente elaborati e concorrono alla definizione del quantitativo totale in t/anno di VOC emesse.
Il secondo sistema (OGI), di tipo qualitativo, viene utilizzato per valutare, in un' area di impianto composta da più componenti, quali di questi è soggetto a perdite oppure no. L'indagine, che permette di monitorare un maggior numero di punti non restituisce un valore numerico e viene utilizzata per filtrare i componenti soggetti a perdite, sui quali poi si utilizza il FID.
Il sistema OGI permette di monitorare i punti difficili da raggiungere con strumentazione FID.
Le valvole di sicurezza sono misurate solo successivamente alla loro eventuale entrata in funzione. Production and Plants provvede ad avvertire ENV circa tali interventi.

5.3 GESTIONE DEI RISULTATI DEL MONITORAGGIO

Al termine di ogni singola campagna, i risultati, opportunamente validati dalla ditta incaricata per le attività di monitoraggio, diventano disponibili su FERP. Gli scenari possibili sono riepilogati in questo modo:

- componenti con valori di perdita al di sotto della soglia di emissione (10.000 ppm vol);
- componenti con valori di perdita superiori alla soglia di emissione (10.000 ppm vol);

I componenti per i quali vengono riscontrate perdite sopra soglia vengono immediatamente contrassegnati dall'operatore con un cartellino identificativo.

Le campagne di monitoraggio, sopra descritte, si concludono con una relazione cartacea fornita dalla ditta incaricata a ENV.

I rapporti con la ditta incaricata dei monitoraggi sono gestiti da ENV. L'elenco dei componenti classificati fuori soglia viene messo a disposizione dell'Ingegnere di Manutenzione che programmerà gli interventi necessari secondo la Istruzione Operativa IO MAN 1000. I tempi di intervento sono riportati nel Mod.1 della presente procedura.

Le informazioni relative alle attività di intervento effettuate da Maintenance sui componenti sopra soglia sono inserite in FERP e rimangono archiviate.

ENV provvede, una volta conclusi i relativi interventi di manutenzione, a programmare le campagne di monitoraggio successive allo scopo di verificare l'efficacia degli interventi eseguiti sui componenti.

Nel caso in cui, per modifiche impiantistiche derivanti da nuove installazioni, risultassero presenti in Raffineria nuovi componenti da monitorare, sarà cura di Engineering darne comunicazione a ENV per l'inserimento nel programma.

Nel caso in cui, per lavori di manutenzione e sostituzioni impiantistiche, risultassero presenti in Raffineria nuovi componenti da monitorare, sarà cura di Maintenance farne comunicazione a ENV per l'inserimento nel programma.

5.4 REPORTING

I risultati del programma LDAR sono registrati in formato elettronico (FERP) e su formato cartaceo e sono allegati al reporting annuale che il gestore invia alle autorità competenti AIA e all'ente di controllo.

Tamoil Raffinazione predispone una sintesi dei risultati del programma di LDAR indicando:

- Valori misurati al netto del rumore di fondo[1]
- il numero di componenti soggetti a misurazione delle perdite rispetto al totale dei componenti presenti sugli impianti;
- caratteristiche dei componenti monitorati;
- strumenti utilizzati;
- periodi in cui si svolgono le campagne di misura;
- condizioni climatiche;
- distribuzione percentuale, dei valori misurati, rispetto ai tre range: > 10.000 ppm vol., 10.000 – 1001 ppm vol. e 1000 – 0 ppm vol.
- gli interventi effettuati di sostituzione, riparazione, manutenzione e le date di effettuazione.

Sarà cura di ENV preparare il report annuale.

Annualmente, viene inoltre calcolato il quantitativo (espresso in t/anno) di VOC emesse dalla Raffineria, utilizzando i dati di ritorno dalla seconda fase (vedi par. 5.1) del sistema LDAR per le aree Impianti e Movimentazione ed una stima di calcolo per le aree API e Stoccaggio prodotti.

Le attività di calcolo dell'emissione globale di VOC e della stima delle emissioni delle aree Stoccaggio Prodotti ed API, sono affidate a Processes and Technology .

[1] Rumore di fondo: valore in ppm misurato dallo strumento nei camminamenti nell'intorno delle linee di processo.

5.5 FORMAZIONE DEL PERSONALE

In relazione a quanto definito nel MSGA sezione 4.2.2, ENV, in collaborazione con Legal Personnel and Office Administration organizza incontri specifici di formazione da erogare al personale addetto al LDAR. Una formazione più generale sulle finalità della presente procedura viene periodicamente erogata al personale non coinvolto direttamente nel programma ma che comunque opera sugli impianti.

6. RESPONSABILITA'

HSE ha il compito di gestire i rapporti con la ditta specializzata per i monitoraggi, segnalare a Maintenance, Engineering and I.T. i componenti sopra soglia per gli interventi, programmare le campagne di monitoraggio successivi agli interventi stessi.

Process and Technology sviluppa le attività di calcolo delle VOC totali di raffineria, che comprendono anche quelle risultanti dal programma LDAR e il Reporting;

Maintenance, Engineering and I.T. gestisce gli interventi di manutenzione con particolare attenzione agli standard costruttivi per i nuovi componenti che potrebbero essere installati al fine di diminuire le perdite dagli elementi definiti emettitori cronici. Comunica a ENV, a seguito di variazioni impiantistiche, lavori di manutenzione e sostituzioni, nuovi componenti da monitorare.

ENV, in collaborazione con Legal Personnel and Office Administration, programma la formazione del personale addetto all' LDAR e del personale non direttamente coinvolto nello stesso ma che comunque opera sugli impianti.

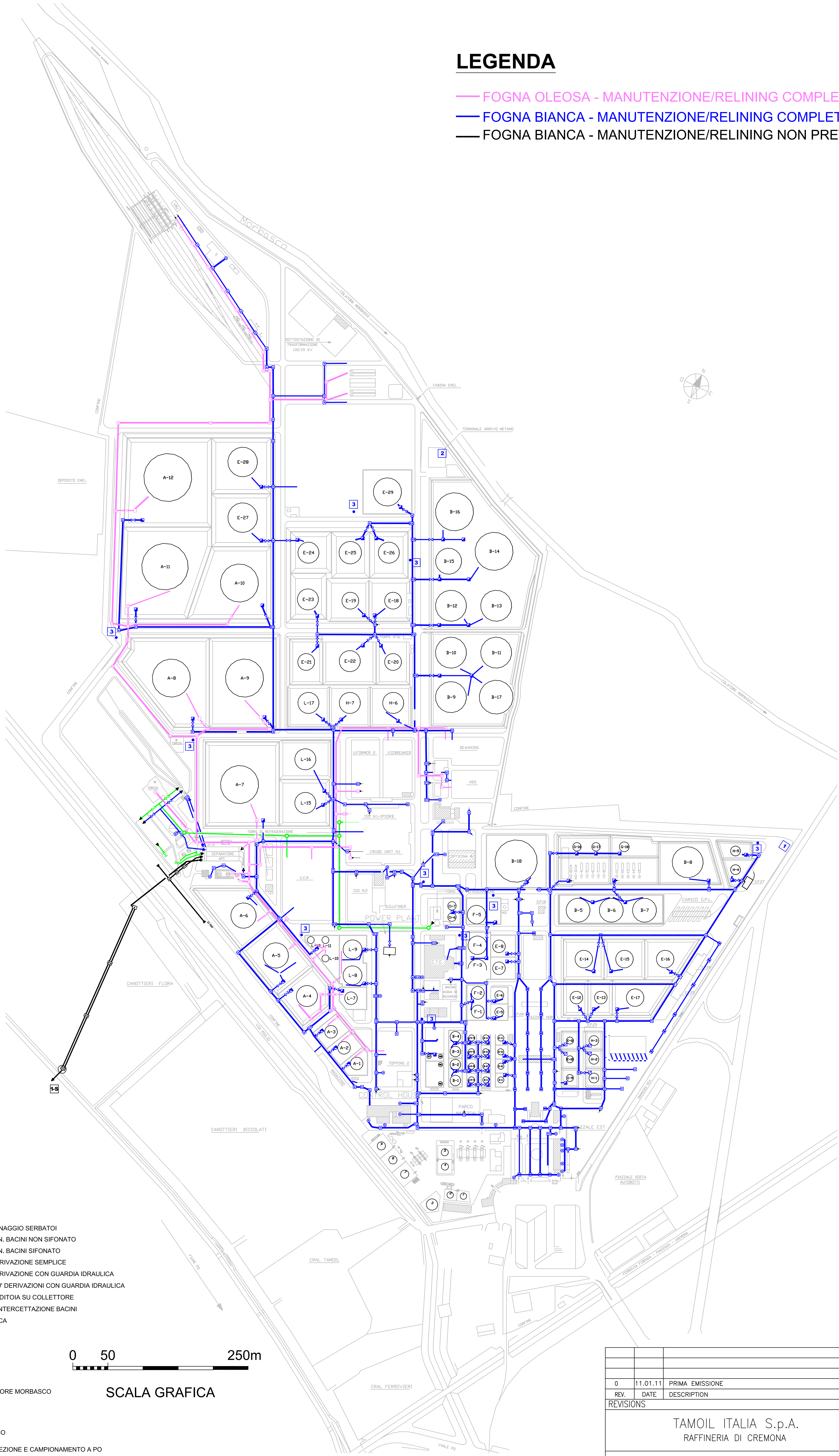
Production and Plan nel caso in cui entrino in funzione valvole di sicurezza avverte ENV affinché tali elementi vengano monitorati.

Allegato 7

Piano di ispezioni e manutenzione delle condotte fognarie

LEGENDA

- FOGNA OLEOSA - MANUTENZIONE/RELINING COMPLETATO
- FOGNA BIANCA - MANUTENZIONE/RELINING COMPLETATO
- FOGNA BIANCA - MANUTENZIONE/RELINING NON PREVISTO



FOGNATURE

- POZZETTO DRENAGGIO SERBATOI
- POZZETTO DREN. BACINI NON SIFONATO
- POZZETTO DREN. BACINI SIFONATO
- POZZETTO A DERIVAZIONE SEMPLICE
- POZZETTO A DERIVAZIONE CON GUARDIA IDRAULICA
- POZZETTO A PIU' DERIVAZIONI CON GUARDIA IDRAULICA
- POZZETTO A CADITOIA SU COLLETTORE
- SARACINESCA INTERCETTAZIONE BACINI
- FOSSA BIOLOGICA

0 50 250m

SCALA GRAFICA

- 1 ACQUEDOTTO
- 2 PRESA DA COLATORE MORBASCO
- 3 POZZI
- 1-S PUNTO DI SCARICO
- POZZETTO DI ISPEZIONE E CAMPIONAMENTO A PO
- H2O ACIDE NEUTRALIZZATE
- IMPIANTO DI TRATTAMENTO

REV.	DATE	DESCRIPTION	BY	CHD	APP.
0	11.01.11	PRIMA EMISSIONE	CA		DA

REVISIONS

TAMOIL ITALIA S.p.A.
RAFFINERIA DI CREMONA

APPROVED FOR CONSTRUCTION
DWG. REV. DATE
SIGNATURE

STATUS RETI INTERRATE
Interventi di relining eseguiti da Tamoil
(aggiornamento a maggio 2010)

ORDER N°
SUPPLIER
CONTRACT N° 1-BH-0342A
FRAME N° FIGURA 1

FOSTER WHEELER

THIS DWG. SUPERSEDED BY /
THIS DWG. SUPERSEDES /
SCALE /
DWG. N° BH0342A-01-38
REV. 0

PIANO DI ISPEZIONE E MANUTENZIONE DELLE CONDOTTE FOGNARIE

Oggetto del Piano

Oggetto del presente Piano è l'esecuzione del controllo delle condotte fognarie della Raffineria Tamoil di Cremona utilizzando la metodologia dell'ispezione televisiva.

Riferimenti normativi

- UNI EN 13508 – Condizioni degli impianti di raccolta e smaltimento di acque reflue all'esterno di edifici
- UNI EN 752 – Connessioni di scarico e collettori di fognatura all'esterno di edifici
- UNI EN 1610 – Costruzione e collaudo di connessioni di scarico e collettori di fognatura

Stato manutentivo del sistema fognario

Tamoil ha svolto e continua a svolgere attività di ispezione, manutenzione e risanamento di tratti fognario al fine di mantenere in efficienza il sistema fognario stesso.

Considerando che la rete fognaria, bianca e oleosa, è stata realizzata in concomitanza dei primi insediamenti della raffineria (anni 60-70), a scopo precauzionale gli interventi sono stati previsti sulla quasi totalità della rete di raffineria.

Le attività hanno previsto la tecnica di "relining" mediante il sistema PHOENIX®; il processo prevede l'introduzione mediante pressione di aria, all'interno della condotta da manutenzionare, di una guaina tessile in feltro poliestere con rinforzo reticolare in poliestere ad alta tenacità, accoppiato in modo permanente con una pellicola in polietilene di spessore variabile in funzione dei diametri e impregnata con resine epossidiche.

In cantiere, il tubolare è pressurizzato con aria affinché aderisca con forza all'intera circonferenza del vecchio tubo; successivamente all'inserimento della guaina viene introdotto un flusso di vapore per consentire la polimerizzazione della resina. La pressurizzazione ad aria e vapore permette l'omogenea pressatura della guaina al tubo.

Tale tipo di intervento assicura un'ampia tutela del sottosuolo, garantita dalle caratteristiche dei materiali utilizzati e dai collaudi costruttivi eseguiti tali da impartire alla tubazione capacità strutturali e di tenuta idraulica.

Le attività dal punto di vista cronologico sono suddivise in due parti:

Prima fase

- Pulizia e ispezione del tratto;
- eventuale fresatura d'allacciamenti o parti sporgenti;
- predisposizione di eventuali by-pass temporanei nei tratti interessati dagli interventi;
- taglio della guaina per la lunghezza del tubo;
- stesura della guaina e avviamento processi di "vuoto" per facilitare la fase di impregnazione con la resina.

Seconda fase

- Impregnazione della guaina con resina epossidica;
- inserimento guaina in invertitore;

- inserimento guaina nella condotta;
- riscaldamento, raffreddamento e taglio dei terminali;
- eventuale riapertura di allacciamenti;
- prove di tenuta e collaudi.

Il programma di relining si è concluso nel Maggio 2010.

Il disegno allegato *BH0342A-01-38_StatusRetiInterrate-AggMag10.pdf* riporta la rappresentazione grafica della rete fognaria di raffineria oggetto di intervento.

Descrizione delle attività oggetto del Piano

Le attività oggetto del Piano consistono nel controllo delle condotte fognarie al fine di verificarne la conservazione e l'efficienza, per poterle esercire in sicurezza.

Per il controllo utilizza la metodologia dell'ispezione televisiva, una delle tipologie di controlli prevista dalle norme UNI EN 752. A fronte delle attività eseguite sarà prodotta una relazione tecnica riportante una valutazione delle risultanze ottenute.

Le attività saranno commissionate a Società terza qualificata.

Cronoprogramma delle attività

Tamoil prevede di effettuare un controllo mediante video-ispezione che dovrà riguardare come minimo un 20% delle condotte per ogni biennio. Successivamente, il controllo sarà in funzione dello stato di conservazione rilevato e comunque non avverrà oltre quanto previsto dagli standard internazionali riconosciuti.

Allegato 8

Piano di monitoraggio pipe-way di stabilimento

PIANO DI MONITORAGGIO PIPE-WAY DI STABILIMENTO

OGGETTO DEL PIANO

Oggetto del presente Piano è l'esecuzione del controllo di tubazioni in acciaio per prodotti petroliferi costituenti le linee di trasferimento di prodotti della Raffineria Tamoil di Cremona utilizzando la metodologia ad Onde Guidate (*Guided Waves*).

Riferimenti normativi

- UNI U45000990 – Prove non distruttive – Controllo mediante onde guidate di tubazioni in acciaio fuori terra
- UNI EN 473:2001 – Prove non distruttive – Qualificazione e certificazione del personale addetto alle prove non distruttive – Principi generali
- UNI EN 1330-2: 2000 – Terminologia termini comuni ai metodi di prove non distruttive
- UNI EN 13480-1-2-3-4-5-6 – Tubazioni industriali metalliche
- API 570 – Piping Inspection code: Inspection, Repair, Alteration and Rerating of in-service Piping Systems – Second Edition and Addendum n°1-2-3-4

Descrizione delle attività oggetto del Piano

Le attività oggetto del Piano consistono nel controllo delle tubazioni di trasferimento dei prodotti petroliferi utilizzando la metodologia ad Onde Guidate, al fine di verificarne la conservazione e l'efficienza, per poterle esercire in sicurezza. A fronte delle attività eseguite viene prodotto un report contenente i risultati del software utilizzato accompagnato da una relazione tecnica riportante una valutazione delle risultanze ottenute.

Le attività sono eseguite da Società terza qualificata.

Cronoprogramma delle attività

Tamoil ha in corso un piano triennale di controllo con Onde Guidate di tutte le tubazioni di trasferimento prodotti; successivamente, il ricontrollo sarà in funzione dello stato di conservazione rilevato e comunque non avverrà oltre quanto previsto dagli standard internazionali riconosciuti.

Allegato 9

Misure del consumo di combustibile delle singole utenze di raffineria - Elenco misuratori di portata installati

PUNTO DI EMISSIONE	UNITA'	FORNO	FUEL	TAG FUEL GAS						FUEL OIL	
				FISCALE	P	T	dens.	COMPENS.	SINGOLO FORNO	TOTALE	SINGOLO FORNO
Camino E01A e E01B	Crude Unit 1	F301	FG/FO	FR_322	PR_322	TI_329	04_AR_01	FKR_322	-	FKFOF301	-
Camino E02	Topping 2	FR300	FG/FO	FR_3022	PR_3022			FKR_3022	-	Locale	-
Camino E03	Diesel Oil Ultrafiner	05F201	FG	77FR_7	77PR_2			77FKR_7	-		-
		05F251	FG						77FR_55		-
	Isomerizzazione 2	02F101	FG	77FR_6	77PR_2			77FKR_6	-		-
Camino E04	Ultraformer2 / Kerofiner	2F1	FG	2FR_44	2PRC_181			2FKR_44	-		-
		2F2A	FG						-		-
		2F2B	FG						-		-
		2F2C	FG						-		-
		2F3	FG						-		-
Camino E05	Isomerizzazione 1	3F1	FG	FR_4_23	PR_4_23			FKR_4_23	FR_3_54		-
		4F1	FG/FO						FR_4_54		FKFO4F1
	Ipsorb	7F151	FG						7FIC_8		-
		7F152	FG						7FIC_9		-
Camino E06	CCR	6F101	FG/FO	6FR_405	6PIC401			6FKR_405	6FIC_108	6FKTOTFO	-
		6F102	FG/FO						6FIC_109		-
		6F201	FG						6FIC_231		-
		6F202	FG						6FIC_234		-
		6F203	FG						6FIC_235		-
		6F204	FG						6FIC_236		-
		6F205	FG/FO						6FIC_208		-
Camino E07	Visbreaker	F601A	FG/FO	FR_6072	PR_6072			FKR_6072	FR_6042	FKFOF601	-
		F601B	FG/FO						FR_6046		-
	Postcombustore	F902	N/A						R_9111+FR_9016		-
Camino E08	HDS	8F1	FG	8FR_33	8PR_33			8FKR_33	-		-
	Dewaxing	5F1	FG	FI_5003	PI_5004			FIK_5003	-		-
Camino E09	Topping 2	FR301	FG/FO	FR_3022	PR_3022			FKR_3022	FR_3051	Locale	-
Camino E10	CTE	SG1	FG/FO	FR_35				FRK_35	50_FR_1_104	FR_10	50_FR_1_103
		SG2	FG/FO						50_FR_2_204		50_FR_2_203
		SG3	FG/FO						50_FR_3_27		50_FR_3_26
Torcia 1	Torcia 1	-	-	FI_382							
Torcia 2	Torcia 2	-	-	99FR_200							

Allegato 10

Procedura per il calcolo della bolla di raffineria, delle emissioni in massa mensili e annuali e del VLE puntuale del camino E10

TAMOIL
Raffineria di Cremona

Sistema Monitoraggio Emissioni

Procedure di Elaborazione della Bolla di Raffineria

0	22.01.2010	Versione iniziale			
			P. Cazzaniga	M. Mazzurco	A. Svideny
Rev	**Data**	**Descrizione**	**Preparato**	**Verificato**	**Approvato**

DOCUMENTO	M	T	0	1	T	0	0	1	3	R	0	0

Contenuto

1 Introduzione

Il presente documento descrive le procedure di elaborazione e di calcolo della emissioni globali (bolla) della raffineria come prescritto nella sezione I, Parte IV dell'allegato I alla Parte V del D. Lgs. 152/06.

1.1 Limiti di Emissione secondo D.Lgs. 152/06

I limiti di emissione sono defini nella Sezione I, Parte IV dell'allegato I alla Parte V del D. Lgs. 152/06 sono riportati nella tabella seguente:

Parametro	Limite di Emissione
Biossido di Zolfo	1700 mg/Nm3
Ossidi di Azoto	500 mg/Nm3
Ossido di Carbonio	250 mg/Nm3
Polveri	80 mg/Nm3

I limti di emissione di ossidi di zolfo, ossidi di azoto, polveri e monossido di carbonio sono riferiti ai valori medi mensili corrispondenti alle ore di effettivo funzionamento.

1.2 Documentazione di riferimento

Le procedure di elaborazione della bolla utilizzano i dati prodotti dagli applicativi del sistema SME relativamente ai punti di emissione dotati di strumentazione o stimati mediante appositi algoritmi di calcolo.
Le procedure utilizzate sono descritte nei documenti:

MT01T0011R00	Procedure di Elaborazione Dati
MT01T0012R00	Procedure di Elaborazione Dati Stimati

a cui si rimanda per gli eventuali approfondimenti.

2 Calcolo delle emissioni

Gli applicativi del sistema monitoraggio emissioni utilizzano i seguenti criteri per la valutazione delle emissioni complessive della raffineria (bolla):

1. Valori acquisiti in continuo per le emissioni provenienti dai camini monitorati, che costituiscono buona parte dei volumi emissivi, mediante misure dei seguenti parametri:
   - Biossidi di zolfo
   - Biossidi di Azoto
   - Ossido di carbonio
   - Polveri
   - Ossigeno
   - Temperatura Fumi
   - Pressione Fumi

2. Stima delle portate fumi per tutti i camini della raffineria.

3. Valori stimati mediante fattori di emissione per i camini privi di strumentazione.

Le procedure di calcolo dei dati misurati e stimati sono riportate nella documentazione richiamata nel capitolo precedente.

In accordo alle disposizioni del D.Lgs. 152/06, i valori di emissione devono essere calcolati come rapporto ponderato tra la sommatoria delle masse di inquinanti emesse e la sommatoria dei volumi degli effluenti gassosi dell'intera raffineria, ovvero:

$$C_{Bolla} = 1000 \cdot \frac{\sum_{i=1}^{N} \Phi_i}{\sum_{i=1}^{N} QF_i}$$

dove C_{Bolla}, in mg/Nm3, è la concentrazione calcolata, Φ_i, in kg/h, è il flusso di massa del parametro, misurato o stimato, di un determinato punto di emissione, e QF_i, in Nm3/h è la portata fumi stimata per il medesimo punto di emissione e riferita al riferita al tenore di ossigeno del 3%.

Gli applicativi del sistema monitoraggio emissioni effettuano il calcolo delle concentrazioni di bolla in tempo reale permettendo una valutazione continua degli assetti emissivi della raffineria. I dati elaborati vengono mediati e riportati nei report di emissione su base oraria, giornaliera, mensile ed annuale.

TAMOIL
Raffineria di Cremona

Sistema Monitoraggio Emissioni

Procedure di Elaborazione dei Dati Stimati

0	22.01.2010	Versione iniziale			
			P. Cazzaniga	M. Mazzurco	A. Svideny
Rev	**Data**	**Descrizione**	**Preparato**	**Verificato**	**Approvato**

DOCUMENTO M T 0 1 T 0 0 1 2 R 0 0

Contenuto

1 Introduzione

Nel presente documento vengono trattate le metodologie di calcolo di alcuni parametri emissivi per i camini che non possiedono un sistema di analisi emissioni in continuo.

I metodi di calcolo trattati possono essere applicati anche ai punti di emissione dotati di analizzatori in continuo in presenza di anomalie strumentali o di altre condizioni che rendono inattendibili i dati analitici.

I parametri stimati vengono registrati negli archivi del sistema monitoraggio emissioni con il codice di stato monitor 20 come definito dalla normativa DDG3536/97 della Regione Lombardia.

Gli algoritmi di calcolo sono ricavati da pubblicazioni e metodi comunemente utilizzati per le stime annuali dei volumi emissioni.

2 Parametri Combustibili e Impianti

La stima dei parametri emissivi utilizza procedure di calcolo basate sulle portate dei combustibili (fuel gas e fuel oil) utilizzati negli impianti connessi al punto emissivo. La composizione e le caratteristiche dei combustibili impiegati sono aggiornate, con una certa frequenza, dal personale del laboratorio analitico della raffineria. Le portate combustibili sono acquisite automaticamente dal sistema SME mediante la comunicazione seriale con il DCS di controllo dell'impianto.

2.1 Caratteristiche del Fuel Gas

Il fuel gas o gas di raffineria è un sottoprodotto della lavorazione del greggio con un elevato contenuto di idrogeno. La tabella seguente riporta i principali componenti del gas determinati dal laboratorio analisi della raffineria.

Componente	PM_n [g/mole]	PCS_n [kJ/mole]	PCI_n [kJ/mole]	C_n [% moli]
Idrogeno (H2)	2,016	286,63	241,56	74,40
Metano (CH4)	16,043	892,97	802,82	7,32
Etano (C2H6)	30,069	1564,24	1429,12	4,14
Etilene (C2H4)	28,054	1413,51	1323,36	0,26
Propano (C3H8)	44,097	2224,01	2043,01	7,18
Propilene (C3H6)	42,081	2061,57	1926,35	0,39
Butani (C4H10)	58,123	2883,82	2658,45	5,07
Buteni (C4H8)	56,108	2721,55	2541,25	0,25
Pentani C5H12)	72,150	3542,89	3272,45	0,83
Esani (C6H14)	86,177	4203,23	3887,71	0,16
Acido Solfidrico (S)	34,082			0,005
Azoto (N)	14,007			0,001

La composizione del fuel gas è aggiornata dal personale del laboratorio della raffineria mediante le pagine del sito WEB del sistema SME.

2.1.1 Calcolo della densità del Fuel Gas

La determinazione della densità del Fuel Gas richiede il calcolo del peso molecolare PM_{FG} mediante la seguente equazione:

$$PM_{FG} = \frac{1}{100} \sum_{n=1}^{N} C_n \cdot PM_n$$

dove C_n è il contenuto percentuale del componente determinato dall'analisi del fuel gas e PM_n è i relativo peso molecolare.
La densità del fuel gas D_{FG} è ricavata dal rapporto tra il peso molecolare e il volume molare:

$$D_{FG} = \frac{PM_{FG}}{22.414}$$

2.1.2 *Calcolo del PCI e PCS del Fuel Gas*

La determinazione del PCI e PCS del Fuel Gas utilizza le elaborazioni previste dalla norma ISO 6976 mediante la seguenti equazioni:

$$PCI_{FG} = \frac{1}{100 \cdot PM_{FG}} \sum_{n=1}^{N} C_n \cdot PCI_n$$

$$PCS_{FG} = \frac{1}{100 \cdot PM_{FG}} \sum_{n=1}^{N} C_n \cdot PCS_n$$

I valori dei poteri calorifici sono espressi in MJ/Kg.

2.2 Caratteristiche del Fuel Oil

Il fuel oil utilizzato nei forni della raffineria è un olio combustibile a basso tenore di zolfo le cui caratteristiche medie sono riportate nella tabella seguente:

	Parametro Fuel Oil	UM	Valore
C_{H2}	Contenuto di idrogeno (H2)	%	12,00
C_C	Contenuto di Carbonio (C)	%	85,00
C_N	Contenuto di Azoto Organico (N)	%	0,20
C_S	Contenuto di Zolfo (S)	%	0,35
PCI_{FO}	Potere Calorifico Inferiore (PCI)	Kcal/Kg	9800
PCS_{FO}	Potere Calorifico Superiore (PCS)	Kcal/Kg	10290
D_{FO}	Densità	Kg/dm3	0,95

I parametri del fuel oil sono aggiornate dal personale del laboratorio della raffineria mediante le pagine del sito WEB del sistema SME.

2.3 Caratteristiche degli impianti

Ai fini delle parametrizzazioni dei procedure di elaborazione risultano significative alcune caratteristiche degli impianti connessi ai punti di emissione soggetti al monitoraggio strumentale o stimato.
La tabella seguente riporta i valori nominali delle potenze termiche degli impianti interessati, il tipo di bruciatori e la temperatura di preriscaldo dell'aria comburente

Camino	Impianti e Forni	Potenza Termica Nominale [MW]	Tipo Bruciatori	Temp. Preriscaldo °C
E01A / **E01B**	Crude Unit 1 (CU1) F300	86,52	Low NOx	30
E02	Topping 2 (T2) FR300	14,11	Standard	30
E03	Diesel Oil Ultrafiner (DOUF) 05F201 05F251	9,53	Low NOx	30
	Isomerizzazione 2 (ISO2) 02F101	3,26	Low NOx	30
E04	Ultraformer2 (UF2) 2F1 2F2A 2F2B 2F2C 2F3	61,55	Standard	120
E05	Isomerizzazione 1 (ISO1) 3F1 4F1	17,23	Low NOx	120
	IPSORB 7F151 7F152	9,98	Low NOx	120
E06	CCR 6F101 6F102 6F201 6F202 6F203 6F204	92,50	Low NOx	30
E07	Visbreaker (VSB) F601A F601B	62,80	Low NOx	30
	Postcombustore F902		Standard	30
E08	HDS (HDS) 8F1	7,09	Low NOx	30
	Dewaxing (CDW) 5F1	10,03	Standard	120
E09	Topping 2 (T2) FR301	6,71	Low NOx	30
E10	Centrale Elettrica (CTE) SG1 SG2 SG3	92,81	Standard	120

3 Stime parametri dei Camini

Nel seguente capitolo sono descritti gli algoritmi di calcolo utilizzati nella determinazione dei parametri emissivi dei camini. Le stima sono basate sull'utilizzo dei fattori di emissione pubblicati nel report Concawe nell'edizione dell'Aprile 2007 e sulle equazioni di calcolo previste dal DPR 416/2001.

3.1 Stima della Portata Fumi (QF)

La procedura di stima della portata fumi utilizza le equazioni di calcolo previste nell'allegato tecnico al DPR 416/2001, ovvero

$$Q_F = \frac{21}{21 - O_{2RIF}} \cdot \left(8.86 \cdot C + 20.89 \cdot H_2 + 3.31 \cdot S\right) \cdot \frac{Q_C}{100}$$

Dove Q_F : il volume in Nm3/h di fumi anidri all'ossigeno di riferimento;
O_{2RIF} : ossigeno di riferimento (pari al 3% v/v)
Q_C : la portata di combustibile in kg/h;
C : contenuto percentuale di Carbonio elementare nel combustibile;
H_2 : contenuto percentuale di Idrogeno nel combustibile;
S : contenuto percentuale di Zolfo elementare nel combustibile;

Il valore stimato si intende al secco e riportato all'ossigeno di riferimento. Il valore della portata fumi del punto di emissione è ricavato dalla sommatoria dei volumi fumi ricavati dalle portate combustibili dei forni collegati al stesso punto di emissione.

3.2 Stima della Potenza Termica (PT)

La potenza termica associata di ogni punto di emissione è data dalla somma degli apporti di energia introdotti dal flusso dei combustibili utilizzati nei forni collegati al camino. Il valore della potenza termica PT in MW è quindi ricavato dalla sommatoria dei prodotti tra le portate combustibili ed il potere calorifico secondo la seguente relazione:

$$PT = \frac{1}{3600} \cdot (PCI_{FG} \cdot D_{FG} \cdot \sum_{n=1}^{N} QFG_n + PCI_{FO} \cdot \sum_{n=1}^{M} QFO_n)$$

dove PCI_{FG} e PCI_{FO} sono i poteri calorici dei combustibili in MJ/kg, D_{FG} la densità del fuel gas, QFG_n le portate fuel gas in Nm3/h, e QFO_n le portate fuel oil in kg/h dei flussi di alimentazione i diversi forni collegati al camino.

3.3 Stima dell'Anidride Carbonica (CO2)

Il flusso di CO2 in Kg/h, associata di ogni punto di emissione è data dalla somma dei contributi calcolati dai flussi dei combustibili utilizzati nei forni collegati al camino, come riportato nella seguente relazione

$$Q_{CO2} = 0.995 \cdot \frac{PM_{CO2}}{PM_C} \cdot \frac{1}{100} \cdot (C_{FG} \cdot D_{FG} \cdot \sum_{n=1}^{N} QFG_n + C_{FO} \cdot \sum_{n=1}^{M} QFO_n)$$

dove C_{FG} e C_{FO} sono il contenuto in % peso di carbonio elementare dei combustibili, D_{FG} la densità del fuel gas, QFG_n le portate fuel gas in Nm3/h, e QFO_n le portate fuel oil in kg/h dei flussi di alimentazione i diversi forni collegati al camino.

3.4 Stima dell'Umidità Fumi (H2O)

Il flusso di H2O in Kg/h, associata di ogni punto di emissione è data dalla somma dei contributi calcolati dai flussi dei combustibili utilizzati nei forni collegati al camino, come riportato nella seguente relazione

$$Q_{H2O} = \frac{PM_{H2O}}{PM_{H2}} \cdot \frac{1}{100} \cdot (H_{FG} \cdot D_{FG} \cdot \sum_{n=1}^{N} QFG_n + H_{FO} \cdot \sum_{n=1}^{M} QFO_n)$$

dove H_{FG} e H_{FO} sono il contenuto in % peso di idrogeno (H2) dei combustibili, D_{FG} la densità del fuel gas, QFG_n le portate fuel gas in Nm3/h, e QFO_n le portate fuel oil in kg/h dei flussi di alimentazione i diversi forni collegati al camino.

3.5 Stima degli Ossidi di Zolfo (SO2)

La procedura di stima degli ossidi di zolfo utilizza i fattori di emissione ricavati dalle formule di combustione stechiometrica.

Per il fuel gas, la composizione del gas è espressa in forma molare, e quindi il fattore di emissione di SO2 espresso in g su kg di combustibile consumato risulta:

$$SO2_{FG} = \frac{1000}{100} \cdot C_S \cdot PM_S \cdot \frac{PM_{So2}}{PA_S}$$

Dove C_S è la percentuale molare di zolfo elementare nel gas, PM_{SO2} e PA_S rappresentano rispettivamente il peso molecolare del SO2 e atomico dello zolfo.

Per il fuel oil il fattore di emissione di SO2, espresso in g su kg di combustibile, è dato da:

$$SO2_{FO} = \frac{1000}{100} \cdot C_S \cdot \frac{PM_{So2}}{PA_S}$$

Dove C_S è la percentuale in peso di zolfo elementare nell'olio, PM_{SO2} e PA_S rappresentano rispettivamente il peso molecolare del SO2 e atomico dello zolfo.

Il flusso in kg/h di SO2 emesso dal punto di emissione è determinato dalla seguente relazione:

$$Q_{SO2} = \frac{1}{1000} \cdot (SO2_{FG} \cdot D_{FG} \cdot \sum_{n=1}^{N} QFG_n + SO2_{FO} \cdot \sum_{n=1}^{M} QFO_n)$$

dove $SO2_{FG}$ e $SO2_{FO}$ sono i fattori di emissione dei combustibili in g/kg, D_{FG} la densità del fuel gas, QFG_n le portate fuel gas in Nm3/h, e QFO_n le portate fuel oil in kg/h dei flussi di alimentazione i diversi forni collegati al camino.

3.6 Stima dell'Ossido di Carbonio (CO)

La stima dell'Ossido di Carbonio è basata sull'utilizzo dei fattori di emissione pubblicati nel report Concawe nell'edizione dell'Aprile 2007.
In particolare sono utilizzati i seguenti parametri:

	Parametro	UM	Valore
CO_{FG}	Fattore di emissione del CO per il Fuel Gas	g/GJ	39,30
CO_{FO}	Fattore di emissione del CO per il Fuel Oil	g/GJ	11,51

Il flusso in kg/h di CO emesso dal punto di emissione è determinato dalla seguente relazione:

$$Q_{CO} = \frac{1}{10^6} \cdot (CO_{FG} \cdot D_{FG} \cdot PCI_{FG} \cdot \sum_{n=1}^{N} QFG_n + CO_{FO} \cdot PCI_{FO} \cdot \sum_{n=1}^{M} QFO_n)$$

dove CO_{FG} e CO_{FO} sono i fattori di emissione dei combustibili in g/GJ, PCI_{FG} e PCI_{FO} sono i poteri calorici dei combustibili in MJ/kg, D_{FG} la densità del fuel gas, QFG_n le portate fuel gas in Nm3/h, e QFO_n le portate fuel oil in kg/h dei flussi di alimentazione ai forni collegati al camino.

3.7 Stima delle Polveri (PLV)

La stima delle polveri è basata sull'utilizzo dei fattori di emissione definiti nel metodo EPA AP 42.

Il metodo prevede un fattore di emissione PLV_{FG} per gli impianti alimentati a fuel gas pari a 3,20 g/GJ.

Per gli impianti alimentati a fuel oil di potenzialità inferiore a 29 MW, il fattore di emissione delle polveri è dato da:

$$PLV_{FO} = 10^3 \cdot \frac{1{,}2}{D_{FO} \cdot PCI_{FO}}$$

dove PCI_{FO} è il potere calorico in MJ/kg e D_{FO} la densità del fuel oil.

Per gli impianti alimentati a fuel oil di potenzialità superiore a 29 MW, il fattore di emissione delle polveri è dato da:

$$PLV_{FO} = 10^3 \cdot \frac{0{,}12 \cdot (3{,}22 + 9{,}19 * C_S)}{D_{FO} \cdot PCI_{FO}}$$

dove PCI_{FO} è il potere calorico in MJ/kg, D_{FO} la densità e C_S il contenuto di zolfo del fuel oil.

Il flusso in kg/h di Polveri emesso dal punto di emissione è determinato dalla seguente relazione:

$$Q_{CO} = \frac{1}{10^6} \cdot (PLV_{FG} \cdot D_{FG} \cdot PCI_{FG} \cdot \sum_{n=1}^{N} QFG_n + PCI_{FO} \cdot \sum_{n=1}^{M} PLV_{FO} \cdot QFO_n)$$

dove PLV_{FG} e PLV_{FO} sono i fattori di emissione dei combustibili in g/GJ, PCI_{FG} e PCI_{FO} sono i poteri calorici dei combustibili in MJ/kg, D_{FG} la densità del fuel gas, QFG_n le portate fuel gas in Nm3/h, e QFO_n le portate fuel oil in kg/h dei flussi di alimentazione ai forni collegati al camino.

3.8 Stima degli Ossidi di Azoto (NOx)

La stima degli Ossidi di Azoto è basata sull'utilizzo dei fattori di emissione pubblicati nel report Concawe nell'edizione dell'Aprile 2007.
Il fattore di emissione degli NOx è determinato da un contributo legato alla reazione di combustione dell'azoto atmosferico (NOx Termici) ed un contributo legato al contenuto di azoto organico contenuto nel combustibile.
I valori dei flussi di emissione degli ossidi di azoto ottenuti dai processi di stima sono espressi come biossido (NO2).

3.8.1 Fattore di Emissione NOx Termici

Il fattore di emissione TNF in g/GJ degli NOx dovuti all'ossidazione dell'azoto atmosferico è determinato dalla seguente relazione:

$$TNF = F_A \cdot F_H \cdot F_C \cdot F_P \cdot F_W \cdot F_L \cdot F_B$$

dove:

F_A Fattore di calcolo determinato in base al combustibile:

Combustibile	**Fattore F_A**
Fuel Gas	69
Fuel Oil	56

F_H Fattore di calcolo determinato in base al contenuto di idrogeno nel combustibile:

Contenuto di Idrogeno % mole	**Fattore F_H**
< 23	1,00
33	1,04
43	1,09
53	1,25
> 63	1,46

Il fattore F_H per il fuel oil è assunto uguale a 1.

F_C Fattore di calcolo determinato in base alla tecnologia dei bruciatori dell'impianto:

Tecnologia Bruciatore	Fattore F_C
Standard	1,0
Low NOx	0,60

F_P Fattore di calcolo determinato in base alla temperatura di preriscaldo dell'aria comburente immessa nel forno:

Temperatura Preriscaldo °C	Fattore F_P
< 38	1,00
38	1,00
93	1,10
149	1,32
204	1,60
260	1,86

F_W Fattore di calcolo determinato in base alla temperatura di preriscaldo dell'aria comburente immessa nel forno:

Contenuto di umidità kg H2O/ kg Aria secca	Fattore F_W
0	1,00
0,01	0,79
0,02	0,67
0,03	0,53
0,04	0,41
0,05	0,29

F_L Fattore di calcolo determinato dal carico dell'unità di combustione

Carico % su nominale	Fattore F_L
40	0,55
60	0,70
80	0,85
100	1,00

F_B Fattore di calcolo determinato in base alla tecnologia dei bruciatori dell'impianto:

Tecnologia Bruciatore	Fattore F_B
Alta Luminosità	1,80
Bassa Luminosità	1,00

3.8.2 Fattori di Emissione NOx da Combustibile

Il fattore di emissione FNF in g/GJ degli NOx dovuti al contenuto di azoto organico nel combustibile è dato dall'equazione:

$$FNF = 10^4 \cdot \frac{3{,}286 \cdot C_N \cdot F_{Nc}}{PCS}$$

dove C_N rappresenta la percentuale di azoto organico presente nel combustibile, PCS è il potere calorico superiore in MJ/kg, e F_{Nk} è un fattore determinato in funzione della percentuale di azoto contento nel combustibile ricavata dalla tabella seguente:

Contenuto di Azoto C_N [%]	Fattore F_{Nc}	
	Bruciatori Standard	Bruciatori Low NOx
<0,05	1,00	1,00
0,05	0,87	0,86
0,10	0,78	0,75
0,30	0,53	0,43
0,50	0,38	0,30
1,00	0,32	0,25

3.8.3 Flussi di Emissione di NOx

Il flusso in kg/h di ossidi di azoto stimati per il punto di emissione è determinato dalla seguente relazione:

$$Q_{NOx} = \frac{1}{10^6} \cdot \left(D_{FG} \cdot PCS_{FG} \cdot \sum_{n=1}^{N} (TNF_n^{FG} + FNF^{FG}) \cdot QFG_n + PCS_{FO} \cdot \sum_{n=1}^{M} (TNF_n^{FO} + FNF^{FO}) \cdot QFO_n\right)$$

dove TNF e FNF sono i fattori di emissione dei calcolati in funzioni dei combustibili e delle caratteristiche costruttive degli impianti, PCS_{FG} e PCS_{FO} sono i poteri calorici superiori dei combustibili in MJ/kg, D_{FG} la densità del fuel gas, QFG_n le portate fuel gas in Nm3/h, e QFO_n le portate fuel oil in kg/h dei flussi di alimentazione ai forni collegati al camino.

4 Stima dei parametri delle Torce

La stima dei parametri emissivi prodotti dalle torce è basato sulle portate dei flussi
La composizione e le caratteristiche dei flussi distrutti, con una certa frequenza, dal personale del laboratorio analitico della raffineria.
Le portate dei flussi sono acquisite automaticamente dal sistema SME mediante la comunicazione seriale con il DCS di controllo dell'impianto.

4.1 Caratteristiche del gas di torcia

. La tabella seguente riporta i principali componenti del gas di torcia determinati dal laboratorio analisi della raffineria.

Componente	PM_n [g/mole]	PCS_n [kJ/mole]	PCI_n [kJ/mole]	C_n [% moli]
Idrogeno (H2)	2,016	286,63	241,56	70,50
Metano (CH4)	16,043	892,97	802,82	4,93
Etano (C2H6)	30,069	1564,24	1429,12	3,02
Etilene (C2H4)	28,054	1413,51	1323,36	0,18
Propano (C3H8)	44,097	2224,01	2043,01	5,64
Propilene (C3H6)	42,081	2061,57	1926,35	0,92
Butani (C4H10)	58,123	2883,82	2658,45	5,70
Buteni (C4H8)	56,108	2721,55	2541,25	1,49
Pentani C5H12)	72,150	3542,89	3272,45	3,86
Esani (C6H14)	86,177	4203,23	3887,71	1,26
Acido Solfidrico (H2S)	34,082			2,50
Azoto (N)	14,007			0,001

La composizione del fuel gas è aggiornata dal personale del laboratorio della raffineria mediante le pagine del sito WEB del sistema SME.

4.2 Stima degli Ossidi di Zolfo

La procedura di stima degli ossidi di zolfo per le torce utilizza i stessi fattori di emissione utilizzati per le emissioni convogliate.

4.3 Stima dell'Ossido di Carbonio

Il flusso in kg/h di CO emesso dalle torce è determinato dalla seguente relazione:

$$Q_{CO} = \frac{1}{10^3} \cdot 0{,}177 \cdot Q_T \cdot PCI_T$$

dove Q_T è la portata in kg/h e PCI_T è il potere calorico in MJ/kg del gas inviato in torcia.

4.4 Stima delle Polveri

La stima delle Polveri utilizza il metodo EPA AP 42 con gli stessi criteri dei punti di emissione convogliati.

4.5 Stima degli Ossidi di Azoto

Il flusso in kg/h di NOx emesso dalle torce è determinato dalla seguente relazione:

$$Q_{NOx} = \frac{1}{10^5} \cdot 3{,}22 \cdot Q_T \cdot PCI_T$$

dove Q_T è la portata in kg/h e PCI_T è il potere calorico in MJ/kg del gas inviato in torcia.

TAMOIL
Raffineria di Cremona

Sistema Monitoraggio Emissioni

Procedure di Elaborazione dei Dati

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			P. Cazzaniga	M. Mazzurco	A. Svideny
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Contenuto

1 Introduzione

Procedure di elaborazioni dati emissioni per impianti soggetti a limiti su base oraria e Grandi Impianti di Combustione.

2 Elaborazione delle Misure

Una serie di normative di Legge regolano le modalità di elaborazione e presentazione dei dati acquisiti dal sistema di analisi. Nei paragrafi seguenti sono riportate le regole di elaborazione adottate dal sistema monitoraggio emissioni senza entrare nel merito delle modalità di prelievo del campione, trattamento e misura per le quali di rimanda alla documentazione della specifica soluzione impiantistica adottata.

2.1 Riferimenti Normativi

Le elaborazioni delle misure effettuate dal sistema monitoraggio emissioni sono conformi ai dettati dei seguenti provvedimenti legislativi:

- Decreto 24 Maggio 1988, n. 203, "Norme in materia di qualità dell'aria…"
- Decreto 8 Maggio 1989, "Limitazione delle emissioni nell'atmosfera…"
- Decreto 12 Luglio 1990, "Linee guida per il contenimento delle emissioni…"
- Decreto 21 Dicembre 1995, "Disciplina dei metodi di controllo delle emissioni in atmosfera degli impianti industriali";
- Decreto Regione Lombardia 29 Agosto 1997, n. 3536, "Criteri e procedure per la gestione del Sistema Monitoraggio delle Emissioni di impianti termoelettrici."
- Decreto Legislativo 3 Aprile 2006 n. 152, "Norme in materia ambientale"

Tali provvedimenti definiscono le procedure di normalizzazione, di calcolo delle medie delle misure nonché i limiti a cui il gestore dell'impianto deve aderire.
Alle norme di carattere nazionali sono solitamente associate norme a validità locale, emanate da enti di controllo competenti quali le Amministrazioni Provinciali o Regionali.
A tal proposito, come descritto nel paragrafo 2.4, il sistema monitoraggio emissioni utilizza le normative emesse dalla Regione Lombardia, per le elaborazioni sub-orarie e per il calcolo del 'Minimo Tecnico'.

2.2 Normalizzazione

Con il termine NORMALIZZARE si intendono una serie di operazioni o calcoli matematici atti a riportare a 'CONDIZIONI NORMALI' le caratteristiche chimico - fisiche di un generico gas. Un gas si dice a 'Condizioni Normali' quando è stivato alla temperatura di 0 °C (273,15 °K) e alla pressione di 1 atmosfera (1013 mbar o hPa).

In aggiunta alla normalizzazione a 0°C e 1 Atm, le normative impongono la normalizzazione delle misure 'a gas secco' e con un valore di 'ossigeno di riferimento'. Ciò deriva dalla necessità di omogeneizzare le misure delle concentrazioni delle emissioni tra i diversi impianti o processi tecnologici.

La formula per la normalizzazione della concentrazione di un generico componente è data da:

$$M_N = M_{TQ} * C_T * C_P * C_U * C_O$$

Dove M_N è la misura Normalizzata

M_{TQ} è la misura Tal Quale acquisita dalla strumentazione

C_T è il coefficiente di correzione in Temperatura, dato da:

$$C_T = \frac{T + 273,15}{273,15}$$ dove T è la Temperatura misurata in °C del Gas

C_P è il coefficiente di correzione in Pressione, dato da:

$$C_P = \frac{1013}{P}$$ dove P è la Pressione misurata in hPa del Gas

C_U è il coefficiente di correzione a Gas Secchi, dato da:

$$C_U = \frac{100}{100 - U}$$ dove U è la misura %V dell'umidità del Gas

C_O è il coefficiente di correzione in Ossigeno, dato da:

$$C_U = \frac{21 - O_{RIF}}{21 - O_{MIS}}$$ Dove O_{MIS} è la misura in %V dell'ossigeno nel GAS e O_{RIF} è il valore in %V dell'ossigeno di riferimento determinato per lo specifico impianto.

Le formule riportate qui sopra si prestano ad alcuni commenti:

- I coefficienti di correzione si basano su alcuni parametri del gas come rilevati in camera di misura. Come si vedrà nel paragrafo seguente, solo per i metodi di analisi 'in sito' vanno considerati i valori misurati sui fumi nel punto di emissione.
- Il coefficiente di correzione in pressione risulta solitamente trascurabile e molto prossimo a 1. In molti casi la misura della pressione non viene neppure implementata.
- Il coefficiente di correzione in Ossigeno può raggiungere valori molto elevati con l'approssimarsi del valore dell'ossigeno misurato al 21%. Ciò solitamente si verifica durante le fasi di fermata o avvio dell'impianto. In condizioni di normale esercizio, il tenore di ossigeno dovrebbe essere prossimo al valore di riferimento, fissato dagli Enti di Controllo, e solitamente pari a:
    - 10% o 11% per gli impianti di incenerimento rifiuti;
    - 3% per gli impianti alimentati ad olio combustibile o gas naturale;
    - 6% per gli impianti alimentati a carbone o biomasse;
    - 15% per gli impianti turbo gas;

- Nel capitolo dedicato alle validazioni delle medie orarie, sono illustrati alcuni accorgimenti, previsti dalle normative, per limitare l'effetto del termine di correzione in ossigeno in condizioni di esercizio non ideali.

2.3 Normalizzazioni per le diverse Strumentazioni di Misura

I paragrafi seguenti illustrano le modalità di applicazione delle formule di normalizzazione in funzione delle diverse realizzazioni strumentali solitamente adottate.

2.3.1 Strumentazione della famiglia Advance Optima

A questa famiglia appartiene la strumentazione tipo URAS, MAGNOS, ecc. . La realizzazione impiantistica solitamente prevede l'utilizzo di un frigo che raffredda il gas analizzato prima dell'immissione in camera di misura e garantisce una temperatura prossima ai 0°C (inferiore a 4 °C per i dispositivi tipo CGE6 o SCC). In queste condizioni i fattori di normalizzazione risultano:

- C_T : risulta uguale a 1 perché la camera di misura è alla temperatura di 0°C circa;
- C_P : viene assunto uguale a 1;
- C_U : viene assunto uguale a 1 perché l'umidità dei fumi viene abbattuta dal raffreddamento del gas effettuata prima della misura;
- C_O : è dato dalla formula illustrata al paragrafo 2.2.

2.3.2 Misura delle Polveri per estinzione

L'analisi delle polveri utilizzando la misura dell'opacità dei fumi avviene 'in sito' cioè direttamente nel punto di emissione. In questo caso tutti i parametri fisici sono rilevanti per il calcolo della misura normalizzata:

- C_T : è dato dalla formula illustrata al paragrafo 2.2 considerando la temperatura dei fumi, quando rilevata, o un valore stimato negli altri casi.
- C_P : è dato dalla formula illustrata al paragrafo 2.2 considerando la pressione dei fumi, quando rilevata o viene assunto uguale a 1 negli altri casi;
- C_U : è dato dalla formula illustrata al paragrafo 2.2.
- C_O : è dato dalla formula illustrata al paragrafo 2.2.

2.4 Calcolo delle Medie

L'appendice VI alla Parte V del Decreto Legislativo 152/2006 definisce in modo puntuale le regole di calcolo delle medie delle misure nei sistemi di monitoraggio emissioni. In sintesi i criteri fondamentali sono:

- Ad ogni media prodotta deve essere associato un indice di qualità o disponibilità che indichi la 'bontà' della misura stessa e le 'performance' del sistema di misura;
- La base di calcolo delle medie di durata superiore all'ora è la media oraria normalizzata;
- Ad ogni media oraria deve essere associato un parametro che indica lo stato dell'impianto, ovvero se questo è in una condizione di esercizio superiore o inferiore al "minimo tecnico".

Inoltre va ricordato che i dispositivi di Legge si riferiscono sempre all'ora solare come periodo di osservazione.

2.4.1 Media Oraria

Il D.Lgs. 152 prevede specifiche regolamentazioni in relazione al calcolo della media oraria delle emissioni e una serie di procedure per la validazione della media stessa.
In aggiunta alle disposizioni del D.Lgs. 152, vengono adottate anche le procedure elaborate dalla Regione Lombardia, e in particolare:

- Ogni misura prodotta dalla strumentazione viene campionata dal sistema di elaborazione ogni 10 secondi (misura istantanea e misura elementare);
- Ogni minuto viene calcolata la media minuto tal quale come media aritmetica delle misure elementari valide rilevate nel minuto precedente.
- La media minuto tal quale viene dichiarata valida se almeno una delle misure elementari acquisita durante il minuto è valida;
- Tra le cause che possono produrre l'invalidità della misura elementare (oltre alle cause impiantistiche, di natura elettrica, calibrazioni e tarature) viene applicata la regola dello scarto massimo tra una misura elementare e la seguente, come previsto dal D.Lgs. 152. Il valore dello scarto massimo è uno dei parametri che è possibile impostare dal sistema monitoraggio emissioni.
- Dalle medie minuto tal quali vengono elaborate le medie minuto normalizzate mediante le formule di normalizzazione del paragrafo 2.2 e utilizzando le medie minuto delle misure di riferimento come base di calcolo.
- Al termine dell'ora sono calcolate le medie orarie tal quali come media aritmetica delle misure elementari valide. Alla media oraria tal quale è associato un indice di disponibilità pari alla percentuale di valori elementari validi. La media viene dichiarata valida se l'indice di disponibilità è superiore al 70%. In caso contrario un messaggio di diagnostica viene registrato nel database storico degli eventi del sistema.
- In base al D.Lgs.152 viene calcolato il massimo scarto tra le misure elementari valide acquisite durante l'ora. Il valore del massimo scarto deve essere compreso tra due parametri prefissati e determinati in base alle caratteristiche dell'impianto e della misura stessa. Se lo scarto massimo delle misure elementari non è compreso tra i parametri prefissati, la media oraria viene dichiarata non valida e un messaggio di diagnostica viene registrato nel database storico degli eventi del sistema monitoraggio emissioni.
- La media oraria tal quale ottenuta dai dati elementari validi acquisiti, deve risultare, secondo il D.Lgs. 152, compresa tra due parametri prefissati per risultare valida e utilizzabile per le elaborazioni successive. Nel caso che non lo sia, il sistema elaborazione emissioni la dichiara non valida registrando un opportuno messaggio di diagnostica nel database storico degli eventi del sistema.
- Il calcolo della media oraria normalizzata viene eseguito secondo le formule del punto 2.2 utilizzando come base la media oraria tal quale delle misure degli inquinanti e delle misure di riferimento. Nel caso una misura di riferimento (ad esempio l'Ossigeno) risulti non valida, la media normalizzata dell'inquinante viene dichiarata non valida e posta uguale a zero.

.

.Al termine delle elaborazioni qui sopra descritte viene prodotta una media oraria normalizzata associata ad un attributo di validità e ad un indice di disponibilità. Tale media può essere già utilizzata per valutare il rispetto dei limiti di emissioni imposti dalle Autorità di Controllo.
Il calcolo delle medie successive deve essere eseguito associando la misura della media oraria allo stato dell'impianto o 'normal funzionamento'.

2.4.2 Minimo Tecnico e Normal Funzionamento

Con "Minimo Tecnico" si intende il carico minimo di processo compatibile con l'esercizio dell'impianto in condizione di regime. Il valore del minimo tecnico deve essere indicato dal gestore dell'impianto e può essere impostato tra i parametri di elaborazione del sistema monitoraggio emissioni. Quando l'impianto è in condizioni di esercizio superiori al minimo tecnico si dice in 'Normal Funzionamento'.

Il sistema di monitoraggio emissioni prevede due metodologie per la determinazione dello stato di normal funzionamento:

- Quando la misura di un parametro impiantistico rilevato (ad esempio la potenza generata) è superiore alla soglia di minimo (tecnico);
- Attraverso un segnale digitale acquisito dal sistema che indica la condizione di impianto a regime.

In entrambi i casi la determinazione dello stato di normal funzionamento viene eseguita su base oraria secondo le procedure della Regione Lombardia. L'impianto viene dichiarato in 'normal funzionamento' se almeno per il 70% delle misure dell'ora risulta in condizioni di esercizio superiori al minimo tecnico.

2.4.3 Medie Giornaliere, 48 Ore Normal Funzionamento e Mensili

Per il calcolo delle medie di periodi di osservazione di durata superiore all'ora vengono utilizzate le medie orarie normalizzare correlate con lo stato di normal funzionamento. Le linee guida delle procedure di calcolo sono dettate dal D.Lgs. 152 come segue:

- La media Giornaliera deve essere riferita al giorno del calendario non deve essere calcolata se il numero di ore di normal funzionamento è inferiore a 6;
- La media Giornaliera è calcolata come la media aritmetica delle medie orarie valide rilevate in condizioni di normal funzionamento elaborate durante il giorno.
- La media Giornaliera è valida se non più di 3 medie orarie sono state dichiarate non valide per anomalie o manutenzioni strumentali. L'indice di disponibilità della media giornaliera è dato dal rapporto tra il numero di medie orarie valide in condizioni di normal funzionamento e il numero di ore di normal funzionamento rilevate durante il giorno.
- La media Mensile viene riferita al mese del calendario in presenza di almeno 144 ore di normal funzionamento. La media mensile è valida se l'indice di disponibilità è superiore al 80%.
- La media delle 48 ore di normal funzionamento viene calcolata considerando un periodo di osservazione comprendente 48 ore di normal funzionamento. Tale media è caratterizzata dall'ora di inizio e termine del periodo di osservazione ed è valida se l'indice di disponibilità risulta superiore al 70%.

2.5 Casi Particolari

In base ai provvedimenti normativi già citati, alcune delle misure rilevate dal Sistema Monitoraggio Emissioni sono calcolate e rappresentate in modo particolare.

2.5.1 Ossidi di Azoto

Gli ossidi di Azoto (NOx) vengono espressi sempre come concentrazione di Biossido di Azoto. Si possono presentare le seguenti situazioni:

- Se è realizzata solamente la misura del NO, questa deve essere espressa come concentrazione normalizzata di NO2, incrementata del 5% per tenere conto della concentrazione residua di NO2. Viene quindi applicata la seguente formula:

$$C_{NOx} = \frac{C_{NO} * 1,53}{0,95}$$

  Dove 1,53 è il rapporto tra i pesi molecolari di NO e NO2

- Se le misure di NO e NO2 sono entrambe realizzate, la concentrazione complessiva degli ossidi di azoto è data da:

$$C_{NOx} = C_{NO2} + C_{NO} * 1.53$$

2.5.2 Misura delle Polveri per Estinzione
Il calcolo della concentrazione delle polveri mediante la misura dell'opacità dei fumi utilizza la seguente formula (retta di regressione lineare):

$$C_{PLV} = K_0 + K_G * V_{EST}$$

Dove K_0 è il coefficiente 'intercetta' della retta
K_G è il coefficiente 'pendenza' della retta
V_{EST} è il valore dell'estinzione misurata dallo strumento.

Il sistema monitoraggio emissioni richiede l'impostazione dei coefficienti di regressione lineare ottenuti per via sperimentale mediante la campagna gravimetrica.

2.5.3 Misura della Portata Fumi da segnale differenziale di Pressione
La misura della portata fumi può essere realizzata con strumentazione che trasmette un segnale differenziale di pressione Δp (ad esempio, DFL100 della Durag). La misura della portata a condizioni normali si ottiene dalla formula:

$$Q_{CN} = K * \Delta p * \sqrt{\frac{P}{T + 273{,}15}}$$

Dove P è la pressione fumi misurata (mBar o hPa), T la temperatura fumi (°C) e K è un coefficiente caratteristico della strumentazione di misura che tiene conto delle caratteristiche costruttive dello strumento, del diametro della sezione di misura e della densità dei fumi sottoposti a misura.
La portata fumi viene portata al secco utilizzando la misura dell'umidità fumi U acquisita dalla strumentazione mediante il coefficente inverso di quello utilizzato per la correzione in umidità.

$$Q_S = Q_{CN}\left(\frac{100 - U}{100}\right)$$

2.6 Intervalli di Confidenza
Le disposizioni del D.Lgs.152 prevedono la sottrazione degli intervalli di confidenza ai dati medi orari.
Il sistema SME prevede l'utilizzo dei valori degli intervalli di confidenza calcolati secondo le norme ISO EN 14956 (QAL1) e EN 14181 (QAL2).
In particolare la procedura adottata è la seguente:
- I valori medi orari TAL QUALI validati secondo le procedure descritte al paragrafo 2.5 vengono corretti in base alle rette di taratura elaborate secondo la procedura QAL2 della EN 14181;
- Calcolo dei dati medi normalizzati al secco e riportati all'ossigeno di riferimento utilizzando i valori medi tal quali corretti;
- Validazione del dato medio normalizzato rispetto ai range di validità calcolati secondo la procedura QAL2;
- Sottrazione dell'intervallo di confidenza alla media oraria normalizzata.

I parametri delle rette di taratura, dei range di validità e degli intervalli di confidenza sono impostati in pagine video predisposte sul sistema monitoraggio emissioni.

Inoltre il sistema prevede la possibilità di predefinire una modalità di calcolo tra le seguenti:

- **Inibizione dell'utilizzo degli intervalli di confidenza.** Di conseguenza i coefficienti della retta di taratura sono impostati in modo da non alterare il dato medio tal quale, la veridica dei range di validità è disabilitata e gli intervalli di confidenza non vengono sottratti;
- **Intervalli di confidenza QAL1 calcolati secondo EN 14956.** I coefficienti della retta di taratura sono impostati in modo da non alterare il dato medio tal quale, la veridica dei range di validità è disabilitata e gli intervalli di confidenza calcolati secondo la EN 14956 sono sottratti al dato medio normalizzato;
- **Intervalli di confidenza QAL2 calcolati secondo EN 14181.** Viene applicata per intero la procedura precedentemente descritta.

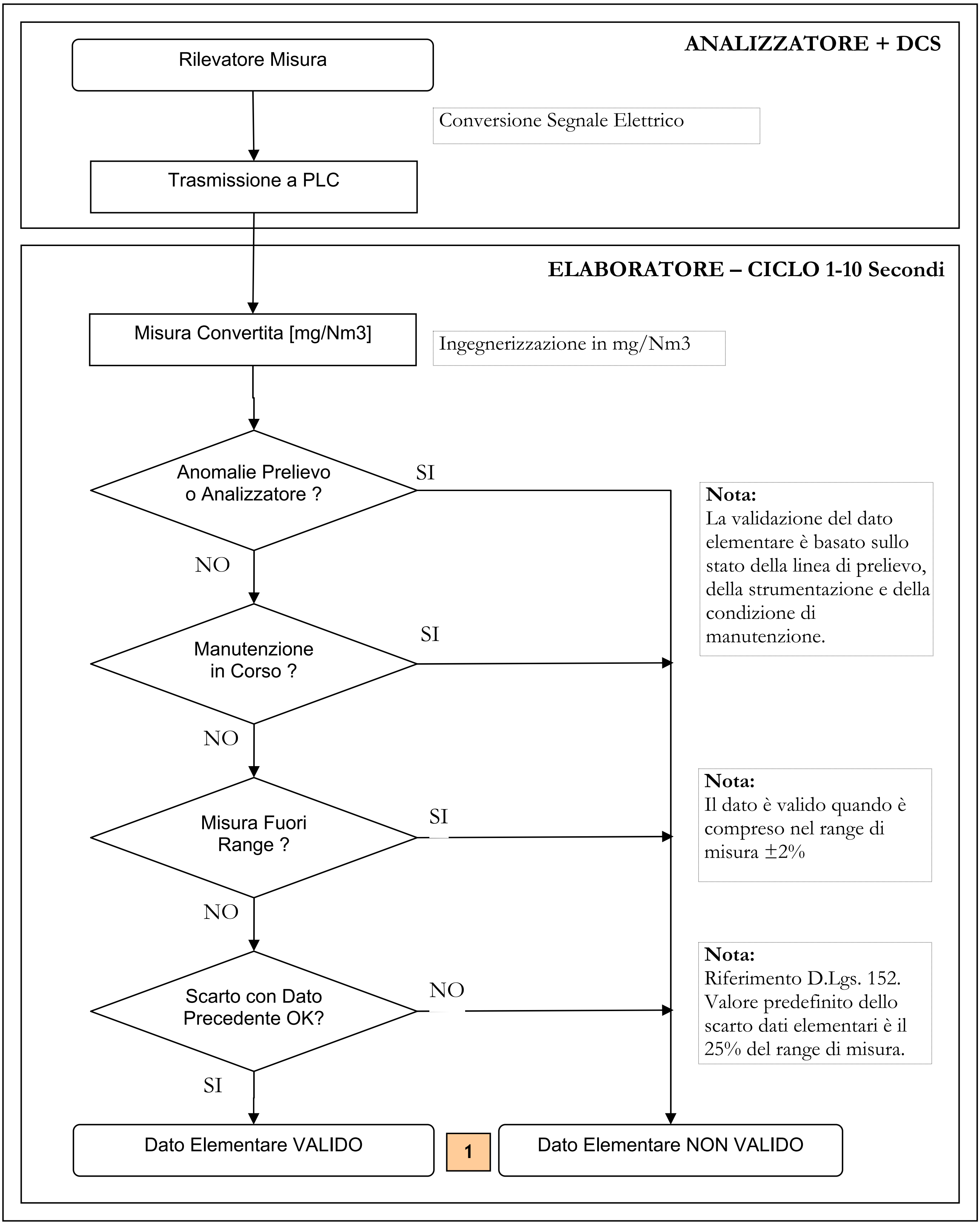
Va notato che il sistema SME prevede anche la verifica delle parametrizzazioni QAL2 secondo le procedure QAL3 riportate nella norma EN 14181.

2.7 Flussi di Massa

Il calcolo dei flussi di massa utilizza le medie orarie riportate a condizioni normali sia per i parametri analitici che per la misura della portata fumi. Il valore della portata massica oraria, ottenuta dal prodotto della media del parametro per la media della portata fumi, viene riportato in Kg/h per tutte le misure ad esclusione della CO2 che viene espressa in t/h.
L'elaborazione delle medie giornaliere, mensili e annuali segue gli stessi criteri previsti dal D.Lgs. 152 e descritti nei paragrafi precedenti.
I valori dei flussi di massa sono calcolati senza l'eventuale applicazione degli intervalli di confidenza.

3 Schemi di Flusso delle Elaborazioni

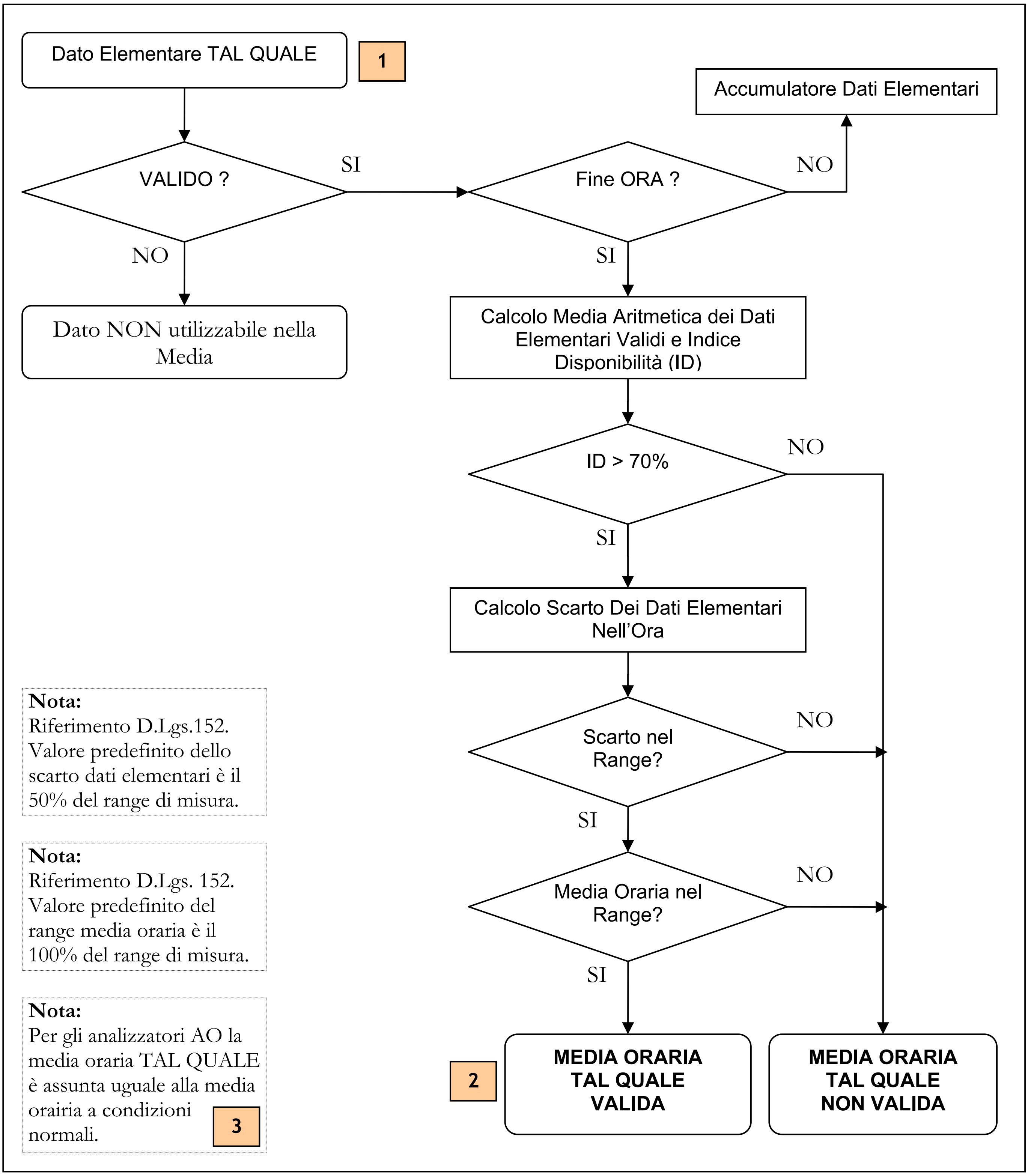
3.1 Elaborazioni DATO ELEMENTARE TAL QUALE



L'elaborazione rappresentata nel precedente flow chart si applica a tutte i parametri analitici rilevati dalla strumentazione compresi il trasmettitore di portata, temperatura, pressione e l'opacimetro.

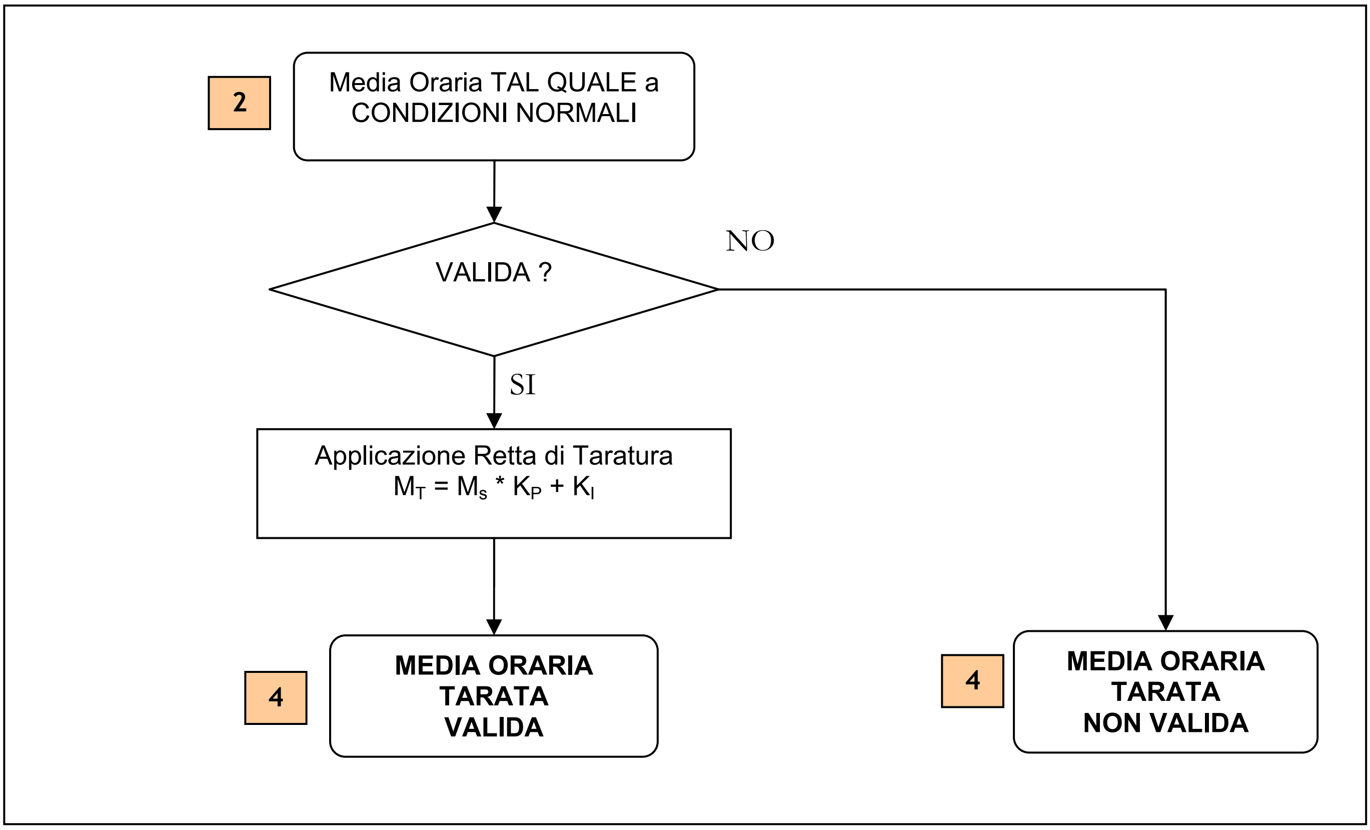
3.2 Elaborazione Media Oraria TAL QUALE

Elaborazione effettuata con cadenza oraria.



3.3 Applicazione retta di Taratura QAL2

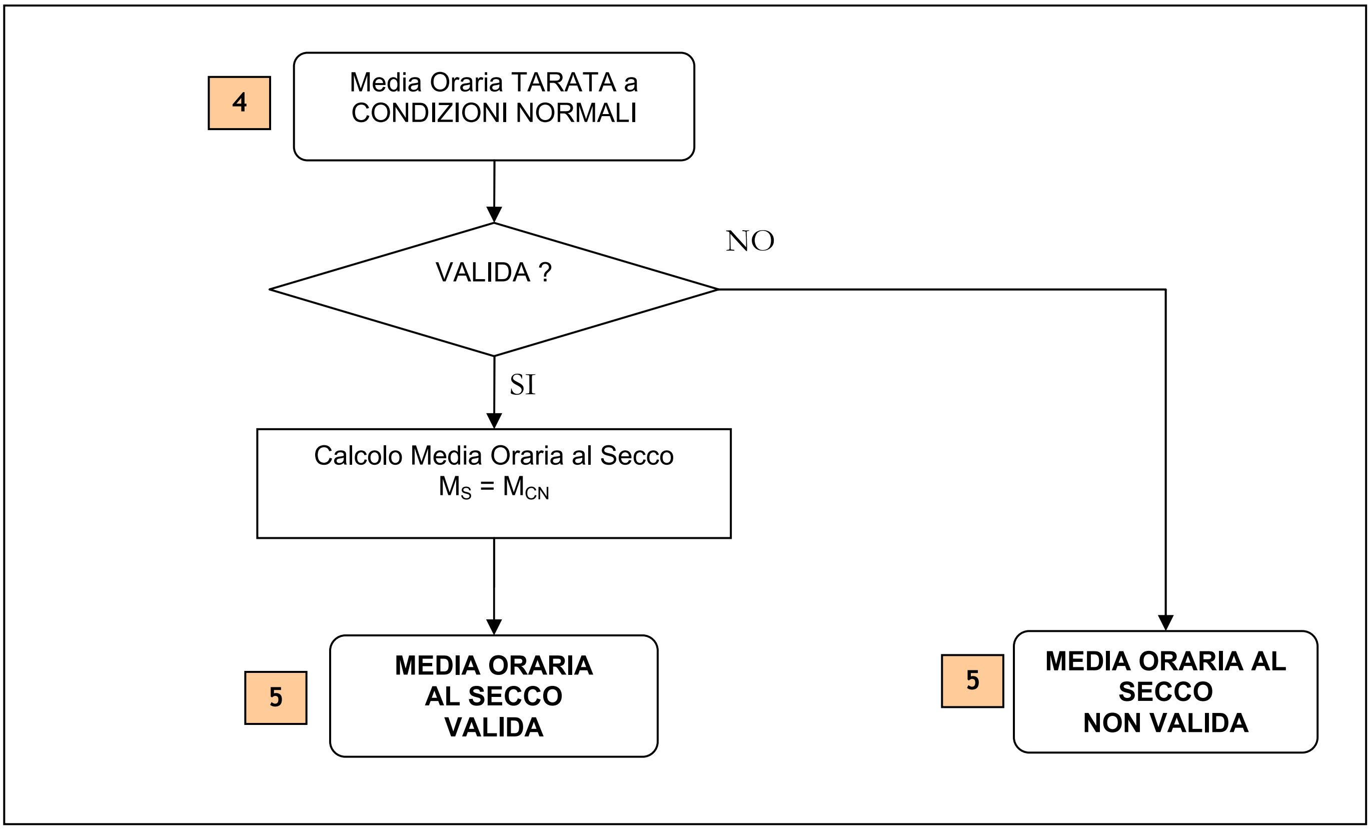
Elaborazione effettuata con cadenza oraria.



La retta di taratura viene applicata se è attivata la modalità di funzionamento QAL2.

3.4 Calcolo Media Oraria al Secco

Elaborazione effettuata con cadenza oraria.



La media oraria al secco è uguale alla media a condizioni normali.

3.5 Elaborazione STATO IMPIANTO

Il calcolo dello stato impianto è riportato nei manuali relativi alle procedure di calcolo dei codici di stato monitor di ogni punnto di emissione.
L'elaborazione prevede che alla scadenza di ogni ciclo di 10 secondi vengano aggiornati i contatori di funzionamento impianto per gli stati di funzionamento riportati nella tabella seguente:

Contatore	Stato Impianto	Codice Stato
A	CAMINO FERMO	34
B	FASE DI ACCENSIONE FASE DI SPEGNIMENTO	31
D	SERVIZION REGOLARE	30

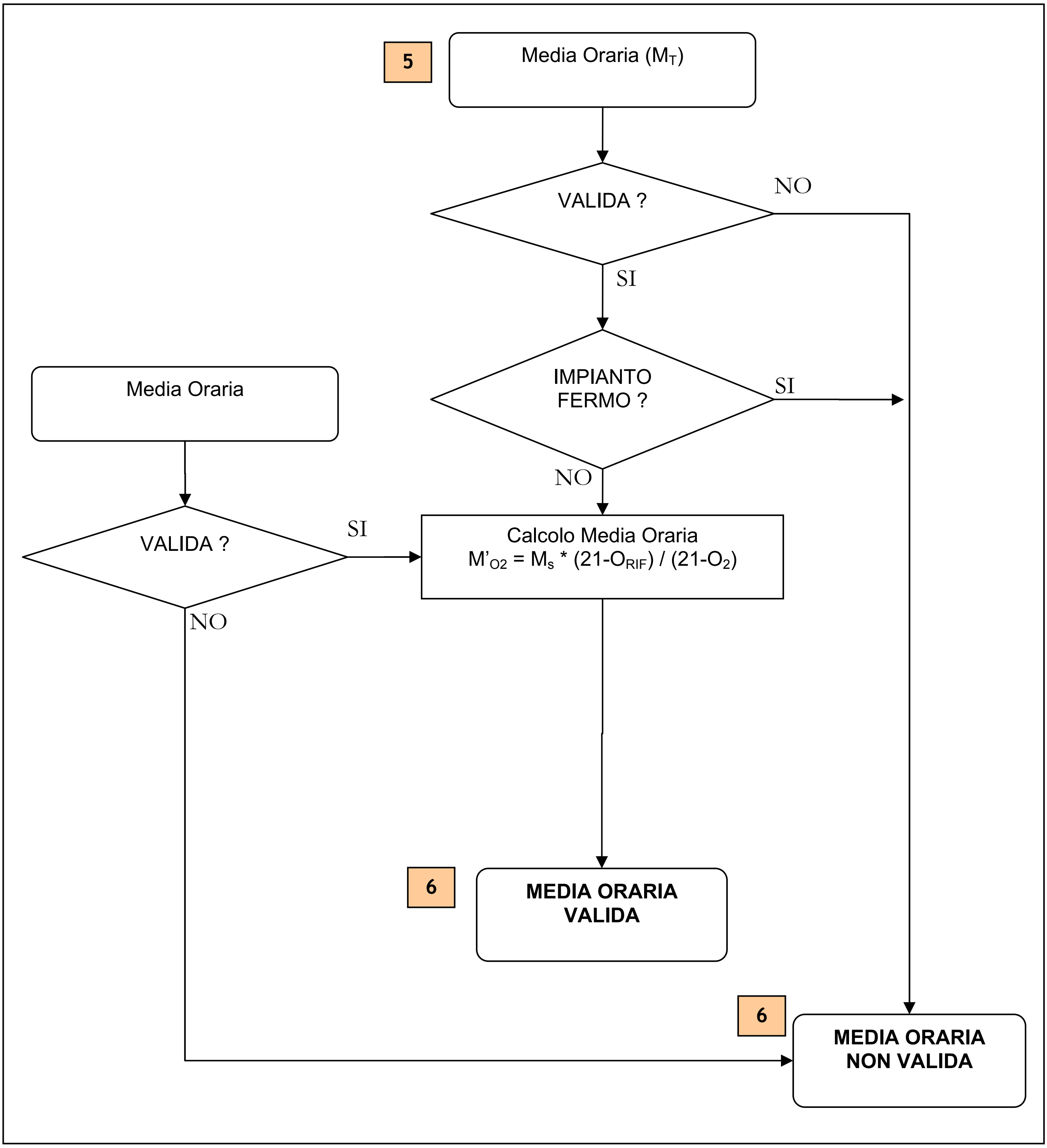
La determinazione dello stato impianto da associare al dato medio orario avviene alla fine dell'ora in base ai valori dei contatori sopra citati.

3.5.1 Elaborazione STATO IMPIANTO Orario

Allo scadere di ogni ora vengono valutati i contatori degli stati di funzionamento impianto. Lo stato di funzionamento dell'impianto nell'ora è determinato dal contatore che ha il valore maggiore. A parità di conteggio si assume l'ultimo stato rielevato nell'ora. Qualora il contatore prevalente ha raggiunto il 70% del valore teorico massimo, il dato medio è assunto valido. Se il contatore prevalente risulta inferiore al 70% del valore teorico massimo, il dato medio non è assunto valido ed anche le medie orarie dei parametri analitici non sono considerate valide.

3.6 Elaborazione Media Oraria sulla base dei dati normalizzati

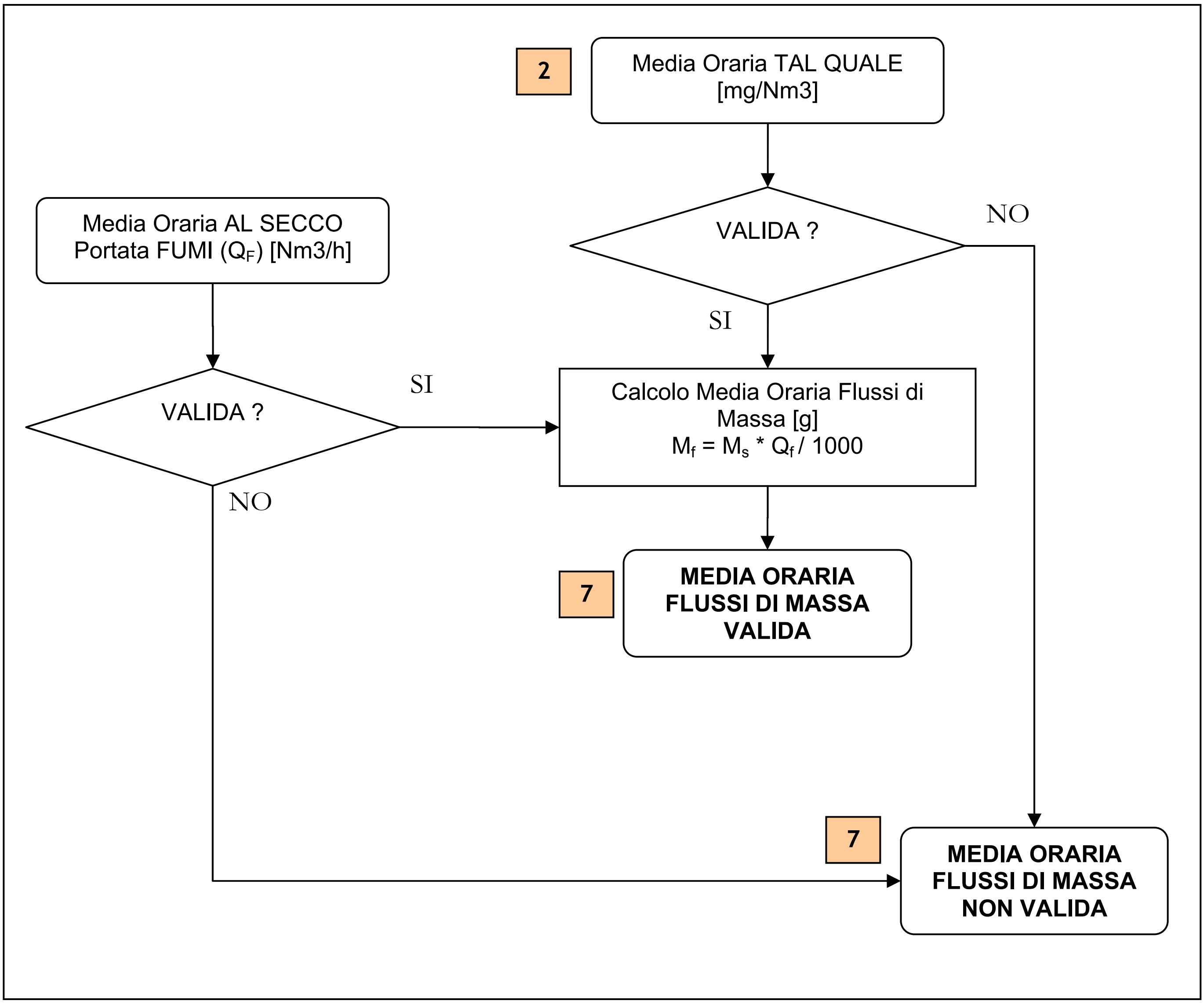
Elaborazione effettuata con cadenza oraria.



La sottrazione dell'intervallo di confidenza viene effettuato se sono attive le opzioni QAL1 o QAL2.

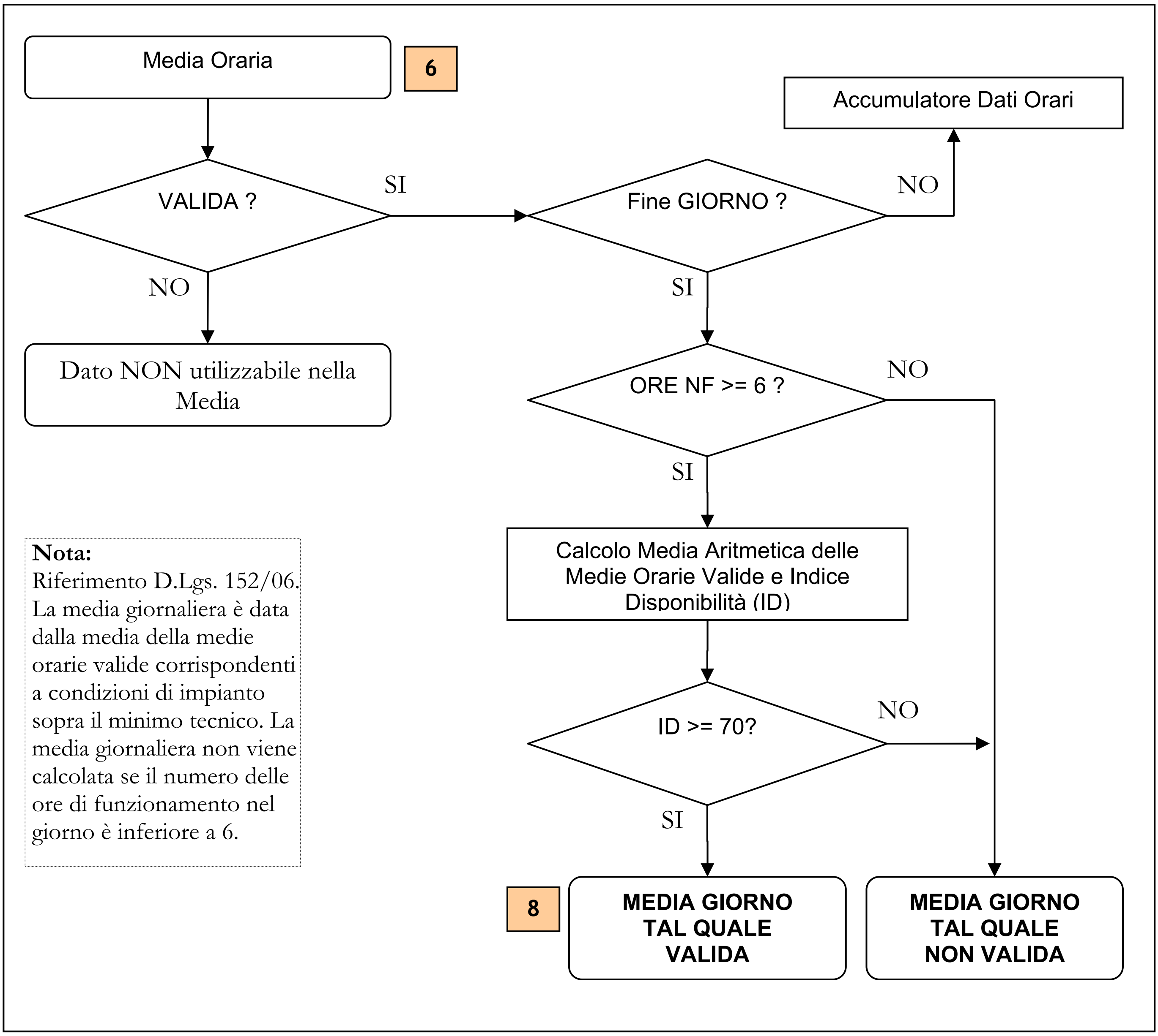
3.7 Elaborazione Media Oraria FLUSSI DI MASSA

Elaborazione effettuata con cadenza oraria.



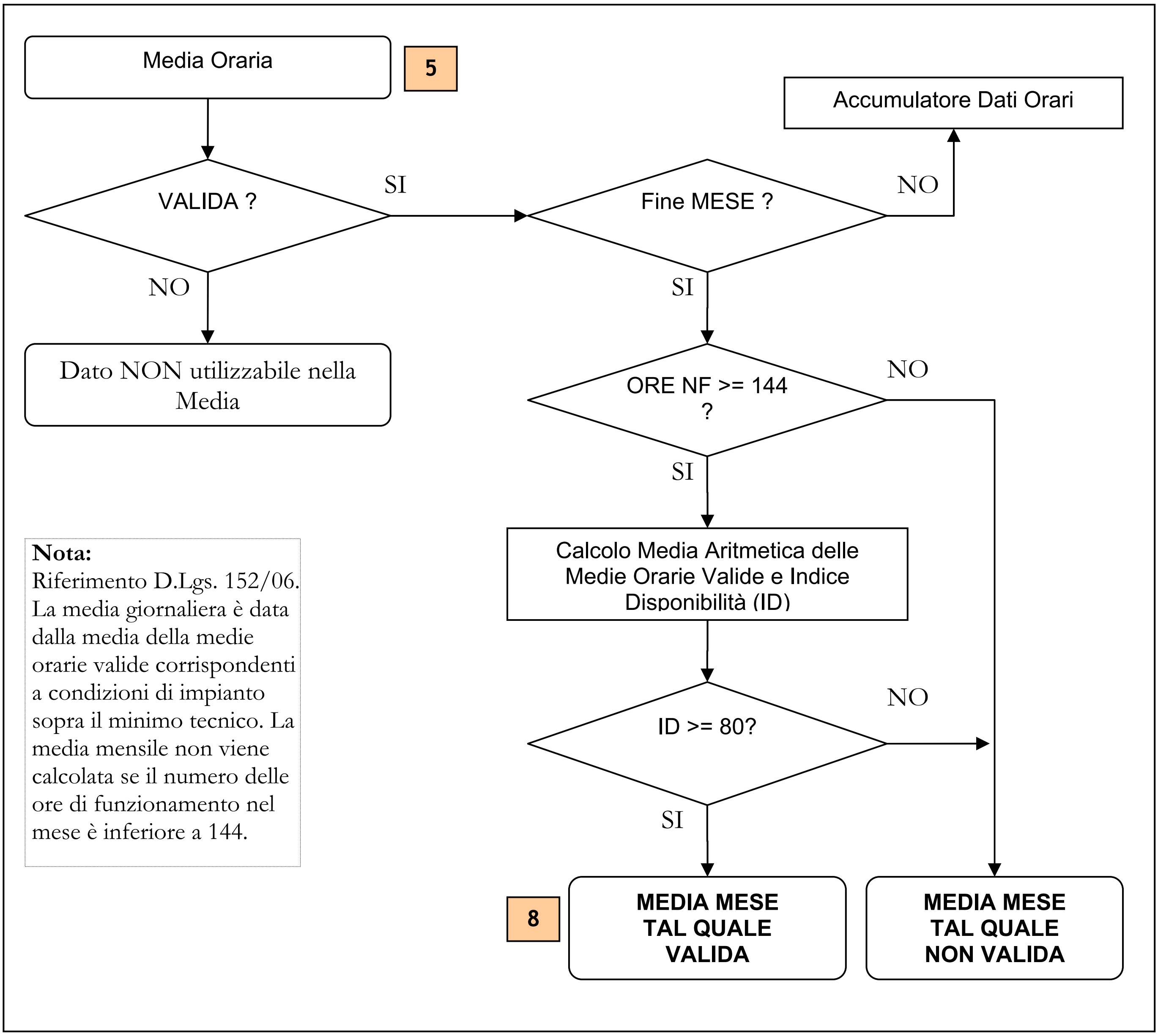
3.8 Elaborazione Media GIORNALIERA sulla base dei dati normalizzati

Elaborazione effettuata con cadenza oraria.



3.9 Elaborazione Media MENSILE sulla base dei dati normalizzati

Elaborazione effettuata con cadenza oraria.



TAMOIL
Raffineria di Cremona

Sistema Monitoraggio Emissioni

Punto di Emissione E10

00	22.01.2010	Versione iniziale			
			P. Cazzaniga	M. Mazzurco	A. Svideny
Rev	**Data**	**Descrizione**	**Preparato**	**Verificato**	**Approvato**

DOCUMENTO M T 0 1 T 0 0 1 0 R 0 0

Contenuto

1 Introduzione

Il presente documento descrive le caratteristiche tecniche-funzionali e le metodologie di elaborazione dei codici monitor e di stato monitor utilizzati dal sistema di monitoraggio emissioni del CAMINO E10, situato nella raffineria TAMOIL di Cremona.
Il documento è redatto in conformità alle prescrizioni della normativa della Regione Lombardia, DDG 3536, del 29 Agosto 1997.

Il camino E10 convoglia in atmosfera i fumi prodotti dagli impianti

- CTE

della Raffineria.

Non sono presenti sistemi di abbattimento o di riduzione dei parametri emissivi.

Il punto di emissione è dotato di un sistema di monitoraggio emissioni in continuo di fornitura ABB e realizzato nel 2009.

2 Misure Analisi

monitoraggio emissioni. I codici monitor previsti sono riportati nella tabella seguente

Misura	Cod. Monitor Tal Quale	Cod. Monitor Condizioni Normali	Cod. Monitor Riferimento Ossigeno
SO2	601	681	691
NOx	602	682	692
CO	603	683	693
Polveri	607	687	697
NO	609	689	699
Polveri Estinzione %	611		
Portata Fumi	623	624	
O2 – Riferimento	630		
O2	631		
H2O	621		
Temp. Fumi	641		
Pressione Fumi	642		

Nei paragrafi seguenti, per ogni parametro, vengono elencati i codici di stato monitor elaborati ai sensi del DDG 3536. Le modalità di elaborazione e calcolo sono risportate nella documentazione

2.1 Biossido di Zolfo – SO2

Analizzatore Advance Optima

		601 Tal Quale	681 Normalizzato	691 Riferito O2
00	Dato valido misurato	✓	✓	✓
10	Monitor non funzionante	✓		
15	Dato non valido	✓	✓	✓
20	Dato valido stimato	✓		
25	Dato non valido per verifica limite			✓
40	Calibrazione	✓		
99	Sistema di acquisizione non attivo	✓		

2.2 Ossidi di Azoto – NOx

Analizzatore Advance Optima

		602 Tal Quale	682 Normalizzato	692 Riferito O2
00	Dato valido misurato	✓	✓	✓
10	Monitor non funzionante	✓		
15	Dato non valido	✓	✓	✓
20	Dato valido stimato	✓		
25	Dato non valido per verifica limite			✓
40	Calibrazione	✓		
99	Sistema di acquisizione non attivo	✓		

2.3 Monossido di Carbonio – CO

Analizzatore Advance Optima

		603 Tal Quale	683 Normalizzato	693 Riferito O2
00	Dato valido misurato	✓	✓	✓
10	Monitor non funzionante	✓		
15	Dato non valido	✓	✓	✓
20	Dato valido stimato	✓		
25	Dato non valido per verifica limite			✓
40	Calibrazione	✓		
99	Sistema di acquisizione non attivo	✓		

2.4 Polveri – PLV

Analizzatore DURAG

		607 Tal Quale	687 Normalizzato	697 Riferito O2
00	Dato valido misurato	✓	✓	✓
10	Monitor non funzionante	✓		
15	Dato non valido	✓	✓	✓
20	Dato valido stimato	✓		
25	Dato non valido per verifica limite			✓
40	Calibrazione	✓		
99	Sistema di acquisizione non attivo	✓		

2.5 Monossido di Azoto – NO

Analizzatore Advance Optima

		609 Tal Quale	689 Normalizzato	699 Riferito O2
00	Dato valido misurato	✓	✓	✓
10	Monitor non funzionante	✓		
15	Dato non valido	✓	✓	✓
20	Dato valido stimato	✓		
25	Dato non valido per verifica limite			✓
40	Calibrazione	✓		
99	Sistema di acquisizione non attivo	✓		

2.6 Opacità – PLV

Analizzatore DURAG

		611 Tal Quale
00	Dato valido misurato	✓
10	Monitor non funzionante	✓
15	Dato non valido	✓
20	Dato valido stimato	✓
25	Dato non valido per verifica limite	
40	Calibrazione	✓
99	Sistema di acquisizione non attivo	✓

2.7 Portata Fumi – QF

Misura Stimata da elaborazioni stechiometriche

		623 Tal Quale	624 Normalizzata
00	Dato valido misurato		
10	Monitor non funzionante		
15	Dato non valido		
20	Dato valido stimato	✓	✓
25	Dato non valido per verifica limite		
40	Calibrazione		
99	Sistema di acquisizione non attivo	✓	✓

2.8 Ossigeno – O2

Analizzatore Advance Optima

		630 Riferimento	631 Misurato
00	Dato valido misurato	✓	✓
10	Monitor non funzionante		✓
15	Dato non valido		✓
20	Dato valido stimato		✓
25	Dato non valido per verifica limite		
40	Calibrazione		✓
99	Sistema di acquisizione non attivo	✓	✓

Il tenore dell'ossigeno di riferimento è assunto pari al 3% in base alle prescrizioni e alle caratteristiche degli impianti del punto di emissione S01.

2.1 Umidità Fumi – H2O

Misura calcolata con metodo ossimetrico

		621 Misurato
00	Dato valido misurato	
10	Monitor non funzionante	
15	Dato non valido	
20	Dato valido stimato	✓
25	Dato non valido per verifica limite	
40	Calibrazione	
99	Sistema di acquisizione non attivo	✓

2.2 Temperatura Fumi – TF

Trasmettitore di Temperatura

		641 Tal Quale
00	Dato valido misurato	✓
10	Monitor non funzionante	✓
15	Dato non valido	✓
20	Dato valido stimato	✓
25	Dato non valido per verifica limite	
40	Calibrazione	
99	Sistema di acquisizione non attivo	✓

2.3 Pressione Fumi – PF

Trasmettitore di Pressione

		642 Tal Quale
00	Dato valido misurato	✓
10	Monitor non funzionante	✓
15	Dato non valido	✓
20	Dato valido stimato	✓
25	Dato non valido per verifica limite	
40	Calibrazione	
99	Sistema di acquisizione non attivo	✓

3 Misure Impianto

In questo capitolo vengono presentate le modalità di calcolo per i codici monitor delle misure impianto acquisite per il punto di emissione E10.

Le misure elaborate ai sensi del DDG 3536 sono elencate nella tabella seguente.

Misura	Cod. Monitor Tal Quale
Portata Combustibile Liquido	651
Portata Combustibile Gassoso	652
Portata Vapore Generato	675
Potenza Termica Generata	660

Per ogni impianto attinente al punto di emissione verrà introdotta una breve descrizione del processo, dei combustibili impiegati e delle condizioni di funzionamento.

3.1 Caratteristiche degli impianti del punto di emissione

La seguente tabella riepiloga gli impianti che immettono fumi nel camino E10.

Impianto	Sigla	Codice Imp.
Centrale Termica	CTE	00

Ai fini delle elaborazioni delle misure impianto, risulta necessaria l’acquisizione dei dati di processo relativi alle portate dei combustibili impiegati, come descritto nei paragrafi seguenti.

3.1.1 Centrale Termica

Le emissioni della Centrale Termica sono prodotte da 3 generatori di vapore, denominati SG1, SG2, e SG3 ed alimentati a fuel gas e fuel oil con tiraggio forzato.

I segnali acquisiti sono elencati nelle seguenti tabelle.

- Caldaia SG1 - Portata FUEL GAS

Tag	Indirizzo	U.M.	Range	Note
50_FR_1_104	07300000	Nm3/h	0 – 4250	

- Caldaia SG1 - Portata FUEL OIL

Tag	Indirizzo	U.M.	Range	Note
50_FR_1_103	07300001	Kg/h	0 – 3000	

- Caldaia SG1 - Portata Vapore

Tag	Indirizzo	U.M.	Range	Note
50_FR_1_101	07300002	t/h	0 – 30	

- Caldaia SG2 - Portata FUEL GAS

Tag	Indirizzo	U.M.	Range	Note
50_FR_2_204	07300003	Nm3/h	0 – 4250	

- Caldaia SG2 - Portata FUEL OIL

Tag	Indirizzo	U.M.	Range	Note
50_FR_2_203	07300004	Kg/h	0 – 3000	

- Caldaia SG2 - Portata Vapore

Tag	Indirizzo	U.M.	Range	Note
50_FR_2_201	07300005	t/h	0 – 30	

- Caldaia SG3 - Portata FUEL GAS

Tag	Indirizzo	U.M.	Range	Note
50_FR_3_37	07300006	Nm3/h	0 – 7100	

- Caldaia SG3 - Portata FUEL OIL

Tag	Indirizzo	U.M.	Range	Note
50_FR_3_26	07300007	Kg/h	0 – 5600	

- Caldaia SG3 - Portata Vapore

Tag	Indirizzo	U.M.	Range	Note
50_FR_3_23	07300008	t/h	0 – 72	

3.2 Portata Combustibile Liquido

Misura Elaborata

		651 Tal Quale
00	Dato valido misurato	✓
10	Monitor non funzionante	
15	Dato non valido	✓
20	Dato valido stimato	✓
25	Dato non valido per verifica limite	
40	Calibrazione	
99	Sistema di acquisizione non attivo	✓

Il segnale portata combustibile liquido è dato dalla somma di tutte le portate acquisite nelle caldaie, come riportato nella tabella seguente:

Impianto	Caldiaia	Tag Misura FUEL OIL
CTE	SG1	50_FR_1_103
	SG2	50_FR_2_203
	SG3	50_FR_3_26

3.3 Portata Combustibile Gassoso

Misura Elaborata

		652 Tal Quale
00	Dato valido misurato	✓
10	Monitor non funzionante	
15	Dato non valido	✓
20	Dato valido stimato	✓
25	Dato non valido per verifica limite	
40	Calibrazione	
99	Sistema di acquisizione non attivo	✓

La misura della portata combustibile gassoso è dato dalla somma di tutte le portate acquisite nelle caldaie, come riportato nella tabella seguente:

Impianto	Caldaia	Tag Misura FUEL OIL
CTE	SG1	50_FR_1_104
	SG2	50_FR_2_204
	SG3	50_FR_3_27

3.4 Portata Vapore Generato

Misura Elaborata

		675 Tal Quale
00	Dato valido misurato	✓
10	Monitor non funzionante	
15	Dato non valido	✓
20	Dato valido stimato	✓
25	Dato non valido per verifica limite	
40	Calibrazione	
99	Sistema di acquisizione non attivo	✓

La misura della portata combustibile gassoso è dato dalla somma di tutte le portate acquisite nelle caldaie, come riportato nella tabella seguente:

Impianto	Caldaia	Tag Misura Vapore
CTE	SG1	50_FR_1_101
	SG2	50_FR_2_201
	SG3	50_FR_3_23

3.5 Potenza Termica Generata

Misura Elaborata

		660 Tal Quale
00	Dato valido misurato	✓
10	Monitor non funzionante	
15	Dato non valido	✓
20	Dato valido stimato	✓
25	Dato non valido per verifica limite	
40	Calibrazione	
99	Sistema di acquisizione non attivo	✓

Elaborata dalle portate Fuel Gas e Fuel Oil totali degli impianti del punto di emissioni utilizzando una stima del potere calorifico dei combustibili.

- .Paramentri previsti:

Parametro	UM	Valore
Potere Calorifico Comb. Liquido (Fuel Oil)	KCal/Kg	9800
Potere Calorifico Comb. Gassoso (Fuel Gas)	KCal/Kg	12000

4 Stati Impianto

In questo capitolo vengono presentate le modalità di calcolo per i codici monitor degli stati impianto acquisiti per il punto di emissione E10.

Le misure elaborate ai sensi del DDG 3536 sono elencate nella tabella seguente.

Misura	Cod. Monitor
Stato Impianto	670

4.1 Caratteristiche degli impianti del punto di emissione

La seguente tabella riepiloga gli impianti che immettono fumi nel camino E10.

Impianto	Sigla	Codice Imp.
Centrale Termica	CTE	00

Ai fini delle elaborazioni delle misure impianto, risulta necessaria l'acquisizione dei dati di processo relativi alle portate vapore generato, come descritto nei paragrafi seguenti.

4.2 Centrale Termica

Le emissioni in atmosfera della Centrale Termica provengono dalle caldaie SG1, SG2 e SG3 collegati al camino E10.

4.2.1 Caldaia SG1

Le condizioni di funzionamento vengono ricavate dalla portata di vapore generato che determina le condizioni di femo, avviamento/spegnimento e marcia regolare dell'unità.

La procedura di determinazione dello stato dell'unità SG1 è riassunta nella tabella seguente:

Portata Vapore Generato	Stato Unità SG1
$< Q_0$	Fermo
$< Q_1$	Accensione Spegnimento
$> Q_1$	Regolare

La procedura richiede alcuni parametri caratteristici di funzionamento dell'impianto come riportato nella tabella seguente:

Parametro	Descizione	U.M.	Valore
Q_0	Portata Vapore di accensione	t/h	2
Q_1	Portata Vapore di Minimo Tecnico	t/h	8

4.2.2 Caldaia SG2

Le condizioni di funzionamento vengono ricavate dalla portata di vapore generato che determina le condizioni di femo, avviamento/spegnimento e marcia regolare dell'unità.

La procedura di determinazione dello stato dell'unità SG2 è riassunta nella tabella seguente:

Portata Vapore Generato	Stato Unità SG2
$< Q_0$	Fermo
$< Q_1$	Accensione Spegnimento
$> Q_1$	Regolare

La procedura richiede alcuni parametri caratteristici di funzionamento dell'impianto come riportato nella tabella seguente:

Parametro	Descizione	U.M.	Valore
Q_0	Portata Vapore di accensione	t/h	2
Q_1	Portata Vapore di Minimo Tecnico	t/h	8

4.2.3 Caldaia SG3

Le condizioni di funzionamento vengono ricavate dalla portata di vapore generato che determina le condizioni di femo, avviamento/spegnimento e marcia regolare dell'unità.

La procedura di determinazione dello stato dell'unità SG3 è riassunta nella tabella seguente:

Portata Vapore Generato	Stato Unità SG3
$< Q_0$	Fermo
$< Q_1$	Accensione Spegnimento
$> Q_1$	Regolare

La procedura richiede alcuni parametri caratteristici di funzionamento dell'impianto come riportato nella tabella seguente:

Parametro	Descizione	U.M.	Valore
Q_0	Portata Vapore di accensione	t/h	2
Q_1	Portata Vapore di Minimo Tecnico	t/h	16

4.3 Stato IMPIANTO

Dato elaborato

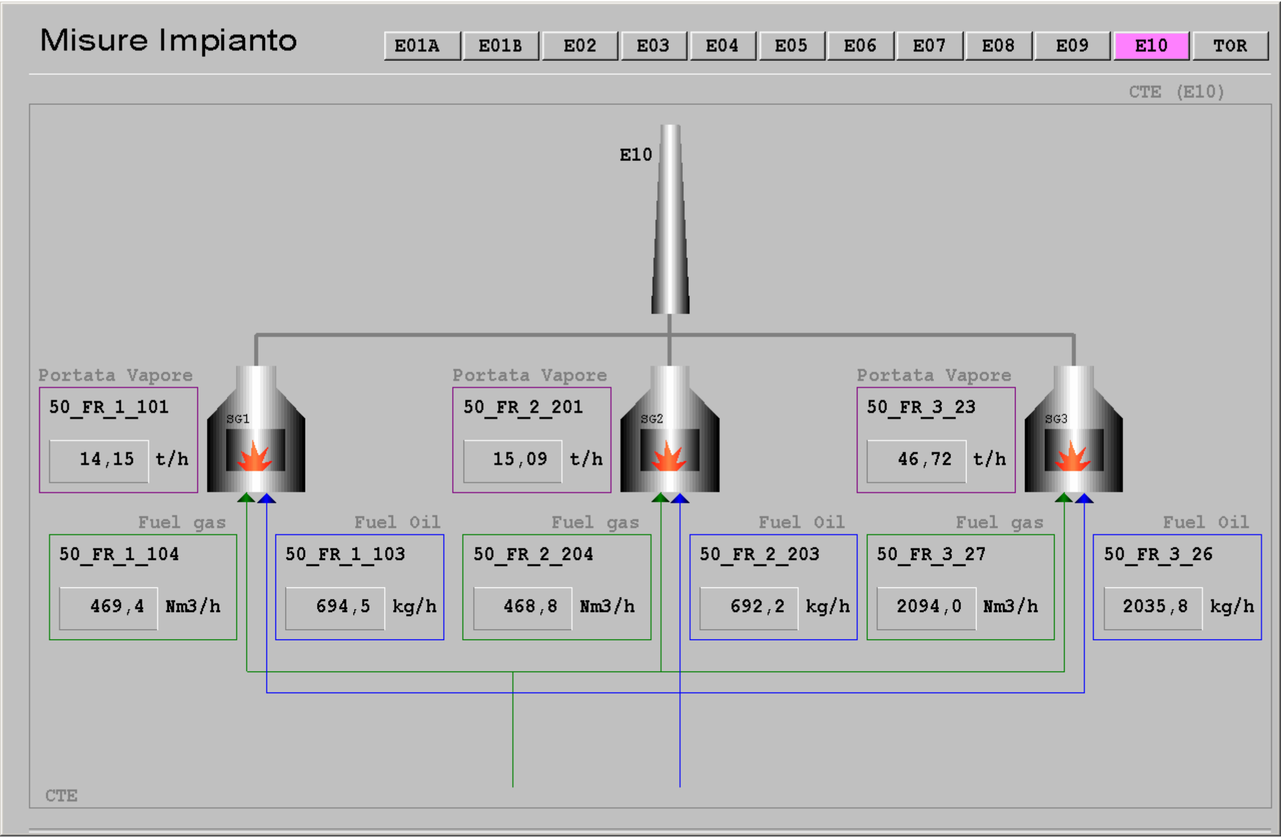
		Codice 670
30	In servizio regolare	✓
31	Accensione	✓
32	Spegnimento	
33	Manutenzione	
34	Fuori servizio per fermata	✓
35	Fuori Servizio per guasto	
36	Funzionamento anomalo/parziale	

La procedura di determinazione dei codici di stato monitor impianto per il punto di emissione E10 è ricavata dallo stato dei forni ad esso collegati.
I criteri adottati per la determinazione dello stato monitor del camino sono i seguenti:

- Se tutti i forni collegati al camino sono fermi allora il camino è dichiarato Fermo (Codice 34);
- Se almeno un forno è in condizione di avviamento o fermata, il camino è dichiarato in Accensione/Spegnimento (codice 31);
- Se almeno un forno è in funzionamento regolare e gli altri forni spenti, il camino viene dichiarato in marcia regolare (codice 30).

La tabella seguente riassume la procedura di elaborazione utilizzata.

Stato Unità SG1	Stato Unità SG2	Stato Unità SG3	Codice Stato Monitor Camino E07 [670]
Fermo	Fermo	Fermo	Fermo [34]
Avviamento Fermata	Qualsiasi	Qualsiasi	Accensione Spegnimento [31]
Qualsiasi	Avviamento Fermata	Qualsiasi	Accensione Spegnimento [31]
Qualsiasi	Qualsiasi	Avviamento Fermata	Accensione Spegnimento [31]
Regolare	Regolare o Fermo	Regolare o Fermo	Regolare [30]
Regolare o Fermo	Regolare	Regolare o Fermo	Regolare [30]
Regolare o Fermo	Regolare o Fermo	Regolare	Regolare [30]


Misure Impianto
E01A
E01B
E02
E03
E04
E05
E06
E07
E08
E09
E10
TOR
CTE (E10)
E10
Portata Vapore
50_FR_1_101
14,15 t/h
SG1
Portata Vapore
50_FR_2_201
15,09 t/h
SG2
Portata Vapore
50_FR_3_23
46,72 t/h
SG3
Fuel gas
50_FR_1_104
469,4 Nm3/h
Fuel Oil
50_FR_1_103
694,5 kg/h
Fuel gas
50_FR_2_204
468,8 Nm3/h
Fuel Oil
50_FR_2_203
692,2 kg/h
Fuel gas
50_FR_3_27
2094,0 Nm3/h
Fuel Oil
50_FR_3_26
2035,8 kg/h
CTE

Allegato 11

Programma di controllo e verifica del fondo serbatoi del parco di stoccaggio dei liquidi idrocarburici di impianto e del deposito nazionale

PROGRAMMA DI ISPEZIONE E MANUTENZIONE DEL PARCO SERBATOI

Nel presente paragrafo sono raccolte, per ciascun serbatoio, le informazioni concernenti lo stato manutentivo, intendendo come tali le ispezioni e gli interventi effettuati.

A tal proposito, per i serbatoi fuori terra, si sottolinea che, oltre alle attività di ispezione e controllo straordinarie, è prassi da parte della Raffineria effettuare attività di controllo e manutenzione periodica; tali attività prevedono un programma annuale di messa fuori servizio di alcuni serbatoi per permettere lo svolgimento delle seguenti operazioni:

- svuotamento del serbatoio;
- pulizia;
- gas-free;
- ispezione di fondo (sabbiatura, determinazione spessore lamiere di fondo e mantelli, integrità saldature, tenute e controllo tubazioni di drenaggio di fondo, sistemi di riscaldamento, ecc.);
- controllo tubazione di drenaggio tetto (serbatoi a tetto galleggiante).

Per alcune tipologie di prodotti stoccati, i serbatoi sono sottoposti a pulizia mediante tecnologia Sludge Recovery Sistem (SRS) che permette di ridurre il rifiuto da inviare a successivo smaltimento.

Tutte le attività di controllo e manutenzione sono svolte da Tamoil in accordo alle normative di settore. Inoltre su alcuni serbatoi, i fondi sono trattati con vernici specifiche per evitare corrosioni. Al fine di verificarne l'integrità, Tamoil sta testando (processo ciclico) i serbatoi di stoccaggio fuori terra presenti all'interno della Raffineria impiegando la tecnica delle emissioni acustiche (EA) prevista dalle UE-BREF per gli stoccaggi. Tale tecnica è una tecnica di controllo non invasiva per le strutture: i sensori per l'emissione acustica "ascoltano" le strutture a determinate frequenze (20-300KHz) e possono determinare le corrosioni attive e le rotture microstrutturali.

Uno dei vantaggi principali di questa tecnologia di controllo non distruttivo è la possibilità di osservare il processo di cedimento strutturale durante l'esercizio senza disturbare la struttura in esame. L'emissione acustica può essere usata quindi come metodo preventivo di monitoraggio dello stato dei serbatoi prima di incorrere in situazioni critiche.

Il metodo di basa sulla rilevazione di segnali ultrasonori attraverso sensori piezoelettrici.

I sensori sono attaccati sul mantello del serbatoio con l'ausilio di supporti magnetici e distribuiti lungo tutta la circonferenza ad un'altezza di circa 1 m. La massima distanza tra due sensori non deve superare i 15 m: questa condizione definisce il numero di sensori necessari per realizzare il test su di un dato serbatoio (numero minimo di sensori impiegato: 6).

I sensori trasformano le onde sonore in segnali elettrici; il segnale pre-amplificato è connesso con uno dei canali di input del sistema di misurazione attraverso un cavo BNC. Il sistema di misurazione è impiegato per processare, memorizzare e rappresentare i dati acquisiti.

Perdite o corrosioni attive sono sorgenti di emissioni acustiche: la possibile ragione di ciò è rappresentata da turbolenze che si creano attraverso i fori e gli elementi della corrosione in formazione.

L'onda sonora si propaga dalla sorgente fino al sensore principalmente nel liquido stoccato all'interno del serbatoio. Pertanto il percorso di propagazione è il seguente: sorgente sul fondo, liquido, pareti metalliche del serbatoio ed infine sensore.

Dal momento che i sensori sono applicati in diverse posizioni, l'onda sonora è captata dai sensori in diversi momenti; la differenza nel tempo d'arrivo di questi segnali di emissioni acustiche, insieme alla velocità del suono ed alla posizione dei sensori, sono i parametri principali per localizzare la sorgente sonora. Attraverso un algoritmo appropriato è quindi possibile calcolare, a partire dal tempo di percorrenza dell'onda sonora, la localizzazione della sorgente.

Tale tecnologia presenta alcune limitazioni che non permettono di effettuare il test in determinate condizioni operative del serbatoio, in particolare:

- *PRESENZA DI FONDAMI:* esiste, infatti, un livello minimo dello spessore/densità del fondame oltre il quale non è possibile effettuare il test; in tal caso il test può essere ripetuto quando il livello del fondame è inferiore al livello minimo.

- *PRESENZA DI RUMORE DI FONDO:* le fonti di rumore poste in vicinanza dei serbatoi generano impedimenti ad effettuare il test, il quale viene eseguito durante la fermata delle/degli unità/impianti; durante la prossima fermata si avrà pertanto la possibilità di poter procedere ad alcuni riesami come menzionato nella tabella che segue.

Per superare le limitazioni tecniche sopraccitate viene utilizzata la tecnologia innovativa CIAET (Compulsory Induced Acoustic Emission Technique), che permette di verificare l'integrità dei fondi dei serbatoi in presenza di fondami e/o rumore di fondo.

La tecnologia CIAET sopraccitata è una metodologia che permette l'indagine dei fondi dei serbatoi tramite l'immissione di un'onda acustica senza necessità di mettere fuori servizio il serbatoio per operazioni di svuotamento o pulizia e, quindi, permette di operare completamente dall'esterno del serbatoio senza arrecare alcun disturbo/interferenza all'attività produttiva.

Si tratta di un metodo di ispezione basato sugli effetti fisici dell'immissione provocata di un'onda acustica; questa metodologia registra e analizza le densità spettrali di segnali acustici indotti come la risposta delle microstrutture degli oggetti testati e, in particolare, analizza i cambi delle frequenze caratteristiche delle emissioni acustiche indotte in sei differenti range di frequenza.

Il metodo comprende un complesso algoritmo e relativo software che permette l'automazione del processo di analisi degli spettri e di interpretazione dei dati; una dedicata routine permette di individuare, localizzare e dimensionare eventuali difetti, valutare l'intensità e il carattere della degradazione e di calcolare la vita residua dell'oggetto testato (determinazione dello stato del serbatoio).

Si riporta di seguito la tabella contenente le informazioni concernenti lo stato di ispezione/manutenzione dei serbatoi; in particolare è specificato per ogni serbatoio l'anno di costruzione, l'anno relativo all'ultimo test effettuato, il risultato delle emissioni acustiche ed eventuali note sugli interventi eseguiti.

Il risultato delle emissioni acustiche EA viene restituito secondi i seguenti criteri:
I: nessuna sorgente significativa (riesame dopo 5 anni)
II: debole corrosione attiva (riesame dopo 3 anni)
III: corrosione mediamente attiva (riesame dopo 1 anno)
IV: corrosione molto attiva (riesame dopo 6 mesi o ispezione interna)

Per quanto riguarda la tecnologia CIAET il risultato indica il tempo del riesame espresso in anni.

Tra il 2005 e il 2008 sono stati testati tutti i serbatoi della Raffineria con la tecnologia delle emissioni acustiche e tecnologia CIAET: i serbatoi non hanno evidenziato perdite ma solo corrosioni attive di entità variabile che comportano intervalli di tempo prima del riesame compresi fra i 4 anni e 1 anno. Le indicazioni ottenute servono a stabilire i criteri di priorità delle manutenzioni dei serbatoi (manutenzione preventiva).

Per quanto concerne i serbatoi interrati, si precisa che quelli in servizio sono stati testati mediante prova di tenuta a vuoto; le prove eseguite hanno dato esito positivo.

N.	SIGLA	TIPO	ANNO DI COSTRUZIONE	ULTIMA ISPEZIONE INTERNA GENERALE	TEST CON EMISSIONI ACUSTICHE (ANNO)	RISULTATO EMISSIONI ACUSTICHE	NOTE	PROGRAMMA CONTROLLI 2010
1	A 1	T.F.	1954	2011			Manutenzione in corso	MAN.
2	A 2	T.F.	1954	1979	2009	I		
3	A 3	T.F.	1954	1997			SERBATOIO D'ACQUA	
4	A 4	T.G.	1956	2000	2009	Riesame dopo 6,4 anni	Manutenzione non eseguita - CIAET 2009	
5	A 5	T.G.	1957	1984	2007	II	Manutenzione 2011	
6	A 6	T.G.	1964	2009	2006	I	Manutenzione in corso	MAN.
7	A 7	T.G.	1966	1989	2007	II		EA (Nota 1)
8	A 8	T.G.	1967	2010			Rientrato dalla manutenzione dopo esecuzione doppio fondo(prossimo controllo 2020)	
9	A 9	T.G.	1968	1995	2010	III	Ripetere il test EA fra 1 anno: programmare MAN se conferma risultato	EA
10	A 10	T.G.	1970	1990	2010	Riesame dopo 2 anni	CIAET	CIAET
11	A 11	T.G.	1971	2002	2008	I		
12	A 12	T.G.	1972	1988	2010	Riesame dopo 2 anni	CIAET	CIAET
13	B 1	T.F.	1954	2007	2005	II	Manutenzione in corso	MAN.
14	B 2	T.F.	1954	1989	2010	III	Ripetere il test EA fra 1 anno	EA
15	B 3	T.F.	1954	2005	2009	I		
16	B 4	T.F.	1954	1988	2006	I		
17	B 5	T.F.	1958	2009			Rientrato dalla manutenzione dopo esecuzione doppio fondo(prossimo controllo 2019)	
18	B 6	T.F.	1958	1967	2009	Riesame dopo 1 anno	CIAET	CIAET (Nota 1)
19	B 7	T.F.	1958	1969			Manutenzione in corso	MAN.
20	B 8	T.F.	1964	MAI	2009	III		EA (Nota 1)
21	B 9	T.F.	1967	2004	2010	Riesame dopo 1 anno	CIAET	CIAET
22	B 10	T.F.	1967	2006	2009	Riesame dopo 2,5 anni	CIAET	
23	B 11	T.F.	1967	1983	2008	Riesame dopo 2,2 anni	CIAET	CIAET (Nota 1)
24	B 12	T.F.	1968	2002	2008	Riesame dopo 2 anni	CIAET	CIAET (Nota 1)
25	B 13	T.F.	1968	MAI	2008	Riesame dopo 1,9 anni	CIAET	
26	B 14	T.G.	1968	MAI	2008	Riesame dopo 2,3 anni	CIAET	CIAET (Nota 1)
27	B 15	T.G.	1971	1994	2007	I		
28	B 16	T.G.	1972	MAI	2008	Riesame dopo 2,3 anni	CIAET	CIAET (Nota 1)
29	B 17	T.G.	1972	1983	2008	Riesame dopo 2,3 anni	CIAET	CIAET (Nota 1)
30	B 18	T.G.	1982	MAI	2009	Riesame dopo 1 anno	CIAET	CIAET (Nota 1)
31	CT 1	T.F.	1954	NON PREVISTA			SERBATOIO D'ACQUA	
32	CT 2	T.F.	1954	NON PREVISTA			SERBATOIO D'ACQUA	
33	CT 3	T.F.	1954	NON PREVISTA			SERBATOIO D'ACQUA	
34	CT 4	T.F.	1954	NON PREVISTA			SERBATOIO D'ACQUA	
35	Ci 6	T.F.	1966	2003	2008	Riesame dopo 2 anni	CIAET	CIAET (Nota 1)
36	Ci 7	T.F.	1966	2000	2008	Riesame dopo 2 anni	CIAET	CIAET (Nota 1)
37	D 1	T.F.	1954	NON PREVISTA			SERBATOIO D'ACQUA	
38	D 2	T.F.	1954	NON PREVISTA			SERBATOIO D'ACQUA	
39	D 3	T.F.	1954	NON PREVISTA			SERBATOIO D'ACQUA	
40	D 4	T.F.	1954	NON PREVISTA			SERBATOIO D'ACQUA	
41	E 1	T.G.	1954	2007	2008	II		
42	E 2	T.G.	1954	2007	2005	I		
43	E 3	T.G.	1954	2005	2009	I		
44	E 4	T.G.	1954	2005	2007	II		
45	E 5	T.G.	1954	2007	2006	I	Manutenzione in corso	MAN.
46	E 6	T.G.	1954	2006	2006	I		EA (Nota 1)
47	E 7	T.G.	1956	2006	2007	II		EA (Nota 1)
48	E 8	T.G.	1956	2007	2006	I	Manutenzione in corso	MAN.
49	E 9	T.G.	1958	1998	2006	I		EA (Nota 1)
50	E 10	T.G.	1958	1983	2006	I		EA (Nota 1)
51	E 11	T.G.	1958	1986	2006	I		EA (Nota 1)
52	E 12	T.G.	1964	2004	2007	II		EA (Nota 1)
53	E 13	T.G.	1964	2004	2007	II		EA (Nota 1)
54	E 14	T.G.	1964	2002	2006	I		EA (Nota 1)

N.	SIGLA	TIPO	ANNO DI COSTRUZIONE	ULTIMA ISPEZIONE INTERNA GENERALE	TEST CON EMISSIONI ACUSTICHE (ANNO)	RISULTATO EMISSIONI ACUSTICHE	NOTE	PROGRAMMA CONTROLLI 2010
55	E 15	T.G.	1964	2003	2010	I	Ripetere il test EA fra 4 anni	EA
56	E 16	T.G.	1966	2004	2006	I		EA (Nota 1)
57	E 17	T.G.	1966	2004	2010	IV	Ripetere il test EA fra 6 mesi: programmare MAN se conferma risultato	EA (Nota 1)
58	E 18	T.G.	1967	2006	2010	III	Ripetere il test EA fra 1 anno	EA
59	E 19	T.G.	1967	2006	2007	II		EA (Nota 1)
60	E 20	T.G.	1967	2000	2007	II		EA (Nota 1)
61	E 21	T.G.	1967	1978	2010	I	Ripetere il test EA fra 4 anni	EA
62	E 22	T.G.	1967	1990	2007	I		
63	E 23	T.G.	1970	1989	2010	Riesame dopo 2 anni	CIAET	CIAET
64	E 24	T.G.	1971	1989	2010	IV	Ripetere il test EA fra 6 mesi: programmare MAN se conferma risultato	EA (Nota 1)
65	E 25	T.G.	1972	1989	2006	I		
66	E 26	T.G.	1972	1973	2006	I		
67	E 27	T.G.	1970	1996	2010	Riesame dopo 2 anni	CIAET	CIAET
68	E 28	T.G.	1971	1995	2009	Riesame dopo 2 anni	CIAET	
69	E 29	T.G.	1996	MAI	2008	II		
70	F 1	T.F.	1955	1993	2006	I		EA (Nota 1)
71	F 2	T.F.	1955	2004	2006	II	Eseguita Ispezione visiva 2010	
72	F 3	T.F.	1956	2004	2006	I		
73	F 4	T.F.	1956	2006	2008	Riesame dopo 2 anni	CIAET	CIAET (Nota 1)
74	F 5	T.F.	1956	2004	2008	I		
75	H 1	T.F.	1958	1992	2007	I		
76	H 2	T.F.	1957	1992	2006	I		EA (Nota 1)
77	H 3	T.F.	1957	1990	2007	I		
78	H 4	T.F.	1957	2004	2007	II		EA (Nota 1)
79	H 5	T.F.	1956	2004	2007	II		EA (Nota 1)
80	H 6	T.F.	1967	2000	2009	II		
81	H 7	T.F.	1967	2009			Rientrato da manutenzione (prossimo controllo 2019)	
82	L 7	T.F.	1954	1989	2006	I		
83	L 8	T.F.	1956	1987	2006	I		
84	L 9	T.F.	1956	1990	2007	II		EA (Nota 1)
85	L 10	T.G.	1958	1992	2010	I	Ripetere il test EA fra 4 anni	EA
86	L 11	T.G.	1958	1992	2010	Riesame dopo 1 anno	CIAET	CIAET
87	L 12	T.G.	1958	1992			SERBATOIO D'ACQUA	
88	L 15	T.G.	1967	2006	2006	I		EA (Nota 1)
89	L 16	T.F.	1967	2001	2008	Riesame dopo 2 anni	CIAET	CIAET (Nota 1)
90	L 17	T.F.	1967	1994	2010	Riesame dopo 1 anno	CIAET	CIAET
91	M 2	T.F.	1955	1991	-		VUOTO	
92	M 6	T.F.	1955	1975	-		VUOTO	
93	M 7	T.F.	1955	1993	2009	I		
94	M 8	T.F.	1955	1966	2008	II		
95	M 11	T.F.	1955		2008	Riesame dopo 2 anni	CIAET	CIAET (Nota 1)
96	M 12	T.F.	1955		-		FONDO CONICO ISPEZIONABILE ESTERNAMENTE	
97	M 13	T.F.	1955		-		FONDO CONICO ISPEZIONABILE ESTERNAMENTE	
98	S 1	T.F.	1955	2002	-		Piccolo serbatoio di servizio	
99	S 2	T.F.	1955	2003	-		Piccolo serbatoio di servizio	
100	S 3	T.F.	1955	1994	2009	Riesame dopo 1 anno	Manutenzione in corso	MAN.
101	S 6	T.F.	1955	1996	-	2008	Manutenzione 2008 (prossimo controllo 2018 - API)	
102	S 7	T.F.	1955	1985	2009	Riesame dopo 2 anni	CIAET	

	(green)	Serbatoi Testati nel corso del 2010
	Nota 1	Controllo nel primo semestre 2011