

**AVAILABILITY IMPROVEMENT OF AN
INTEGRATED GASIFICATION
COMBINED CYCLE PLANT: A
SUCCESSFUL EXAMPLE AT API
ENERGIA SPA – FALCONARA FACILITY**

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1. Introduction

This article provides an overview of the project successfully executed by Foster Wheeler Italiana (FWI) in the period ranging from 2002 to 2004 to drastically improve the availability and the performances of the Integrated Gasification Combined Cycle Plant (IGCC) of api ENERGIA at Falconara Marittima (AN). That plant started the commercial operation in April 2001.

In particular, after a short description of the plant, the following aspects of the project are considered in this document:

- project drivers
- project implementation strategy
- key project elements
- implementation and results
- future objectives.

2. Plant Description

The IGCC is a multi unit complex designed to process the heavy oil and produce approximately 280 MWe (gross power output).

The feedstock is heavy visbroken residue from the adjacent refinery. It is an extremely heavy oil with 6 %wt S and about 800 ppm of metals (Ni, V, Na, Ca). The electric energy produced is delivered to the National Transmission grid.

Additionally, approximately 65 tons of steam is co-generated at three pressure levels: 4.0, 9.0 and 41 barg for export to the adjacent api Refinery.

The description of the IGCC should be read in conjunction with the attached block flow diagram of the Complex (fig. 2.1).

The Process Units of the IGCC are designed to process 60 t/h of Visbroken Residue.

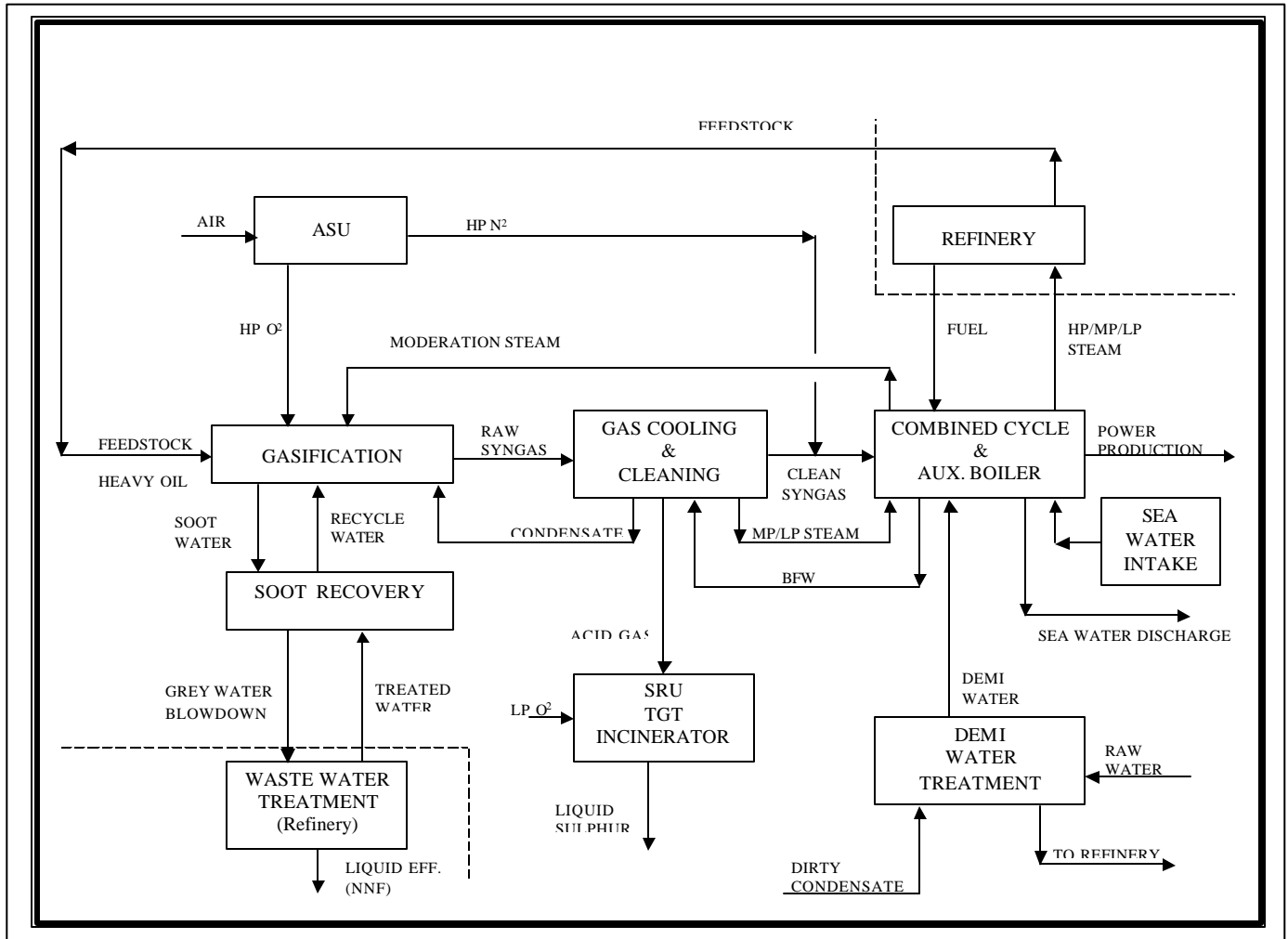
The Gasification Unit is based on two parallel trains, including two G.E. Energy quench type gasifiers (formerly Texaco); the gasification reaction is a partial oxidation conducted with pure oxygen, in presence of HP steam as feedstock atomizer and temperature moderator.

Syngas produced is quenched with water inside the gasifiers and then routed to a scrubbing tower, adequately sized to remove solid particles (unreacted carbon, ashes and metals).

The syngas components are H₂, CO, CO₂, H₂O, H₂S, COS, CH₄, and Ar/N₂.

The soot water from the bottom of gasifiers is sent to the treatment for the recovery of unreacted carbon, recycled to the gasifiers, and elimination of ashes and metals, precipitated to constitute a metal cake.

Fig. 2.1 – api ENERGIA - Block flow diagram of IGCC complex



After carbon recovery, most of the water (grey water) is recirculated to the syngas scrubber.

The raw syngas from the scrubbing section of the gasification unit is passed through and Hydrolisis Reactors, to convert COS into H₂S, then is cooled producing MP and LP steam: the separated condensate is returned back to the gasification as scrubbing water.

The cold syngas is fed to the Selexol Unit to remove selectively H₂S with minimum absorption of CO₂.

The clean syngas, after pressure reduction in an expander to recover energy, is diluted with nitrogen to a level of 50%, which allows a drastic cut of NO_x produced in the gas turbine combustors.

The concentrated H₂S gas from the Selexol Unit is converted to liquid sulphur in the oxygen Claus Unit (SRU) followed by a tail gas treatment unit (TGTU).

The oxygen required both for the gasification reaction (high pressure) and the Claus reaction (low pressure), as well as the HP nitrogen for syngas dilution, are produced in the Air Separation Unit (ASU) where air is fractionated by cryogenic distillation.

The clean and diluted syngas is fed to the gas turbine of the Power Island, consisting of one gas turbine (Alstom Power 13E2 ver. A), one Heat Recovery Steam Generator (with a post combustion system) and one steam turbine, using an open circuit of sea water for condensation.

The Power Island is integrated with the process units in order to increase the Complex overall efficiency; HP steam is exported mainly to the gasification reactor while the MP and LP steam produced in the process units are sent to the combined cycle for power recovery.

One auxiliary boiler (AB) is also provided to supply steam in case of GT outage. During normal operating conditions the AB is kept at minimum load and steam produced is recirculated into the steam water cycle.

3. Project Drivers

Since the start of the commercial operation, in despite of the continuous efforts made by the plant operation and maintenance staff, various problems of different nature have seriously lowered the plant productivity and availability well below the design and potential values.

The problems were originated by the following main causes:

- low instrumentation reliability
- low safety system effectiveness
- metallurgy inadequacy
- equipment limited performances

that also caused, in some cases, spurious plant trips.

The reduced plant availability problems (even less than 70%) and the productivity below the expectations also caused:

- problems with the investors;

- high maintenance costs;
- problems with the surrounding community due to some excess of flaring and steam safety valve discharge noises during plant offset.

The resolution of the above problems and the achievement of the following main targets were therefore the business drivers that justified the start of the “Availability Improvement Project”:

- increase of the plant reliability in terms of availability and safety;
- increase of the plant productivity and efficiency;
- improvements of the relationships with the local community;
- switch from the emergency maintenance to the predictive and routine maintenance.

4. Reliability Study and Problems Assessment

To assess the key elements of the Project, in early 2002 api ENERGIA awarded Foster Wheeler Italiana (FWI) a reliability study, aimed at individuating the main causes of trips, proposing the remedial actions and defining the associated beneficial impacts on plant reliability. FWI, with api ENERGIA management and plant O&M staff, reviewed the main problems occurred during the first two years of operation and made a clear picture of the whole situation.

These reviews evidenced to FWI the need to split the project into three main streams:

- Stream A dedicated to a systematic review of key plant design items
- Stream B dedicated to the solution of identified problems and plant deficiencies
- Stream C for the optimization of efficiency and plant management.

The reliability study showed the main directions to follow for the improvement of plant operation:

- review systematically the ESD logics to improve safety and minimize the possibility of spurious trips;
- maximize the instrumentation system reliability by implementing a wide range of corrective actions on measurement elements, control loop chains, DCS components and software load;
- optimize high level control logics to maximize the electric power production;
- monitor materials in the critical circuits and define a material substitution program;

- plan the substitution of few equipment, such as the motor of the Air Separation Unit (ASU) main compressor, whose operation had not been satisfactory in terms of capacity and reliability during the first period of plant operation;
- commission and start the syngas expander to increase plant efficiency.

In the reliability study FWI evaluated a theoretical plant equivalent availability of 87% on syngas (taking into account both planned and unplanned outages), based on Falconara plant configuration and on FWI reliability data base relevant to operating IGCC plants. Api ENERGIA and FWI took that figure as the reference target in the definition of the plant modifications to be implemented.

5. Availability Improvement Program Realization

The areas of investigation indicated by the year 2002 Reliability study have been developed through several studies for the careful evaluation of each possible modification.

All the modifications related to safety have been implemented, while modifications related to plant reliability and performances have been submitted to a cost/benefit analysis.

On the basis of these studies, FWI and api ENERGIA agreed an upgrading program and an execution schedule for the realization of the modifications during the planned maintenance periods in years 2002, 2003, 2004.

The studies performed by FWI and the main modifications realized are described in the following paragraphs 5.1 through 5.7.

For the project implementation, api ENERGIA selected Foster Wheeler Italiana due to the following main reasons:

- previous experience as EPCC (Engineering, Procurement, Construction and Commissioning) Contractor for the IGCC plant of ISAB Energy at Priolo Gargallo in Sicily;
- strong experience and capability of the main involved FWI technical disciplines including: Power Plant Process, Instrument & Automation, HSE Design, Technological;
- strong FWI management capabilities.

5.1 Sistematic Review of Design Aspects

5.1.1 SIL Study

A complete SIL Study according to the IEC-61508 (ref. 1, 2) has been carried out on no. 192 safety functions for the Integrated Gasification (SMPP) and 125 for the Combined Cycle (CCPP) sections of the IGCC plant.

The SIL study included the execution of the following main steps:

- SIL classification, that, in terms of SIL levels distribution brought to the results shown in the following table 5.1.1.

Tab. 5.1.1 – SIL classification – Summary of results

Required SIL	Safety Function Number	Percentage
No SIL	23	50%
SIL 1	2	4%
SIL 2	10	22%
SIL 3	11	24%
SIL 4	-	0%
	46	100%

- SIL vs. PFD comparison that evidenced the need to improve the safety function reliability of 22 loops in the Integrated Gasification section (SMPP) and for 16 loops in the Combined Cycle section (CCPP).
- Identification of the required corrective measures that included the following:
 - Definition of more stringent test intervals;
 - Reduction of the time needed to replace faulty components providing spare parts ready available at the warehouse;
 - Duplication or more of the trip initiator to obtain a redundant configuration (2 out of 3 logic);
 - Duplication of the solenoid valves on the shut-down valves (1 out of 2 logic);
 - Replacing of the sensor with new one with certified reliability, SIL certified sensors.

The SIL Verification has been carried for the safety functions with a SIL requirement greater than 1.

5.1.2 Maximization of instrumentation system reliability

The analysis made on the list of the spurious trips and the systematic reviews carried out during the project execution highlighted the need to implement some specific corrective actions on the plant instrumentation from the level 0 of the field instrumentation to the upper DCS levels.

In the following paragraphs a short description is provided of the main implemented improvements.

Operation of the existing pressure and flow transmitters

Installation of an automatic flow regulator suitable to maintain a stable fluid flow rate, in lieu of the existing simple restriction orifice, on the purging systems of more than one hundred transmitters operating on very dirty and fouling applications and consequently, provided, since the design phase, with purging system using as flushing medium suitable process fluids.

Availability of the existing control loops

At first an analysis was carried out to identify all those control loops that, when set in manual mode (due for instance to maintenance reasons), could lead the plant to a trip caused by the impossibility, for the operator, to react with sufficient speed to sudden plant offsets.

Also the transmitters on severe applications (from the instrument measurement point of view) used for control applications, were considered critical and then requiring improvement.

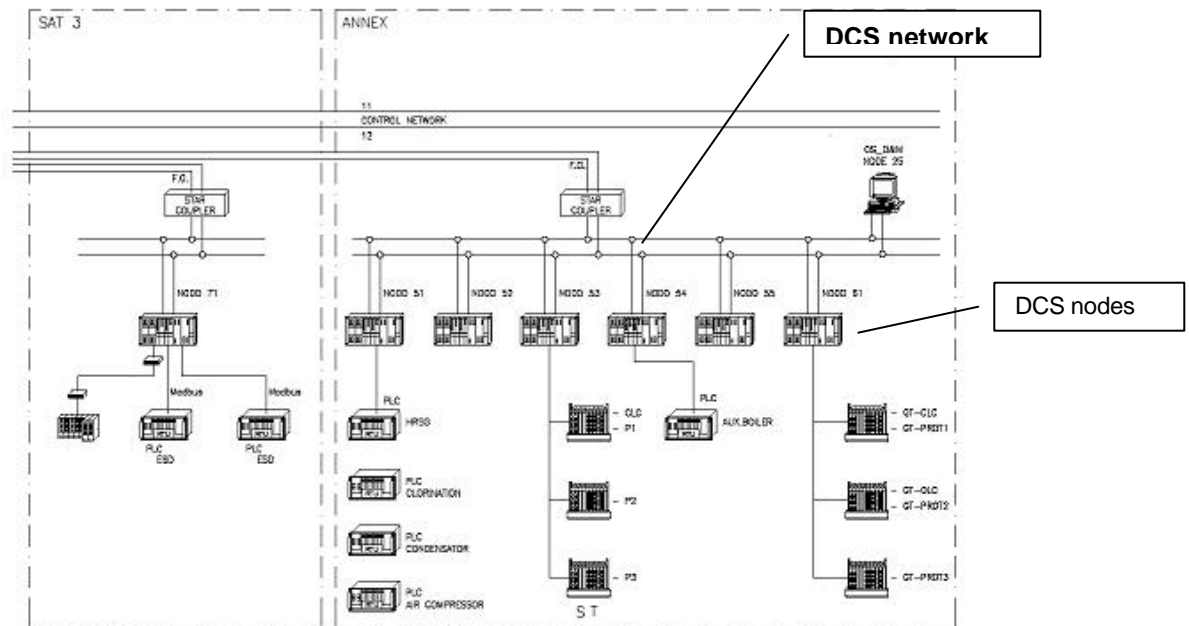
In all cases the proposed improvement was based on the installation of an additional transmitter in redundant configuration or, in few cases in the installation of two additional transmitters in 2 out of three voting configuration.

Software loads of DCS network and nodes

In order to solve the problem of the heavy software load that was cause of unacceptable delays in the controllers response time two type of corrective actions have been implemented:

- replacement of the node CPU's with new ones with higher performance features and
- review of the implemented application software in order to optimise it and to "remove" all unused parts.

Fig. 5.1.2 – DCS system architecture



Operator stations time of response

Instead, in order solve the problem of the software load affecting the DCS operator stations that were generally too slow and then not suitable to allow the plant operators to promptly react upon plant offsets the following were implemented:

- analysis of the alarms with the aim to leave implemented only the really necessary ones;
- replacing of the operator stations controllers with new ones based on new microprocessors with improved performance.

In addition, recently (autumn 2004), in order to further improve the operators' environment also the monitors were replaced with new ones of the LCD type.

5.2 Solution of Identified Problems

5.2.1 Steam and Water Cycle Upgrading: Reliability

Auxiliary Boiler Reliability

The Auxiliary Boiler is an essential item to assure steam to the refinery and to the IGCC gasifiers in case of combined cycle trip.

The auxiliary boiler is equipped with four burners. In the first period of operation of the plant, the four burners of the boiler were operated on an on-off basis, but the start of these burners on demand was often not sufficiently reliable.

To overcome this situation FWI, in co-operation with the burner Vendor, explored the burner limits in terms of maximum load and turn down, by organizing proper test sessions. The test results were positive and demonstrated that the burners are enough flexible to allow three of them operating in parallel and covering the whole range of steam requirement.

Then the burner management system could be simplified with the elimination of the on/off limiters/positioners on each burner.

The BMS results are now more reliable, faster for ramp up and down on demand, capable of fuel switchover sequencing and double combustion.

Steam and water cycle reliability

The reliability of the steam/water cycle has been increased by several measures, among which the most important are:

- duplication of desuperheating valves or of whole letdown/desuperheating stations to allow on line maintenance;
- installation of a reliable control valve at Auxiliary Boiler outlet, in place of the previous on-off valve, to allow a smooth and reliable release of HP steam to atmosphere in case of ST trip or trip of the whole Combined Cycle.

5.2.2 Materials Upgrading

The attention was focused on two circuits:

- the grey water system, to study the corrosion/erosion phenomena;
- the oxygen system, to verify the adequacy of the material to all the operating conditions.

Grey water system

A thickness monitoring campaign, supported by visual inspections where possible, was organized by FWI and performed by the IGCC Operator to focus the status of the Grey Water lines/equipment/control valves made of carbon steel.

Corrosion/erosion phenomena, due to the effect of formic acid, not neutralised, in presence of solids (soot, ashes) were detected.

In August 2002 it was decided to add process condensate (rich in ammonia) in order to neutralise formic acid, but this process remedial did not solve definitely the problem.

Therefore, where the corrosion/erosion phenomena detected were severe (vessel D-302, some lines and some control valves), it was decided a replacement of the lines/ equipment/control valves during the April/May 2002 turnaround using Duplex/Superduplex SS.

This material, compared to carbon steel, assures much higher resistance to acid corrosion and to erosion and does not suffer from the chlorides present in the water.

Detailed engineering of the substitution works was made by FWI.

Oxygen system

Following a period of plant shutdown due to a loss of oxygen, api ENERGIA asked FWI to analyze the oxygen system and provide a technological solution in order to assure the best safety and reliability level.

The intervention has been basically focused on the replacement of the previous stainless steel material with Monel 400 in some portions of the oxygen supply system to gasifiers, where high oxygen velocity have to be withstand without any ignition problems.

In addition to material replacement, FWI made other modifications to maximize safety and reliability:

- addition of new lines and isolating valves, as well as the installation of a protective wall, to allow the maintenance of one of the two oxygen filters while the plant is in operation;
- installation of a multistage restriction orifice on each oxygen vent line, in place of the previous manual globe valve, to avoid local intervention of the operator during start-up;
- installation of new automatic valves, complete of position transmitters and opening/closing permissive signals, participating to the start-up and shutdown sequences of gasifiers, in agreement with gasification Licensor (GE, previously Texaco);
- routing optimization of the oxygen lines towards the gasifiers, consisting of some valves relocation on new platforms above the two gasifiers.

After these modifications the oxygen system has worked regularly at the maximum level of safety.

5.2.3 Installation of new equipment

ASU – New electric driving motor for base load air compressor

The electrical motor in subject, rated 24,53 MW, is synchronous type with brushless exciter and will be coupled to the Base Load Air Compressor .

The motor is fed at 10 kV level and will replace the existing motor (of the same type but with lower rating - 23MW), which was repaired few years ago after a failure on the insulation due to water leakages from the coolers to the windings and hence doesn't guarantee any more the required reliability for such a vital function.

For the new compressor special attention has been therefore paid in the design of the cooling system in order to provide optimum resistance to seawater corrosion, to marine organism erosion and to motor vibrations:

Titanium was used for all wet parts and water-to-air heat exchangers arrangement was designed in such a way that seawater can never come in contact with windings:

- Double tube heat exchangers;
- Water collecting tray under the coolers;
- Water leakage detectors.

Further, to increase the performance of the insulation of the motor windings, they have been subjected to double impregnation (VPI) treatment.

Motor electrical design was carried out so as to obtain reactances and time constants allowing direct-on-line starting without negative impacts of the electrical system.

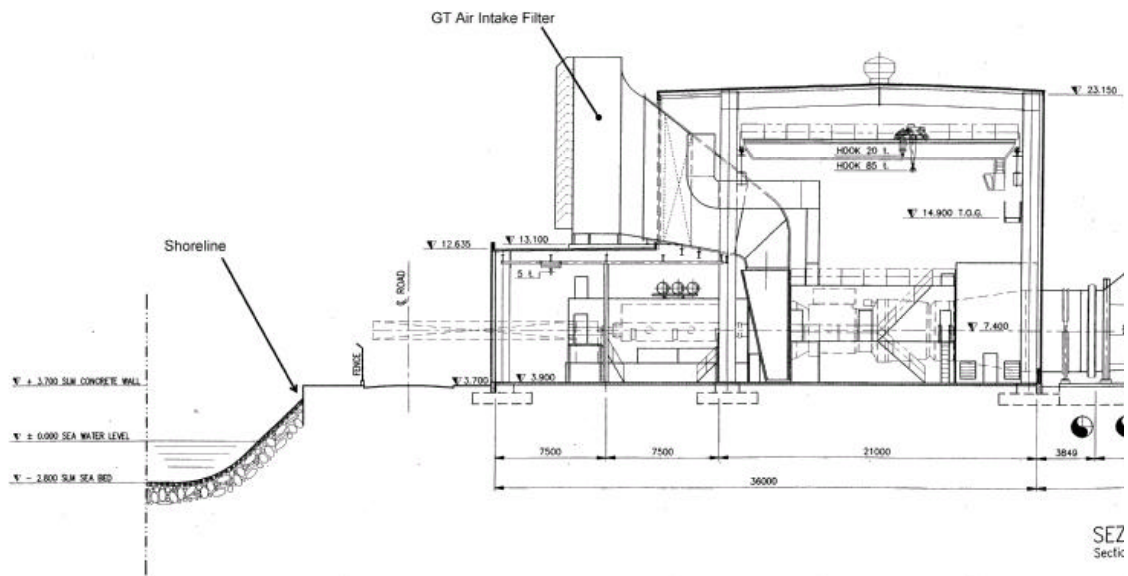
Last, in order to allow for thorough remote supervision of all motor parameters, in addition to the standard instrumentation (RTD's, vibration probes etc.), the motor has been equipped with an on-line Partial Discharges monitoring system and with Rotor Telemetry equipment allowing the monitoring, without slip rings, of rotor temperatures, rotor current, rotor voltage and rotor earth fault.

Substitution of gas turbine air intake filter

The substitution of the originally supplied GT air intake filter (GT filter) was decided by api ENERGIA during 2003, based on operation and maintenance experience, which indicated severe fouling of GT compressor airfoils (basically from NaCl) and consequent loss of GT performance. GT fouling was associated with the coastal location of the filter (about 14 m from the shoreline, see Fig. 5.2.1), in an area exposed to wintertime storms and rough-sea conditions.

Additionally, the absence of water removal provisions in the existing filter likely resulted in droplet carryover into particulate filters, with wetting/drying cycles to follow, which prematurely reduced the media particulate arresting efficiency. Salt carryover into the GT was the obvious consequence.

Fig. 5.2.1 – Air intake filter



The new filter was specified based on the following design data and installation constraints:

1. Layout to fit into the space available, without modifications to the intake air duct;
2. Face velocity not to exceed 2.7m/s;
3. High droplet removal efficiency, accomplished through:
 - a. stainless-steel demister section (removes particles $\geq 18 \mu\text{m}$)
 - b. two-stage coalescer section (99% efficient on particles $\geq 8 \mu\text{m}$, 90% efficient on droplets $\geq 3\mu\text{m}$)

4. Bag type pre- filter (coarse filter) section with a EN 779 gravimetric efficiency class G4;
5. Final “fine” filter of the mini-pleat, rigid-pocket construction, with EN 779 efficiency class F8.

The new filter was installed and commissioned during the combined cycle turnaround at the end of 2003 and it started operation at the beginning of 2004.

From the records of the operating parameters of the new filter throughout the first year of operation, it can be remarked that the fine filter DeltaPi shows a very smooth increase, reaching some 220 Pa after one year (value recommended by manufacturer for filter substitution is 450 Pa). The service life of fine filters is essential for station availability as these filters can only be replaced while the GT is not running.

The performance of the new GT filter was satisfactory during the first year, service life of the media elements exceeded expectations and no abnormal behaviour was observed throughout the year, including wintertime storms and high humidity spells.

5.2.4 Syngas expander commissioning

Foster Wheeler has taken the task of setting all the procedures necessary for the syngas expander GI-82001 commissioning and upgrading.

The syngas expander is able to produce 1.6 MW by utilizing the expansion energy of the syngas, from the gasifier production pressure down to the gas turbine inlet pressure. The machine is connected to the 6.6 kV grid and it has not yet operated since IGCC commercial operation on early 2001.

Machine testing and “make-good” activities are on going and the syngas expander should be ready for stable operation in July 2005. In January 2005 FWI has executed a test of the machine and its auxiliaries; the test has been satisfactory and has given useful indications for the finalization of the control and protection systems.

Every precaution has been taken for safety. Load timings and valve response timings have been carefully determined; upgrading of fire and noise protection devices is foreseen along with automation upgrading. Instrumentation redundancy, valve positioners/limit switches, DCS pages improvement, are part of the lot.

Every aspect for overspeed protection in case of disconnection of the generator has been considered. Syngas expander protections have been improved with the introduction of a new PLANAR processor performing:

- complete isolation of the machine (inlet/outlet);
- further fastening of closing time of trip valve at expander inlet.

Every precaution has, furtherly, been taken to avoid, in case of expander trip, the trip of the downstream gas turbine and therefore the loss of the entire IGCC production.

All the control issues related to the syngas expander bypass valve, so as to take immediately load for syngas expander trip, have been implemented, verified in the January 2005 test and proved to work correctly (see figure 5.3.2 under paragraph 5.3.2).

The January 2005 test has proved also that the syngas expander is able to cover the syngas full load, so the by-pass valve will be normally closed and will open in control only at start-up and in case of expander trip. In these situations the opening range will be 50% or even more, therefore the test demonstrated that the addition of a new small by-pass control valve to operate at low load is not necessary.

From a machinery point of view, every component detail has been checked together with the syngas expander Vendor, as the machine has not operated for a long time. Syngas expander seal, pressurization and lubrication have been tested during the machine commissioning in January 2005 and have proved to work satisfactorily.

From an electrical point of view, finally, connection to the 6.6 kV grid has been considered with the difficulties related to the actual manual synchronization; an automatic rampup to the generator 3000 rpm, avoiding the machine critical velocities, is under study.

5.3 Optimization of Efficiency and Plant Management

5.3.1 Steam and Water Cycle Upgrading – Steam Turbine Power

Foster Wheeler has carried out several works to improve the combined cycle configuration in terms of instrumentation and control philosophy, so as to achieve the maximization of steam turbine power and steam export control to the Refinery.

Reference is made to Fig. 5.3.1 attached to this paragraph.

The steam turbine is supplied of steam through several admissions, two of which are at high pressure: one from the HRSG at about 100 barg (SHHS steam to 1st admission) and one from the Auxiliary Boiler at few bar less (HHS steam to 2nd admission).

The control system as originally designed allowed some fluctuations of the two streams, related to GT load variations (affecting the 1st admission flowrate) and to the availability of steam from the Auxiliary Boiler (affecting the 2nd admission flowrate); in this way the steam turbine production could not be kept at the maximum level.

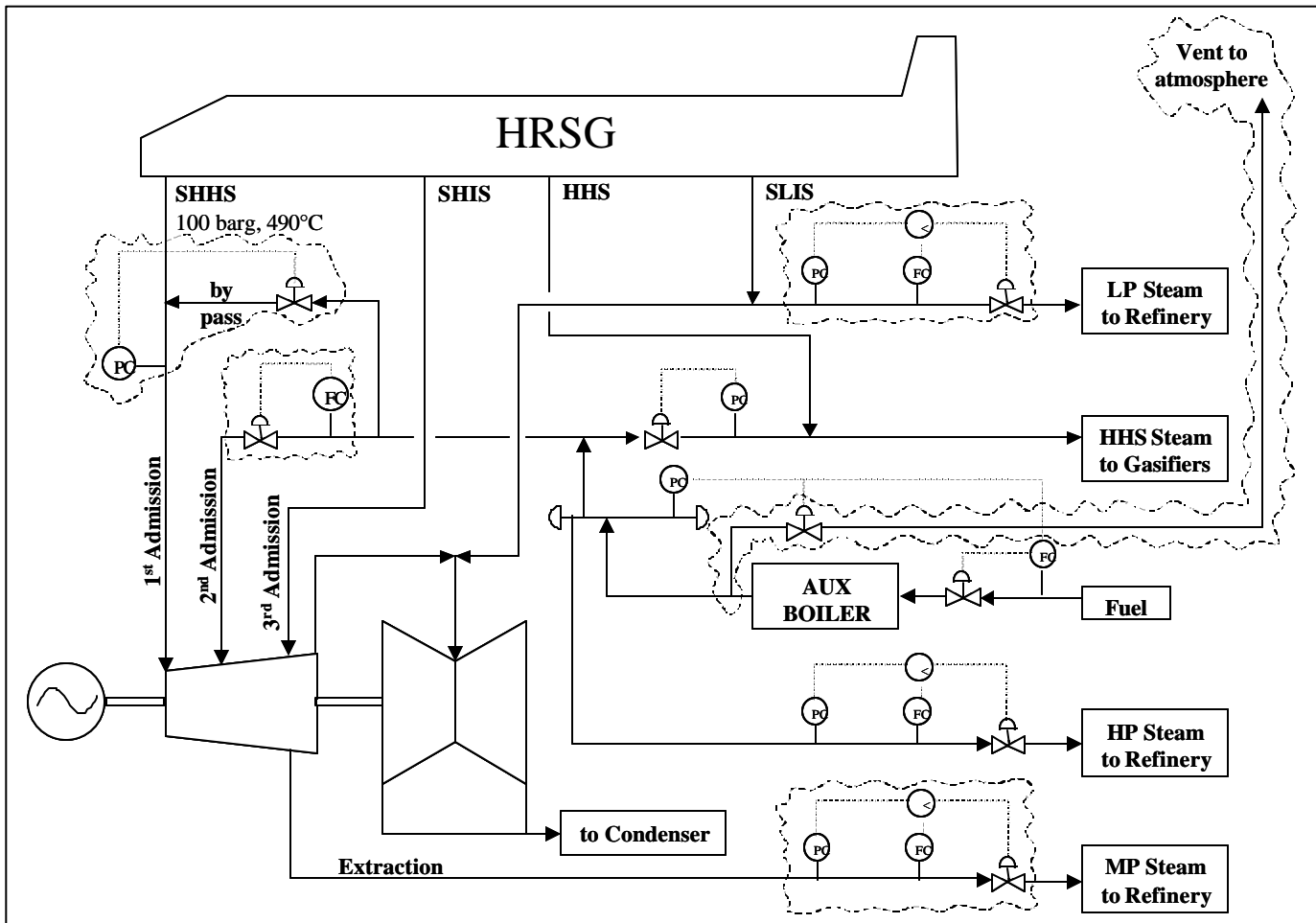
To enable the maximization of this production in whichever combined cycle situation, FWI implemented the following changes in the steam control systems (see attached scheme):

- introduction of flow control for the HHS steam to the 2nd admission, in place of the existing system controlling this stream under Auxiliary Boiler pressure;
- addition of a HHS steam 2nd admission bypass to the SHHS steam 1st admission, under 1st admission pressure control, able to compensate the decrease of the SHHS steam (from HRSG) when the GT operates at reduced load;
- implementation of a correlation, based on steam turbine Vendor requirements, aimed at admitting the two streams in the correct proportion to the machine and at the maximum possible flowrates.

The steam turbine was also equipped with an extraction to feed MP steam to the adjacent refinery. FWI upgraded this circuit by adding a flow controller, with the set point in charge of the operator, in order to limit the MP steam subtracted to the steam turbine in the situation of high steam demand of the refinery.

Finally, flow control on HP, MP and LP steam headers to the refinery (overridden by the pressure control in case of low pressure) has been introduced and this now allows to not exceed the limits for a smooth operation.

Fig. 5.3.1 - Upgrading of steam turbine control system



Before, control of steam exports to the refinery was only based on pressure control and therefore these limits could be easily exceeded. This resulted in heavy steam loss from the combined cycle and, therefore, indirectly in steam turbine power production loss.

After the implementation of all the above described modifications, in November 2004 FWI and api ENERGIA held a steam turbine test, aimed at verifying the progress in steam turbine production and collect the data to fine tune the new control system. The test has demonstrated that the steam turbine is now put in the condition to normally produce about 5 MW more than before.

5.3.2 Master controller

The IGCC Master Controller (MC) is a high level control system able to co-ordinate the operations of the entire complex. Its main task is to balance the whole system so that the syngas consumption of the IGCC back end (gas turbine and post firing) can match continuously the syngas production of the IGCC front end (gasification), by controlling the pressure of the HP section of the syngas circuit.

The Master Controller takes also into consideration the ASU saturation signals linked to the limitation of the oxygen required for the heavy oil gasification and of the dilution nitrogen needed to adjust the heating value of the fuel entering the gas turbine.

The main control strategies are here below summarized. Reference can be made to the attached scheme (Fig. 5.3.2).

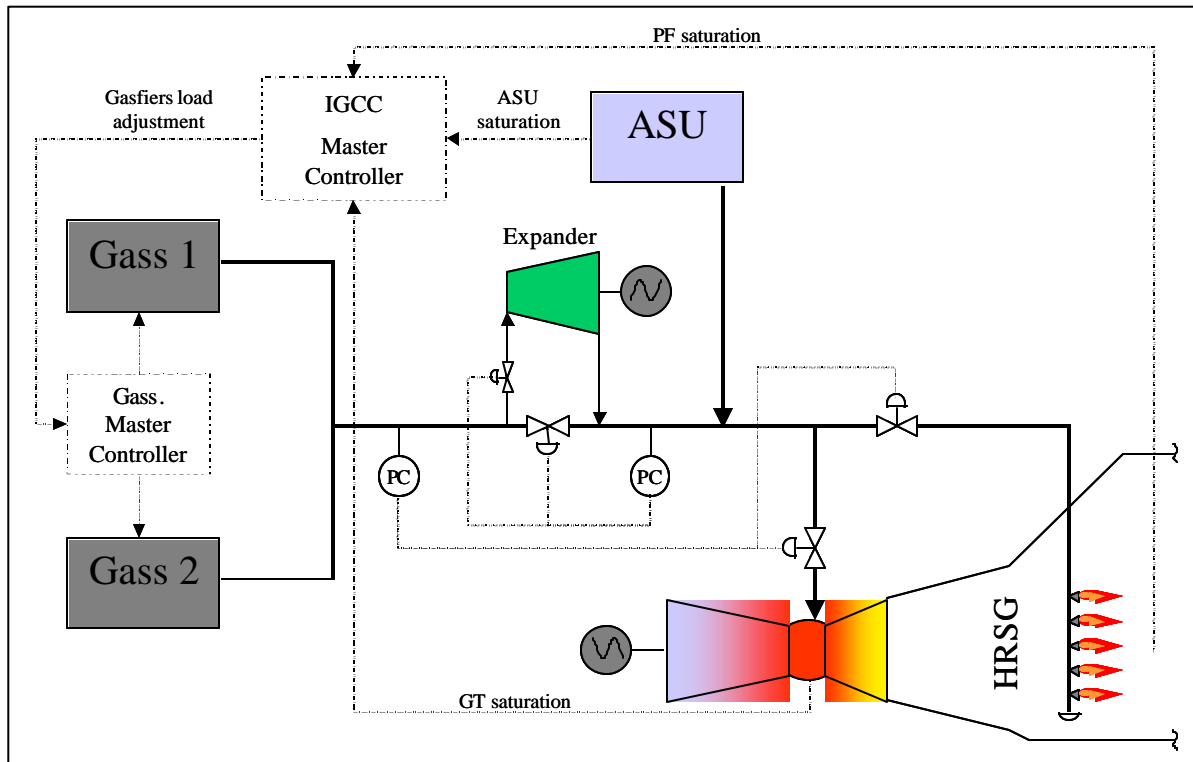
The Master Controller adjusts the syngas production by changing the gasifiers' total load in order to maximise the GT Power output, considering the limitation of the CCPP and of the ASU. This means that, in case of saturation of the syngas consumers or of the ASU (oxygen or nitrogen), the Master Controller automatically reduce the gasifiers total load progressively through a pre-imposed sequence of small step, each step followed by a pause to let the plant react to the change of set. The reduction ends when all the saturation signals disappear.

On the other side, in case there are conditions for the CCPP (gas turbine and post firing) to take more syngas and for the ASU to produce more oxygen and nitrogen, the Master Controller automatically start the gasifiers load increase with the same pre-imposed sequence of steps and stops when the ASU or CCPP saturation signals appear.

In this way, the syngas release to flare, due to plant saturation, is minimised and the maximum power production compatible with the limitations of the CCPP and ASU (oxygen and nitrogen) is maximized.

The Master Controller manages also the distribution of load between the gas turbine and the post- firing with the purpose to maximise the syngas flowrate to gas turbine and then to discharge the excess to the post-firing.

Fig. 5.3.2 – IGCC master controller



Other duty of the Master Controller is to manage automatically the emergency conditions of the plant, such as gasifier trip or gas turbine trip, with the purpose to maintain in operation the IGCC whether possible or to enable a smooth shut down.

Herebelow are summarized the most important emergency transients:

1. Single gasifier trip:

- Gas Turbine automatically unloads down to a prefixed value of 32% load following the PLS sequence;
- The load of the remaining gasifier is automatically increased to the maximum allowable production load;
- Dilution nitrogen is reduced in proportion to the syngas flowrate;
- Syngas expander and post firing are shutdown.

2. Both gasifiers trip:

- The gas turbine is switched from syngas to diesel as soon as possible (emergency change over);
- Dilution nitrogen is reduced in proportion to the syngas flowrate down to zero;
- Syngas expander and post firing are shutdown.

3. Gas Turbine trip:

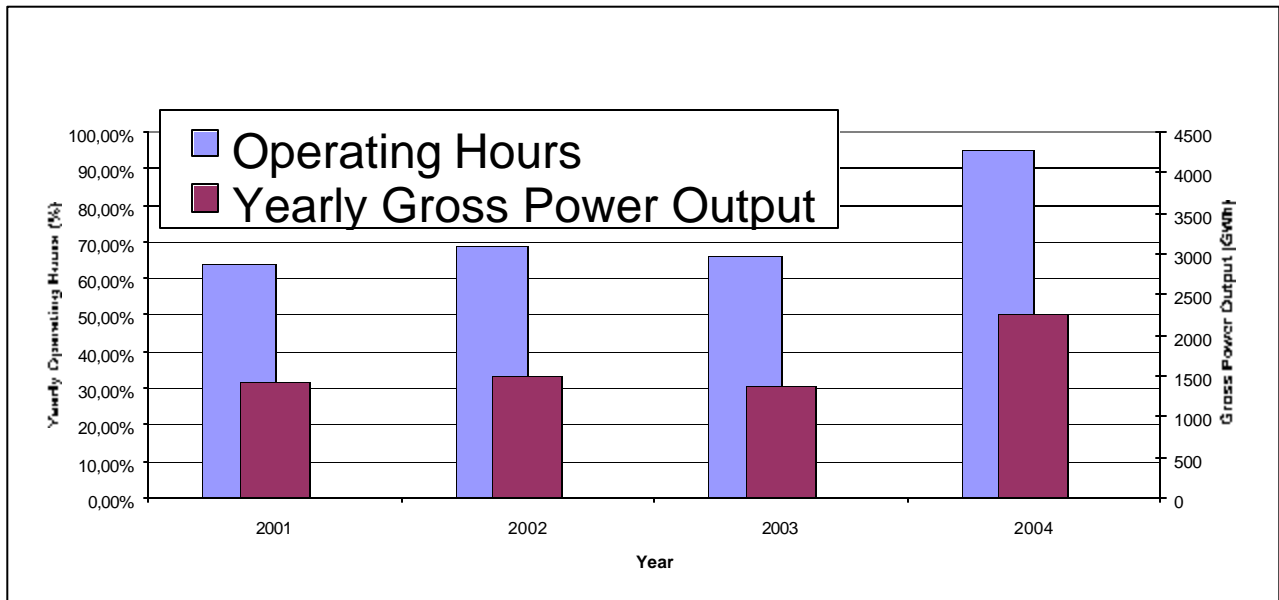
- Dilution nitrogen is reduced in proportion to the syngas flowrate;
- Syngas expander, post firing and steam turbine are shutdown.

6. Results in Terms of Availability

After the realization of the Availability Improvement Project described in this article, the plant availability has reached very satisfactory levels.

The attached Fig. 6.1 shows the plant availability in years 2001 (start of commercial operation in April), 2002, 2003, 2004, in terms of yearly operating hours (% with respect to 8760 h).

Fig. 6.1 – IGCC Availability Trend



The progress is evident, from 63% of year 2001 to 95% of year 2004 and is concentrated in the last jump of 28% from year 2003 to year 2004; this trend reflects the realization schedule of the

Reliability Improvement Project, whose major part was implemented in the long turnaround of late 2003, in shadow of the gas turbine major overhaul.

Fig. 6.1 shows also the yearly gross power output production.

The availability figures shown in the diagram are relevant to the syngas operation and include a small percentage relevant to the GT operating hours on diesel, necessary to perform the GT start-up and to manage emergency situations.

The year 2004 figure, i.e. 95% operating hours is in line with or even better than the theoretical equivalent availability of 87% on syngas, evaluated by FWI on the basis of Falconara plant configuration and adopted by FWI and api ENERGIA as target of the Reliability Improvement Project.

7. Near Future Objectives

After the significant results obtained in improving the plant performance, availability and safety, FWI and api ENERGIA agreed to continue the co-operation in year 2005.

The scope is to explore the residual margin of availability increase and to further optimize the plant efficiency, through the deep analysis of the present plant balances and performances.

For this purpose, FWI is preparing a Plant Performance and Availability Evaluation Software Program, capable to monitor the plant operating parameters and to compare them with the theoretical plant performances, calculated as a function of the feed characteristics, actual atmospheric conditions and boundary conditions with the adjacent refinery.

This software will allow to acquire the plant operational data through a Real Time Data Base recently installed by FWI.

The theoretical plant performances are based on the plant design data and are corrected to the actual plant conditions through equations and graphics. The corrections reflect also the real performances of the steam turbine obtained during the recent test.

8. Conclusions

The Availability Improvement Project completed by Foster Wheeler Italiana for the api ENERGIA Integrated Gasification & Combined Cycle plant located at Falconara has allowed a tremendous increase of the plant availability from 63% in year 2001 (start of commercial operation) to 95% in year 2004.

These results have been reached by means of a systematic review of the overall plant design; such review have included a detailed SIL Study, an optimization of high level control logics, the maximization of instrumentation systems reliability and an extensive monitoring of the critical circuits metallurgy.

This extensive work has been integrated with the analysis of the occurred problems and of the plant deficiencies previously identified by the IGCC Operator.

The project implementation strategy adopted by FWI for the IGCC plant of api ENERGIA can be applied to any process plant having a complex configuration and can provide significant benefits when the plant operation is not satisfactory and great potential exists for availability and performances improvements.

In these conditions the costs of the availability improvement project are by far justified by the increases that can be obtained of the plant productivity.