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144 MW DELIMARA DIESEL POWER PLANT MALTA

COMMISSIONED IN 2012

Burmeister & Wain Scandinavian Contractor A/S

PROJECT BACKGROUND

In 2012, Burmeister & Wain Scandinavian Contractor A/S (BWSC) completed the design, construction and commissioning of a 144 MWe diesel engine-based power plant for Enemalta Corporation (Enemalta) on Malta.

The plant is located on Enemalta's Delimara site and is to replace older generation units in another power station on the island.

Delimara site location, Malta.

The new 144 MW Delimara Diesel Power Plant was from the outset required to comply with stringent environmental standards, while also providing reliable, flexible and cost efficient electrical power.

On top of these challenges, the plant was to occupy as little space as possible to allow room for future extensions on the Delimara site.

Diesel engines utilising low-cost residual fuel oil fulfill the before-mentioned objectives, and were accordingly applied for the Delimara project.

Unit size, start/stop and part-load flexibility as well as high efficiency and a fuel type being globally available further supported this choice of prime mover technology.

However, utilising residual fuel oil, necessitated introduction of secondary abatement technologies for reduction of NO_x, SO_x and particulate matter to fulfill the environmental requirements.

PLANT DESCRIPTION

The power producing units of the plant are eight medium speed diesel generation sets, type Wärtsilä 18V46 with ABB AMG1600 alternators, each rated 17.1 MWe.

The plant is designed for and has been tested with low-sulphur Heavy Fuel Oil (maximum sulphur 1%). The fuel is stored at the existing storage tank facility in Delimara.

To augment plant efficiency, each unit is fitted with a dual pressure Waste Heat Recovery (WHR) boiler, generating bottom cycle steam for one common Dresser Rand steam turbine generator with a Converteam alternator rated at 13.1 MWe.

Steam turbine generator.

Nominal plant gross electrical capacity is 150 MWe with a gross electrical efficiency close to 50% and a net plant electrical efficiency of approx. 48%.

The plant is cooled by sea water. In addition the plant comprises two desalination units, each rated 700 m^3/day driven by engine cooling water, thus achieving a total thermal efficiency exceeding 50%.

The entire flue gas abatement facility for the plant is arranged outdoor of the powerhouse in a space optimised configuration to reserve site space for future use.

FLUE GAS ABATEMENT

A challenge for the project was that the unabated emission level, despite using relatively low-sulphur Heavy Fuel Oil, required secondary abatement to reduce the SO_2, NO_x and particulate emission level to meet the local requirements.

Unabated flue gas emission level is listed together with the emission requirements in the table below:

Emission	Unit	SO_x (as SO_2)	NO_x (as NO_2)	Dust
Unabated emission conc.	[mg/Nm^3, 15%O_2, dry]	Approx. 570	Approx. 2,000	Approx. 70
Required emission conc.	[mg/Nm^3, 15%O_2, dry]	Max. 112.5 (300@5%O_2)	Max. 150 (400@5%O_2)	Max. 50
Required abatement efficiency	%	Min. 80%	Min. 93%	Min. 30%

In order to achieve the specified emission levels, the plant is equipped with flue gas abatement equipment including NO_x by Selective Catalytic Reduction (SCR), SO_x and Particulates by dry Flue Gas Desulfurisation (dry-FGD) with Sodium Bi-Carbonate (SBC) injection followed by filtration in a bag-house cyclone type filter.

Abatement and stack area.

SCR ($DeNO_x$) Facility

The required NO_x reduction is obtained by the SCR principle with ammonia supplied by injection of urea in aqueous solution.

The plant has been designed for delivery of granular urea in 20' standard containers with internal liner bags to preserve the urea quality and to provide a moisture barrier for longer storage period until use.

Urea solution preparation tanks.

Granular urea is stored dry on site in 20'containers. Before use, the urea is being dissolved into a 40% aqueous solution in a batch process system.

The urea solution is injected up-stream of the SCR reactor directly in the hot exhaust gases. The urea hereby release ammonia (NH_3) as required for the SCR $DeNO_x$ process to take place.

Unabated NO_x level around 2,000 mg/Nm^3 is reduced by 92.5% to the required emission level at a specific urea consumption of 8 g-urea/kWhe gross power generated.

NOISE ABATEMENT

Dry-FGD ($DeSO_x$ & PM reduction) Facility

In response to project and site conditions, and to achieve the required SO_2 reduction of approx. 80%, a dry Flue Gas Desulfurisation (dry-FGD) process was applied.

Sodium-bi-Carbonate (SBC) powder is injected in a reactor downstream the exhaust gas Waste Heat Recovery (WHR) boilers. This process is well-proven for effective removal of acidic flue gas components such as SO_2 but naturally needs to be adapted to the specific application of diesel engines burning Heavy Fuel Oil.

SBC is very reactive allowing for a simple and compact dry process working at normal flue gas release temperature downstream the WHR boilers without the complexity of having to control temperature and humidity and work with slurry or water phase chemistry.

Inside FGD bag-house filter.

As for urea, SBC is also planned for delivery and storage on site in lined 20 standard containers. SBC is handled dry and transported internally by dense phase systems. Immediately before being pneumatically dosed into the flue gas stream from a buffer silo, the SBC passes through a grinding mill to control and reduce particle size for improved reactivity.

SBC injection takes place in a reactor chamber providing good mixing and a reaction time of a few seconds. Separation of SBC residue from exhaust gas is carried out by FGD bag-house filters.

In addition to the strict flue gas emission limits, an external noise pressure level contribution limit of max. 45 dB(A) was set at the site boundary located only around 40m from the edge of the new powerhouse.

Inside the engine room, a maximum noise pressure level of 85 dB(A) (ear defender limit) was required during engine shutdown for service while other units being in operation.

To meet this requirement, each engine unit is located within a separate noise enclosure. Noise enclosures are arranged in two groups of four in a common engine hall separated by a mid-section loading bay.

Engine in noise enclosure.

Each enclosure is of a lightweight sandwich panel structure with a specially sealed and removable ceiling which can be lifted off in sections in order to share two common overhead cranes for service and access to the common loading bay.

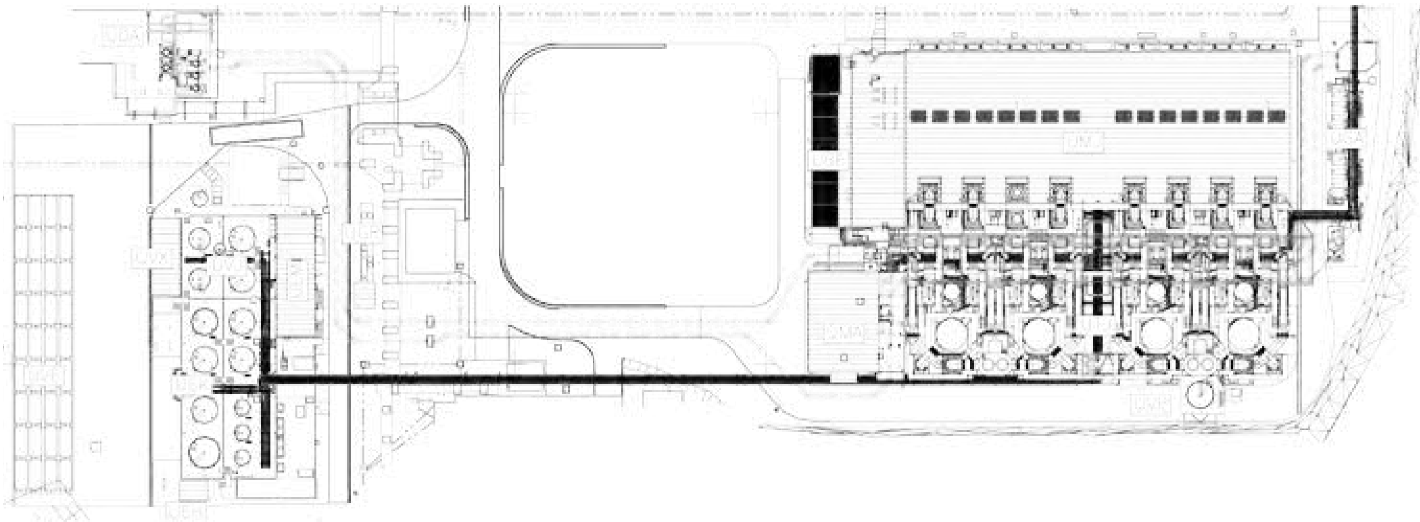
Noise emission measured at the performance test confirmed the detailed noise design management to be correct despite the plant complexity.

Noise level in the engine hall outside the genset noise enclosure cells was actually recorded as 75 - 79 dB(A) and inside a cell with stopped engine and neighbour cell engines operating on average 77 dB(A), both values well below the defined limit of 85 dB(A).

GENERAL PROJECT EXPERIENCE

A major challenge for the design of the Delimara Diesel Power Plant was the limited space made available for such a complex installation, both in the abatement area and within the powerhouse and genset noise cells.

This required a structured and very detailed engineering phase, including creative and untraditional solutions. A very detailed 3D CAD model was established and space management routines observed to avoid equipment clashes.



General site layout.

Plant control room.

Challenges related to control of the abatement systems were mainly linked to transient operations like precoating of FGD filter bags with SBC prior to starting, starting-up procedures, shifting between bypass operation and normal operation and sootblowing for cleaning of WHR boilers.

Even in case of a trip of abatement systems, the power production should not be interrupted.

For compliance with emission regulations, a subsequent shift from Heavy Fuel Oil operation to diesel oil operation is possible until normal operation can be resumed.

All these considerations required thorough analysis of many operational scenarios in order to structure and prepare the control system correctly.

Following the successfull completion of the 30-day reliability test, the Delimara Diesel Power Plant was handed over to the client in December 2012.

SUMMARY

Contract:

Type: Turnkey
Effective contract: July 2009
Handing over: December 2012
Plant capacity: 144 MW

Technical Data:

Diesel engines
Make: Wärtisilä, Finland
Type: 8 x W18V46, 4 stroke
Speed: 500 rpm

Alternators
Make: ABB, Finland
Type: AMG 1600SS12 DSE
Voltage/ frequency: 15 kV/50Hz
Rated output: 17.1 MW/21.35 MVA

Steam turbine
Make: Dresser-Rand, UK
Type: Multi-stage impulse condensing
Speed: 5,800 rpm
Voltage/ frequency: 15 kV/50Hz
Rated output: 13.1 MW

Exhaust gas boilers/Auxiliary boiler
Make: Aalborg, Finland
Type: AV-6N natural circulation
Steam capacity, primary 8 x 8,760 kg/h, 11 bara/350 °C
Steam capacity, auxiliary 8 x 560 kg/h, 4.7 bara/150 °C

$DeNO_x$ system
Make: H+H GmbH
Type: 8 x SCR reactors & 8 x SCR catalysts
Catalyst: Honeycomb/full contact
Ammonia source: Urea granulate

$DeSO_x$ system
Type: FDG 4 x reactors & 4 x bag-house filters
Reagent: Sodium biocarbonate

Fuel oil treatment
Make: Alfa Laval
Type: SU 876
Rated capacity: 6 x 12.2 m^3/h

Step up transformers
Make: CG Electric System Hungary Zrt.
Type: HOSV 650000/145
Ratio: 138 kv / 15 kV
Rated output: 3 X 65 MVA

HV switchgear
Make: Siemens
Type: Metal-enclosed Gas-insulated; 8DN8
Rated voltage: 145 kV

MV switchgear
Make: Areva
Type: PIX air insulated switchgear
Rated voltage: 17.5 kV

Control system
Make: ABB
Type: System 800xA

Civil work construction
Concrete works: Vassallo Builers Ltd.
Steel and cladding works: Vassallo Builers Ltd.

Powerhouse
Length: 76 m
Width: 30 m
Height 19 m
Overhead crane: 2 x 32/5 t

Electrical annex
4 story concrete construction building with cable basement
Length: 30 m
Width: 11 m
Height 25 m

Steam turbine generator building
Length: 20 m
Width: 19 m
Height 18m

Fuel oil treatment building and Service tank farm
Length: 52 m
Width: 27 m

Stack for fluegas
Make: VL Staal A/S
Stack configuration: 2 stacks, each with 2 liners
Stack height: 65 m

BWSC

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