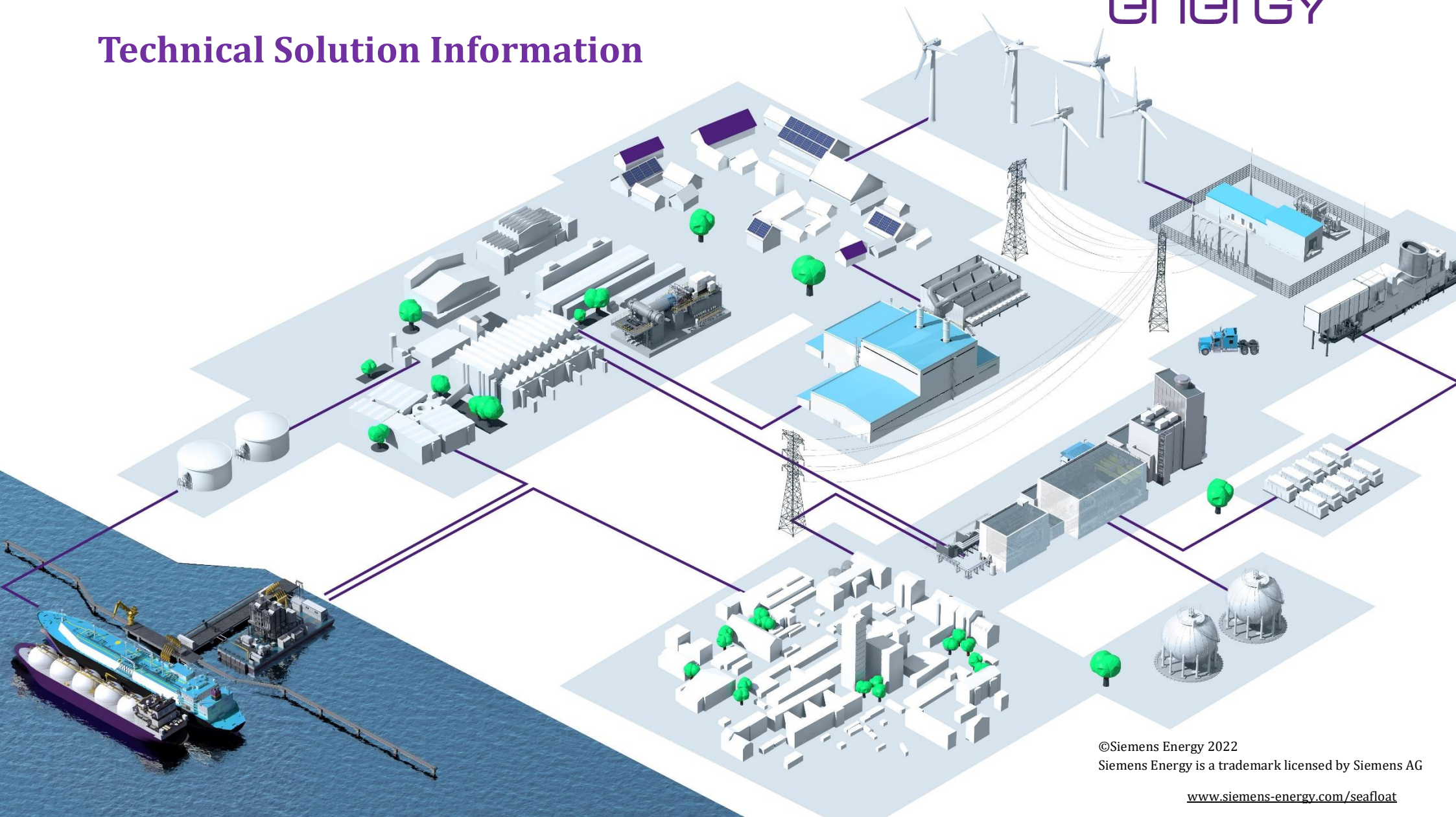
SeaFloat SCC-8000H

Technical Solution Information



www.siemens-energy.com/seafloat

SeaFloat SCC-8000H

Key Benefits of SeaFloat SCC-8000H 1+1

Substitution of coal fired power plants without interference with existing asset during off-site construction

Substitution of aged coal fired power plants with high efficient combined cycle solutions

- up tp 20% better LCoE*
- No Brownfield Risk such as demolishing works, relocation of existing infrastructure.

Emissions compared to coal fired plants
More than 50% savings in CO2 Emissions
with related impact on project financing/tax

Fuel supply from shore or via separate FSRU possible – alternatively with FSRP** concept

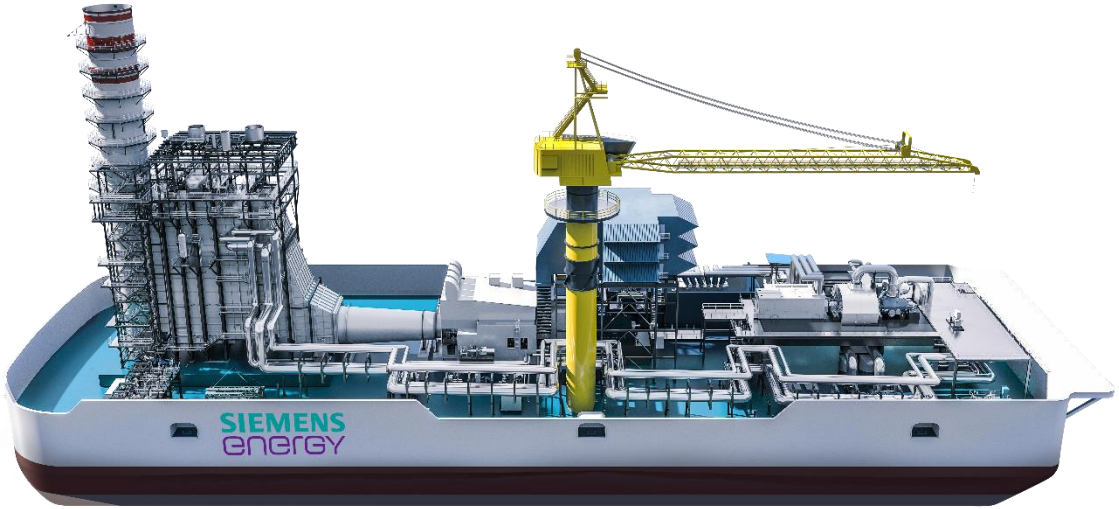
For location where Real Estate is a prime actor such as megacities with water access

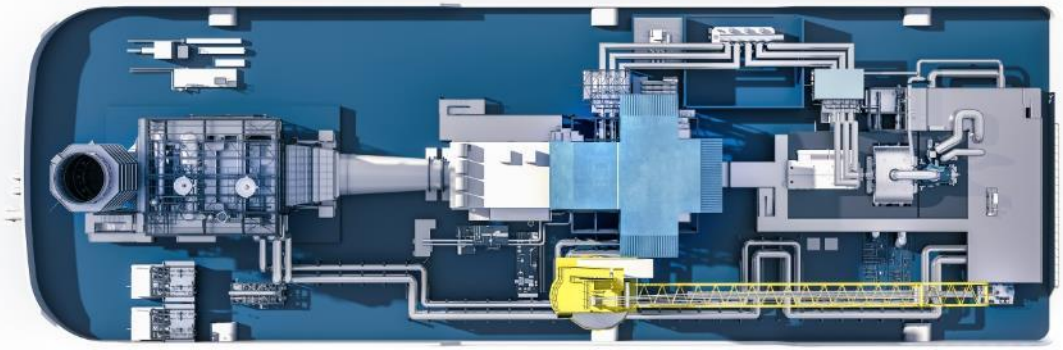
Scope of supply and services

The Siemens Energy scope of supply for main components of the SCC-8000H in a 1x1 configuration comprises the following major equipment:

- SGT-8000H gas turbine
- SGen-2000P gas turbine generator
- SST-5000 steam turbine
- SGen-100A steam turbine air-cooled generator
- Steam condenser
- Drum type, triple pressure, reheat heat recovery steam generator
- Power control center for Siemens supplied items (including uninterrupted power supply, battery, low voltage switchgear)
- SPPA-T3000 plant control system
- Sampling and chemical dosing skid
- Components for gas handling (including gas flowmeter, gas-chromatograph, gas-preheater)
- Main pumps
- Erection and commissioning service for Siemens supplied items (as a separate contract)

All remaining scope of supply is within the obligation of the shipyard or third party, which closely aligns with Siemens Energy to ensure a state of the art and reliable power plant.





1x1 SCC-8000H = 170m x 56m (length x width); Draft 7m -10m

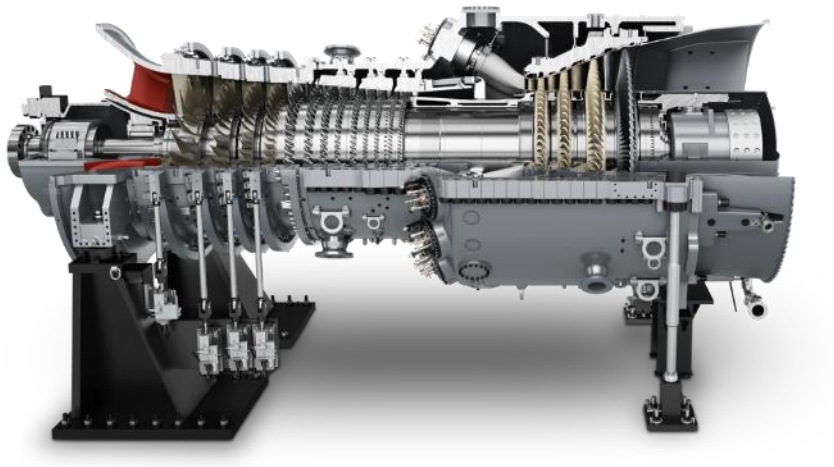
Outstanding performance available in SeaFloat application

The SGT-8000H based combined cycle power plant, in a multi shaft arrangement, has been optimized for the SeaFloat application (i.e., it can be installed on floating devices such as barges or platforms). The design is based on Siemens Energy's proven land-based reference power plant, known to provide reliable electricity at high efficiency and low cost.

SCC-8000H SeaFloat multi shaft plants are arranged in 1x1 arrangement: one (1) gas turbine, one (1) HRSG, and one (1) steam turbine. If desired simple cycle installation can be provided as well.

The SeaFloat adaption of the SGT-8000H is designed to withstand typical maritime conditions motions (roll & pitch, accelerations), hull deflections and respective environmental conditions. With the SCC-8000H SeaFloat power plant, the proven H-class benefits have now been complemented with all the benefits of a mobile, floating power plant.

The SCC-8000H based SeaFloat combined cycle power plant provides an optimum balance between capital cost, plant performance as well as operation and maintenance benefits.



Key benefits of SGT 8000H

- High efficiency (up to 41% SC, >61% CC)
- Fast start-up capability, high operational flexibility
- Low lifecycle costs
- High reliability and availability
- High serviceability
- Reduced emissions per kWh
- High efficiency and low emission also in part-load operation
- Future fit: capable of burning up to 30% hydrogen

Brief description of the main components

Pre-designed single lift packages will be installed at highly qualified shipyards. The high grade of pre-fabrication of Siemens Energy in-house Heat Recovery Steam Generator (HRSG) contributes to the quick installation on the barge.

Commissioning of the systems, inclusive HRSG cleaning, is done at the shipyard, thus the hook up and hot commissioning at final destination is minimized.

Gas Turbine (GT)

The SGT-8000H is a single shaft gas turbine of single casing design with high efficiency, low fuel consumption and low emissions, high availability and reliability, and a service-oriented design with long inspection intervals. Following a long history of successful Siemens Energy gas turbine development, the SGT-8000H provides the following advanced design features:

- 16 can annular combustor-based Platform Combustion System (PCS)
- Axial 13 stage compressor with high mass flow and four rows of variable guide vanes for improved turndown
- Four stage turbine: rows 1 to 3 with improved thermal barrier coated blades and vanes, proven casting materials
- Disc-type rotor with central tie bolt and radial serrations
- Two journal bearings and one thrust bearing
- Generator drive at compressor intake
- Axial exhaust diffuser

The rotor is supported by two journal bearings and one thrust bearing. The combined journal and thrust bearing are located at the compressor end and the second journal bearing at the exhaust end of the turbine.

The rotor is an assembly of blade carrying disks, and hollow shaft sections, held together by a pre-stressed central tie bolt. Hirth serration ensures the alignment of disks and hollow shaft sections at the same time allowing free radial expansion and contraction. The turbine rotor is air-cooled internally.

The combustion system consists of 16 baskets with air cooled transitions. The annular arrangement provides a remarkable uniformity of the exhaust gas temperature field over the full cross-sectional area of the turbine inlet, thus eliminating hot and cold spots. The ultra-low NOx technology reduces the formation of thermal NOx without injection of steam or water. This combustion system combines all the advantages of optimal combustion, including:

- Low NOx and CO emissions
- Low pressure drop
- High operating flexibility
- Optimal size and number of burners
- Compact design with easy accessibility

Gas Turbine Generator

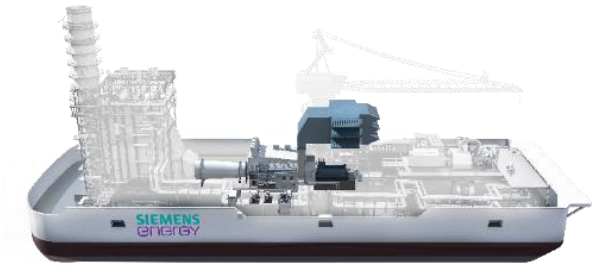
The two-pole SGen-2000P generator uses a directly water-cooled stator winding and a radially direct air-cooled rotor winding. The air coolers are arranged at the bottom of the base frame, divided into three sections. The three-phase winding inserted in the stator core slots is of two-layer transposed-bar design. The winding is vacuum pressure impregnated together with the stator core. The high-voltage insulation is provided according to the proven MICALASTIC system. The generator rotor shaft is a vacuum-cast forging and is supported in two babbitt-lined journal pedestal bearings. At each end of the generator, a shaft-mounted low-pressure single-stage compressor circulates of the pressurized cooling air. Cold and warm gas temperatures are monitored in the relevant areas. The air gauge pressure is controlled in relation to the actual loading to optimize the part load efficiency. The stator winding bars contain stainless steel cooling ducts. Demineralized cooling water flows through these ducts and dissipates the heat from the stator winding. The water flows from the inlet manifold into the stator bar ends of the top stator bar through Teflon™ insulated hoses. When being discharged from the bars at the other end, the water is redirected into the bottom bar, collected by hoses and a discharge manifold, and is returned to the skid mounted water tank.

An excitation transformer is used to take the excitation current from the auxiliary power system. A start-up frequency converter is provided for start-

up of the turbine generator unit. The generator acts as a motor in the converter mode to start the gas turbine set without an additional rotating prime mover. The converter forms part of the static excitation equipment.

Features of the generator:

- highest efficiency
- proven epoxy-mica insulation system of stator winding
- low maintenance costs



Steam Turbine (ST)

High Pressure (HP)/Intermediate Pressure (IP) Turbine

With the compact design of the combined HP/IP turbine, hot steam conditions are confined to the middle of the casing, while the steam glands at the casing ends are in regions of relatively low steam conditions. Temperature decay is much slower when compared to the design with individual turbine casings. Consequently, the start-up times are significantly shorter.

This compact design perfectly fits to the SeaFloat application which aims to decrease the footprint of the entire plant as much as possible.

Low Pressure (LP) Turbine

The main feature of the LP turbine is the double shell inner casing, which can be displaced axially by means of pushrods. The differential expansion between rotor and casings is thus minimized under all operating conditions. This is essential for high efficiency.

Condensing Plant

The condenser is a box-type surface condenser. The steam space is of a rectangular cross-section in order to achieve optimum utilization of the enclosed volume for the necessary condensing surface. The condenser is located below the LP turbine and forms an integral part of it.

The steam dome, shell, hotwell and the water boxes are steel fabrications. The condenser is fixed to the foundation. Thermal expansion will be accommodated by means of Teflon pads.

The double-flow LP turbine outer casing is connected to the condenser via the steam dome. The steam dome is welded to the exhaust casing of the turbine to form one unit.

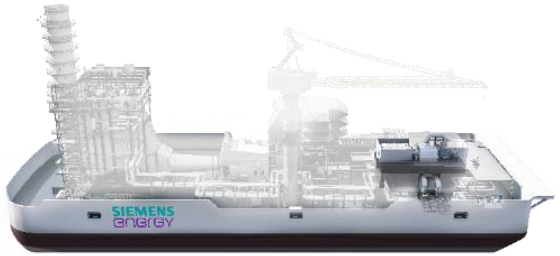
Final design of the condenser and the connection type to the LP section of the steam turbine can vary dependent on specific customer or site conditions.

Baffle plates in the water boxes prevent sloshing of water due to anticipated movement of the barge.

Steam Turbine Generator

The generator is of two-pole type, with direct radial air rotor cooling and indirect air cooling for the stator winding. This generator uses either brushless excitation with a stationary field exciter and rotating bridge-connected rectifier or static excitation, whereby the excitation power is taken from static excitation equipment and supplied to the rotor winding via the brush gear, carbon brushes and slip rings.

The standard design is IM 7215 according to IEC 60034-7 and features pedestal type sleeve bearings.



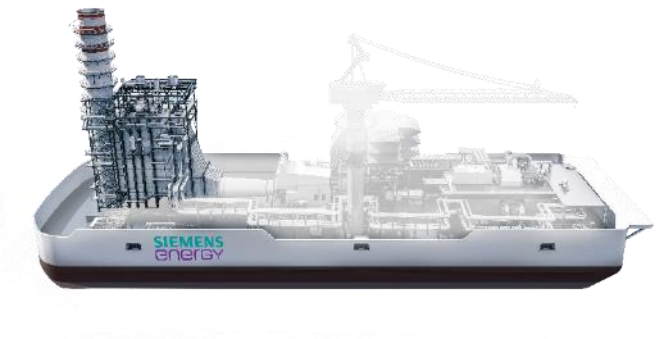
Heat Recovery Steam Generator (HRSG)

The HRSG provided is a triple pressure reheat natural-circulation drum-type steam generator and generates steam in high, intermediate, and low-pressure sections.

A condensate preheater is integrated in the HRSG. This arrangement enables higher efficiencies of the combined cycle power plant by using the exhaust gas energy to preheat the condensate before it passes through the feed water pump and into the LP system.

The HRSG is designed for outdoor installation and there is no bypass stack between the gas turbine and the HRSG.

Baffle plates in in the drums prevent sloshing of water due to anticipated movement of the barge.



Instrumentation and Control

To meet the technical, economic, and environmental aspects of modern power plants, Siemens Energy offers the SPPA-T3000 digital control system. Siemens Energy's instrumentation and control expertise and in-depth knowledge of the power plant process shape automation solutions. It is a well proven, structured, and redundant concept to ensure a maximum of availability and reliability.

Siemens Energy power plant automation will be used for almost the entire power plant equipment: turbines, generators, and main systems. It is based on open standards in hardware and software technology. Therefore, it can benefit from the continuous innovations being made in microelectronics. It is open for interfaces to automation systems supplied by other vendors, and to a possible extension of the plant in the future.

Electrical Plant (Power Control Center)

The electrical plant is designed to ensure maximum reliability of the plant's auxiliary power supply in all modes of operation, using reliable, proven and standardized equipment.

The necessary auxiliary power is taken from the generators. The auxiliary consumers are connected to different voltage levels in accordance with their function and power rating requirements.

The electrical equipment, such as batteries, battery chargers, LV switchgear, etc. is arranged in container-type enclosures (Power Control Centers) which are pre-assembled, and factory tested. The transformers and the generator circuit breakers are located outdoors.

Plant Start-up Times

Plant start-up time begins with GT ignition and is completed with GT at base load (inlet guide vane position at base load position) as well as HP and IP steam bypass stations closed.

Defining values for plant start-up conditions are ST HP/IP rotor temperatures and pressures and temperatures of HP-drum and HP-superheater. Plant

shutdown durations before start-up are predicted based on average cool-down rates.

Cold Start
A cold start-up is defined as a start-up after a plant shutdown of more than 48h but not longer than 120h.

Warm Start-up

A warm start-up is defined as a start-up after a plant shutdown of more than 8h but not longer than 48h.

Hot Start-up

A hot start-up is defined as a start-up after a plant shutdown not longer than 8h.

Frequency Range (Example for 50Hz Cycle)

The continuous operational frequency range of the power plant without restrictions is from 49 Hz to 51 Hz.

Operation in the frequency ranges from 47 Hz to 49 Hz and from 51 Hz to 52 Hz is limited to 30 seconds per event. After this time span the protection system will disconnect the power plant from the grid. The accumulated operation time in these frequency ranges is limited to 30 minutes in total. After 30 minutes an inspection is recommended. At 47 Hz and 52 Hz, power plant disconnection is initiated without time delay.

Fulfilment of Grid Code Requirements

Primary Frequency Control is achieved by an increase or decrease of the gas turbine output. Primary Frequency Control is available in the inlet guide vane range of the Gas Turbine. The load dynamics during Primary Frequency Control depend on the project specific requirements. The maximum value is up to 3%/s of the GT nominal output. The droop setting is adjustable at the GT speed controller. Typical droop setting values are in the range from 3% to 8%. Secondary Frequency Control is achieved by load setpoint adjustment by the load dispatch center, provided that the plant is operated in part load accordingly.

Motion Detection on GT, ST and HRSG

As the power plant is built on a barge/ship the movement of the barge/ship is monitored by motion detectors (acceleration & angles). The following directions are monitored:

- x = surge/longitudinal
- y = sway/transversal
- z = heave/vertical

If the plant is in operation and the GT, ST or HRSG exceeds the allowed level of acceleration, the equipment will be tripped.

Consideration of Marine Conditions

While the SCC-8000H based SeaFloat power plant uses well proven equipment from Siemens Energy's vast experience in land based combined power plants, the marine conditions, mainly movements, acceleration and hull deflection have been addressed by the following main measures:

- Multiple supports with vibration de-coupling of rotating equipment
- Stiffening of steel structures and frames (e.g., in HRSG)
- Flexible elements and interfaces
- Optimization of bearings of rotating equipment
- Baffle plates in lube oil reservoirs, boiler drums and condenser to avoid sloshing

Main Features and Performance Information

SGT-8000H based SeaFloat power plants provide the highest floating combined cycle plant efficiency, even at part load operation. Dry low-NOx single or dual fuel burners ensure low NOx and CO emissions.

- High GT reliability of 99.5%
- High CC availability
- Highest efficiency, refer to below table
- Dry Low Emissions (DLE)
- Low water consumption for steam cycle make up, no condensate polishing plant on board

Simple Cycle	50Hz	60Hz
Gross power output	450 MW	310 MW
Gross efficiency	>41%	>40%
Typical fuel gas mass flow	~22 kg/s	~16kg/s

Combined Cycle	1x1 /50Hz	1x1 /60Hz
Gross power output	~675 MW	~470 MW
Gross plant efficiency	>61%	>61%
Number of gas turbines	1	1

Note:

Emissions, NOx, [ppmV] <25 @ 15% O2 (50-100% GT load)

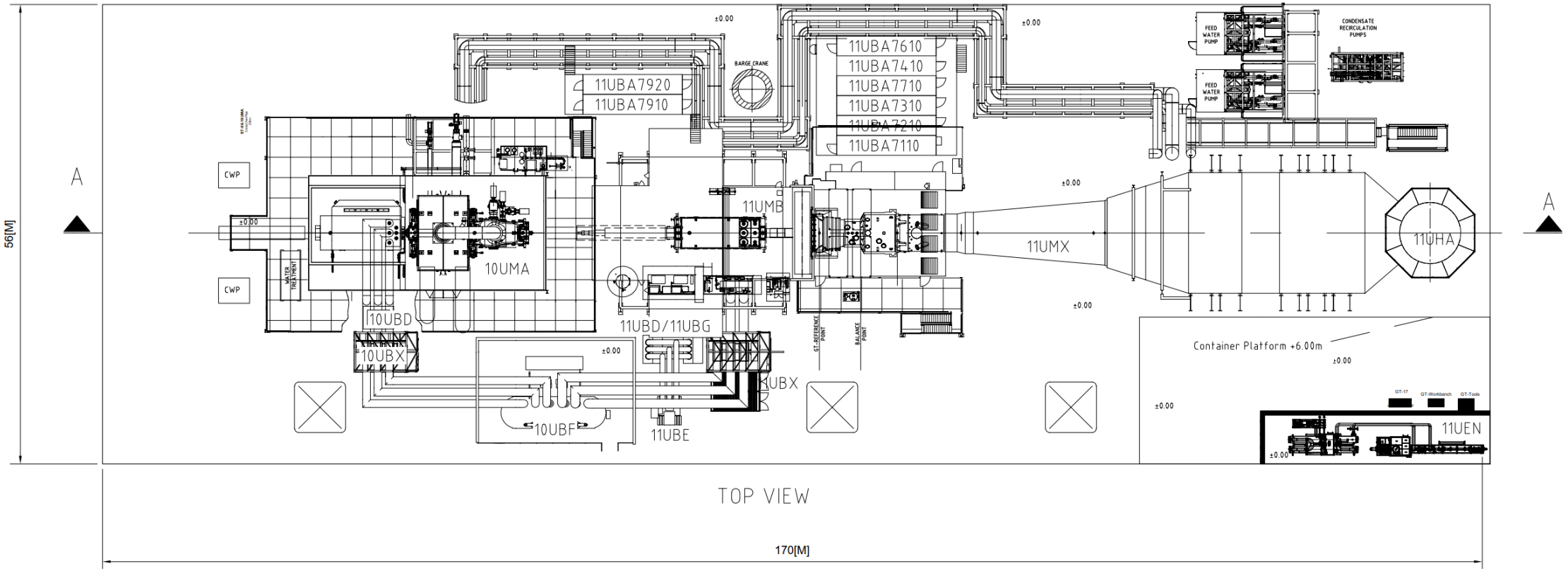
Emissions, CO, [ppmV] <10 @ 15% O2 (50-100% GT load)

Installed performance at ISO conditions

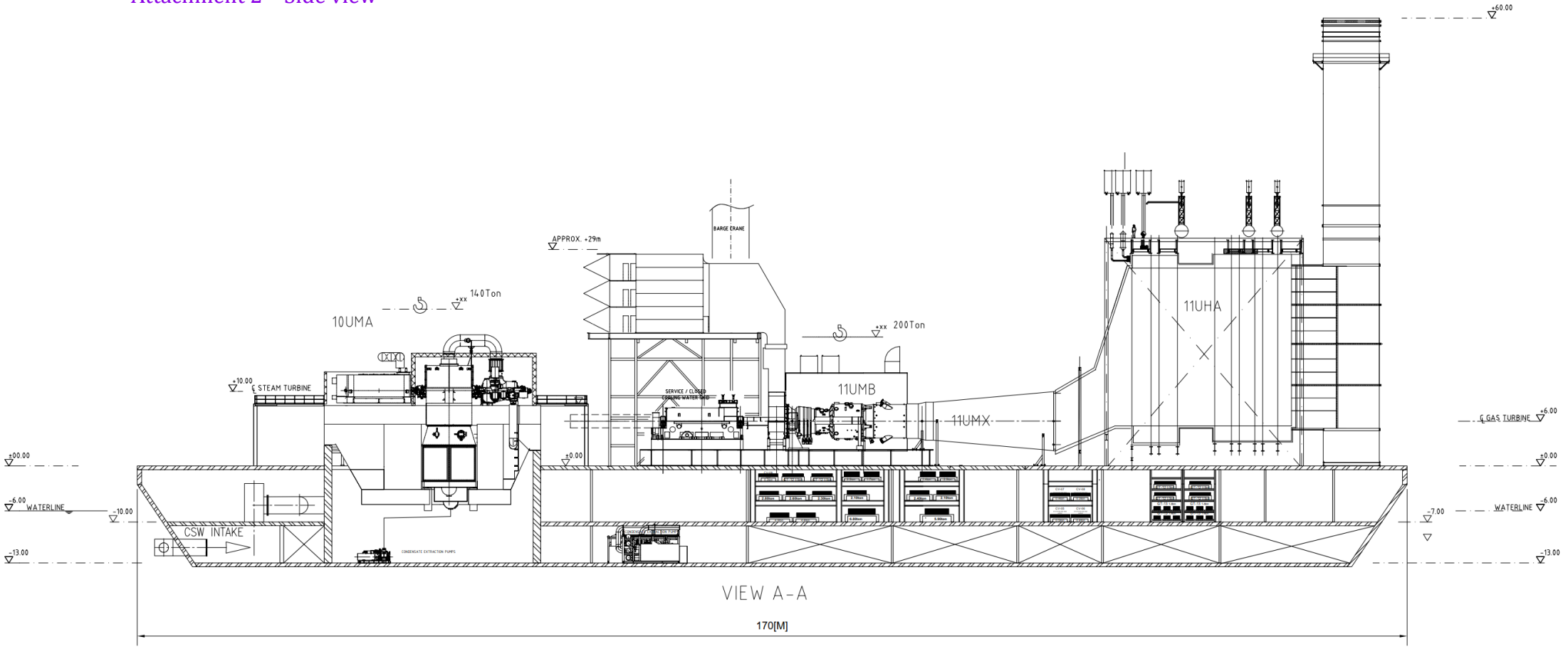
List of Attachments

Attachment 1 Plant Layout Drawing 1x1 – Top View
Attachment 2 Plant Layout Drawing 1x1 – Side View
Attachment 3 Typical main flow diagram

Attachment1 – Top view



Attachment 2 – Side view



Attachment 3 – Typical main flow diagram