

Synchronous Condenser

Mitsubishi Electric Power Products, Inc.

- ***Substation Systems Division***
- ***Generation Systems Division***



Synchronous Condenser System

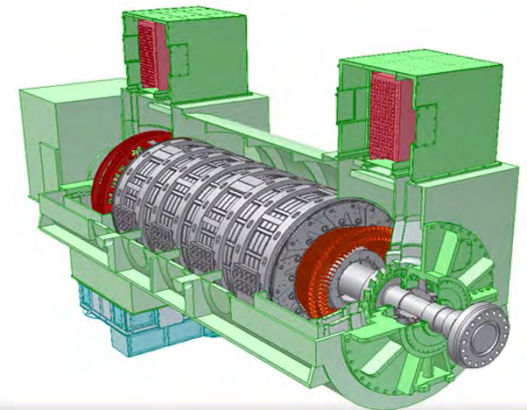
Energy Plant & Systems Department

 **MITSUBISHI ELECTRIC CORPORATION**

MITSUBISHI ELECTRIC POWER PRODUCTS, INC.

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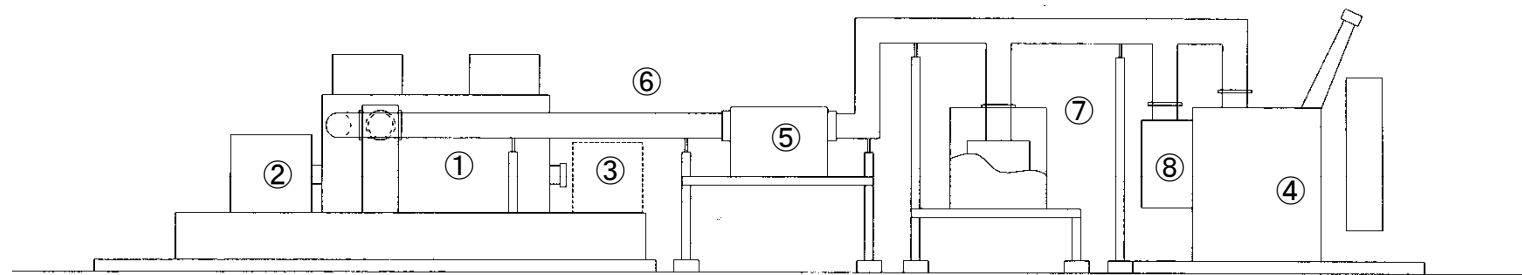
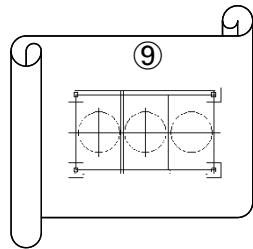


Comparison of Power Factor Correction Options



	Fixed Capacitors	Switched Capacitors	Static VAR Compensators	Synchronous Condensers
First Cost	Low	Medium	High	Medium
Installation Cost	Low	Medium	High	Low
Harmonic Problems	Yes	Yes	Yes	No
Voltage Transients	No	Yes	Yes	No
Infinitely Adjustable	No	No	Yes	Yes
Physical Capability	Small	Medium	Large	Medium
Overload Capability	No	No	No	Yes
Outage Ride-Through	No	No	No	Yes
Maintenance	Easy	Easy	Complex	Easy
Install Outdoors	No	No	No	Yes

Conception Diagram of Synchronous Condensers System - Main Components -



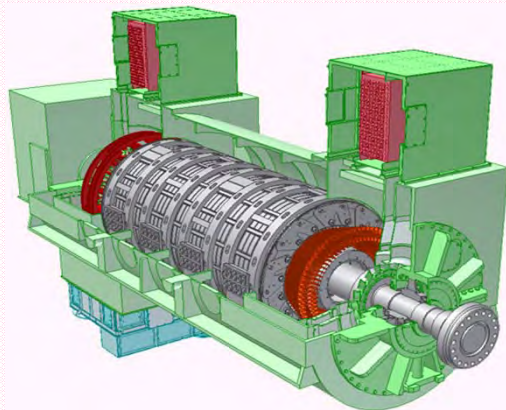
- ① Synchronous Condenser
- ② Slip Ring (or Brushless Exciter)
- ③ Starting Motor
- ④ Main Transformer
- ⑤ GMCB
- ⑥ IPB
- ⑦ EXC TR(EXC & SFC Package)
- ⑧ UNIT AUX TR
- ⑨ Cooling System
- ⑩ Electrical & Control Package

MELCO's Generator Line up



AIR COOLED

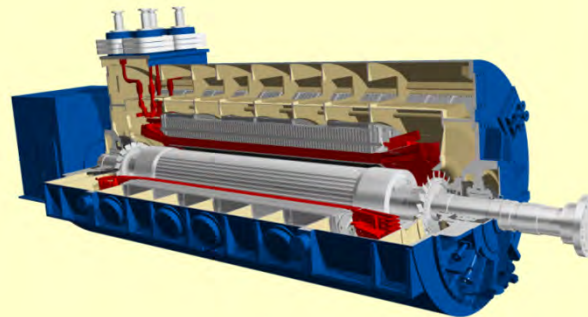
~400MVA



- Larger Capacity Air-Cooled Turbine Generator
- Simple and Higher Efficiency

HYDROGEN INDIRECTLY COOLED

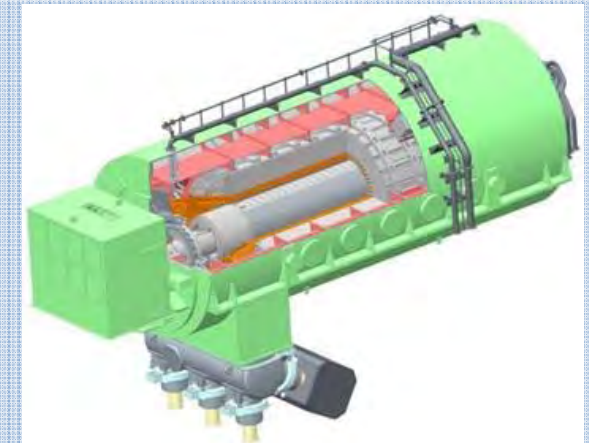
~800MVA



- Larger Capacity Hydrogen Indirect Cooled Generator
- High Reliability / Proven design based on long experience
- Simple and Higher Efficiency

WATER COOLED

~1200MVA



- Larger Capacity Water / Hydrogen Cooled Generator
- High Reliability / Proven design based on long experience
- Higher Efficiency

Advantages of 2-pole over 4-pole Generators



1

Very lower mass moment of inertia with the same power (appr.1:4)
This results in a smaller starting motor

2

Higher rotational energy due to the double speed, more stable
in the grid

3

Higher thermal time constants. This results in a higher over load
capability

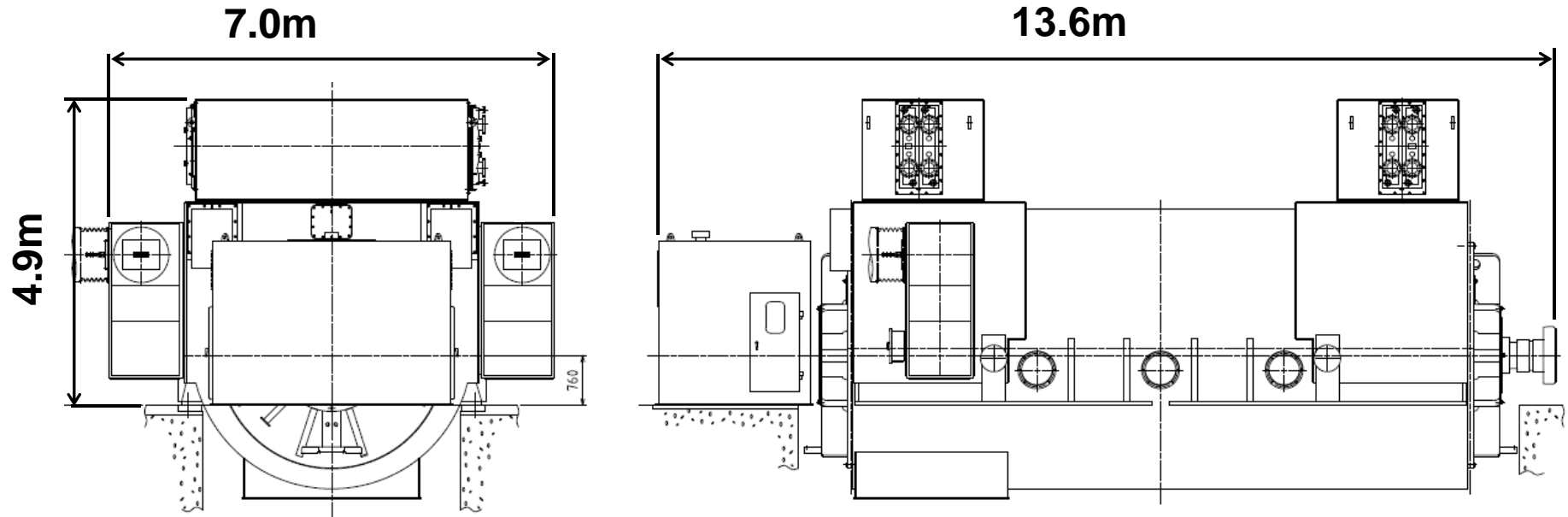
4

Higher unbalance load capability due to the damper winding,
which is composed of rotor wedges and retaining ring

5

Modern reliable Generators

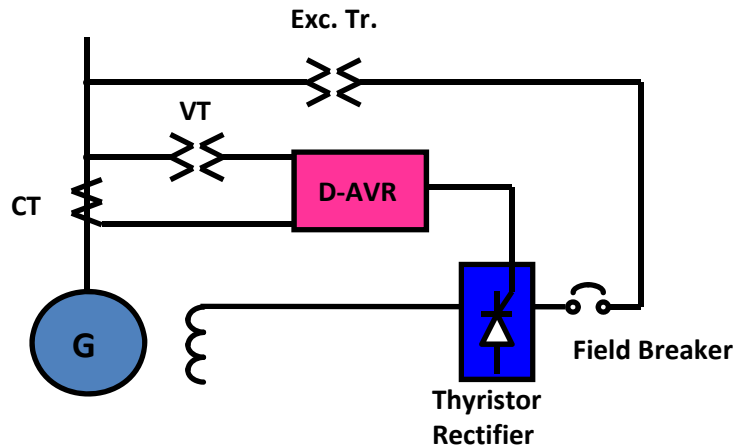
Typical Outline of Synchronous Condenser



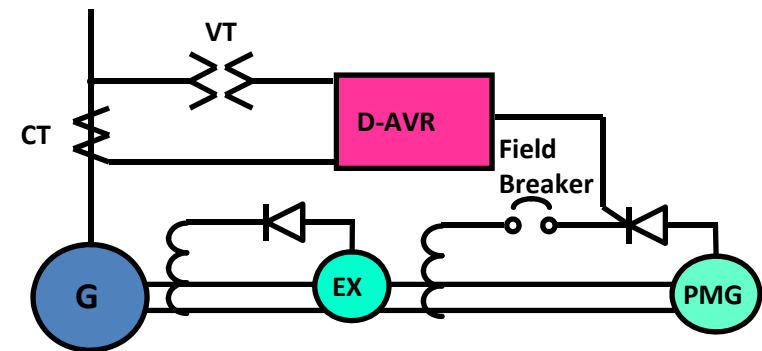
Power (at PF=0)	Over / Under excited: 240 / 180 MVar
Voltage	18kV
Frequency	60Hz
Cooling	Air Cooled
Excitation	Static

Mass	Stator	274 ton
	Rotor	63 ton
	Total	412 ton

Type of the Excitation System



Static (Thyristor) Excitation System



Brushless Excitation System

Item	Static (Thyristor) Excitation System	Brushless Excitation System
Equipment	Slip Ring Digital AVR Cubicle Excitation Cubicle	AC Exciter with PMG Digital AVR Cubicle
Features	Shorter Shaft Length Larger Equipment Space	Longer Shaft Length Smaller Equipment Space
Response Time (Excitation System)	High Speed (~ 0.05sec)	Nominal: 0.5 – 2.0 sec HIR application: Less than 0.1sec
Maintenance	Periodic Brush Replacement	Periodic Visual Inspection of Rotating Fuse

Type of the Starting Method – Technical Features



Static Frequency Converter(SFC)



Starting Motor Controlled by Variable Frequency Drive(VFD)

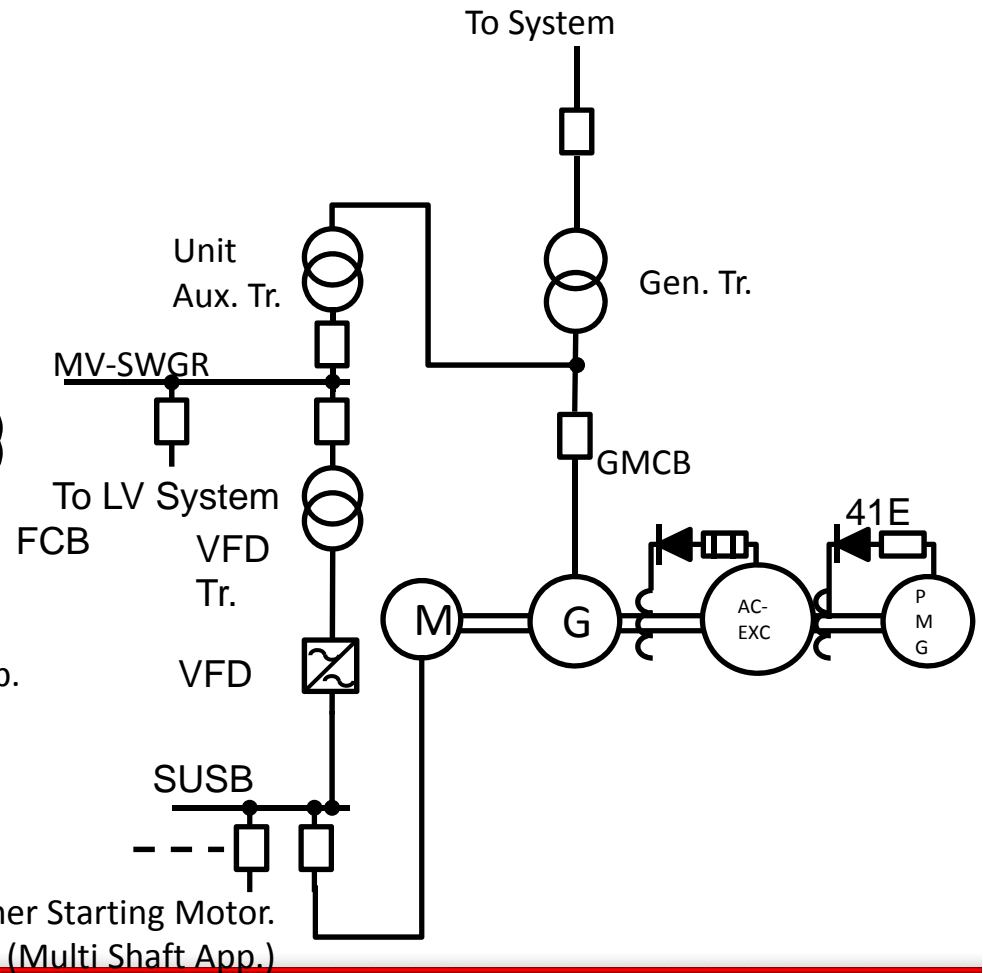
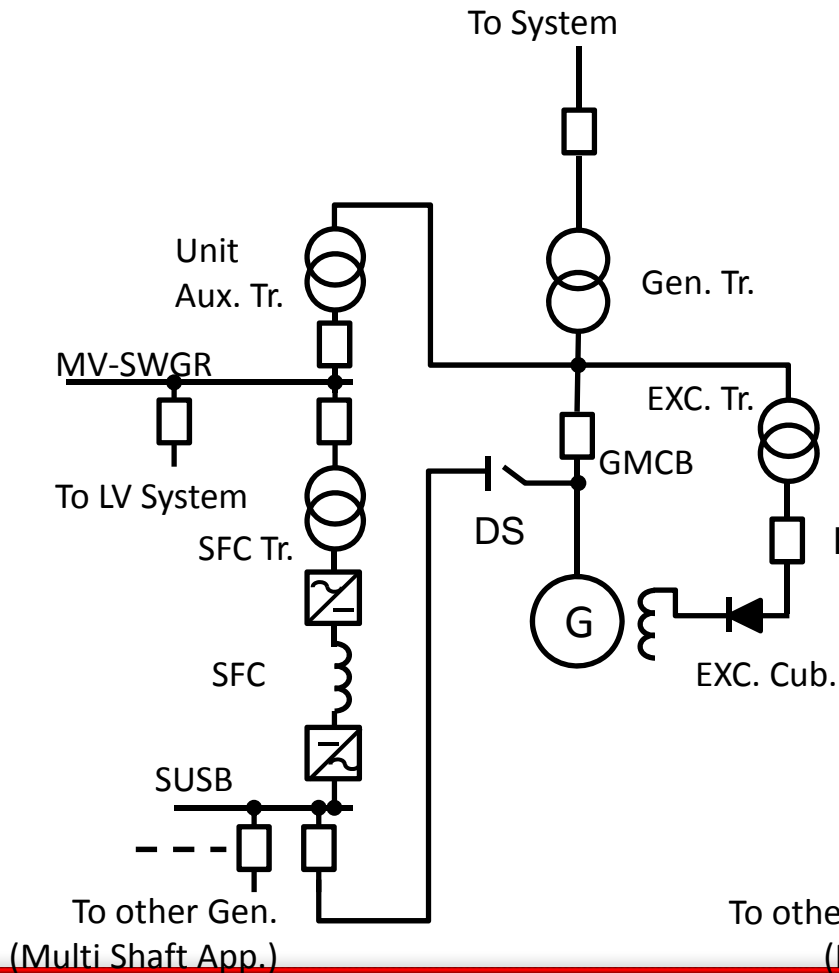
Item	SFC	Starting Motor with VFD
Equipment	Static Frequency Converter(SFC)	MV - Starting Motor Variable Frequency Drive(VFD)
Operation	The generator is accelerated as synchronous motor.	The generator is accelerated by the starting .
Features	Shorter Shaft Length	Longer Shaft Length or Mechanical Device
Applicable Excitation System	Static	Static or Brushless
Multi-shaft Application	SFC can be used as a common for multi-shafts.	One(1) VFD can be used as a common for multi-shaft. But, each generator requires own starting motor.

Type of the Starting Method – Single Line Diagram



Static Frequency Converter(SFC)

Starting Motor Controlled by Variable Frequency Drive(VFD)



Provision of equipment from MELCO's Factories



TRANSMISSION & DISTRIBUTION SYSTEMS CENTER

Itami Works

- IPB
- GMCB

Ako Works

- Generator Transformer
- Unit Aux. Transformer
- Excitation Transformer

JAPAN

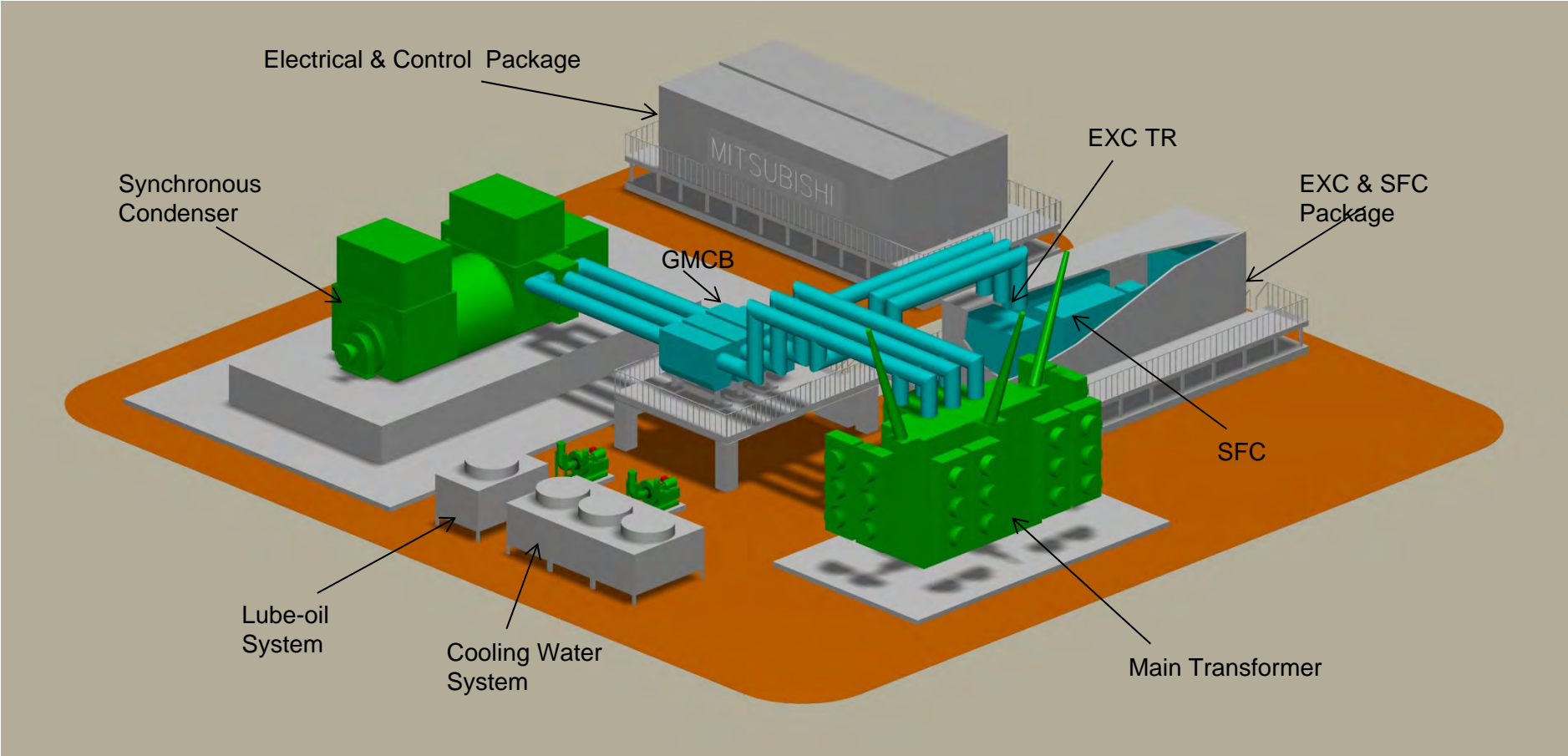
ENERGY SYSTEMS CENTER

- Plant Engineering
- Generator
- Excitation System(AVR/EXC)
- Digital Control System
- Protection Relay System
- DC system /UPS system
- Package House
- Lube Oil System
- Cooling Water System
- TMEIC - SFC/VFD

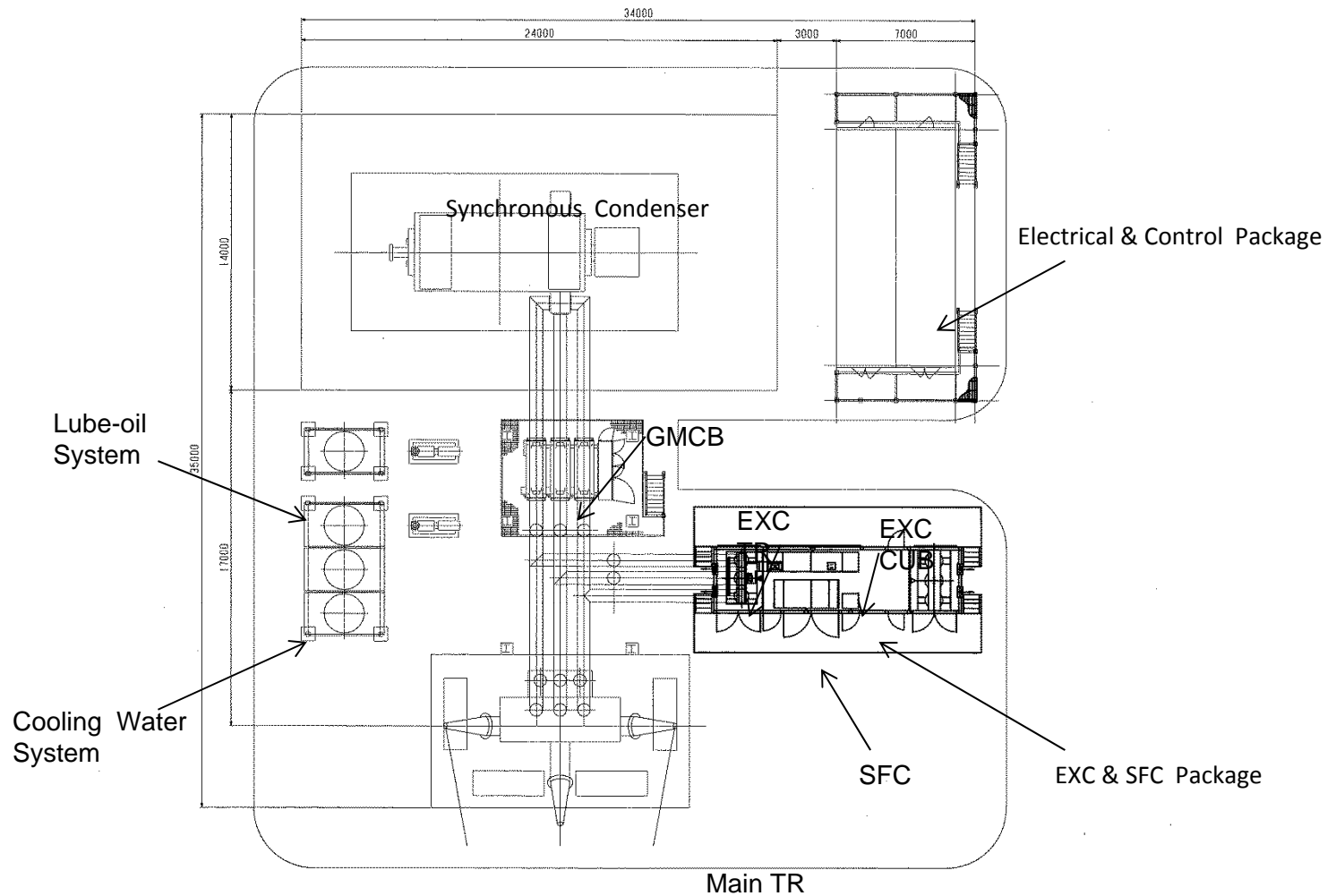
POWER DISTRIBUTION SYSTEMS CENTER

- MV/LV SWGR
- MCC, D/B

Layout Image of Synchronous Condensers System



Layout Plan of Synchronous Condensers System



Benefits of MELCO's Synchronous Condenser System



1

MELCO is one of large generator supplier in the world.
MELCO has rich experience/acknowledge of design/manufacturing/installation of large generators.

2

MELCO also has capability for provision of electrical equipment, the excitation systems, the digital control/protection system, the starting device, large transformers, MV/LV-SWGRs, power distribution system and so on, which are required for the synchronous condenser system.

3

MELCO also has rich experience of total(plant) engineering in the power station.

4

MELCO can be a single contact windows for electrical equipment for the synchronous condenser system in the newly installation and future service.