



Hydro Balance of Plant (BOP) & Auxiliaries

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Imagination at work

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Hydro Power Plant - Generalities



*‘Water
to Wire’*



Hydro Power Plant - Generalities

Agenda

- Introduction
- Balance of Plant x Auxiliaries
- Energy Production
- Electrical and Mechanical BoP
- Machine Auxiliaries



Introduction





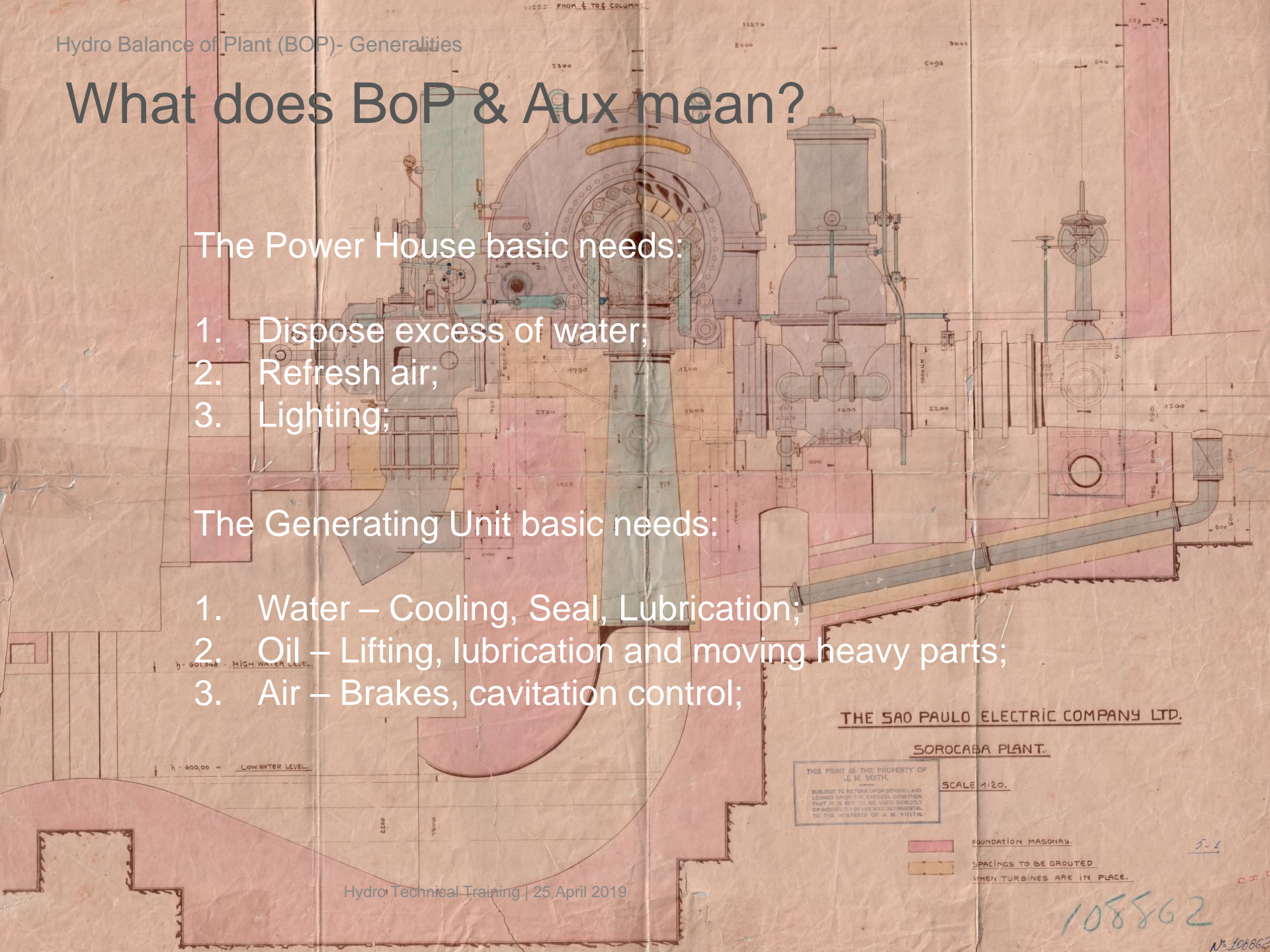
What does BoP & Aux mean?

The Power House basic needs:

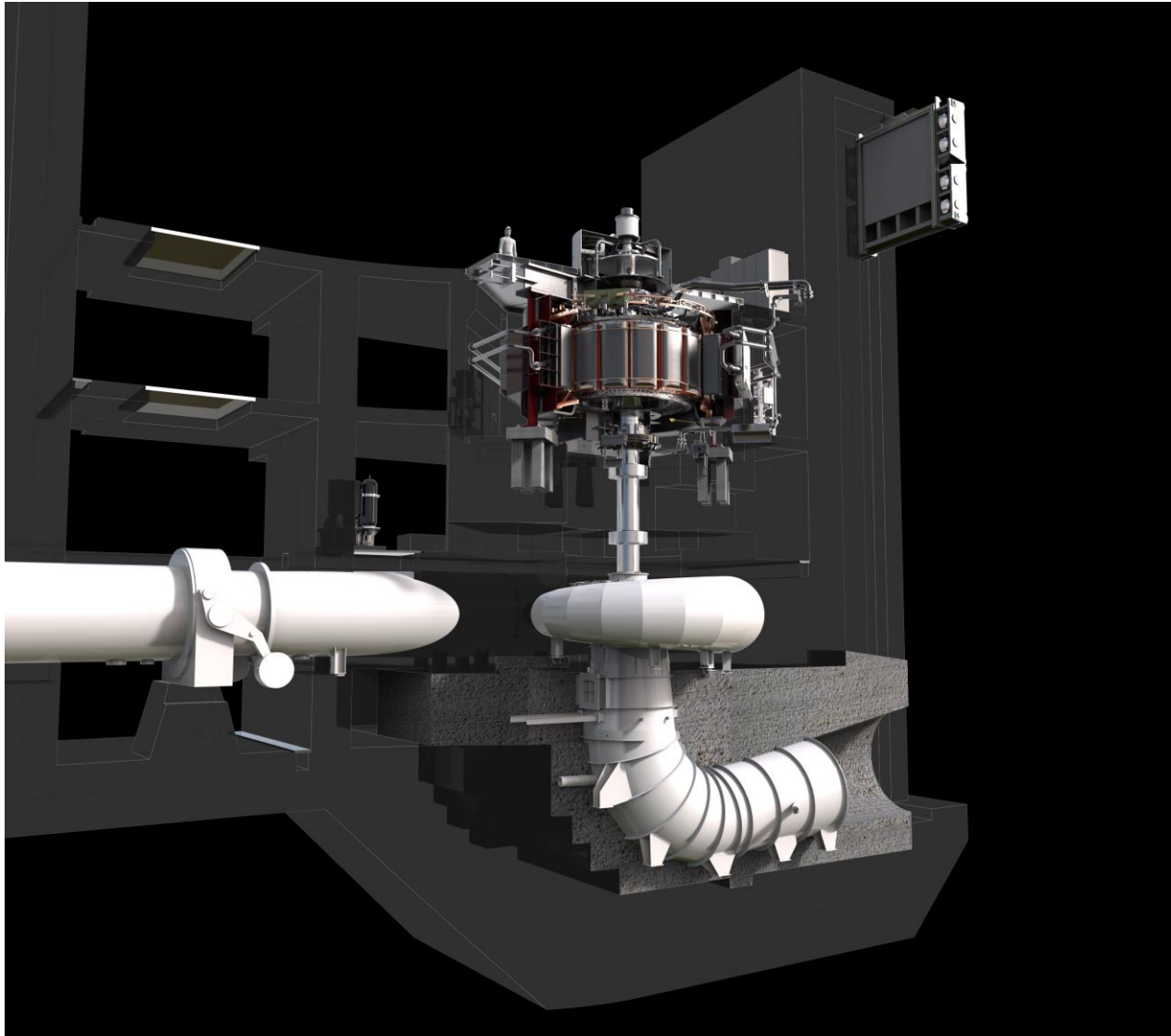
1. Dispose excess of water;
2. Refresh air;
3. Lighting;

The Generating Unit basic needs:

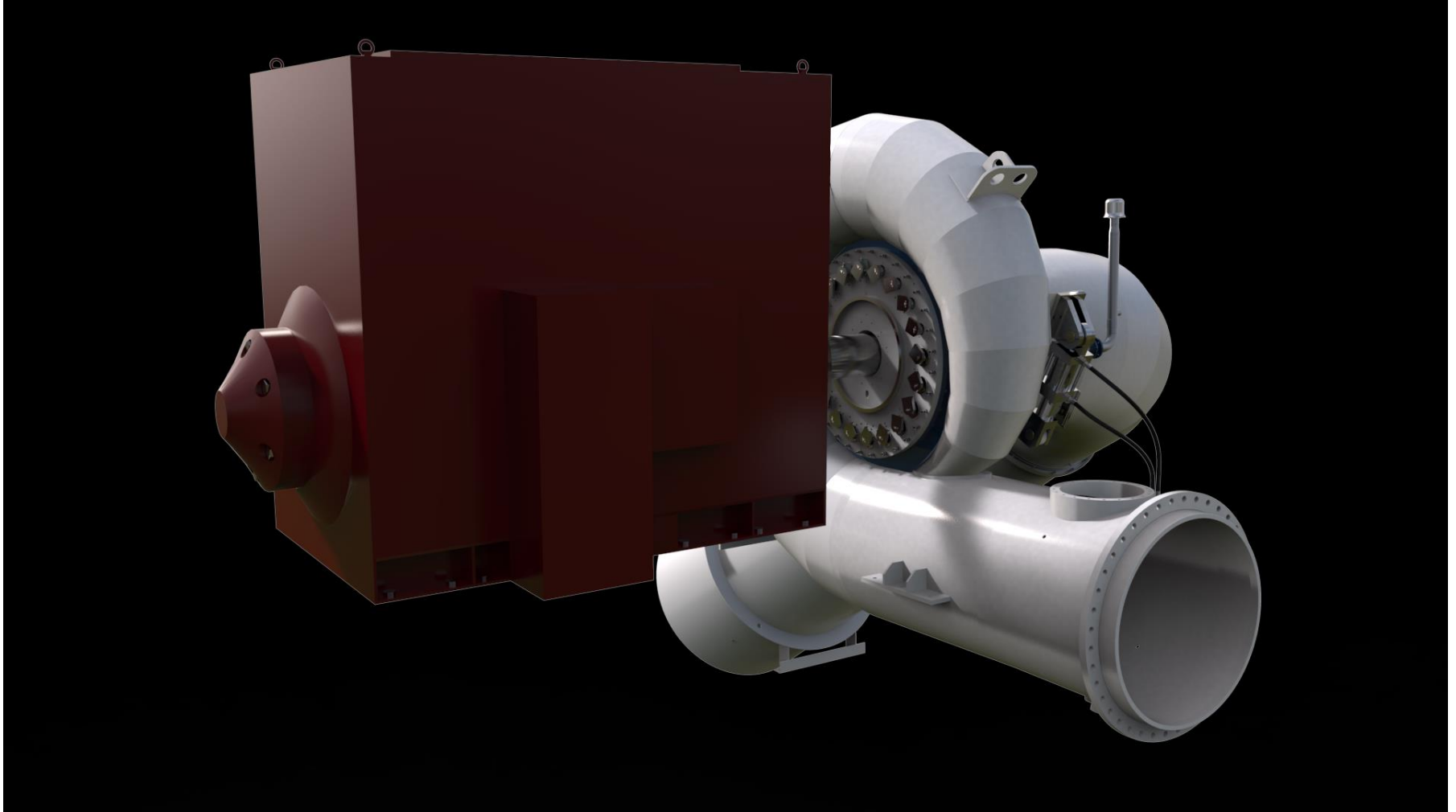
1. Water – Cooling, Seal, Lubrication;
2. Oil – Lifting, lubrication and moving heavy parts;
3. Air – Brakes, cavitation control;



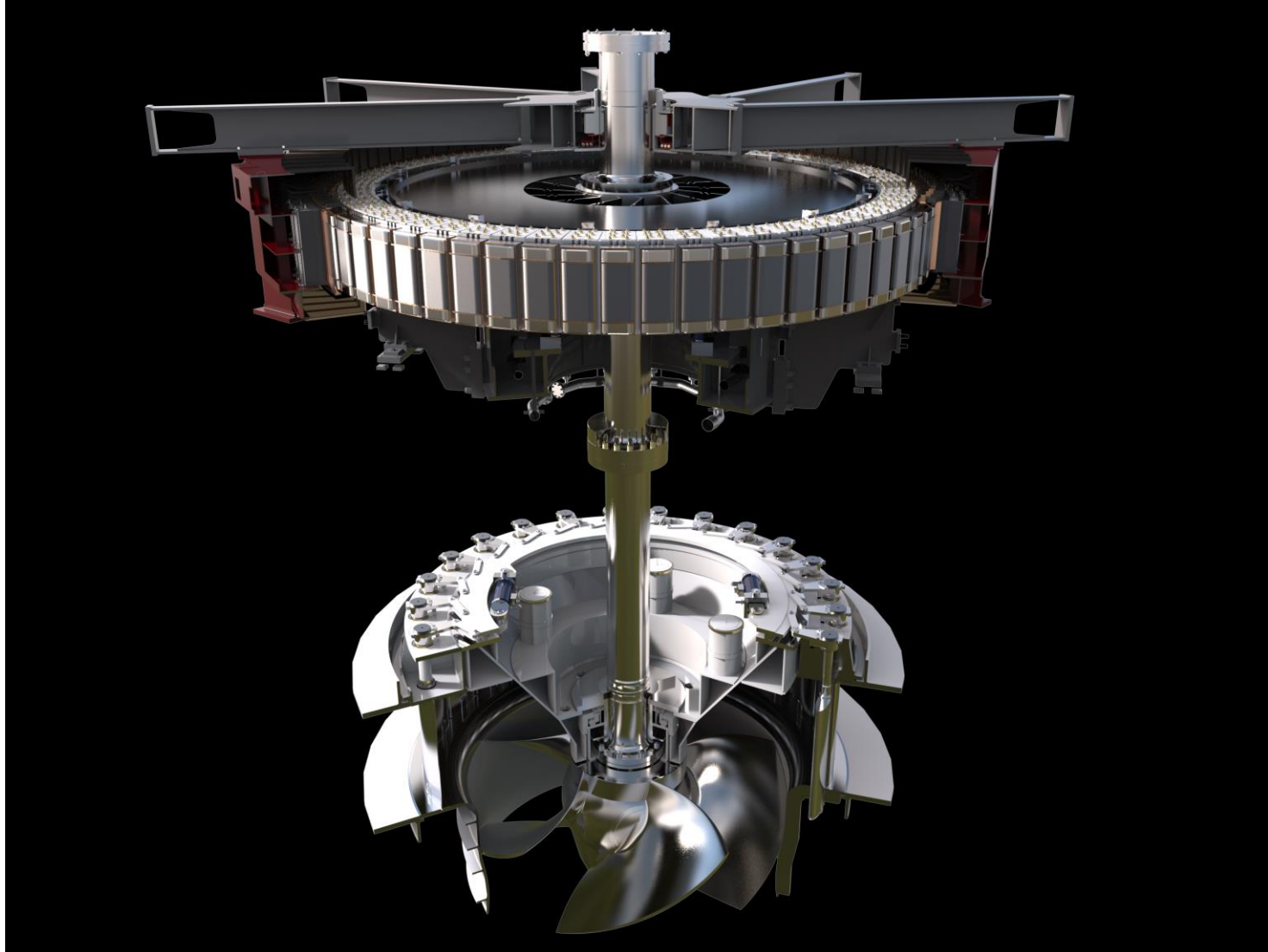
Vertical Francis



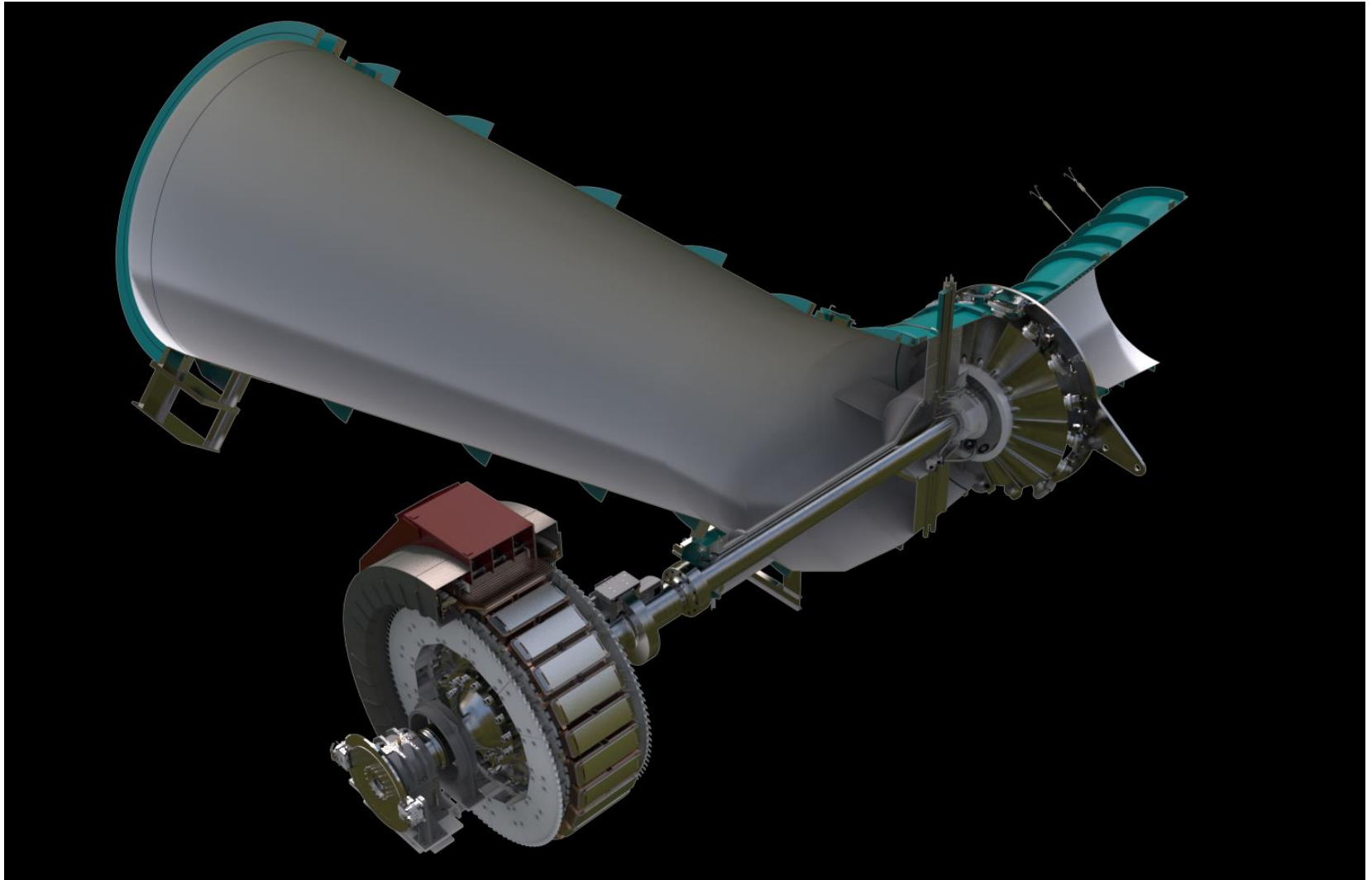
Horizontal Francis



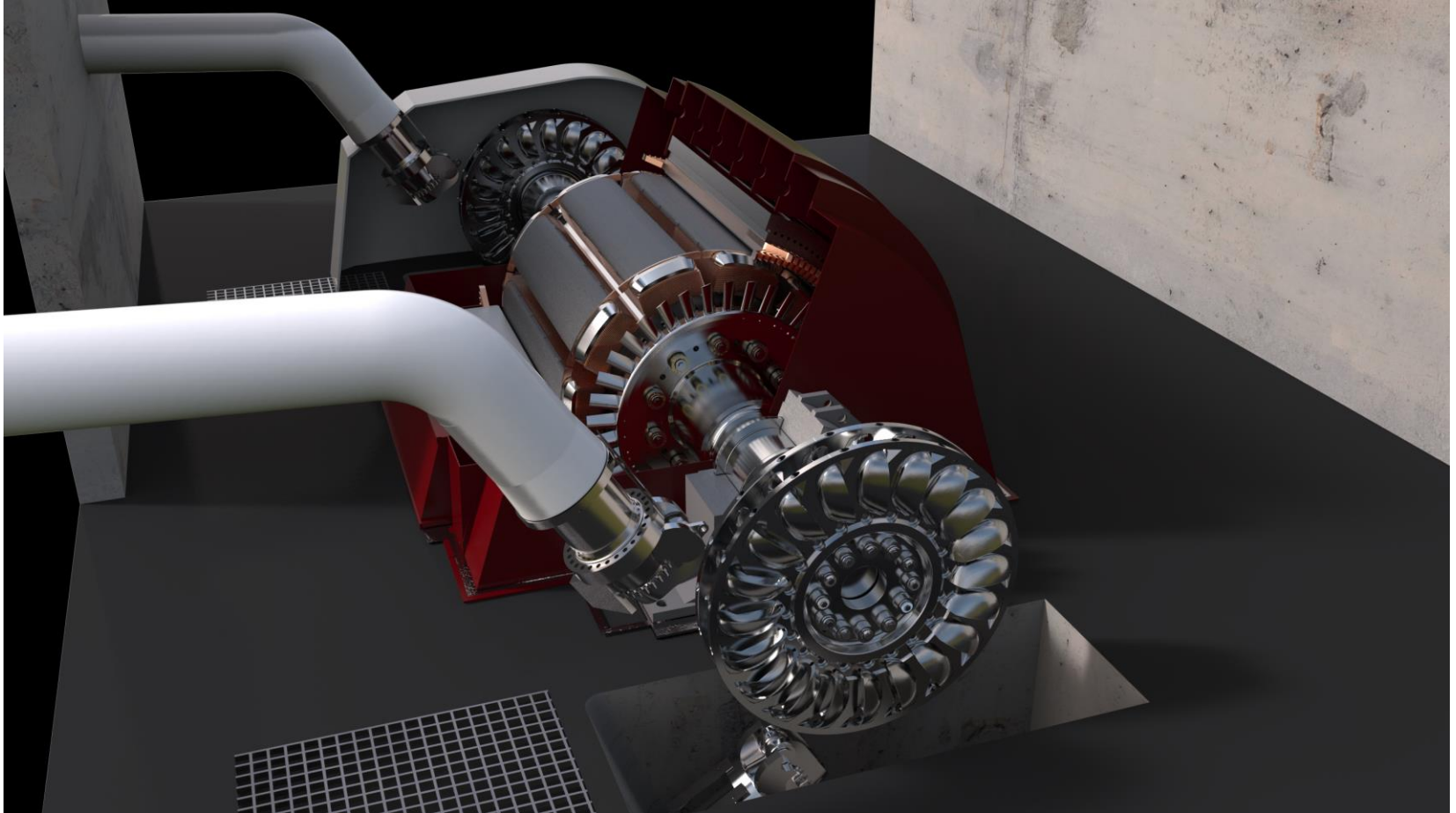
Vertical Kaplan



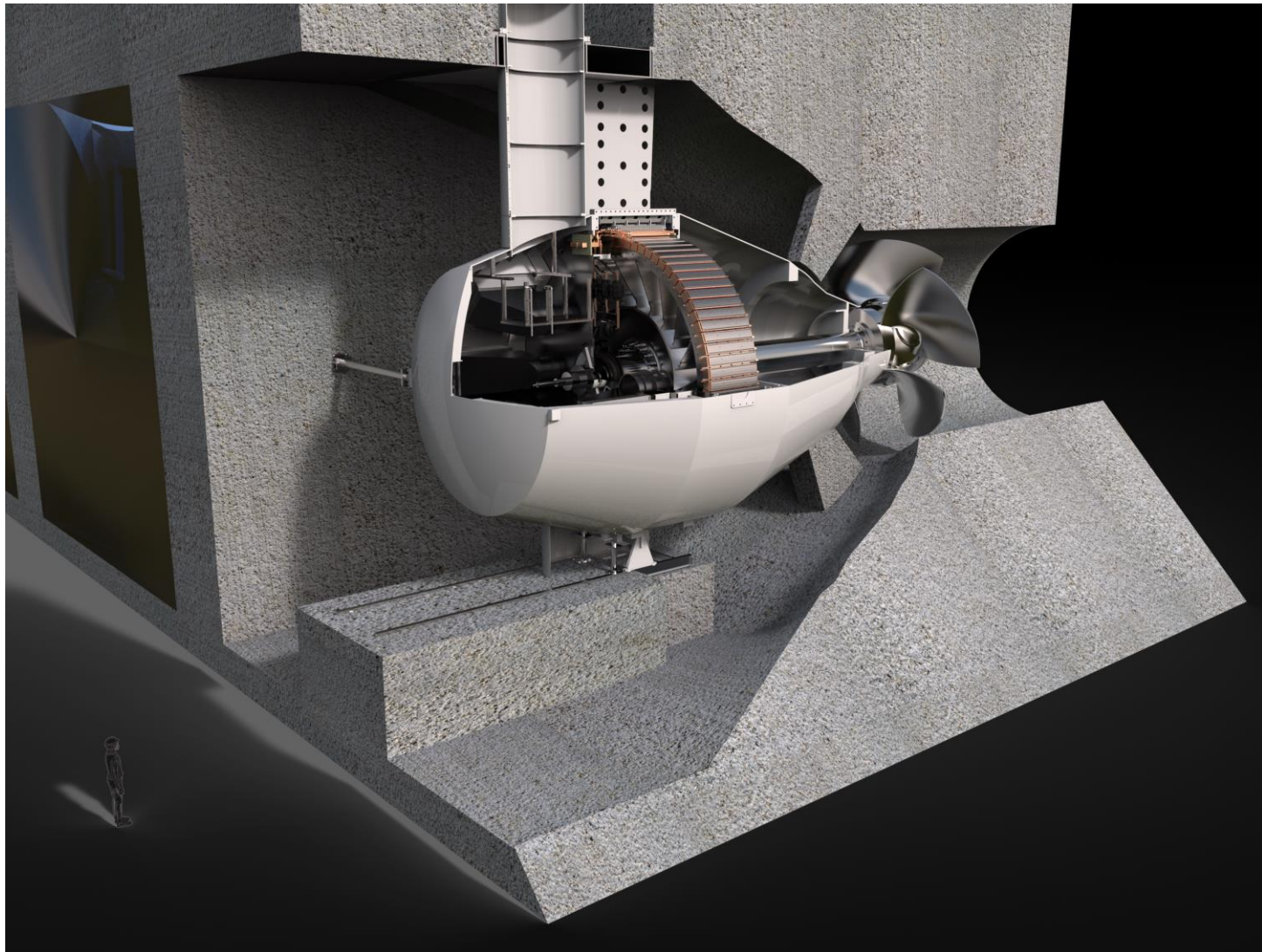
SAM – Horizontal Kaplan



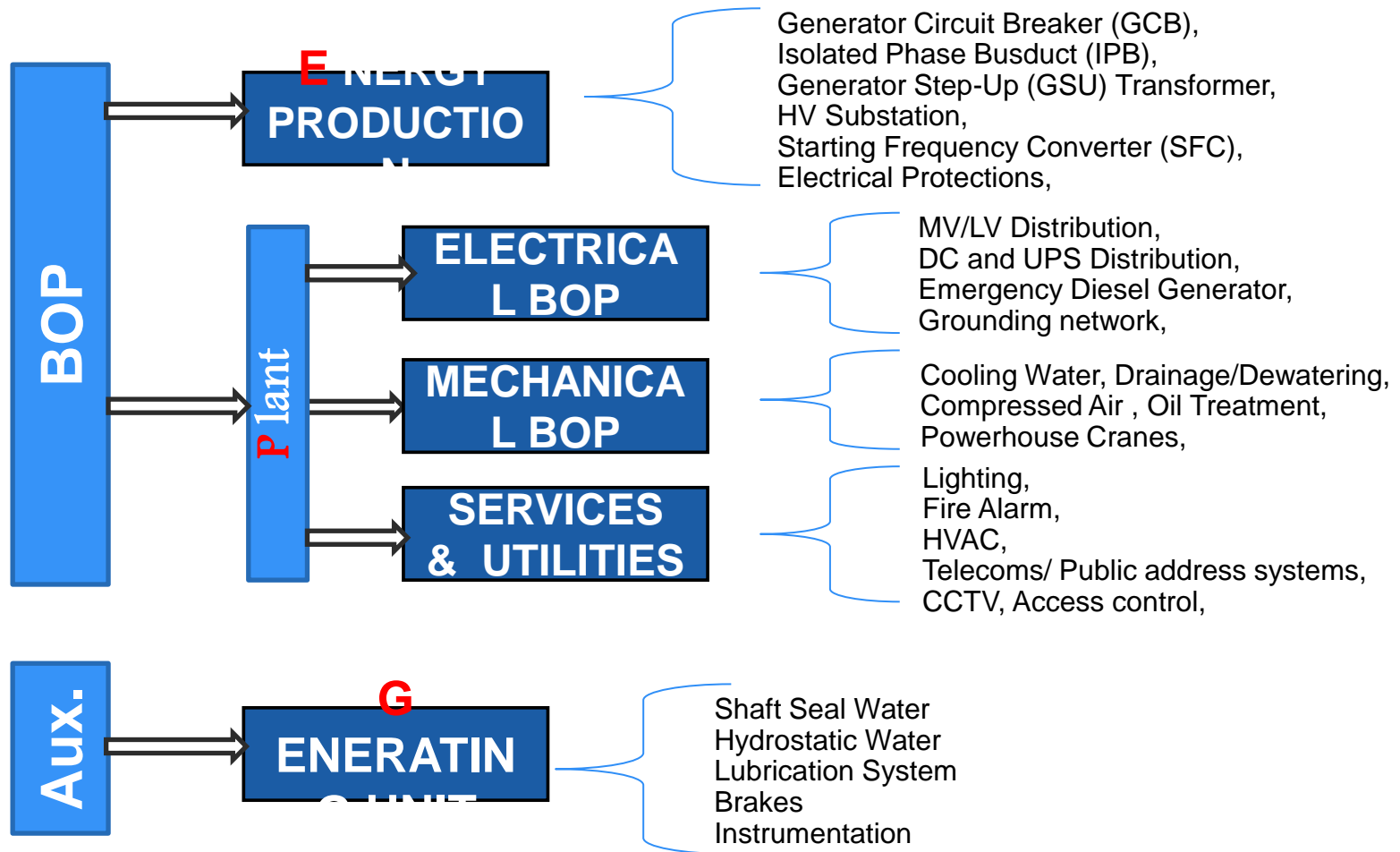
Horizontal Pelton



Bulb



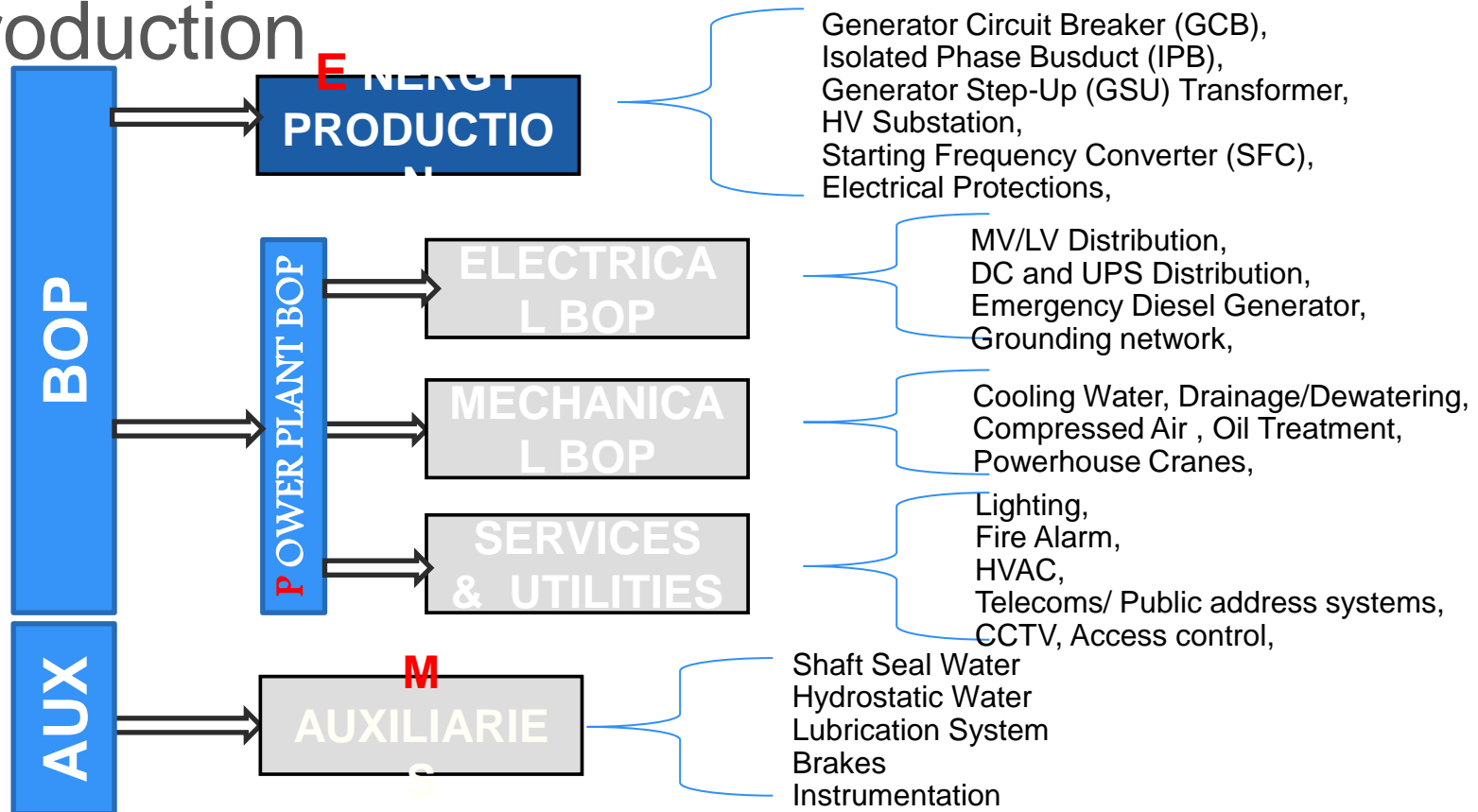
Introduction- what does BoP&Aux. contain?



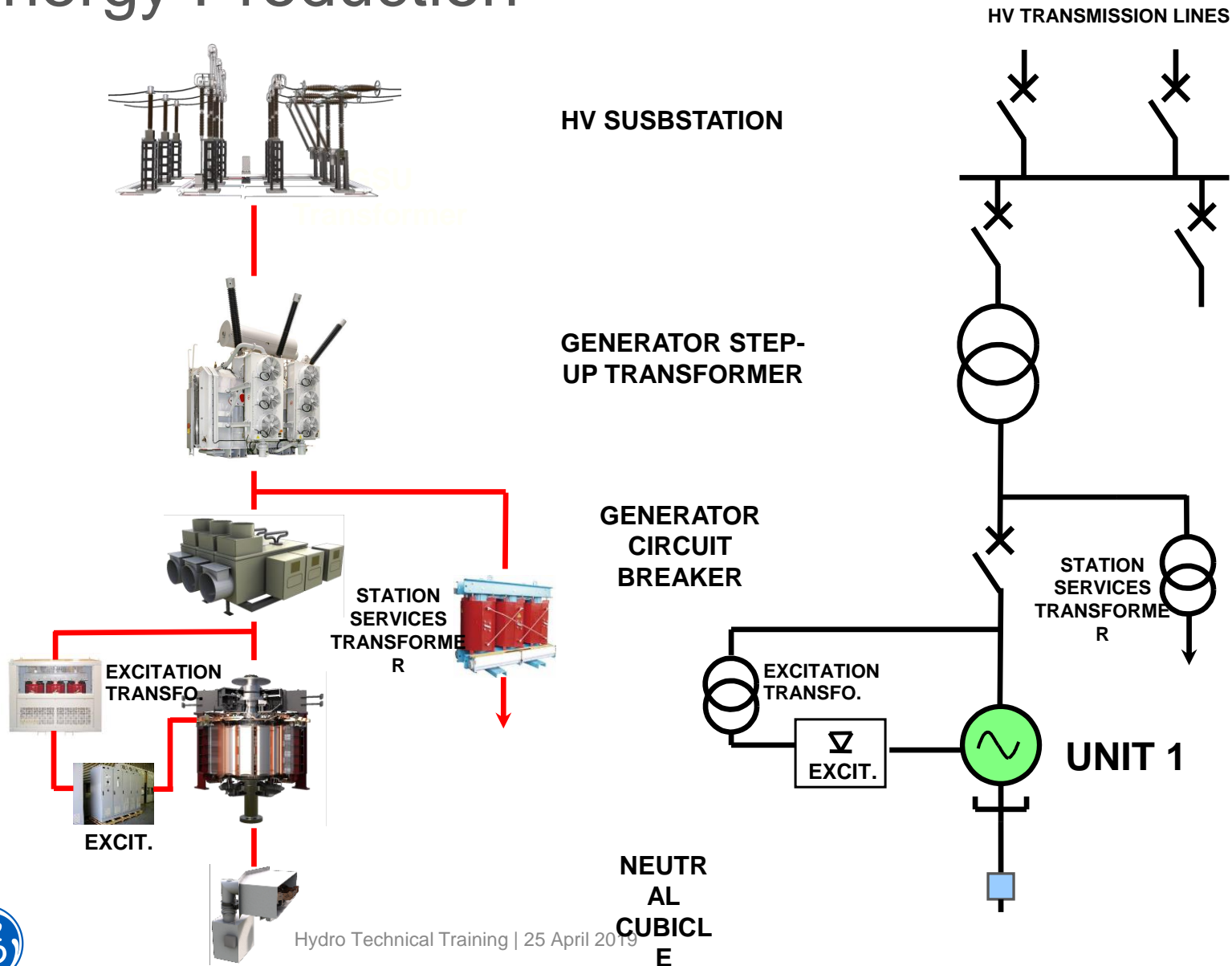
Energy Production



What does BOP&Aux. contain? Energy Production



Energy Production



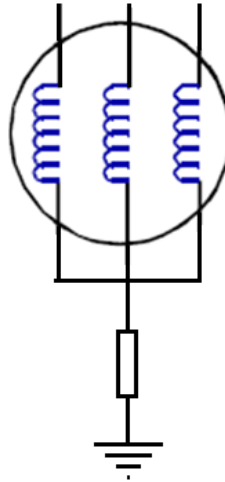
Energy Production- Neutral Cubicle

Function :

- Keep fault to earth under low values.
- Avoid Voltage Surge

Design:

- Sized according parasite capacitance.
- It may contain single phase distribution transformer and LV resistor or only MV resistor.
- It shall be sized to avoid surge voltage and high current.
- Voltage and current transformer for protection are needed.



Energy Production- Generator Circuit Breaker

Function:

- Isolate generator from the system in case of fault;
- Ensure the breaking of current in any circumstance (even in case of fault)
- Synchronization to the network Grid during the starting up (coupling)

Design:

- Electrical parameter (rated and short-circuit currents ...), calculated with inputs from Generator and HV grid.
- Associated with disconnector, earthing switch, current and voltage transformer...
- Physical integration (connected to busduct)
- Interface with electrical protection and control system,



Energy Production- Isolated Phase Busbar

Function:

- Electrical connections between the generator, the GCB and the main transformer.
- Can withstand the maximum short-circuit current.
- Limit the electro-magnetic perturbation,
- Limit the risk of phase to phase short-circuit (each conductor phase is located inside its individual enclosure,
- Ensure safety of people (enclosure at 0V).



Design:

- Important criteria: low losses at rated current,
- Temperature of conductor and enclosure,
- In short-circuit condition: very high currents and high electro-dynamic forces.

Challenges :

- Rigid connection: final layout (on-site equipment and voltage building...) is not as per the improvements during design.
- Assembly (on-site welding, layout)
- According to the supplier selection, the external diameter can be different



Energy Production- Main Transformer

Function :

- Generated power converted from MV to HV.

Design:

- Transport restriction (tunnel, bridge...) → single phase transformers in case of strong restriction.
- Protection against the overvoltage (lightning surge)
- Cooled by water (cavern) or by air (outside installation)
- Significant civil work interface

Challenges :

- Long time delivery (12 months)
- Customised and optimised for each project → transformers are different in each project,
- Sensitive construction (a lot of manufacturing knowhow)
- Difficult transportation (high weight, and size);
- Guaranteed performances;
- In case of failure during test → new design, new manufacturing → 12 months delay...



Energy Production- High Voltage Substation

Function:

- Connection of the power plant to the HV network.
- Tariff metering, electric protection
- Substation Synchronisation



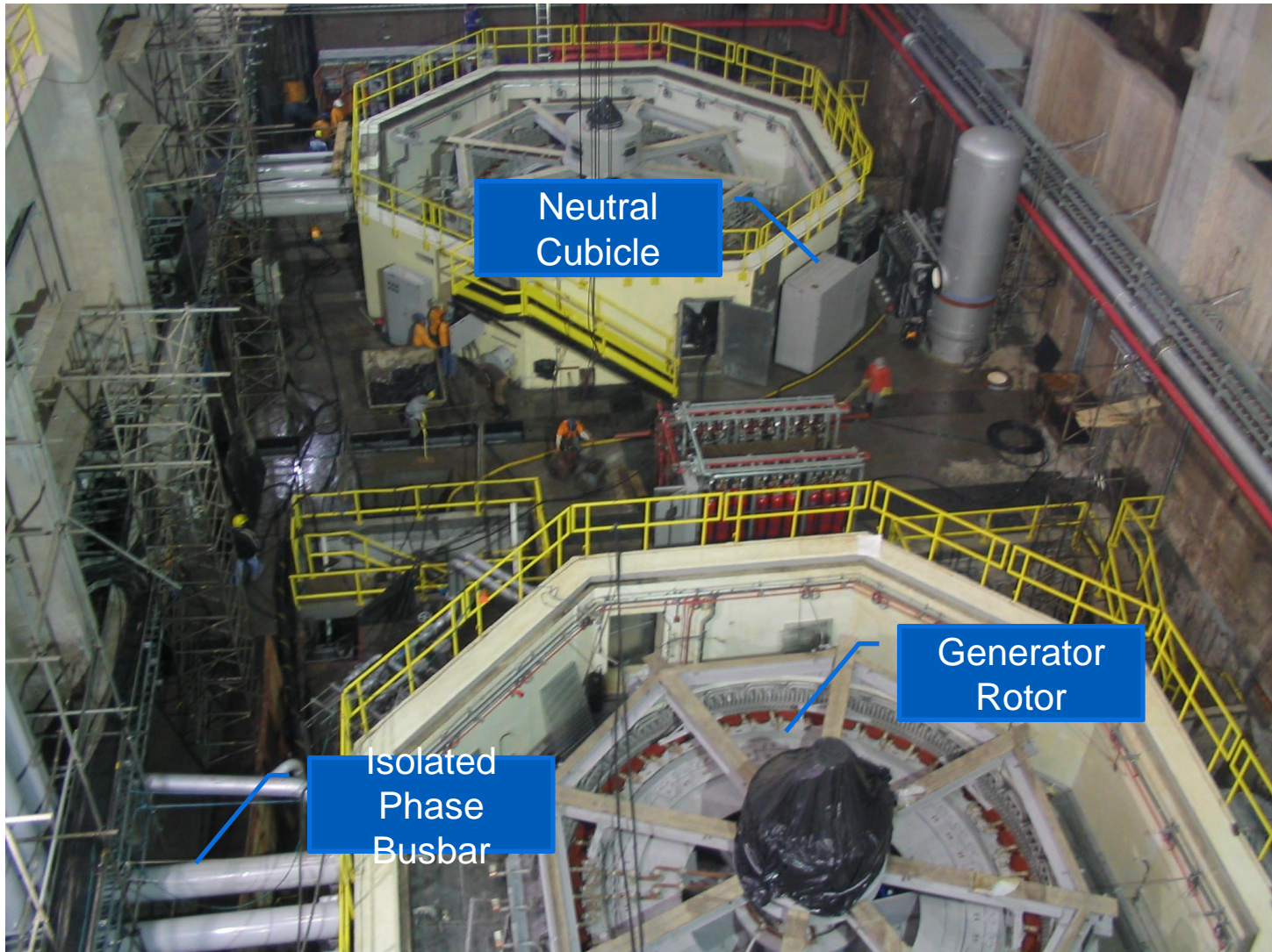
Design :

- Many aspects are to be considered, as protection against overvoltage (lightning, switching...), integration of transformers, HV cables, level of redundancy...
- Each country has a different grid code !!

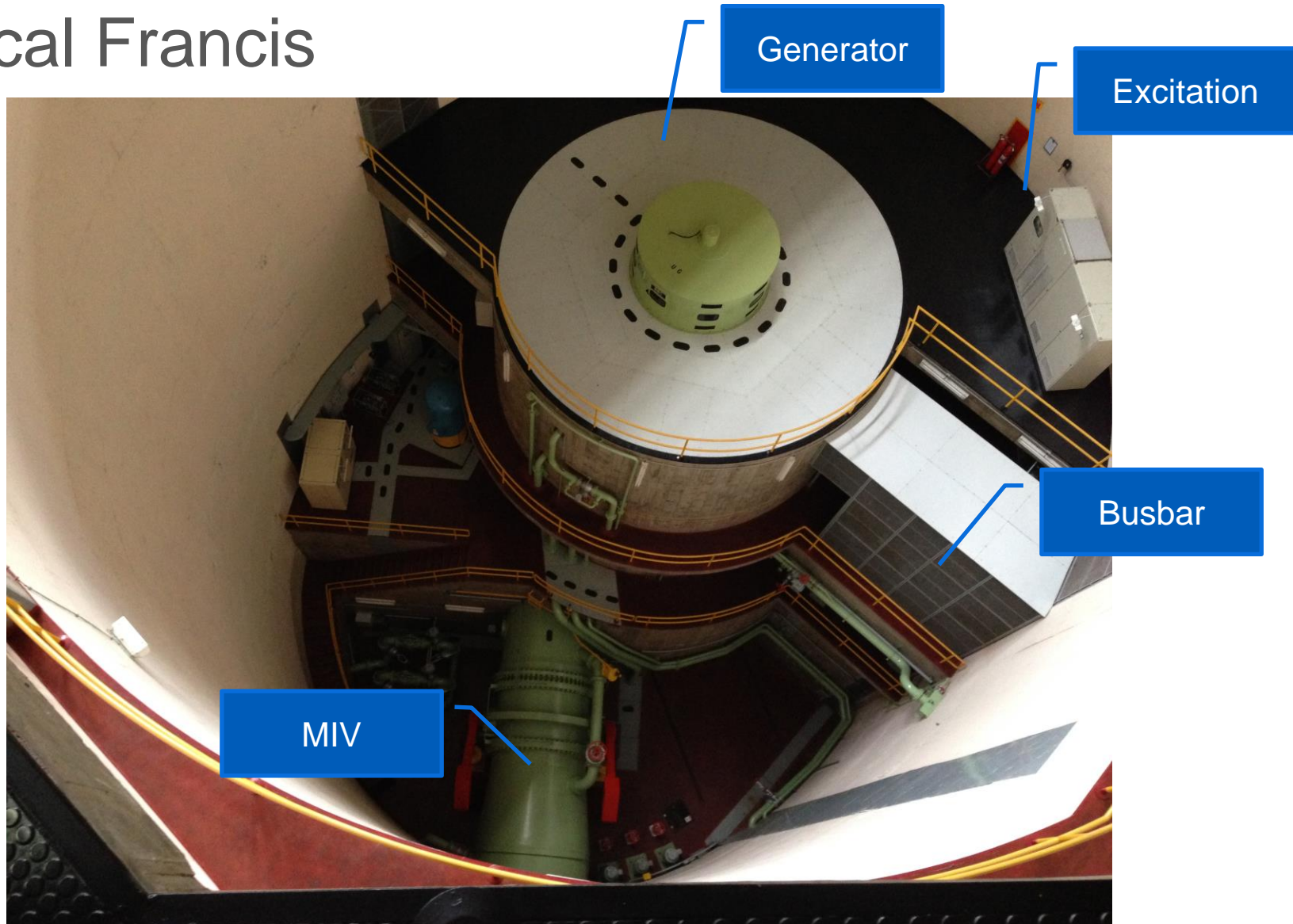
Energy Production- High Voltage Substation



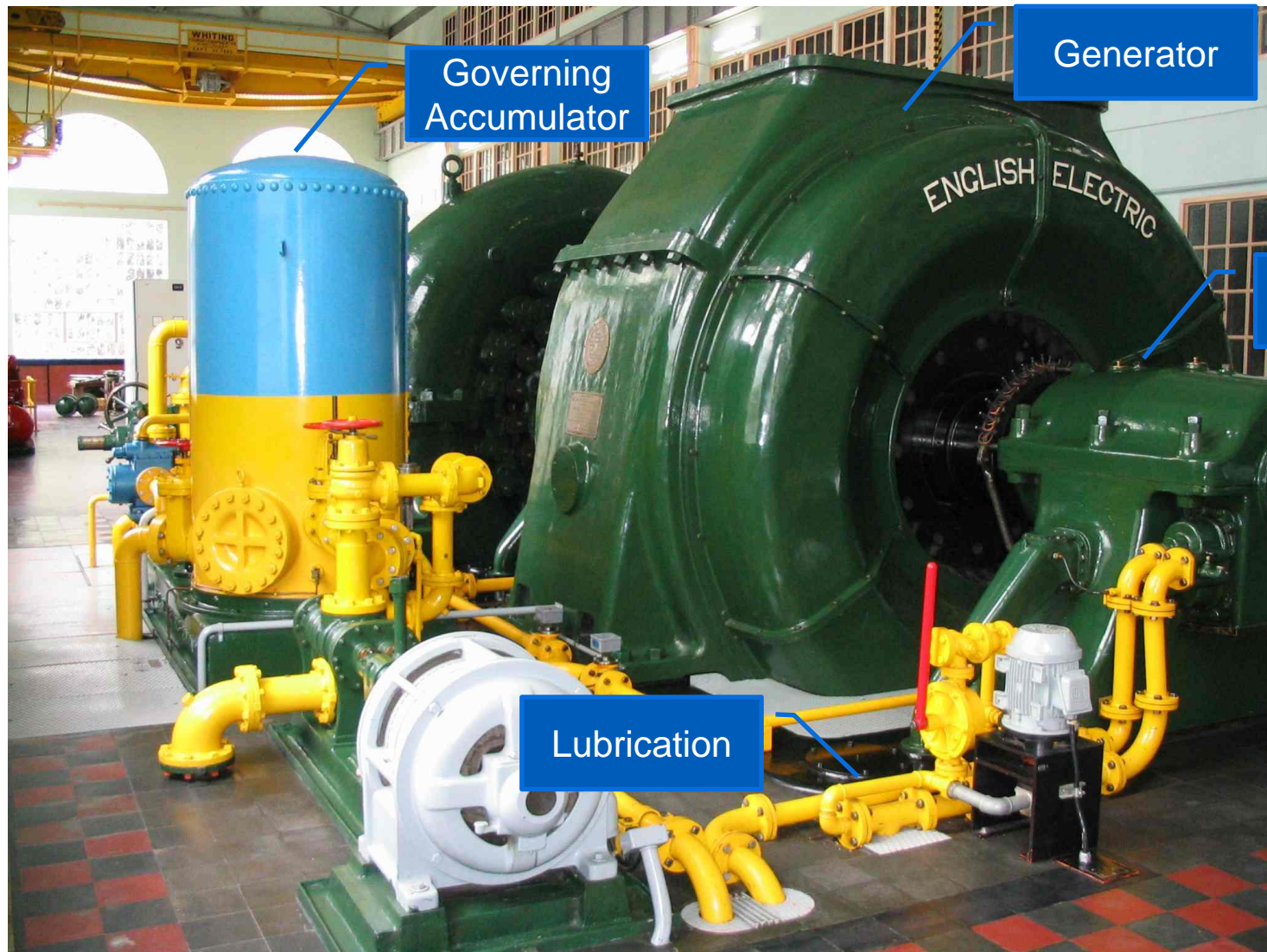
Vertical Kaplan

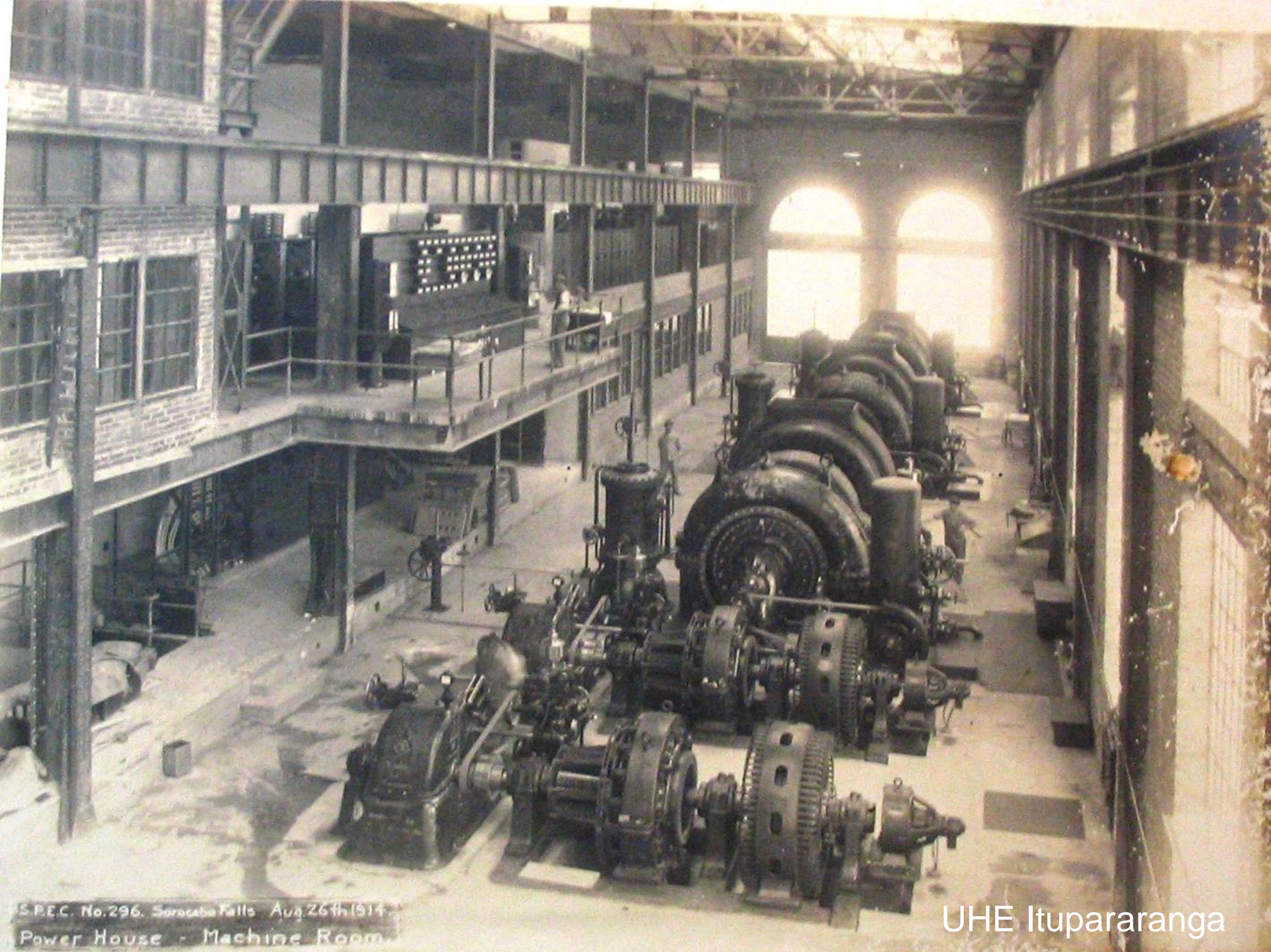


Vertical Francis



Horizontal Francis





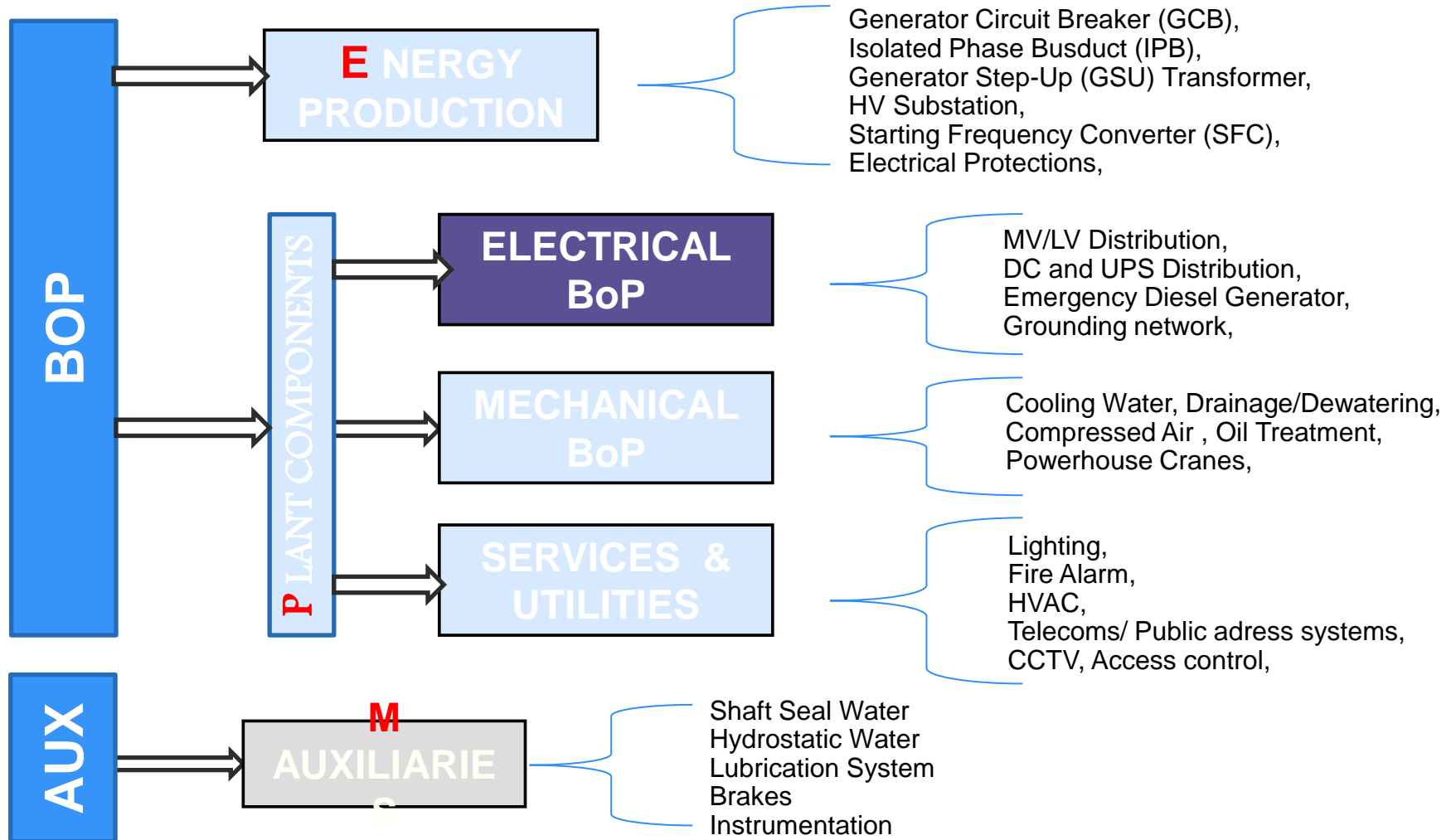
S.P.E.C. No. 296. Sorocaba Falls Aug. 26th 1914.
Power House - Machine Room

UHE Itupararanga

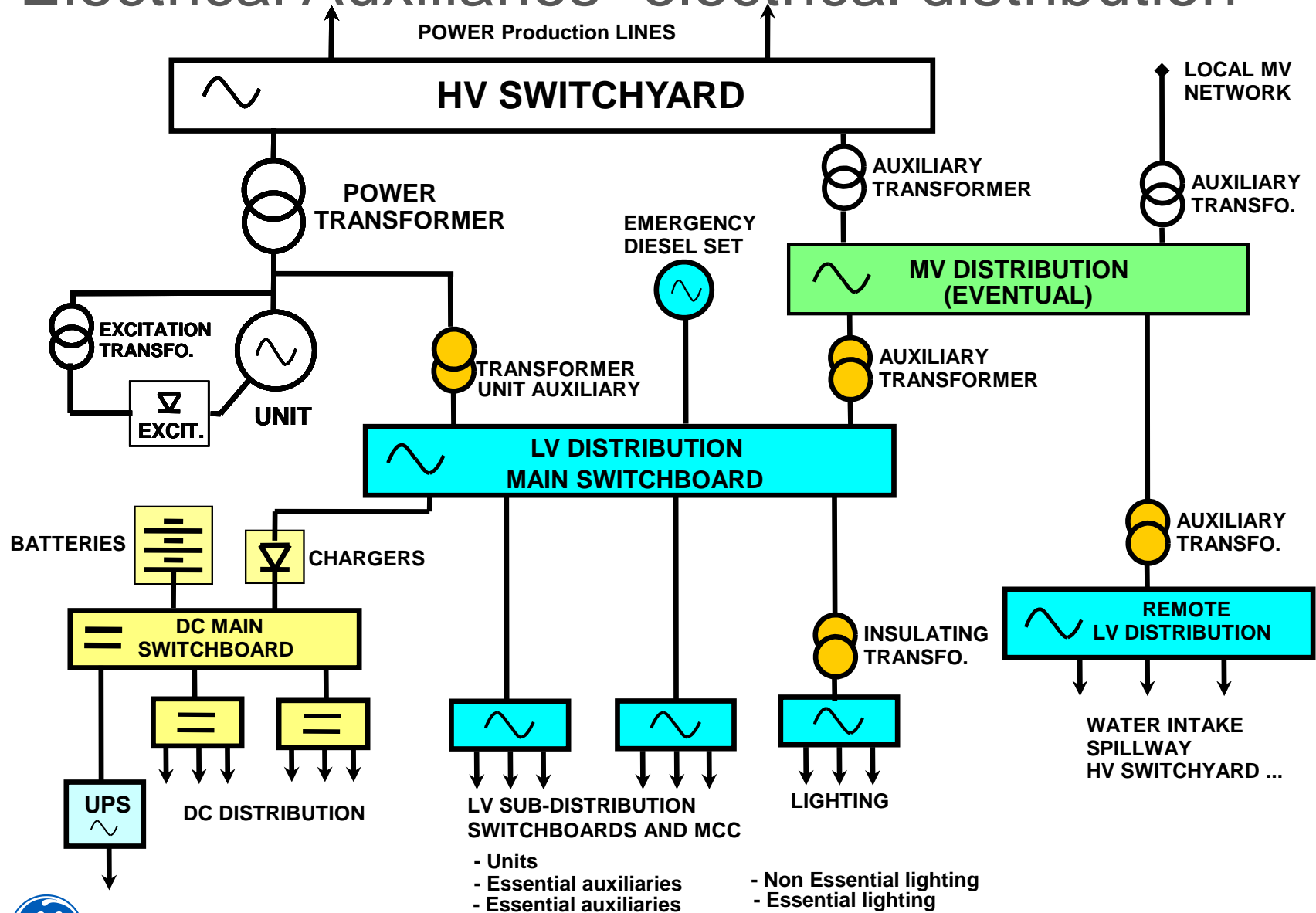
Electrical and Mechanical Components



What does BOP contain? Electrical Auxiliaries



Electrical Auxiliaries- electrical distribution



Electrical Auxiliaries- MV and LV distribution



Medium Voltage distribution boards



Station Services "dry" transformer



Low Voltage Distribution boards



Diesel generator



Electrical Auxiliaries- DC distribution



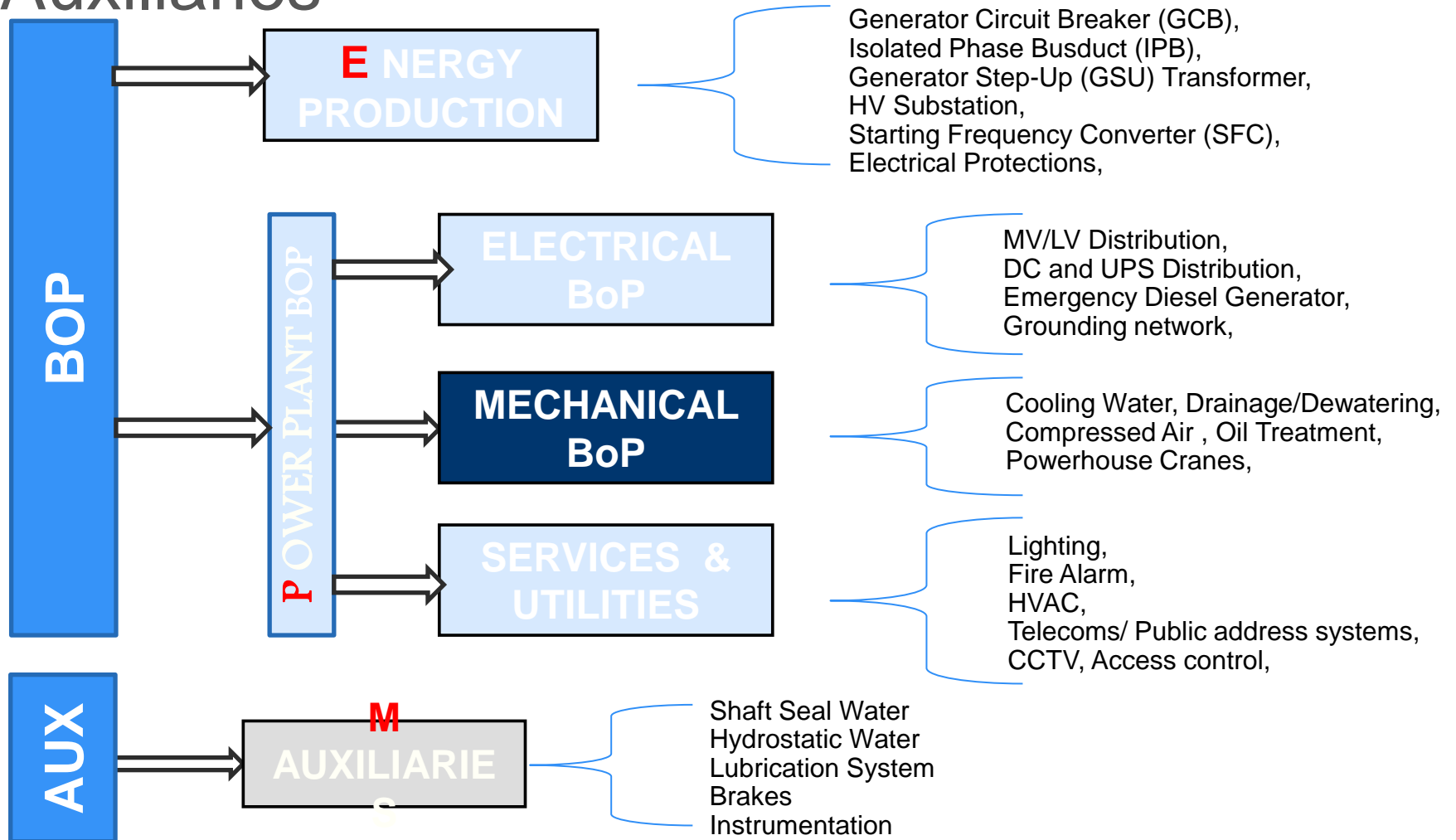
Battery Bank

Battery Charger





What does BOP contain? Mechanical Auxiliaries



Mechanical Auxiliaries



Drainage System



Air Compressor



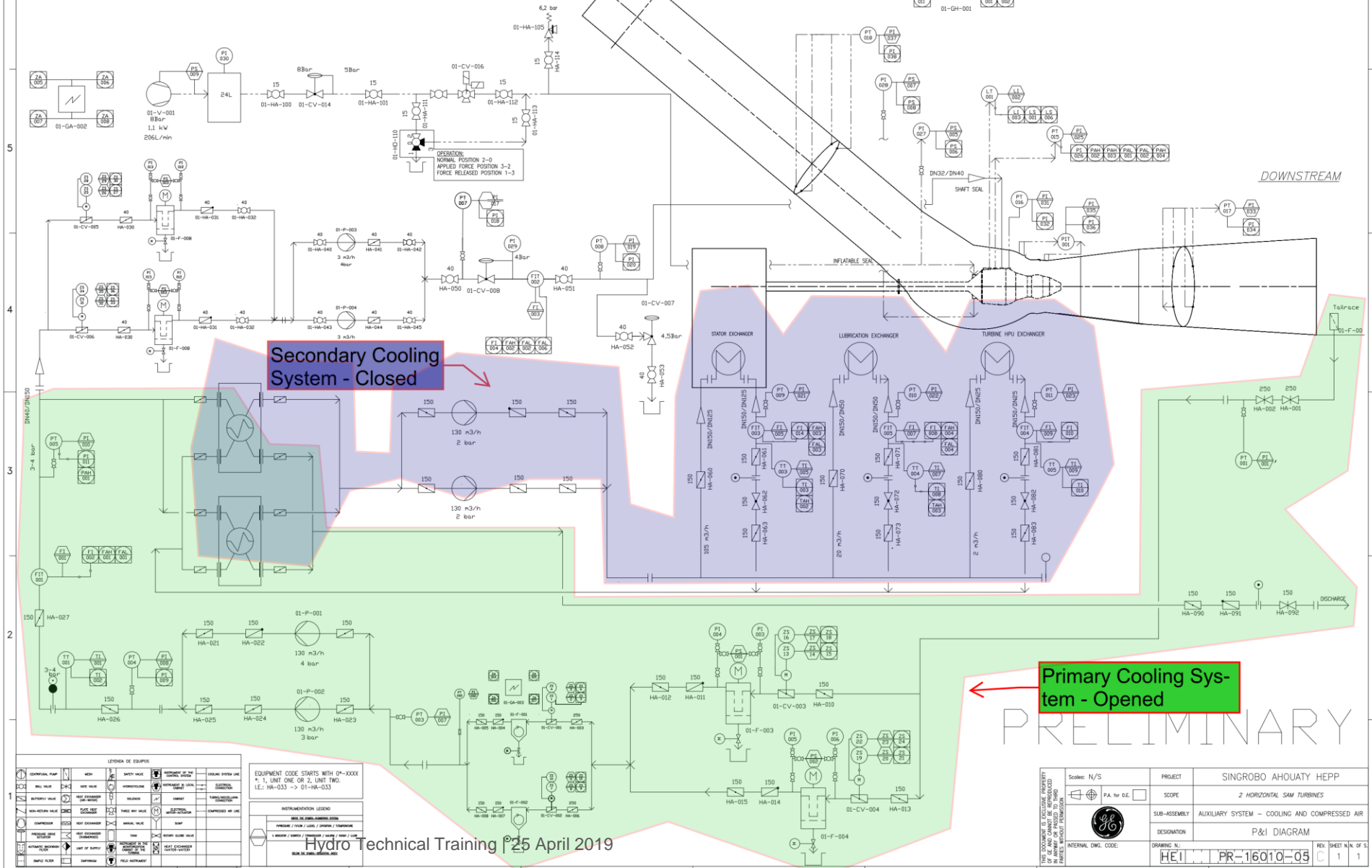
Cooling water system



Dewatering System



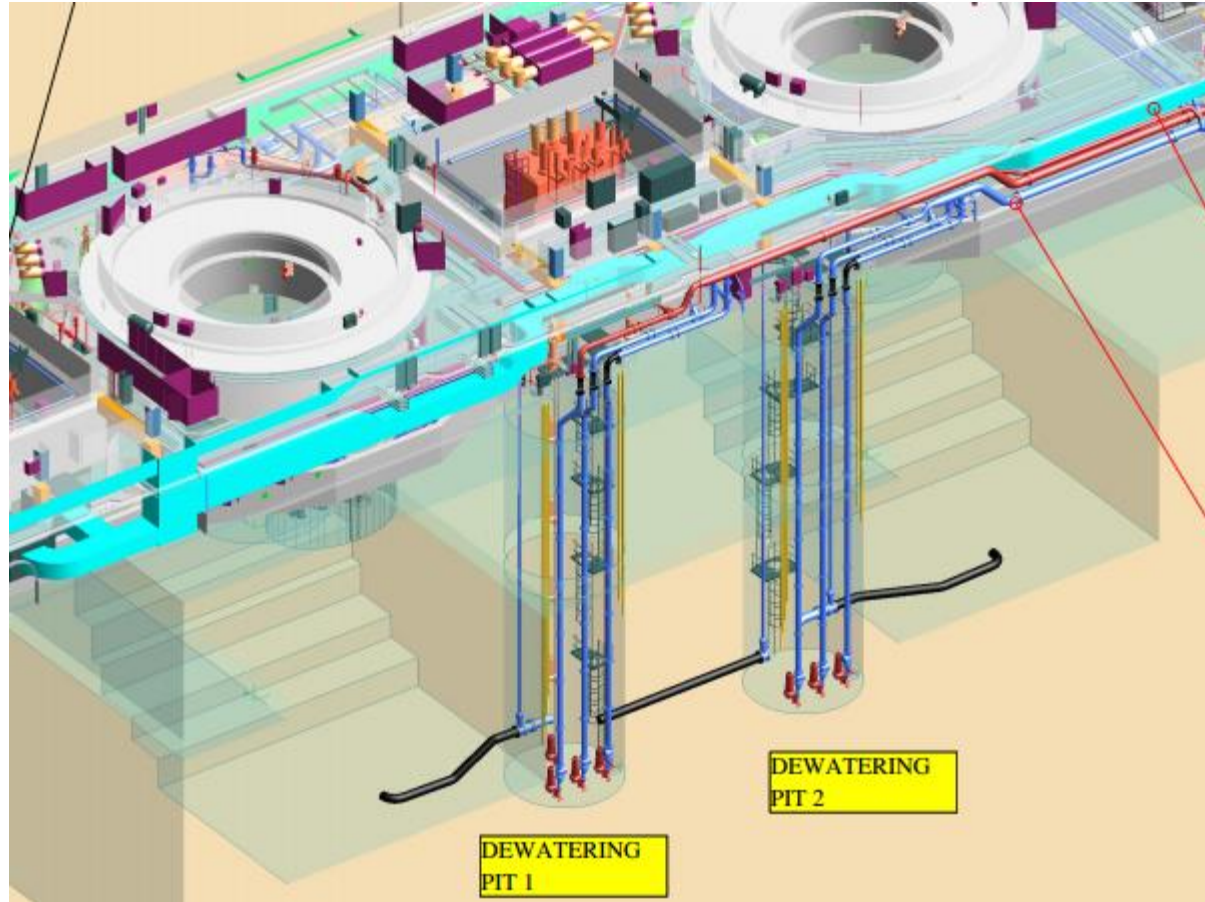
Mechanical Auxiliaries- Cooling water system



PRELIMINARY

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	PA. for D.E.	SCOPE	2 HORIZONTAL SAM TURBINES	
	INTERNAL DWG. CODE:	SUB-ASSEMBLY	AUXILIARY SYSTEM - COOLING AND COMPRESSED AIR	
		DESIGNATION	P&I DIAGRAM	
	DRAWING N°:	HEI	PR-16010-05	REV. SHEET N° OF S.
				1 1

Mechanical Auxiliaries- Drainage & dewatering



Mechanical Auxiliaries- Drainage & dewatering



- Vertical pump
- Submersible pumps



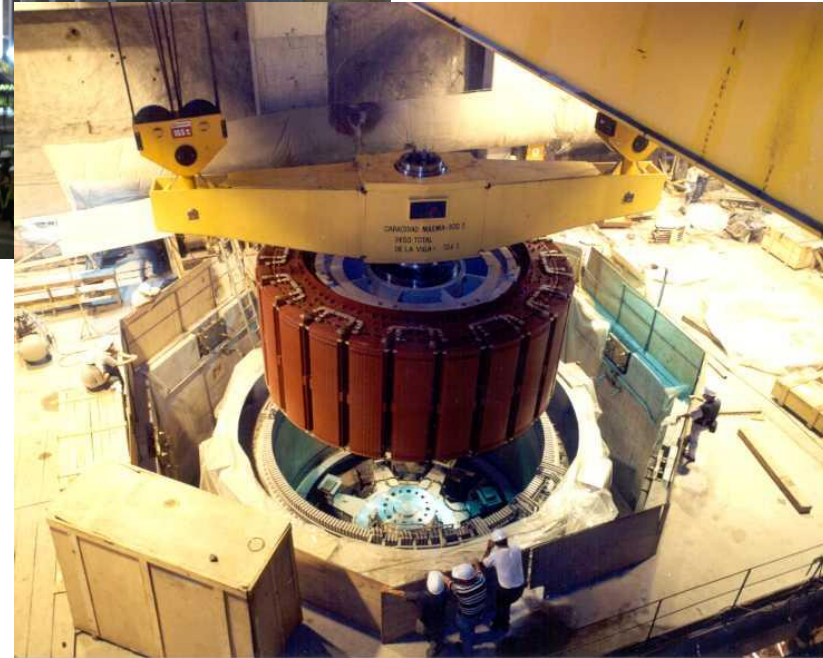
Mechanical Auxiliaries- Travelling crane



Capacity generally from 100 to 500 ton.
Generally, the heaviest part (the rotor) is lifted with 2 cranes coupled together.

Many parameters are customized for the project (capacity, span, headroom, lifting height...) → important role of the integrator

Main use: during erection of turbine and generator at site.



Then used for maintenance purpose



Mechanical Auxiliaries



Water level measurement



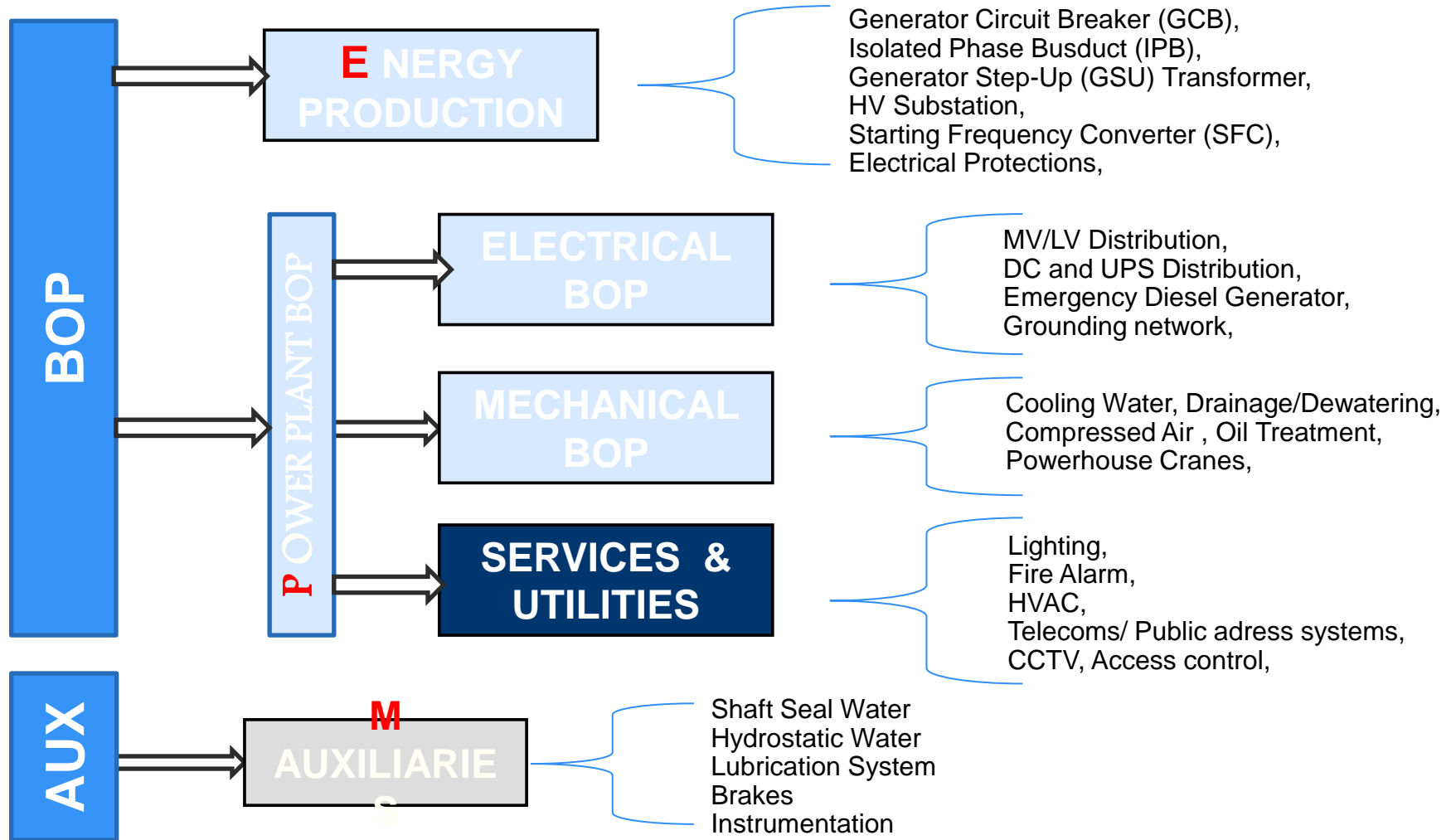
Water treatment



Air Compressor



What does BOP contain? Services & utilities



Services & Utilities

- Lighting and power socket
- Telecommunication
 - Telephone, Public address system, Radio system...
- Video System (CCTV)
- Control Access System
- Fire alarm and fire fighting
- HVAC (Heating, Ventilation, Air Conditioning)



Services & Utilities - Lighting

Lighting and power socket

- Essential and non-Essential
- System is composed by power transformers, distribution panels, inverters & balance of materials



Services & Utilities - Telecommunication

- Internal and external telephone system



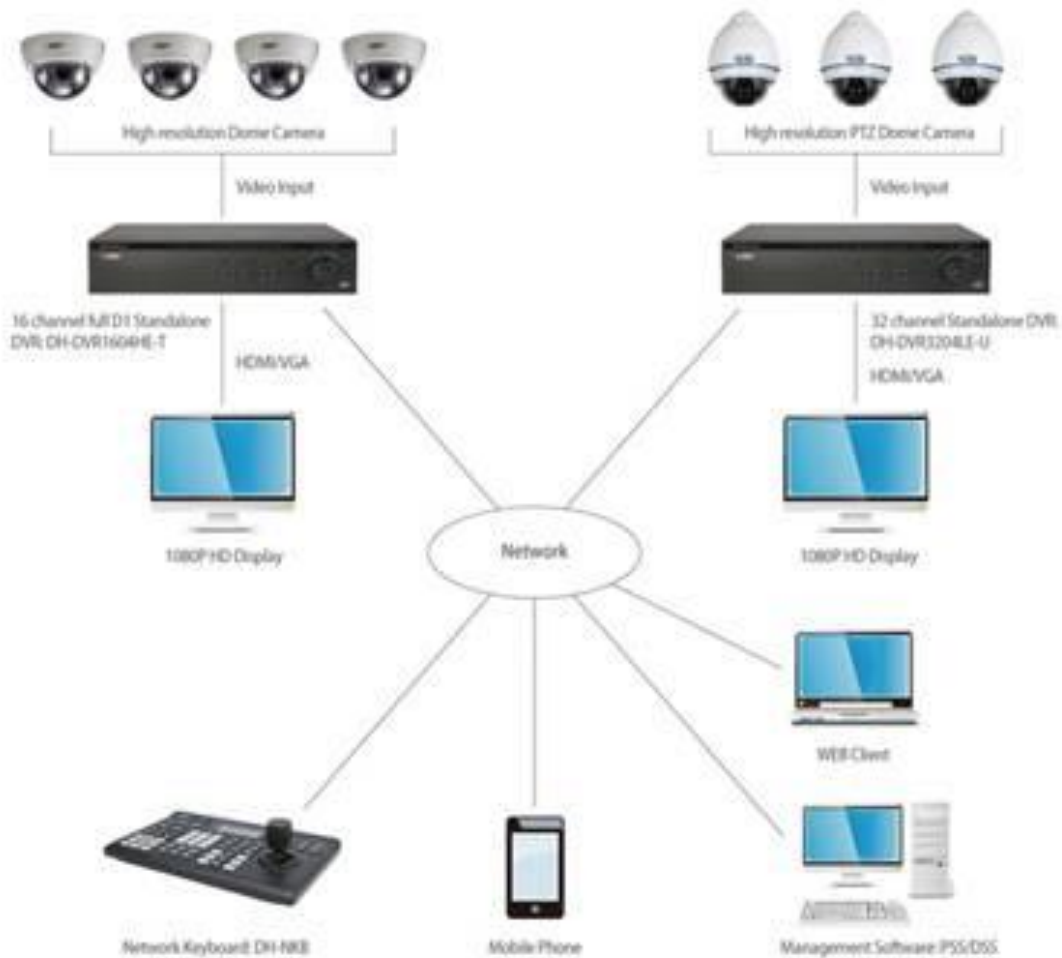
- Radio



- SDH Multiplexer



Services & Utilities - CCTV



Services & Utilities – Fire Fighting

Fire fighting Water



Fire fighting CO2



Fire fighting Deluge

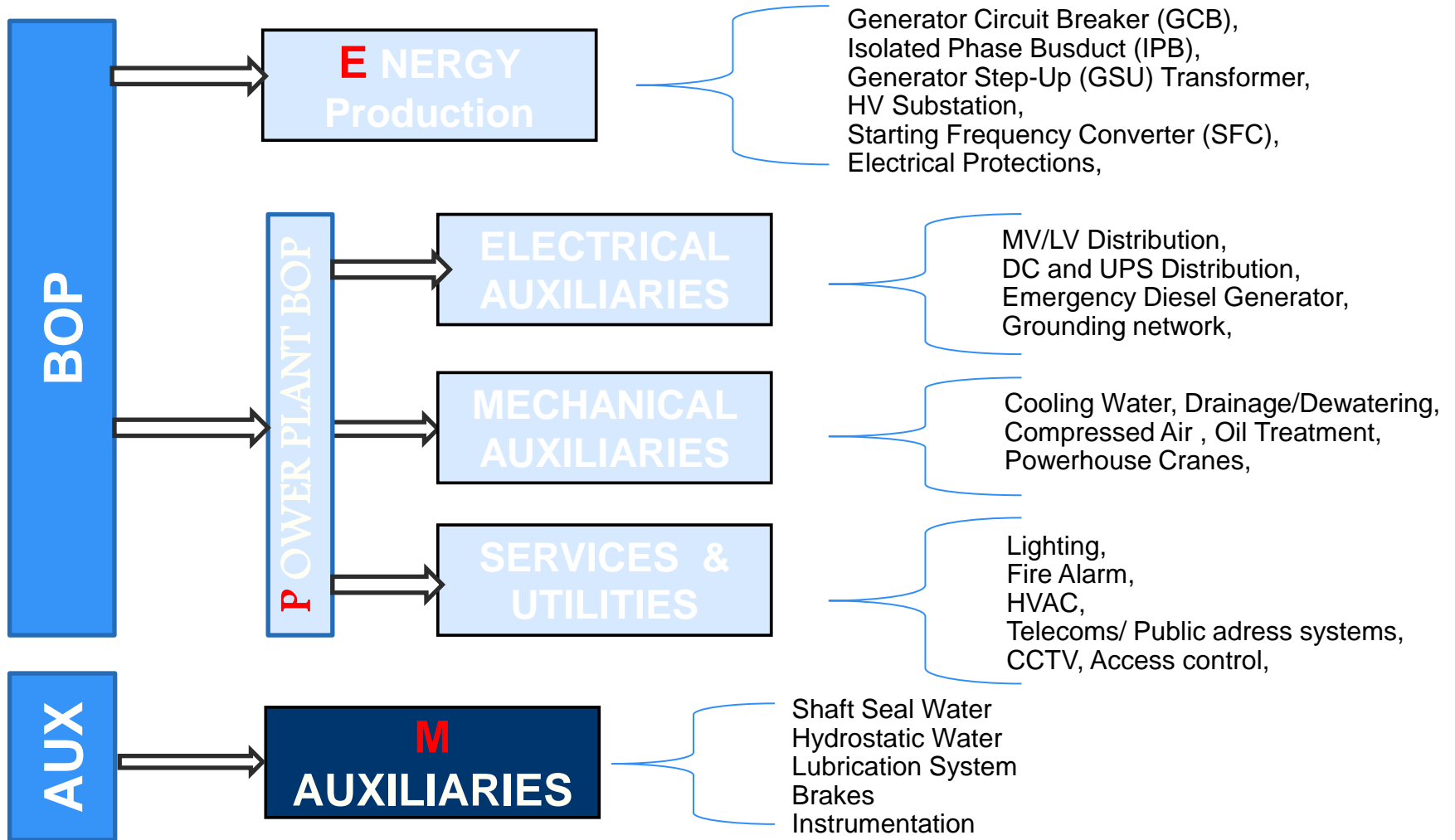




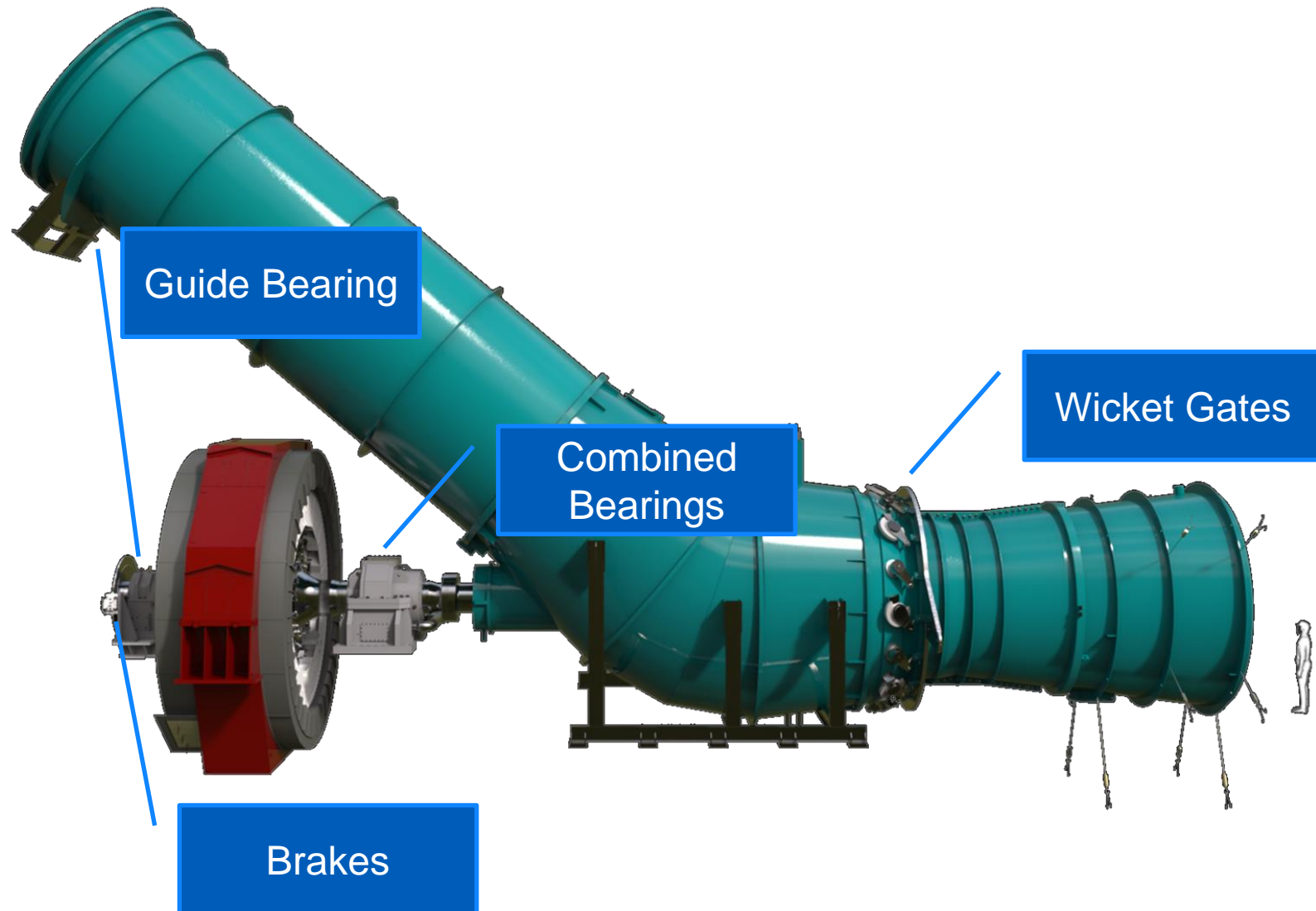
MACHINE AUXILIARIES



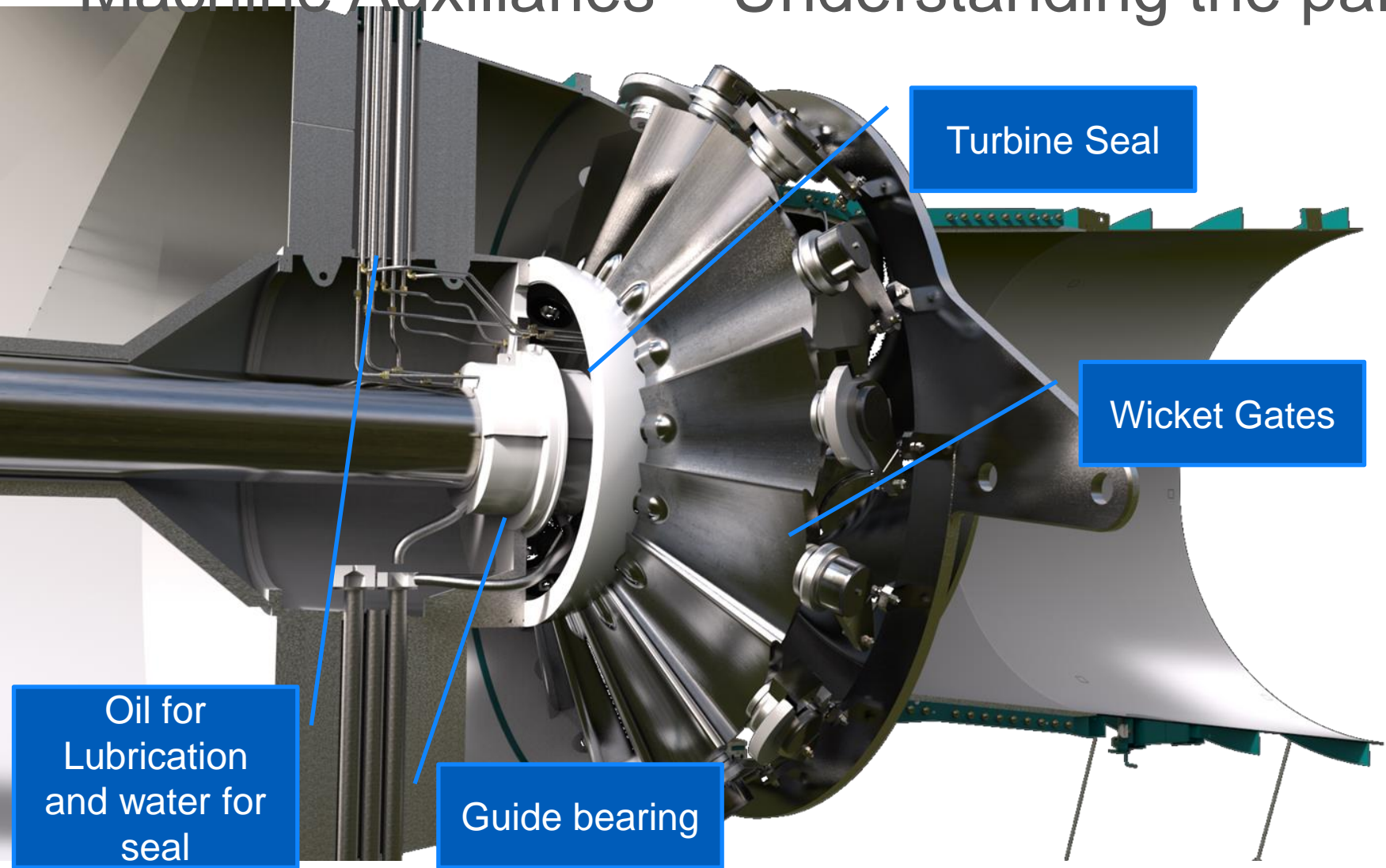
What does BOP contain? Layout design



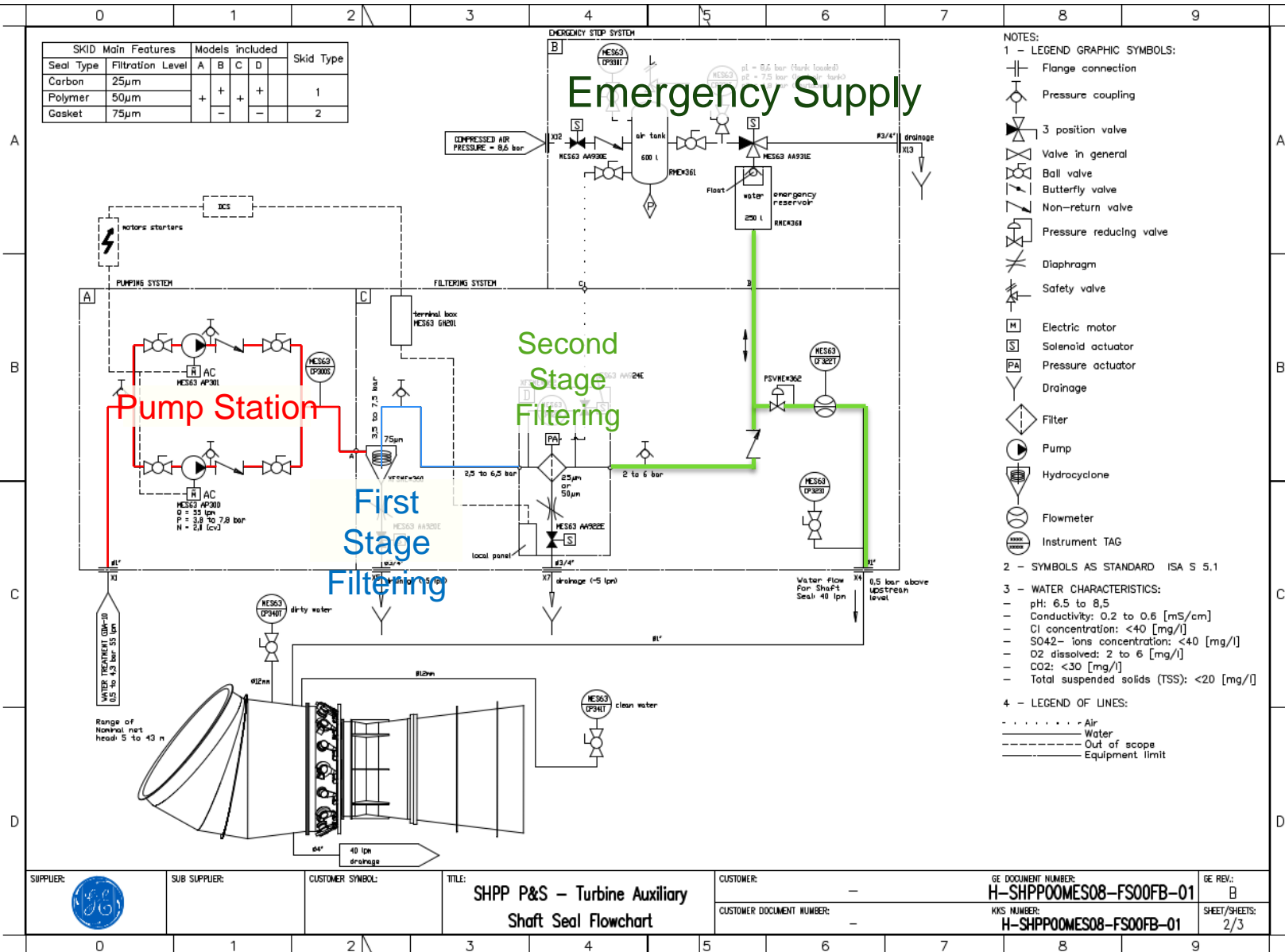
Machine Auxiliaries – Understanding the parts



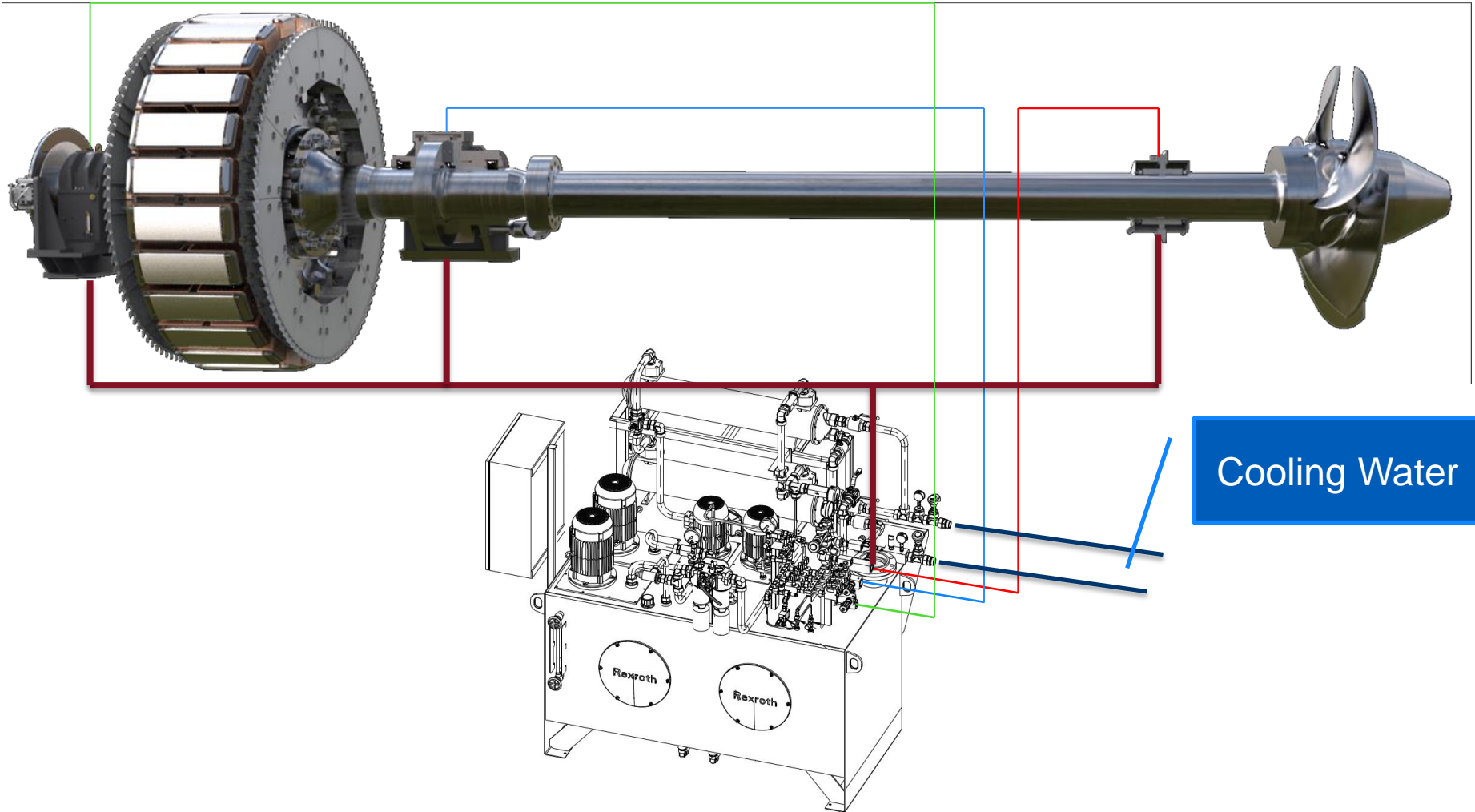
Machine Auxiliaries – Understanding the parts



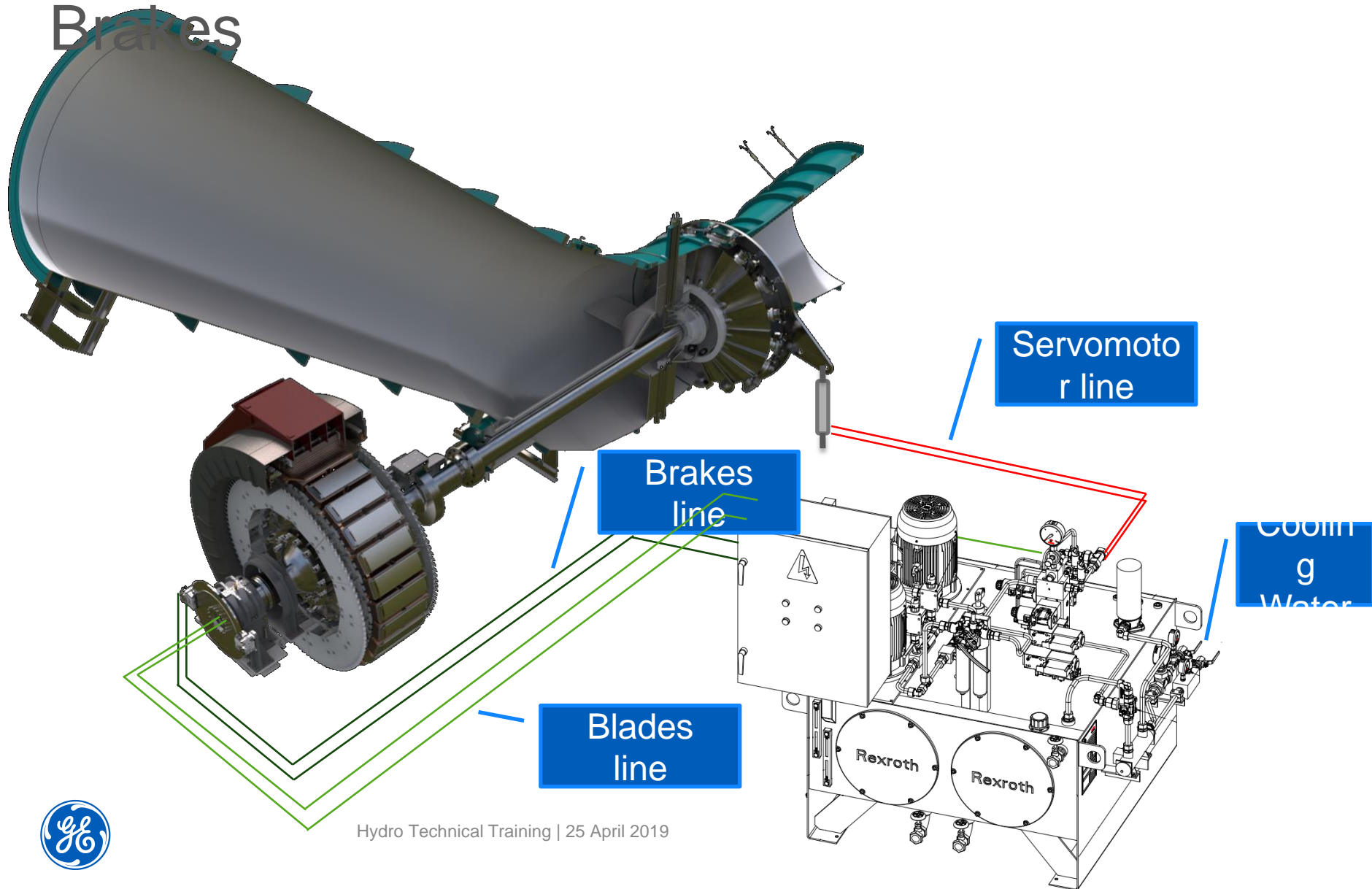
Shaft Seal Water Skid



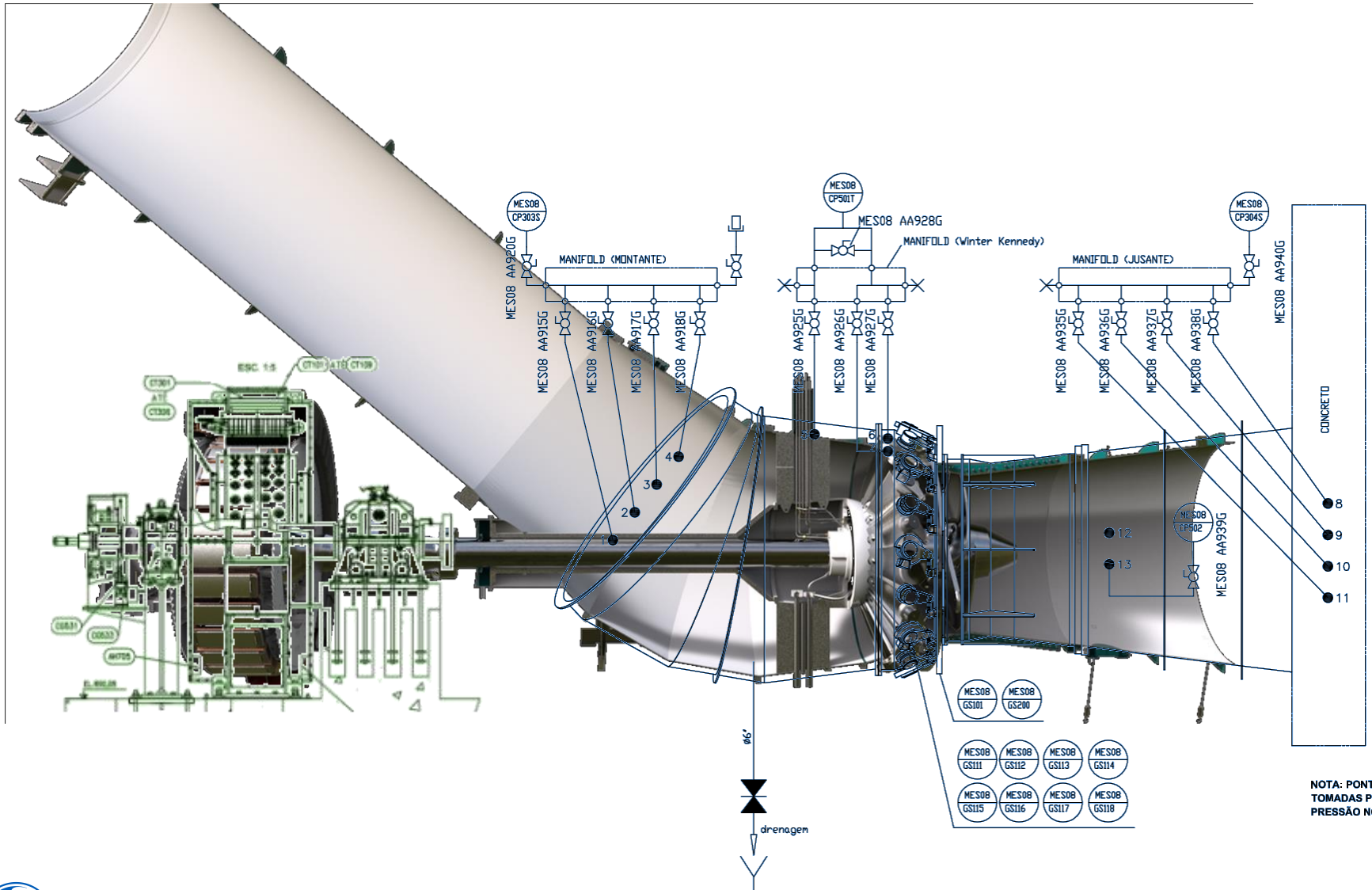
Machine Auxiliaries - Lubrication



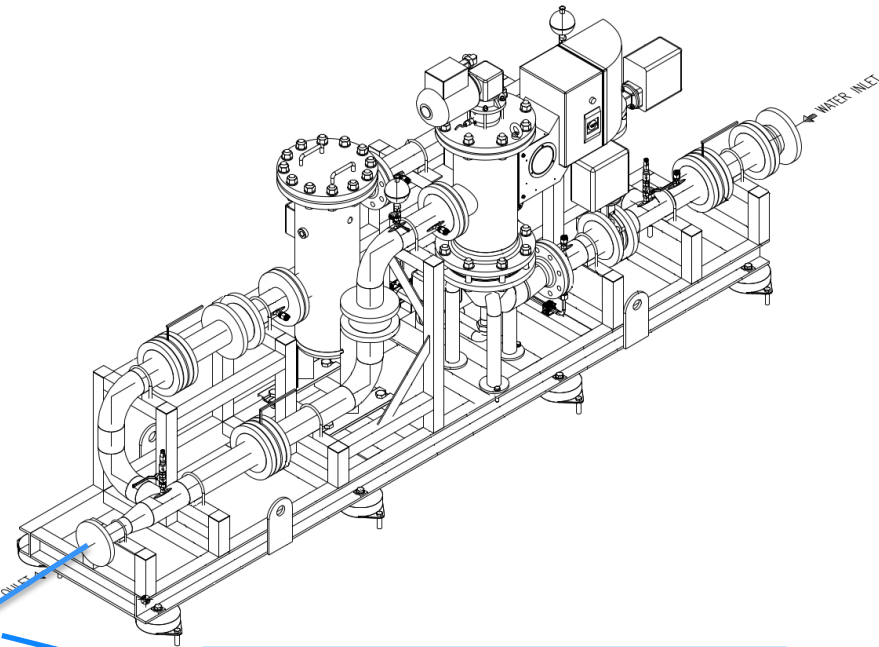
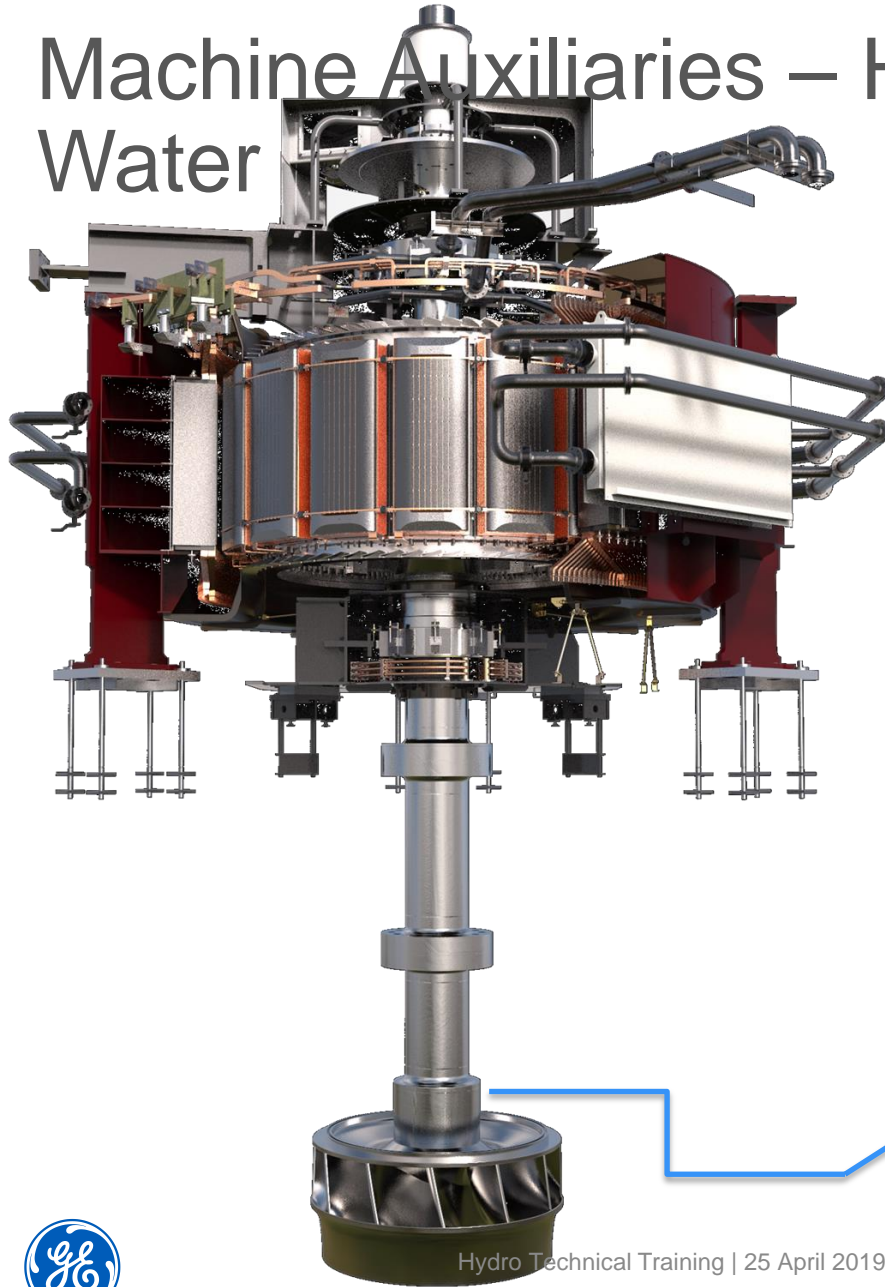
Machine Auxiliaries – Governing HPU & Brakes



Machine Auxiliaries – Instrumentation



Machine Auxiliaries – Hydrostatic Bearing Water



Water @ 25 bar, 4,14
l/min, 70 microns



Conclusion



CONCLUSION

- Main scope: BOP = Energy Production, Auxiliaries,
- Many different competencies (electrical, mechanical,...)
- Many input data from others,
- Need a strong knowledge of products available in the market,
- Strong link with Integrator and with civil contractor.



