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# **QUEEN ELIZABETH POWER STATION EXPANSION**

## **A CLEAN, FLEXIBLE, AND RELIABLE CCGT APPLICATION**

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- Location: Saskatoon, SK
- Originally commissioned in 1959 with 2 steam turbines – 123 MW (total)
- In 1971, a 95 MW steam turbine was commissioned – 218 MW
- Today, the facility contains an additional 12 combustion turbines, 12 heat recovery steam generators (OTSGs), and 2 steam turbines
- 634 MW Net (2<sup>nd</sup> largest in MW and most GTs of any CC plant in Canada)



## QEP – Plant D Addition

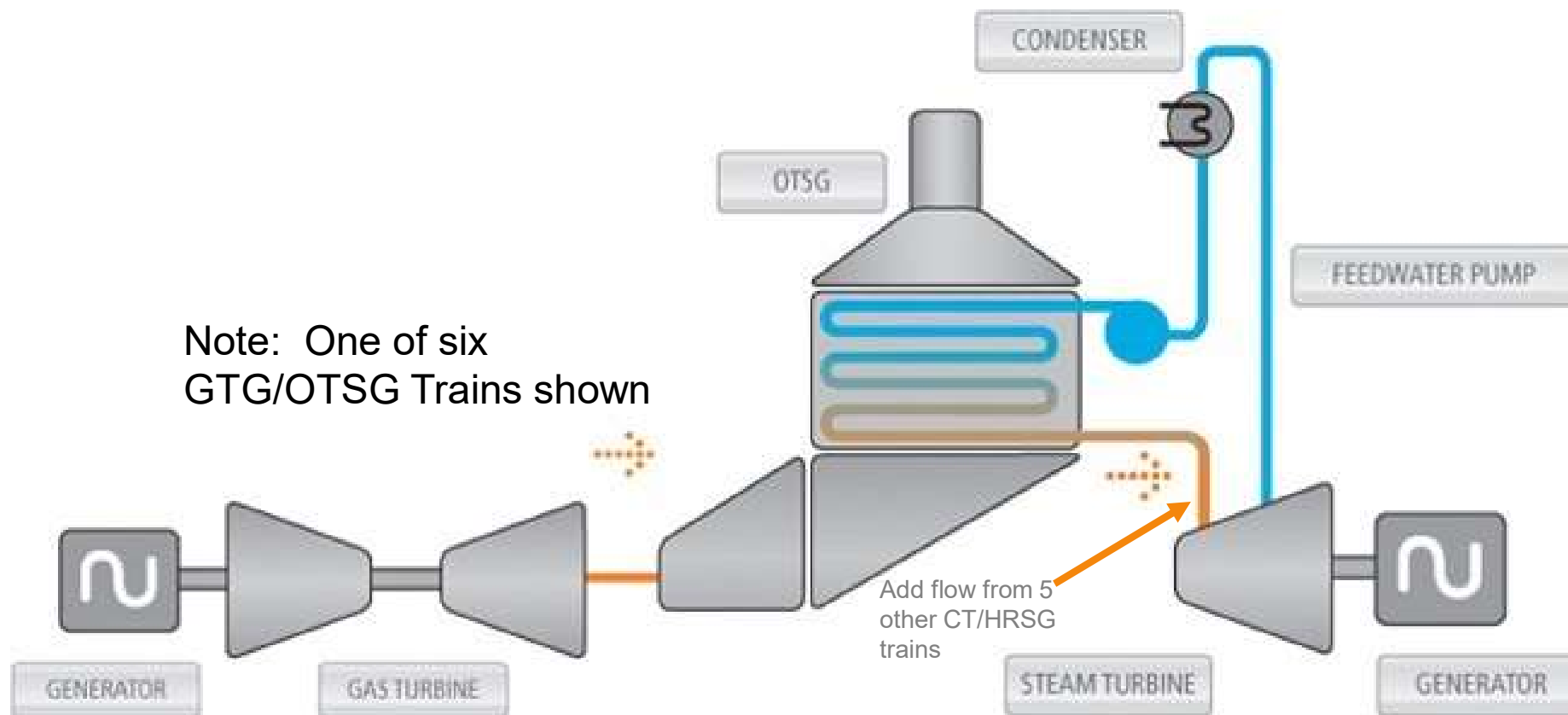
- Commissioned Oct. 2015
- 204 MW expansion of the facility
- Added the final three H-25 gas turbines and closed the loop on six H-25 gas turbines with six OTSGs and a steam turbine
- Provides enough electricity for 200,000 homes
- Produces less than half the green house emissions of conventional coal

*"It is a flexible technology that can provide baseload (24/7) power, but can quickly provide power for peak hours as well"*





# Combined Cycle Plant Overview



Plant D Commercial Operation Date: 2015

## Existing Equipment:

- 3 direct Fired NG Boilers feeding 2 steam turbines (218MW) – first 2 decommissioned
- Six (6) Hitachi H-25(28\*) Gas Turbines in Combined Cycle, with six (6) OTSGs and two (2) Steam Turbines (210MW)
- Three (3) Hitachi H-25(35) Gas Turbines in Simple Cycle (105 MW)

## Plant D Addition (204MW):

- Three (3) new Hitachi H-25(35) Gas Turbines in Combined Cycle, with IST OTSGs
- Six (6) new IST OTSG's to close the cycle for all H-25(35) Gas Turbines
- One (1) Fuji 100MW Steam Turbine

## Ambient Conditions:

- Temperature: -40°C to 40°C (Design T = 15°C)
- Elevation: 480 meters AMSL
- Relative Humidity: 60%

## H-25(35) Gas Turbine – Site Performance:

- Output = 31.4 MW per Unit (at generator terminal)
- Exhaust Temperature = 552°C
- Exhaust Flow = 103 kg/s
- NOx Emissions = 25 ppmvd@15% O<sub>2</sub>

## OTSG – Site Performance:

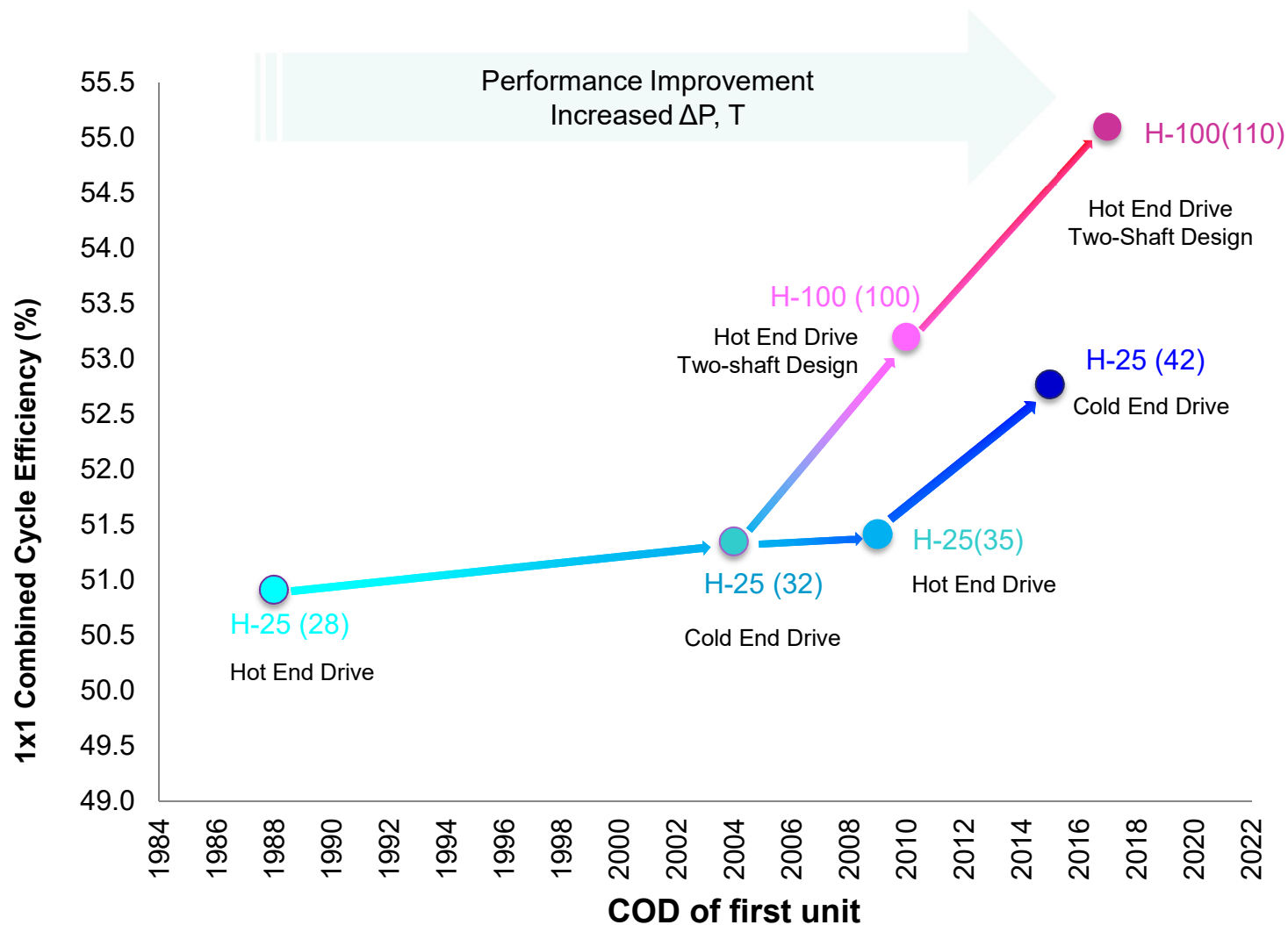
- HP Steam: 13.2 kg/s, 506°C, 86 bar
- LP Steam: 2.8 kg/s, 224°C, 6 bar
- 6x flow produces roughly 100MW at STG



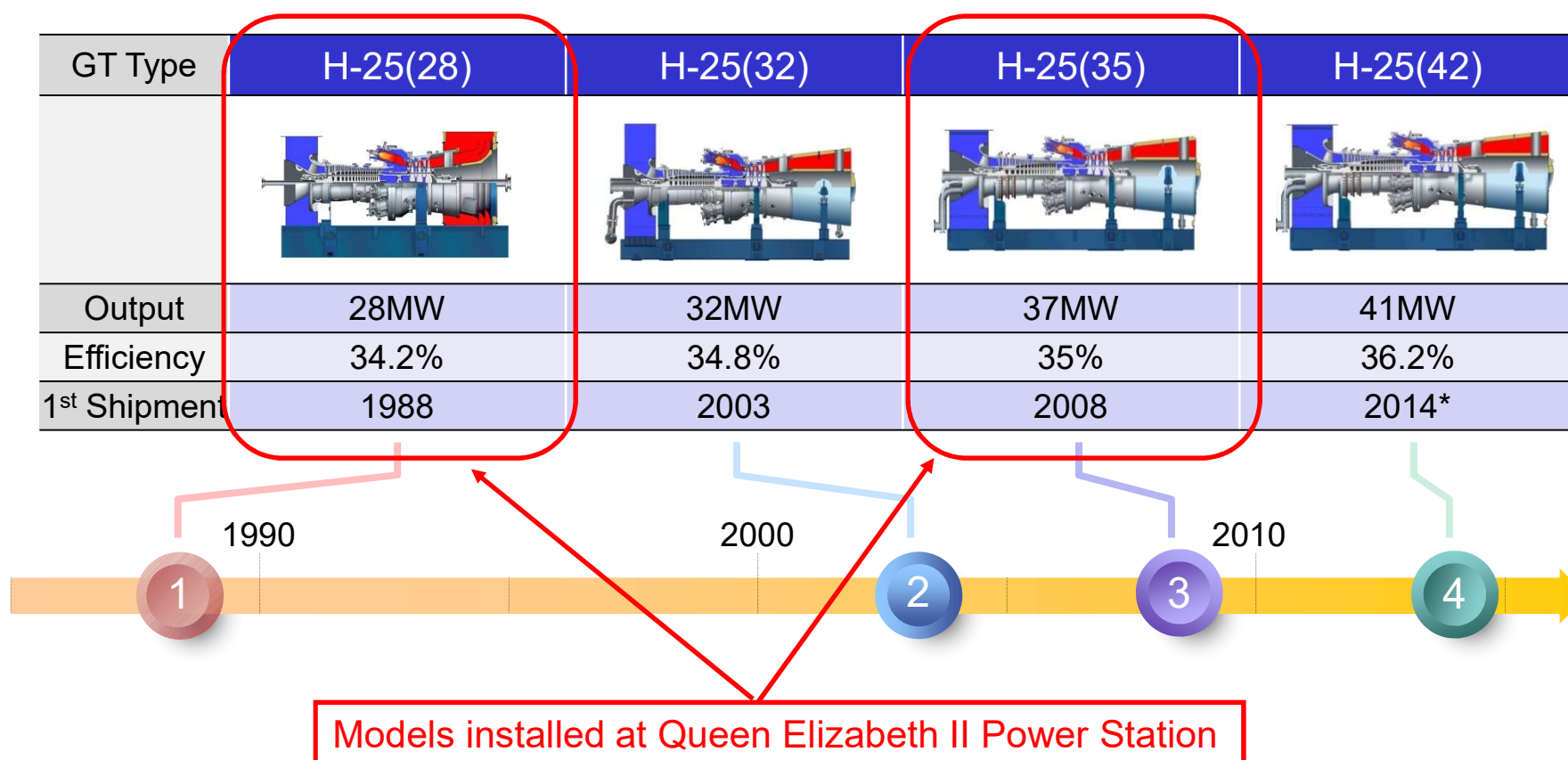
\* Denotes the turbine output class in MW

# MHPS H-Series Gas Turbines

Predictability & Reliability through Evolution



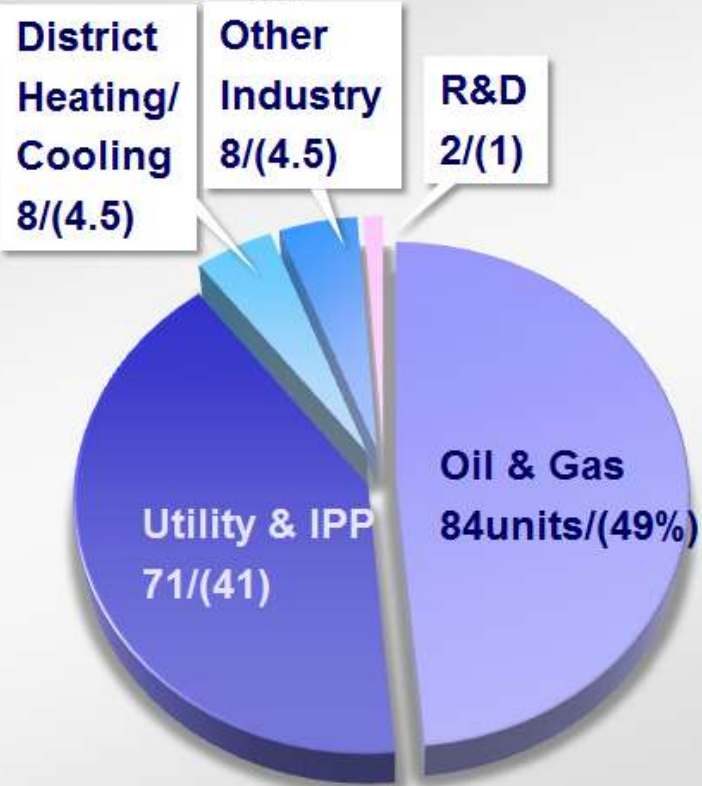
- Worldwide Fleet of 176 Units
- Over 6.3 Million AOH
- >99% Fleet Reliability



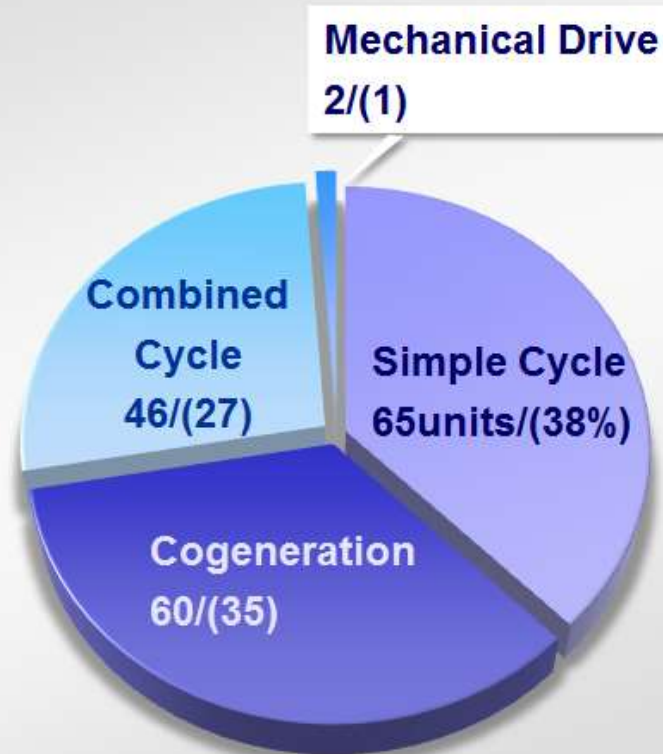
\* 1<sup>st</sup> commercial unit delivered for final product validation

- A variety of applications in different markets, such as petrochemical, utility & independent power producer, district heating, industrial, etc.

## ● Industry Type



## ● Application





Reliable Heavy Duty Design

Horizontal Split Casing

Single Shaft Configuration

Reduction Gear for 50 Hz and 60 Hz

## Compressor

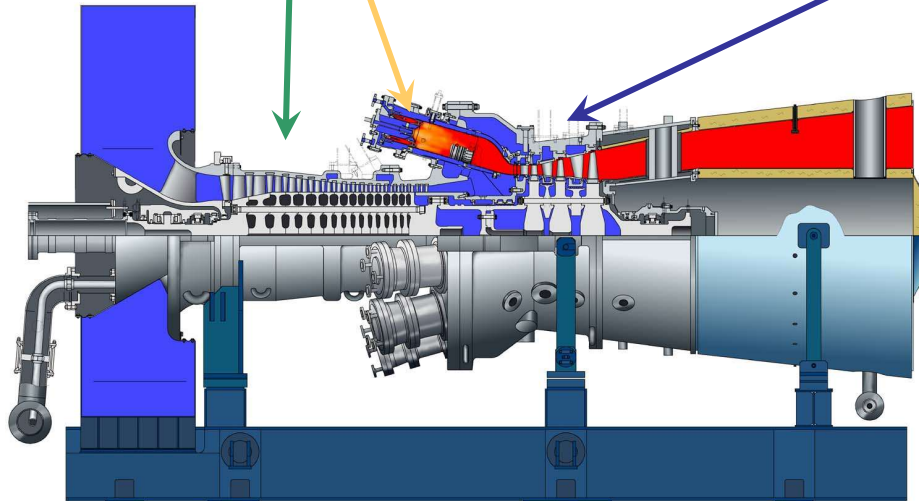
17 stages  
Axial Type

## Combustor

10 cans  
Reverse Flow Type

## Turbine

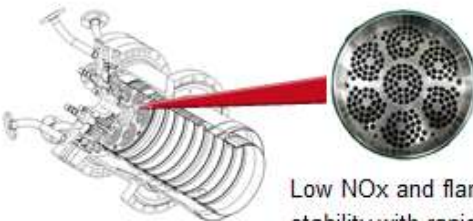


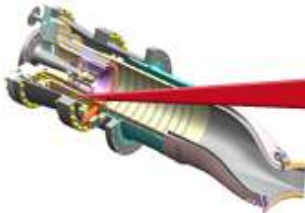



3 stages  
Impulse Type



Rotating Speed:  
H-25: 7,280 rpm

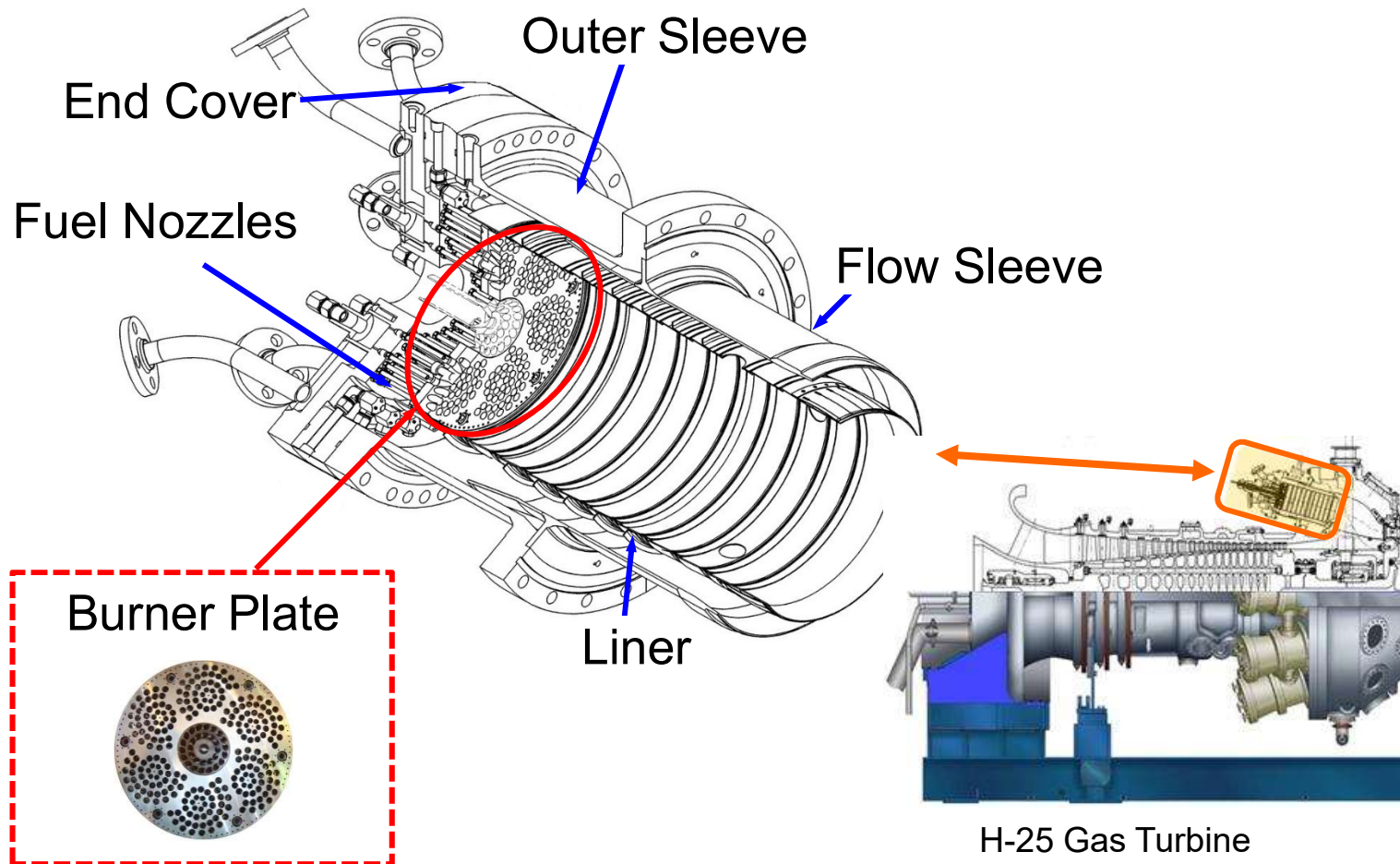
Hot End or Cold End Drive

- H-25 Combustors enable fuel flexibility, including LNG, NG, LPG, H2 Rich Fuels & Oil.

Type	Fuel	NOx[ppm]	Combustor
Multi-cluster	LNG	15	 <p>Low NOx and flame stability with rapid mixing</p>
	LPG	74	
Cone-cluster	Gas/Oil Dual	25(Gas) 74(Oil)	 
DLE (F2 Pencil)	LNG/NG	25	  <p>F2 Pencil</p>
Conventional	Gas/Oil Dual	25(Gas) 300(Oil)	  <p>Dual (LNG / Distillate Oil)      Diffusion(LPG)</p>
	LPG	74	

# Multi-Cluster Combustor

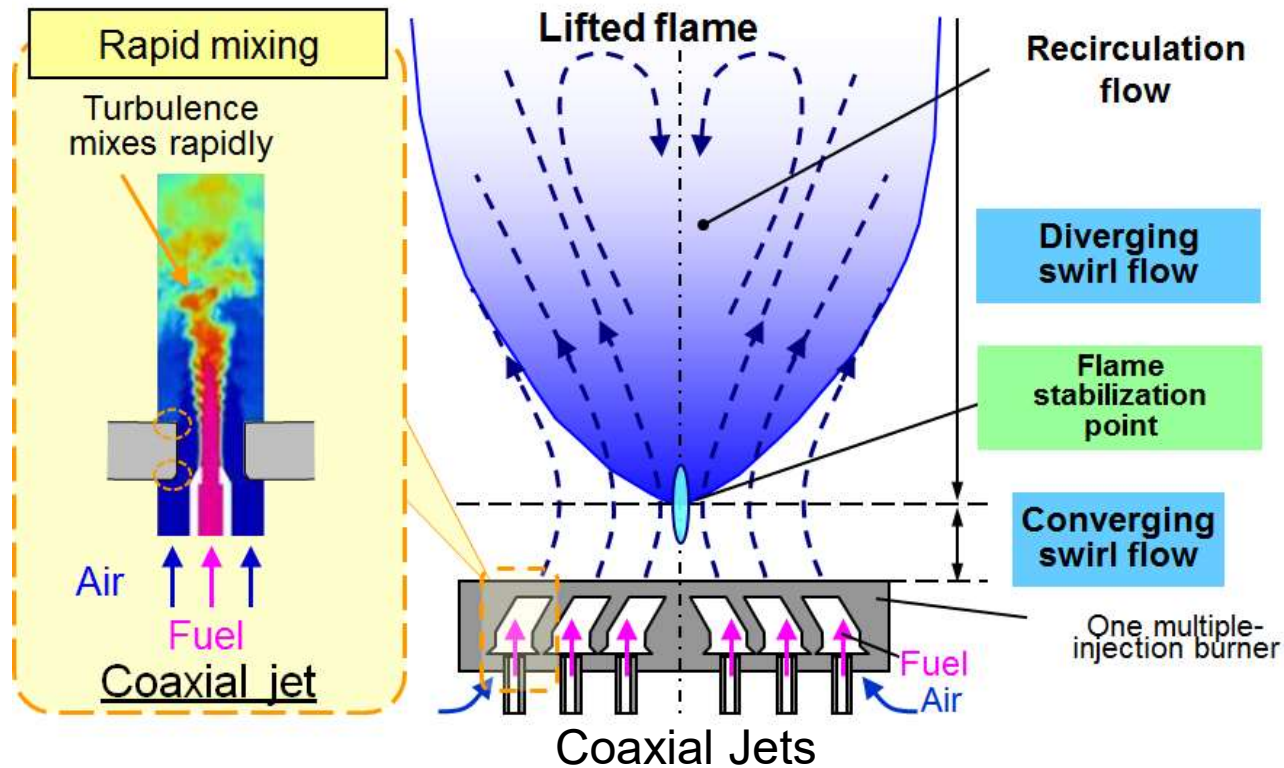
## Advancement in Combustor Technology



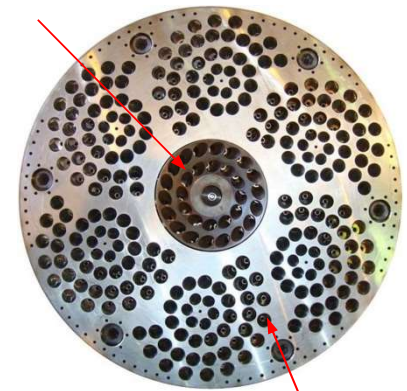
**Single can, DLN combustor with multiple fuel/air injection nozzles**



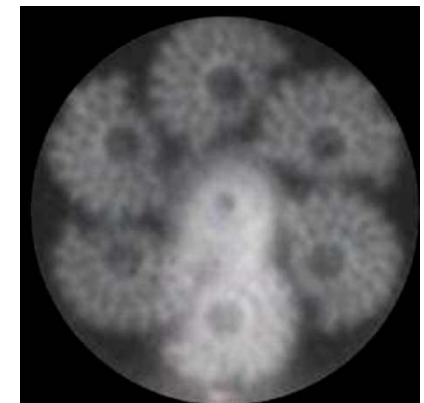
1. Rapid mixing with fuel-air coaxial jets
2. Flame lifting by converging-diverging swirl flows with multiple nozzles
3. Inherently Flashback Free



Pilot Burner



Main Burner



Flame Observation



Inspection Type	Typical Interval (EOH), hrs	Reference Operation <sup>1)</sup>	Downtime
<b>1</b> Combustion Inspection	16,000 (Natural Gas fuel) 12,000 (Oil fuel)	2 years	7 days
<b>2</b> Hot Gas Path Inspection	32,000 (Natural Gas fuel) 24,000 (Oil fuel)	4 years	16 days
<b>3</b> Major Inspection	64,000 (Natural Gas fuel) 48,000 (Oil fuel)	8 years	25 days

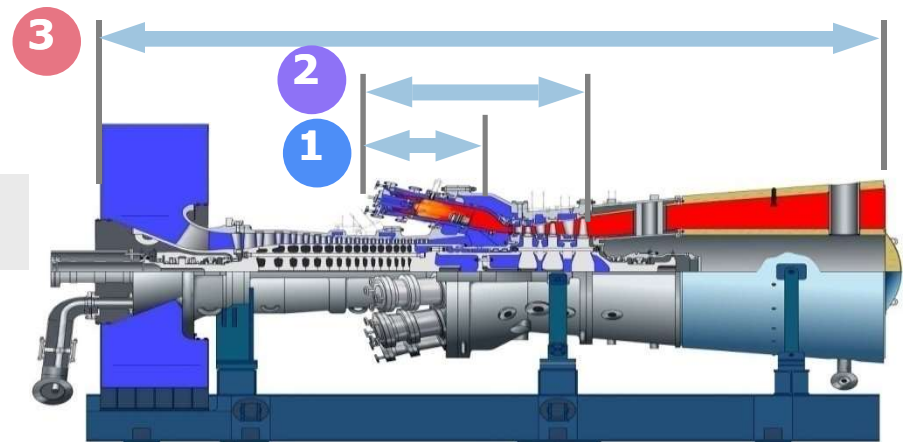
1) 8000 hours/year continuous operation Case

\* Interval & downtime is subject to operating cycle and conditions, etc.

\* Cool downtime (1 days) and start-up (1~2 days) are not included in downtime.

## Scheduled Maintenance

Availability of 97.6% based on  
fleet reliability of over 99%.



- OTSG is a type of HRSG with the following key differentiators
  1. Drumless design: OTSG = Once-Through Steam Generator
  2. Dry-run capable: All internal metallurgy is designed to accept the full gas turbine exhaust temperature while the OTSG is empty and dry.
  3. Simple Controls: Half the valves and instruments of a traditional HRSG
  4. Ultra-modular Installation: 5 major pieces to be assembled on site

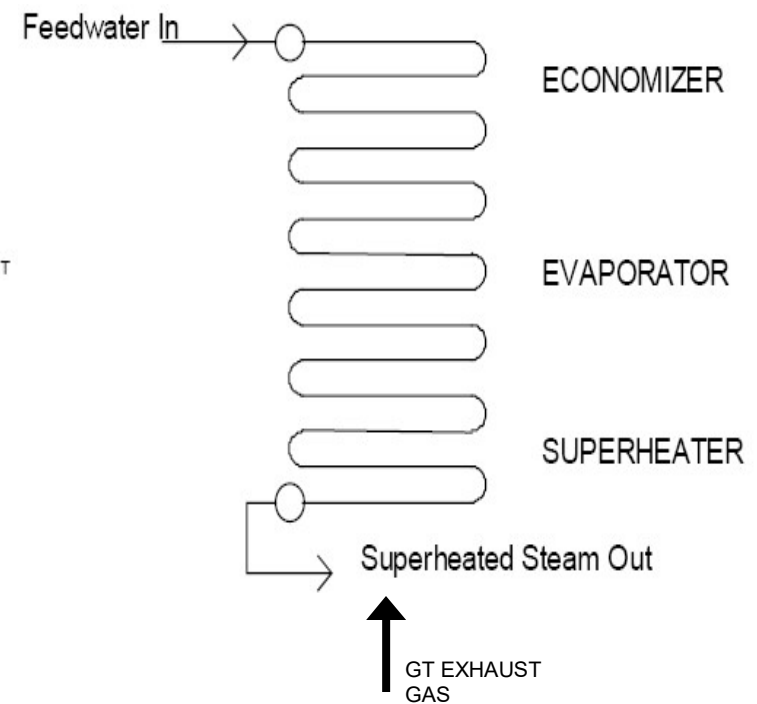
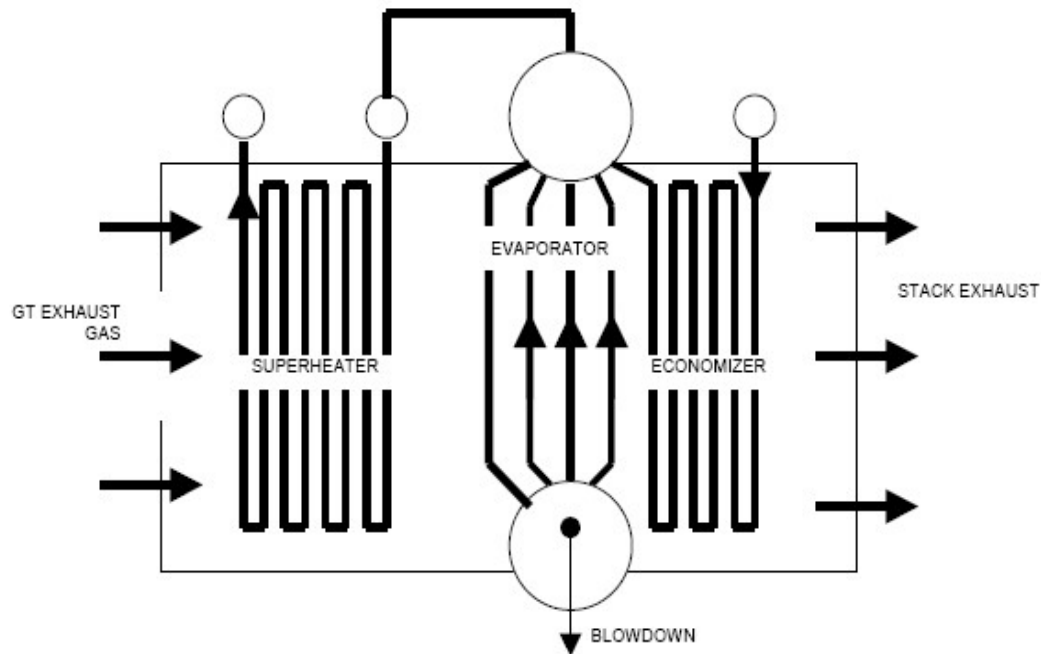


# 1. Drumless Design

## HRSG

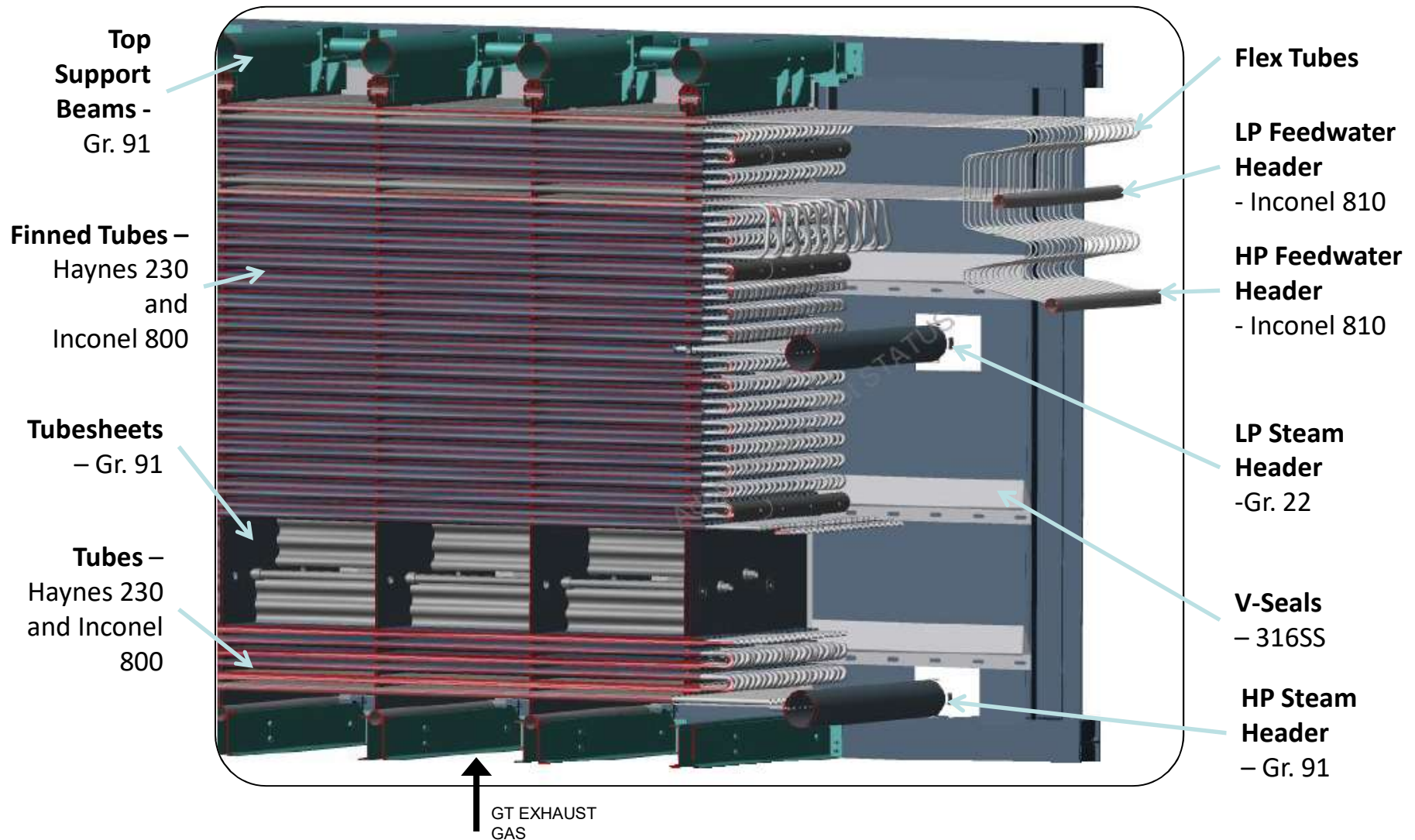
VS

## OTSG



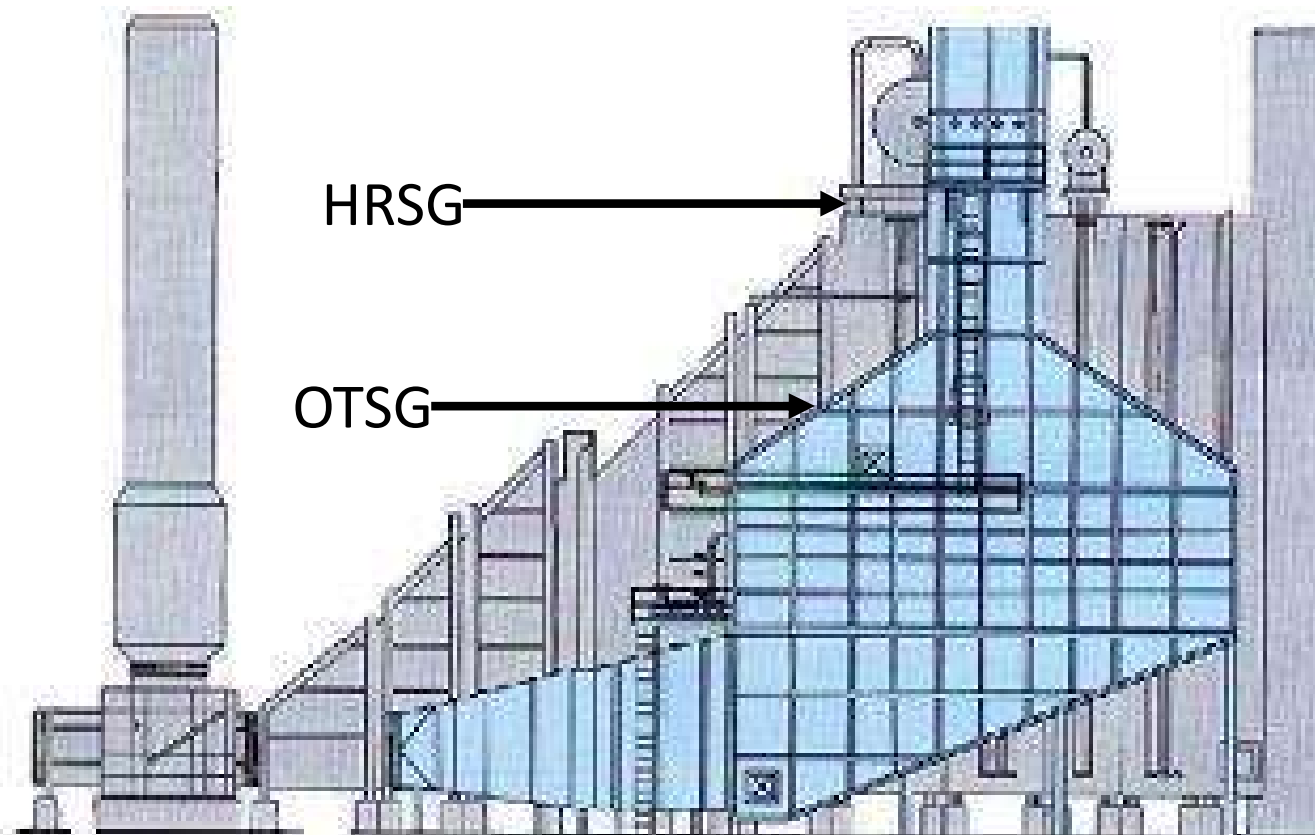


## 2. Dry-Run Capable OTSG

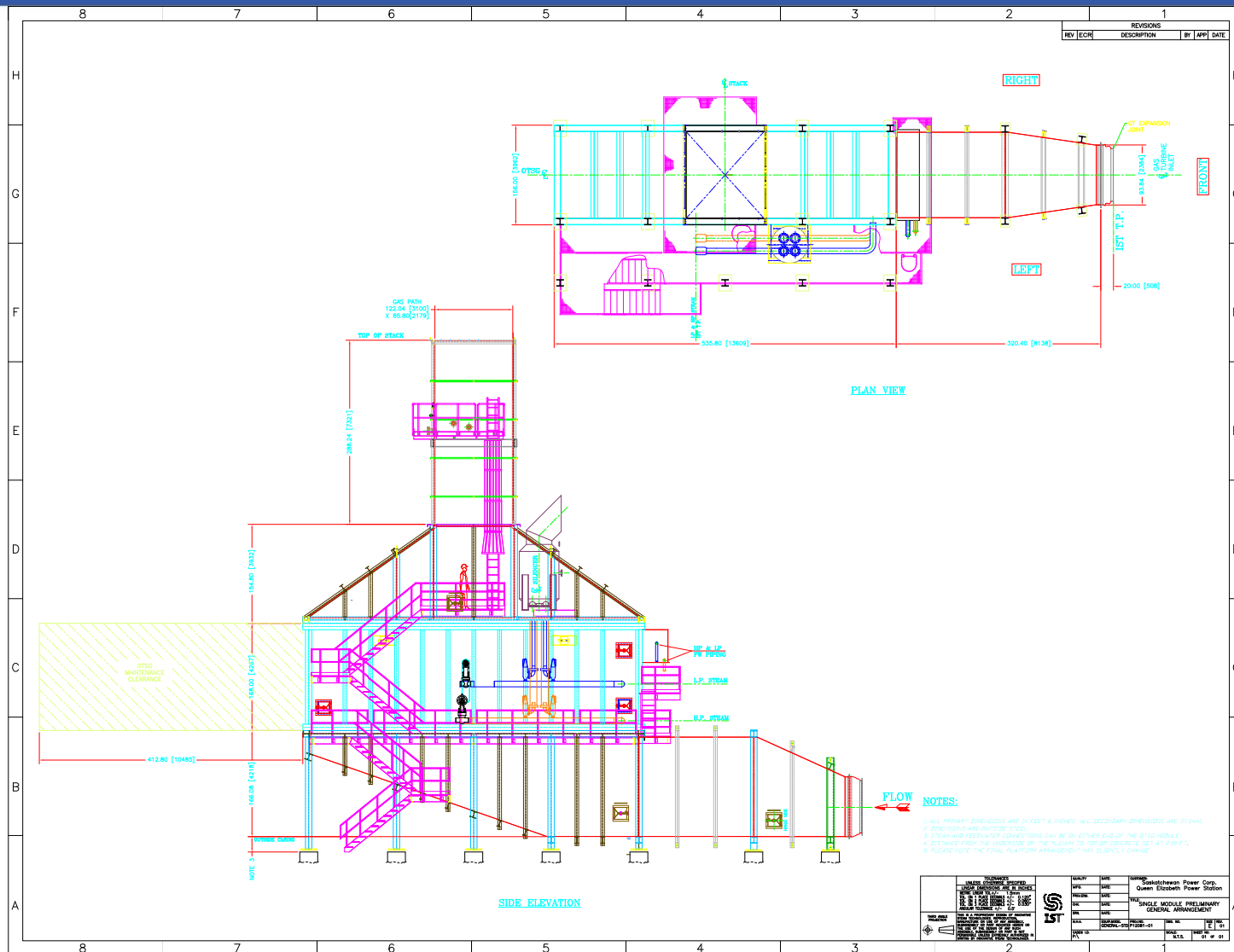


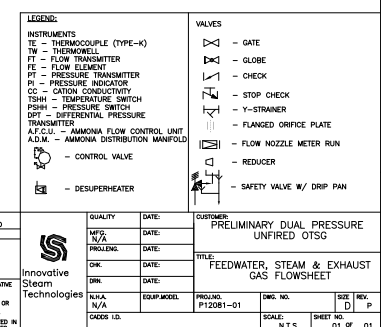


## 2. Dry-Run – Impact on Footprint



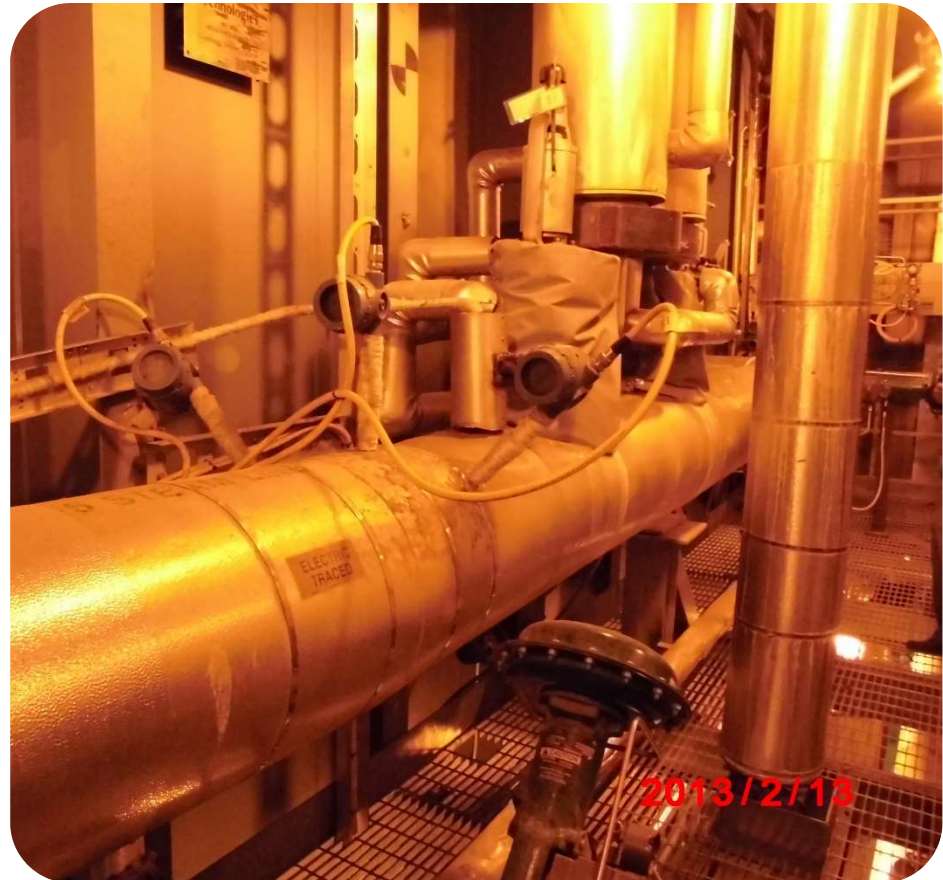
## 2. Dry-Run – Impact on Footprint







**HP Feedwater Inlet Piping**



**HP Steam Outlet Piping**



## 4. Modularity



## 4. Modularity





## 4. Conclusions

QEPS has become a large scale power production facility with industry-leading efficiency and reliability while still boasting operational flexibility through redundancy and equipment selection.

Thank you for your time.  
Questions?

