Development of HK Electric Gas Receiving Facilities at Lamma

Presentation for “How does Natural Gas Re-shape the Low Carbon Economy / Energy Market” - Ir Y.L. Kwan, HK Electric
Development of HK Electric Gas Receiving Facilities at Lamma

- Introduction
- Major Features of GRS
- GRS Development in Phases
- GRS Reliability Improvement Work
### Lamma Power Generation (1982-2013)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Type</th>
<th>Capacity (MW)</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1-3</td>
<td>Coal-Fired Units</td>
<td>250 x 3</td>
<td>1982-84</td>
</tr>
<tr>
<td>L4-6</td>
<td>Coal-Fired Units</td>
<td>350 x 3</td>
<td>1987-92</td>
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<tr>
<td>L7-8</td>
<td>Coal-Fired Units</td>
<td>350 x 2</td>
<td>1995-97</td>
</tr>
<tr>
<td>GT1</td>
<td>Oil-Fired GT Units</td>
<td>55</td>
<td>1978</td>
</tr>
<tr>
<td>GT2,3,4,6</td>
<td>Oil-Fired GT Units</td>
<td>125 x 4</td>
<td>1989-90</td>
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<tr>
<td>GT57CC</td>
<td>Gas/Oil Dual-Fired CCGT</td>
<td>345</td>
<td>2002</td>
</tr>
<tr>
<td>L9</td>
<td>Gas/Oil Dual-Fired CCGT</td>
<td>335</td>
<td>2006</td>
</tr>
<tr>
<td>Lamma Wind</td>
<td>Renewable Energy</td>
<td>0.8</td>
<td>2006</td>
</tr>
<tr>
<td>TFPV</td>
<td>Renewable Energy</td>
<td>1</td>
<td>2013</td>
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</table>

**Total Installed Capacity:** 3,737 MW
Gas Supply to Lamma Power Station

LNG from Australia and Qatar are blended and stored in Guangdong Dapeng LNG Terminal.

Blended gas is gasified and delivered via 92km submarine pipeline and landed at GRS of LMX.
Gas Receiving Station (GRS)

- Located at south west of Lamma Power Station Extension

- Receives natural gas from Mainland via a 92 km submarine pipeline operating at a pressure of around 80 bar

- Controls gas supply to Unit 9 at a gas pressure of around 40 bar and to GT57 at around 28 bar

- Fenced off as a Natural Gas Controlled Area
Major Features of GRS

Pig Receiver
• Receive pigs launched from Shenzhen for cleaning and inspection of the submarine pipeline
Major Features of GRS

Flaring and Venting System
- Blowdown of the 92km submarine gas pipeline in case of emergency or maintenance
- No continuous purging of natural gas through the flare stack during normal operation
Emergency Shut Down Valves

- Incoming and outgoing ESDV are provided
- Shutdown gas supply from the LNG Terminal in case of emergency
Major Features of GRS

- Pig Launcher
- Inlet Valve
- ESDV Pig Receiver
- Natural Gas
- Gas Filter
- Gas Meter
- Gas Heater
- Pressure Regulating Station
- Flare Stack
- GT Unit

Gas Filter
- Remove solid particles larger than 5µm in sizes from the incoming natural gas
Major Features of GRS

- Pig Launcher
- Inlet Valve
- ESDV
- Pig Receiver
- ESDV
- GT Unit
- Regulating Station
- Gas Heater
- Gas Meter
- Gas Filter
- LNG Terminal
- Natural Gas

Gas Metering System
- Ultrasonic gas metering stream to measure the volumetric flow of natural gas to generating units
Gas Heater

- Gas temperature will drop after undergoing pressure reduction at the pressure regulating station due to Joule-Thompson effect

- Gas-fired water bath type heater to heat up natural gas to maintain gas temperature after pressure reduction well above gas dew point for satisfying the requirement of gas turbine combustion system
Pressure Reduction Streams
• Pressure reduction streams to regulate gas pressure to meet requirement of the gas turbines

• Two streams for each gas turbine: One stream on duty mode and other stream on standby mode which will be cut in automatically in case the duty stream is mal-functioned

• Each stream provided with HIPPS comprising an active regulator, a monitor regulator, a quick shut off valve, a pressure relief valve and associated vents, valves and fittings
Major Features of GRS

Gas Supply Piping
• Deliver natural gas from GRS to gas turbines
GRS Development in Phases

2006

**Initial Design**
Supply natural gas to six new gas-fired combined cycle units (L9-L14)

Construction of GRS is separated into different phases:
Phase 1 for L9 with provision for L10 & L11; Phase 2 for L12, L13 & L14
GRS Reliability Improvement Work

Inlet ESDV
Filters
Metering Skid
Water Bath Heater
Pressure Reduction Station
Outlet ESDV

To L9
## GRS Development in Phases

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<th>2008</th>
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<td><strong>Gas Facilities for GT57 Gas-fired Combined Cycle Plant</strong>&lt;br&gt;Installation of a pressure reduction skid for the GT57 combined cycle unit which was converted from existing two simple cycle gas turbines by retrofitting a steam bottoming cycle</td>
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GRS Reliability Improvement Work

Gas Facilities for GT57 Gas-fired Combined Cycle Plant
# GRS Development in Phases

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GRS Reliability Improvement Work

New Inlet ESDV To GT57

New Gas Heater To L9

Additional ESDV and Gas Heater
## GRS Development in Phases

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<th>Phase</th>
<th>Description</th>
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<td>Additional ESDV</td>
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<tr>
<td>2012</td>
<td>GRS Reliability</td>
<td>GRS Reliability Work</td>
</tr>
<tr>
<td></td>
<td>Improvement</td>
<td>Improvement work to ensure that spurious trip of GRS will not lead to loss of gas supply to both L9 and GT57 while maintaining safe, reliable and efficient operation</td>
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- **GRS** refers to Gas Reliability System.
Necessity for GRS Reliability Improvement Work

Two incidents in 2010:

- Shutdown of Unit 9 due to failure of electronic components of Pressure Reduction Streams (PRS) control valves.

- Fire computer power failure led to closure of all emergency shutdown valves (ESDV). Gas supply to two gas-fired combined cycle units L9 and GT57 was cut off.
GRS Reliability Improvement Work – Work Scope

- Segregation of gas supply to Unit 9 and GT57 so that failure of a single system will not affect the other system
  - Addition of Inlet ESDVs for L9 and GT57 streams
  - Addition of GT57 Flowmeter and Modification of Flow Computer System
  - Addition of 1 Gas Heater
  - Modification of GRS Control system
  - Addition of Hardwired Interlock Panel for the GRS Inlet ESDVs, L9 ESDVs and GT57 ESDVs
  - Modification of ESDV Control Logic and Configuration
  - Modification of Fire & Gas Detection Systems
  - Modification of associated pipework
GRS Reliability Improvement Work – Work Scope

- Replacement of Unit 9 Pressure Reduction Skid
  - Use mechanical instead of electronic control for pressure control valves of similar design as that of GT57 to reduce the reliance on electronic control of Unit 9 gas supply system
GRS Reliability Improvement Work

Replacement of L9 Pressure Reduction Station

New Gas

Facilities

To GT57

To L9

Common Inlet ESDV
Filters
Individual Train Inlet ESDV
Metering Skid
Water Bath Heater
Pressure Reduction Station
Individual Train Outlet ESDV
GRS Before Improvement Work

- Flow Meter for both Unit 9 and GT57
- 2 Gas Heaters for Unit 9 and GT57
- Unit 9 and GT57 Pressure Reduction Systems
- To L9
- To GT57

Legend:
- Blue: Common gas supply system
- Green: L9 gas supply system
- Orange: GT57 gas supply system
GRS After Improvement Work

Common gas supply system
L9 gas supply system
GT57 gas supply system
GRS After Improvement Work

Separation of Unit 9 and GT57 fuel gas supply lines from gas filter outlet header

1 set of ultrasonic flow meter 200 mm in size with a bypass line for GT57 fuel gas supply line

To L9  To GT57

- Common gas supply system
- L9 gas supply system
- GT57 gas supply system
Addition of emergency shutdown valves with bypass valves and partial stroke test devices at inlets of the 2 ultrasonic flow meters

Removal of interconnection pipes at inlet and outlet of gas heaters

- Common gas supply system
- L9 gas supply system
- GT57 gas supply system
GRS After Improvement Work

1 additional gas heater as a standby heater

- To L9
- To GT57

- Common gas supply system
- L9 gas supply system
- GT57 gas supply system
GRS After Improvement Work

- Replacement of L9 PRS to the type using in GT57
- Removal of common header at inlet of Unit 9 and GT57 pressure reduction systems

Legend:
- Common gas supply system
- L9 gas supply system
- GT57 gas supply system
GRS Reliability Improvement Work - Major equipment

- Flow meter Layout
GRS Reliability Improvement Work - Major equipment

- Flow meter arrived to Lamma Extension Site
GRS Reliability Improvement Work - Major equipment

- Water Bath Heater Layout
GRS Reliability Improvement Work - Major equipment

- Water Bath Heater
GRS Reliability Improvement Work - Major equipment

Unit 9 Pressure Reduction System Arrangement

- Active Regulator
- Monitoring Regulator
- Slam Shut Valve (SSV)
GRS Reliability Improvement Work - Major equipment

Unit 9 Pressure Reduction System
GRS Reliability Improvement Work – Major equipment

- Fire and Gas (F&G) Detection System
  - Separation of GRS into three major fire zones:
    i) Area upstream of gas filter outlet header (common gas supply system)
    ii) Area of Unit 9 gas supply system
    iii) Area of GT57 gas supply system
  - F&G Detection System for Unit 9 gas supply system will trip Unit 9 gas supply stream if fire or gas is detected, i.e. shutdown of Unit 9 inlet and outlet ESDVs; similar for GT57
  - If both Unit 9 and GT57 ESDVs are tripped, the two main ESDVs upstream of gas filters will also trip
GRS Reliability Improvement Work

Major Fire Zones at GRS

- Common Inlet ESDV
- Filters
- Individual Train Inlet ESDV
- Metering Skid
- Water Bath Heater
- Pressure Reduction Station
- Individual Train Outlet ESDV

To GT57

To L9
GRS Plan View at Initial Operation in 2006
GRS Plan View After Upgrade in 2012

- WBH 3
- WBH 2
- WBH 1
- GT57 FM
- Main Trunk
## GRS Reliability Improvement Work – Project Key Dates

<table>
<thead>
<tr>
<th>Event</th>
<th>Date(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract Award</td>
<td>28/9/2011</td>
</tr>
<tr>
<td>Delivery of Major Equipment</td>
<td>1/2012</td>
</tr>
<tr>
<td>GRS Outage</td>
<td>27/1/2012 – 23/2/2012</td>
</tr>
<tr>
<td>GRS Gas In</td>
<td>24/2/2012</td>
</tr>
<tr>
<td>Completion of Testing &amp;</td>
<td>End 3/2012</td>
</tr>
<tr>
<td>Commissioning</td>
<td></td>
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</tbody>
</table>
GRS Reliability Improvement Work – Project Challenges

- All works could only be carried out during a 27 days GRS outage when all natural gas in the working area are purged.
- Time frame from contract award to project completion date was less than 6 months.
- Complexity of work associated with the modification of GRS control and F&G system, re-routing of high pressure gas piping, stringent statutory approval procedures and gas safety control requirement.
- HK Electric supervision teams working with contractor have overcome all challenges and hiccups arising during project execution and all works were completed on time.
GRS Reliability Improvement Work – Erection

Welding of Gas Piping

Site Arrival of Major Equipment
GRS Reliability Improvement Work – Erection

Site Welding Preparation

Piping Alignment Adjustment
GRS Reliability Improvement Work – Erection

Equipment Installation

Equipment On Base
Gas Safety

- Quantitative Risk Assessment (QRA) and Hazard and Operability (HAZOP) studies on all gas facilities to identify and eliminate all possible risks.
- HK Electric has introduced a Natural Gas Safety Management System to gear all procedures entailed in the design, construction, commissioning, operation and maintenance of the gas facilities.
- Special devised programmes have been implemented to promote safety awareness among employees and contractors and ensure that all personnel are fully training in safety requirements and procedure.
Concluding Remarks

- Fully committed to providing a reliable, cleaner and greener electricity supply to meet Hong Kong’s power requirements, HK Electric has successfully introduced the use of natural gas for power generation since 2006. HK Electric will ensure the reliable operation of the GRS to supply natural gas to the two gas-fired units for power generation with much lower emissions than those of the coal-fired units.

- Rooted in Hong Kong for over a century as one of the world’s longest-established electricity companies and dedicated to the city’s sustainable development in future, HK Electric constantly pursues continual improvement in its services to supply reliable electricity to its customers in a clean, reliable, high-efficiency, environmentally friendly, and affordable manner.
Thank You