Kawasaki Gas Turbines-Americas
Gas Turbines
Power Generation
Technology & Applications
Gas Turbine (GT) Technology Overview
Gas Turbine Theory

Idealized Brayton Cycle

P-v Diagram

T-s Diagram
GT - Centrifugal Compressor

FUEL INLET

COMBUSTION CHAMBER

1

2

3

4

TURBINE

CENTRIFUGAL COMPRESSOR

Fuel → Combustion → Work out

Fresh Air

Exhaust gasses
GT - Axial Compressor
Gas Turbine Generator

- Air Inlet
- Gearbox
- Electric Generator
- Combustion Chamber
- Turbine
- Compressor
- Exhaust

Rated @ 1500 kW's
Gas Turbine Generator Unit
Gas Turbine Generator Package
Gas Turbine Performance

- **Power Output (kW):**
  - 5,000
  - 5,500
  - 6,000
  - 6,500
  - 7,000
  - 7,500
  - 8,000

- **Heat Rate (kJ/kWh):**
  - 10,800
  - 11,000
  - 11,200
  - 11,400
  - 11,600
  - 11,800
  - 12,000

- **Ambient Temperature (°C):**
  - 0
  - 5
  - 10
  - 15
  - 20
  - 25
  - 30
  - 35
  - 40

- **Legend:**
  - Blue line: Power Output
  - Red line: Heat Rate

**Kawasaki Gas Turbines**
Kawasaki Gas Turbine
Product Overview
The Kawasaki Everyone Knows
Kawasaki Gas Turbines
Global Presence

Kawasaki Gas Turbine Europe GmbH
(Bad Homburg, Germany)

Kawasaki Heavy Industries, Ltd.
(Akashi, Japan)

Kawasaki Gas Turbine Asia
(Kuala Lumpur, Malaysia)

Kawasaki Machine Systems, Ltd.
(Osaka, Japan)

Kawasaki Gas Turbines-Americas
(Houston, TX)
Kawasaki Gas Turbine Highlights

1952  Began Overhauling Jet Engines
1972  Began Development of Industrial Gas Turbine (IGT)
1974  Completed Development of First IGT Model
1977  Delivery of 1st First Kawasaki IGT
1984  Delivery of 1st Cogeneration System
1988  1.5 MW Class Introduced (Model M1A-13 IGT)
1993  5.5 MW Class Introduced (Model M7A-01 IGT)
1995  1.5 MW Class with Dry Low NOx (< 25 PPM) Introduced
1999  Delivery of 5000th Unit
      6.5 MW Class Introduced
      5.5 MW Class with Dry Low NOx Introduced
2000  18 MW Class Introduced (Model L20A IGT)
2002  1.5 MW Class with Ultra Low NOx (<2.5 PPM) Introduced
2006  7.5 MW Class Introduced (Model M7A-03 IGT)
2007  Delivery of 7000th Unit
2009  7.7 MW Class with Dry Low NOx (<15 PPM) Introduced
2010  1.7 MW Class Introduced (Model M1A-17 IGT)
2011  7.7 MW Class, 9ppm (NOx) M7A-03D introduced
Kawasaki
Gas Turbine Products
GTG Technology

- **GPB**
  - Base Load Power Generation
    - Combined Heat & Power (or co-generation)
    - Combined Cycle Power Generation
  - Gas / Liquid / Dual Fuel

- **GPS**
  - Stand-by Power Generation
    - Emergency Power
    - Peak Shaving Power
  - Gas / Liquid / Dual Fuel
Model GPB
Base Load Gas Turbine Generator Package
GPB Model Overview

- GPB15/15D 1.5 MW Class
  > D: Dry Low NOx (<25 PPM)
- GPB17/17D 1.7 MW Class
  > D: Dry Low NOx (<15 PPM)
- GPB30/30D 3.0 MW Class
  > D: Dry Low NOx (<25 PPM)
- GPB60/60D 5.5 MW Class
  > D: Dry Low NOx (<35 PPM)
- GPB70/70D 6.5 MW Class
  > D: Dry Low NOx (<25 PPM)
- GPB80/80D 7.7 MW Class
  > D: Dry Low NOx (<9 PPM)
- GPB180D 18.0 MW Class
  > D: Dry Low NOx (<25 PPM)
Model GPB15/17 (M1A-13/17)

- 1.5 MW / 1.7 MW Class
- Compact Design
  - 2 Stage Centrifugal Compressor Section
  - 3 Stage Axial Turbine Section
  - Short Rotor Span
  - Single Combustion Chamber
- Fuel Options
  - Gas / Liquid / Dual Fuel (-13)
  - Gas (-17)
- Introduced in 1988
  - Nearly 1000 Units Delivered
Model GPB15/17 (M1A-13/17)
GPB15/17 Model Performance

• Power Output
  > 1.49 MW @ ISO (GPB15)
  > 1.69 MW @ ISO (GPB17)

• Steam Generation
  > ~11,000 lb/hr (5,000 kg/hr) @ 125 psig (8.62 bar)

• Chilled Water Generation
  > ~1100/1200 TR Steam/Exhaust Fired

• Efficiency
  > Power Generation Only:
    – GPB15: ~24%
    – GPB17: ~27%
  > Co-generation:
    – GPB15: ~79%
    – GPB17: ~82%
Model GPB30 (M1T-13)

- 3.0 MW Class
- Dual M1A-13 Configuration
  > Dual M1A-13 Turbines
  > Single Gearbox
  > Single Generator
- Gas / Liquid / Dual Fuel
- Option for Redundancy
  > Dual Turbine/Gearbox/Generator Model PGU30
Model GPB30 (M1T-13)
GPB30 Model Performance

- **Power Output**
  > 2.93 MW @ ISO

- **Steam Generation**
  > ~22,000 lb/hr (10,000 kg/hr) @ 125 psig (8.62 bar)

- **Chilled Water Generation**
  > ~2200/2400 TR Steam/Exhaust Fired

- **Efficiency**
  > Power Generation Only: ~24%
  > Co-generation: ~79%
Model GPB60/70/80 (M7A-01/02/03)

- 5.5 MW / 6.5 MW / 7.7 MW Class
- Efficient Design
  > 11/12 Stage Axial Compressor Section
  > 4 Stage Axial Turbine Section
  > Six Combustion Chambers
- Gas / Liquid / Dual Fuel
- Introduced in 1993
  > Over 100 Units Delivered
Model GPB60/70/80
Model GPB60/70/80
GPB60/70/80 Model Performance

• Power Output
  > 5.53 MW @ ISO (GPB60)
  > 6.80 MW @ ISO (GPB70)
  > 7.45 MW @ ISO (GPB80)

• Steam Generation
  > ~32,000 lb/hr (14,500 kg/hr) @ 125 psig (8.62 bar) [GPB60]
  > ~36,000 lb/hr (16,400 kg/hr) @ 125 psig (8.62 bar) [GPB70/80]

• Chilled Water Generation
  > ~3200 TR Steam Fired [GPB60]
  > ~3600 TR Steam Fired [GPB70/80]

• Efficiency
  > Power Generation Only
    - GPB60: ~30%
    - GPB70: ~30%
    - GPB80: ~33%
  > Co-generation (Equivalent): ~83%
Model GPB180 (L20)

- Power Generation Design
- Gas or Liquid Fuel
- Introduced in 2000
GPB180D Model Performance

• Power Generation: 18.42 MW @ ISO
• Steam Generation
  > 88,000 lb/hr (40,000 kg/hr) @ 125 psig (8.62 bar)
• Efficiency
  > Power Generation Only: ~33.8%
  > Combined Cycle Efficiency – 48-50%
  > Co-generation: ~83%
Model GPS
Stand-by Gas Turbine Generator Package
GPS Model Overview

- GPS750  750 kVA  600 kW
- GPS1250  1250 kVA  1000 kW
- GPS1500  1500 kVA  1200 kW
- GPS2000  2000 kVA  1600 kW
- GPS2500  2500 kVA  2000 kW
- GPS3000  3000 kVA  2400 kW
- GPS4000  4000 kVA  3200 kW
- GPS5000  5000 kVA  4000 kW
- GPS6000  6000 kVA  4800 kW
GPS Advantages

- High Power Density
  - 50% Weight and 50% Footprint (vs. Engine)
  - Roof Mounting Capability
- Dual Fuel (Gas / Liquid)
  - Automatic Fuel Switching (Additional Level of Redundancy)
  - Potential for Much Smaller Diesel Storage Tank
- High Emissions Density (Diesel)
  - Less than 100 ppm NOx (Engines Typically: 500-700 ppm)
- High Start Reliability - Greater than 99%
- Instantaneous 100% Load Acceptance
- Low Noise Levels – 85 dBA or less
- Fast Start – 40 Seconds
  - Not Applicable for Life Safety (per US Codes)
GPS Installations

Roof-top Installation

3 x 3,000 kVA
GPS Installations

Indoor Installation

2 x 2,500 kVA
GPS Installations

Outdoor Installation

5 x 3,500 kVA
Gas Turbine Generator Applications
Best GTG Applications

• CHP
  > Requires High Quality / Quantity Heat Source
  > Requires Chilled Water Production
    – Steam to Chilled Water
    – Exhaust to Chilled Water

• Dual Fuel Simple Cycle Power Generation

• Combined Cycle Power Generation
  > HRSG (w/Supplemental Firing)
    + Steam Turbine → 48%-50% Efficiency
CHP (with Steam)
CHP (with Steam & Chiller)
CHP (Exhaust Fired Chiller/Heater)
Gas Turbine Generator
Reliability / Availability / Maintainability
Reliability / Availability / Maintenance

- **Reliability**
  > Typically Greater Than 99%

- **Availability**
  > Typically Greater Than 96%

- **Maintenance**
  > Inspection Interval: Annually
  > Hot Section Inspection: Every 2 Years
  > Major Overhaul: Every 4 Years
Extended Services

• Extended Warranties

• Extended (Long Term) Service Agreements
  > Multi-year Contracts (4 Year Cycles)
  > Availability Guarantees
  > Regional Service Support
  > 24 Hour Support (via Internet)

• Spare Parts
  > Recommended On-site Spare Parts
  > Replacement Engine Cores Available for Shipment in 24 Hours
  > Overnight Delivery of Other Critical Spare Parts
Questions