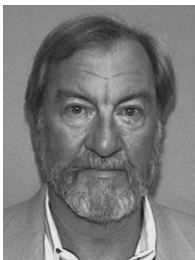


# AERODERIVATIVE, INDUSTRIAL, AND LIGHT INDUSTRIAL GAS TURBINES— A COMPARISON

by

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*The following is a copy of the author's PowerPoint submittal. It has received no editing.*

## Aeroderivative, Industrial, and Light Industrial Gas Turbines A Comparison

The purpose of this Tutorial is to compare Industrial, aeroderivative, and light industrial gas turbine characteristics and their applications. It will also provide some example economic comparisons for different applications and constraints

Slide 1.

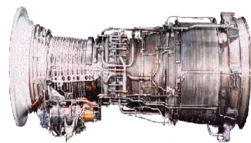
## Aeroderivative Engines

- Better response to load changes (less GG mass)
- Condition maintenance may be easier due to more inspection ports.
- Higher firing temperatures
- Higher efficiency, better fuel consumption
- Higher NOX and CO

Slide 3.

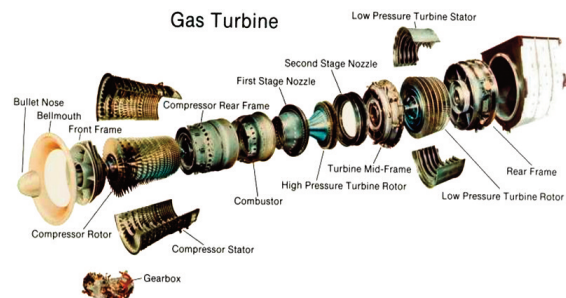
## Aeroderivative Engines

- Based of aircraft flight engine
- Lightweight, fabricated casing
- Modular construction
- Rolling element bearings
- Two separate oil systems, gas turbine and driven equipment
- Synthetic oil required because of higher bearing temperatures



Slide 2.

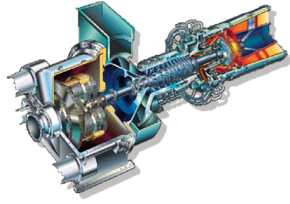
## Aeroderivative Engines



Slide 4.

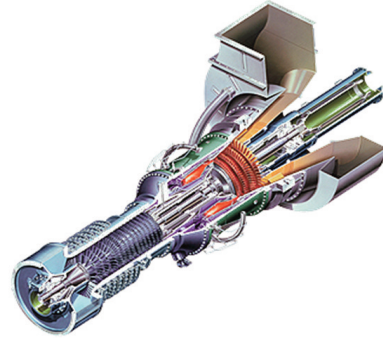
## Industrial Engines

- Robust design
- Cast main casings
- Common lube oil system
- Mineral oil suitable
- Hydrodynamic bearings
- Lower firing temperatures



Slide 5.

## “Lightweight” Industrial



Slide 9.

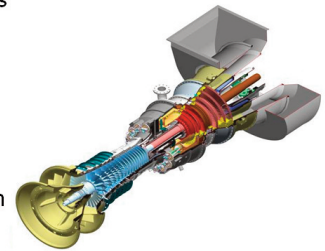
## Industrial Engines

- Lower in emissions than other engines
- Lower firing temperatures
- Lower efficiency, 32-25% simple cycle

Slide 6.

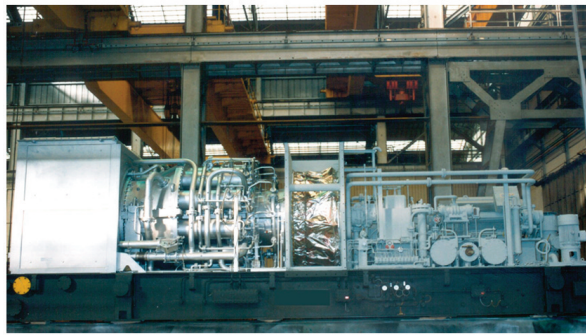
## “Lightweight” Industrial

- Fabricated Main Casings
- Hydrodynamic bearings
- Mineral lube oil
- Common lube oil system



Slide 10.

## Industrial Engines

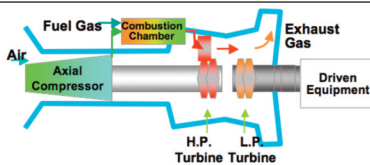


Slide 7.

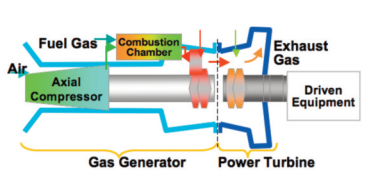
## Application Considerations

- Original capital cost
- Sparing philosophy
- Maintenance turn-around time
- Maintenance access
- Field service availability
- Cost of fuel gas
- Weight of package
- Emissions requirements

Slide 11.



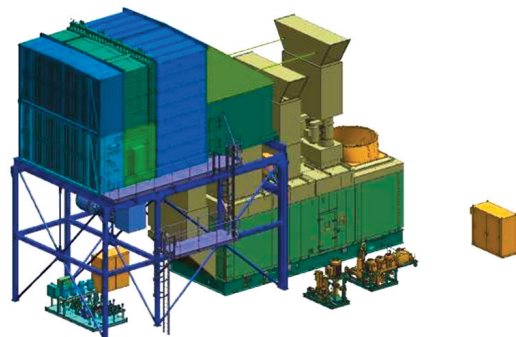
- Heavy Duty**
- Single or double shaft
  - Moderate Compression Ratio
  - Moderate Firing Temperature (...New generation GTs approaching Aeros')
  - 30MWGT Typical Efficiency 36% for Recent Models
  - Simpler, Heavier, Cheaper
  - Less Maintenance



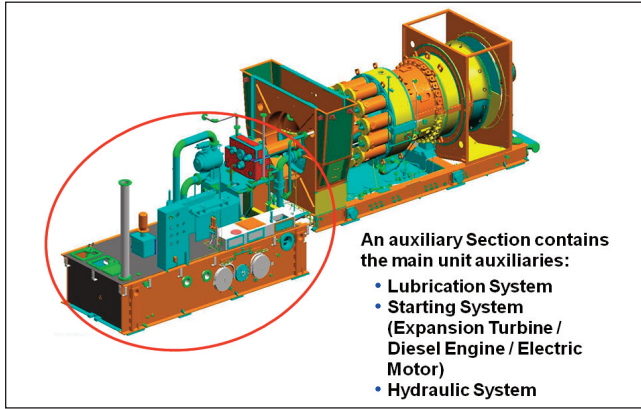
- Aeroderivative**
- Gas Generator and Power Turbine in Separate Modules
  - Always double shaft (or more)
  - High Compression Ratio
  - Higher Firing Temperature
  - 30MW GT Typical Efficiency 39%
  - High Tech., Lighter, Expensive
  - Higher Maintenance

Slide 8.

## Typical Package Layout



Slide 12.



Slide 13.



Slide 17.



Slide 14.



Slide 18.

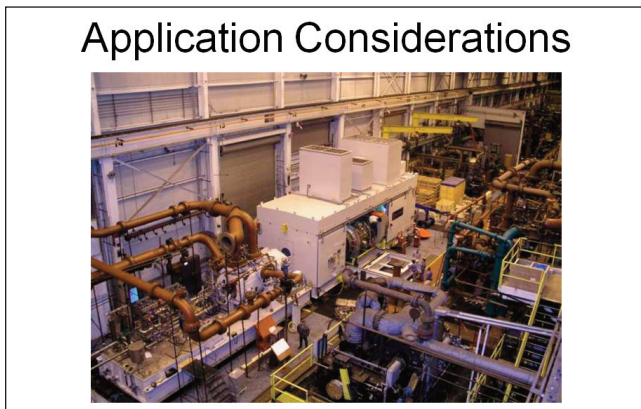


Slide 15.

### Case Studies

- Capital Cost
- Installed cost
- Fuel cost
- Heat rate
- CO and NOX penalties or credits
- Off design performance (if required)
- Design points/alternate operating conditions
- Replacement/repair costs

Slide 19.



Slide 16.

### Case Studies

EVALUATION PROCEDURE FOR REINJECTION COMPRESSOR PACKAGE

Tenderer:	Date:
Responsible Person:	Location:
<b>Calculation 3 - Reinjection Lifecycle Costs : Calculation of OPEX vs Production Profile : Years 1 through 19.</b>	
Annual figures are based on 97% plant uptime.	
Data to be entered from tender	
Monthly Support Contract Cost	\$1,000 \$US
Fired Hour Charge	\$150 \$US/quiv hr
Data to be entered from commercial evaluation - CAPEX calculation	\$25,000,000 \$US
Reference data	
NOx Polluter Pays Cost	\$38 \$US/ton
CO2 Polluter Pays Cost	\$24 \$US/ton
Fuel Gas Cost/MBTU	\$2 \$US/MMBTU
Turbine Heat Rate	11600 BTU/kW-hr
Power	29000 kW
Fired Hours per Year	

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### Case Studies

PRODUCTION PROFILE DATA		ANNUAL PERFORMANCE TOTALS					OPEX COSTS					LIFECYCLE COST	
Actualized Gas Production	Actualized Gas Production Rate	Fuel Gas Consumption	NOx Emissions	CO2 Emissions	Fixed Hour Consumption	Support Contract	Fuel Gas Consumption	NOx	CO2	Total OPEX	Lifecycle cost weighting factor	Lifecycle Cost Summation	EBB
Actualized	Actualized	Actualized	Actualized	Actualized	Actualized	Actualized	Actualized	Actualized	Actualized	Actualized			
MMBtu/yr	MMBtu/yr	MMBtu/yr	tonnes/yr	tonnes/yr	MMBtu/yr							NPV	OPEX CAPEX
1	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.9585	-\$3,791,238	-\$54,319,562
2	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.9669	-\$3,228,209	
3	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.796	-\$4,752,462	
4	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.796	-\$4,321,120	
5	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.692	-\$3,837,840	
6	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.592	-\$3,371,738	
7	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.5003	-\$2,942,650	
8	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.4483	-\$2,551,120	
9	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.4448	-\$2,202,802	
10	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.4044	-\$1,892,224	
11	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.3676	-\$1,617,254	
12	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.3342	-\$1,376,718	
13	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.3039	-\$1,162,474	
14	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.2762	-\$968,608	
15	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.2511	-\$794,508	
16	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.2283	-\$637,728	
17	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.2078	-\$498,978	
18	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.1886	-\$373,878	
19	0.000	2,413,980,000	87	125	0.0	-\$1,000,000	-\$4,828,780	-\$2,197	-\$2,748	-\$8,021,703	0.170	-\$269,478	
												NPV OPEX	-\$43,319,662

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### Case Studies

	Turbine 1	Turbine 2	Turbine 3	Turbine 4	Turbine 5
Change	Base Case	Increased Heat Rate	Increased CAPEX	Increased Emmissions	Increased Monthly Support Contract
NPV OPEX	-\$29,319,562	-\$32,369,680	-\$29,319,562	-\$29,331,132	-\$35,152,654
NPV CAPEX	-\$25,000,000	-\$25,000,000	-\$30,000,000	-\$25,000,000	-\$25,000,000
NPV TOTAL Life	-\$54,319,562	-\$57,369,680	-\$59,319,562	-\$54,331,132	-\$60,152,654

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