Life Cycle Cost Analysis of Gas Turbines

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Agenda

- Considerations in unit selection
  - Capital Investment requirements
  - Operational Needs
  - Maintenance
- Case Study #1
- Case Study #2
- Case Study #3

Capital Investment

Design Outputs

- Fuel Consumption
- Load Factor
  - Efficiency
  - Multiple Units
- Starts/Stops
- Operating Hours
- Operating Conditions
- Emissions
  - Air
  - Noise

Utilities

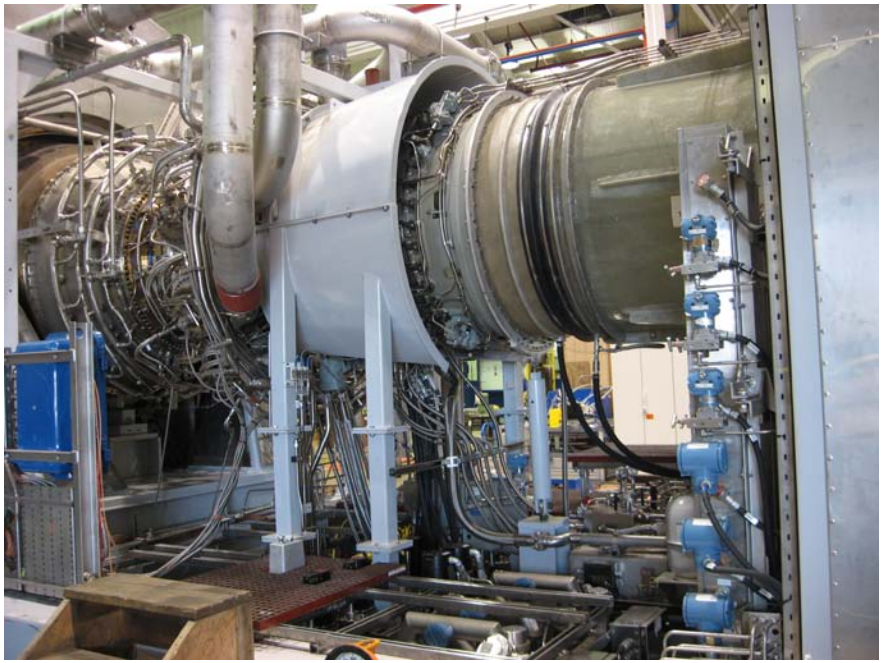
- Power
- Water
- Fuel
- Heating
  - Domestic
  - Fuel
- Compressed Air
  - Requirements
  - Multiple Systems

Facilities

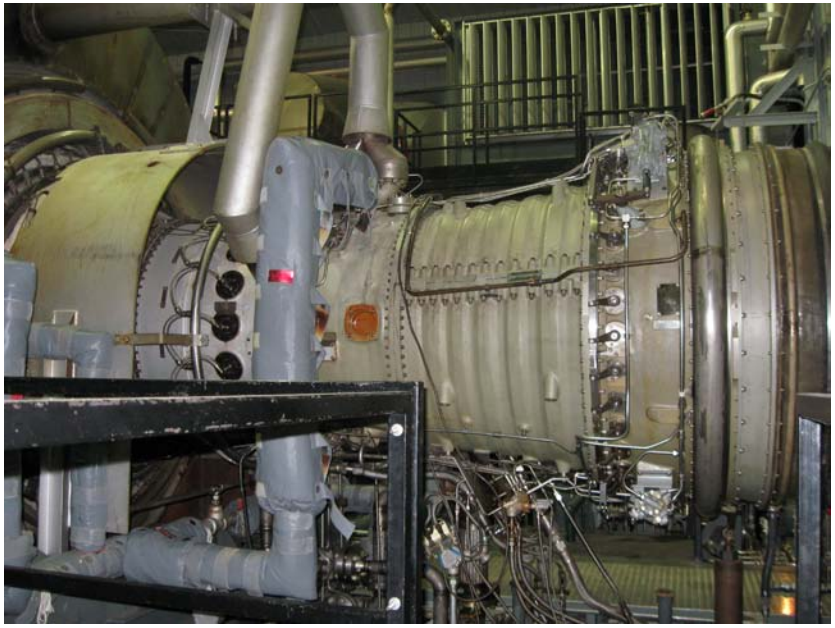
- Land Area
  - Current
  - Future
  - Accessibility
  - Security

Spare Inventory

- Inventory
  - Filter Elements
  - Seal Kit
  - Bearings
  - Ignitors
  - Combustors
- Tooling



Operating Costs



Personnel

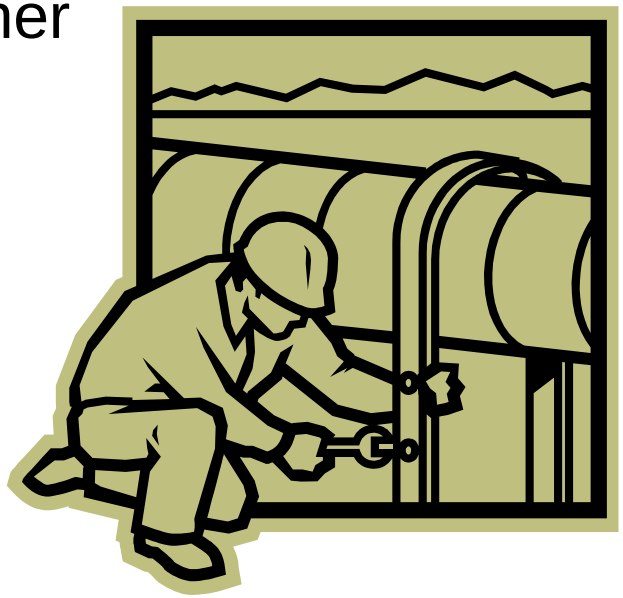
Operation

- Operating season/lifespan
- Remote vs staffed facilities
- Operating Engineers vs Turbine Operators and Mechanics
  - Wages
  - Background
  - Training costs
  - Union Considerations

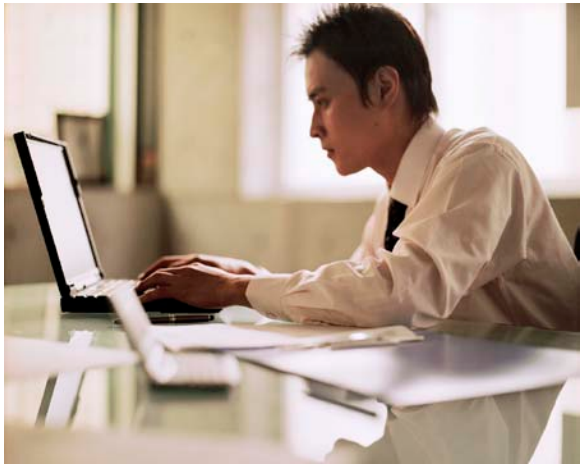
Personnel

Maintenance

- Industrial Mechanics, I&C Technicians, Electricians (crossover), Other
- LTSA/FSR support



Management/Administrative



Utility Costs

Electrical Power

- Consumers
  - Air Compression
  - Motors
  - I&C Systems - control panels, consoles, transmitters, fire and gas detection
  - Cooling systems
- Grid Power vs. On-Site Generation
  - Availability
  - Reliability
  - Cost (Smart Metering)

Utility Costs

Fuel

- Type – depends on location/product
- Thermal and Pneumatic Loads
- Fuel Conditioning
- Fuel quality monitoring – chromatography
- Piping system maintenance/inspection
- Utility Measurement Facilities

Utility Costs

Lubricating Oils

- Sampling
- Stocked quantities
    - Climate control, shelf life

Emission Monitoring

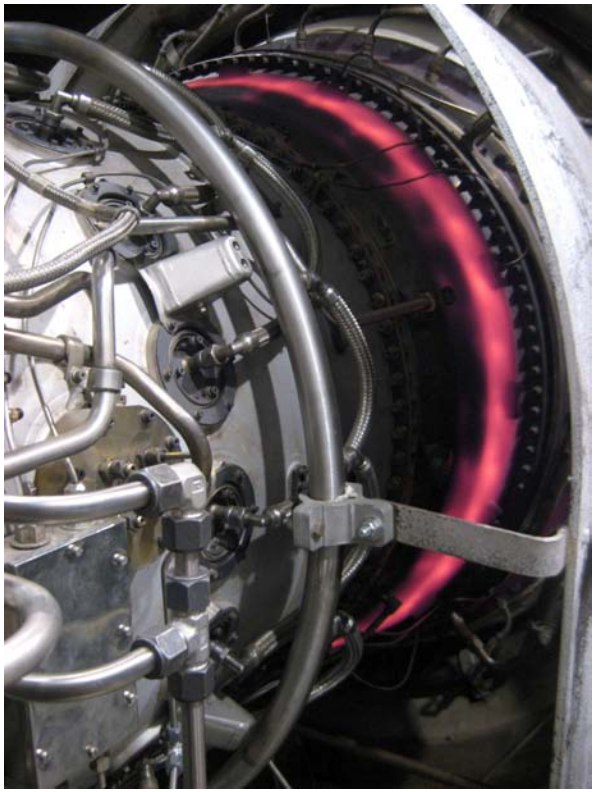
- CEMS
    - Equipment O&M Costs
- PEMS
    - Cost to maintain instrumentation for additional inputs


Maintenance

Maintenance

Scheduled Inspections

- Compressor soak wash
  - Design Consideration
    - Off line wash = equipment downtime
    - Online wash = additional capital
- Oil sampling



Maintenance

Scheduled Inspections

- 4000 hours (igniters, borescope inspection, VIGV check mechanism)
- 8000 hours BOV checks, pressure switches, electrical, HP3 air filter
- Pre-start inspections

Maintenance

Scheduled Overhauls

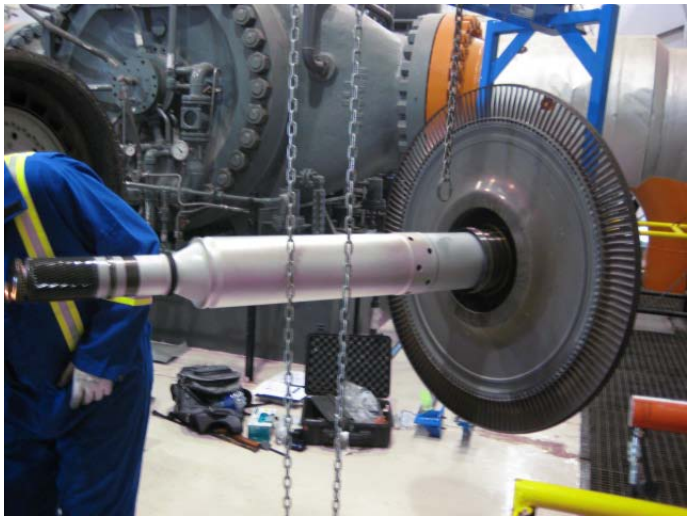
- Scheduled Overhauls
  - Midlife overhaul
  - Complete overhaul
- Prolonged outage
- Options
  - Lease Engine
  - LTSA
  - Spare engine

Maintenance

Unscheduled

Resource considerations

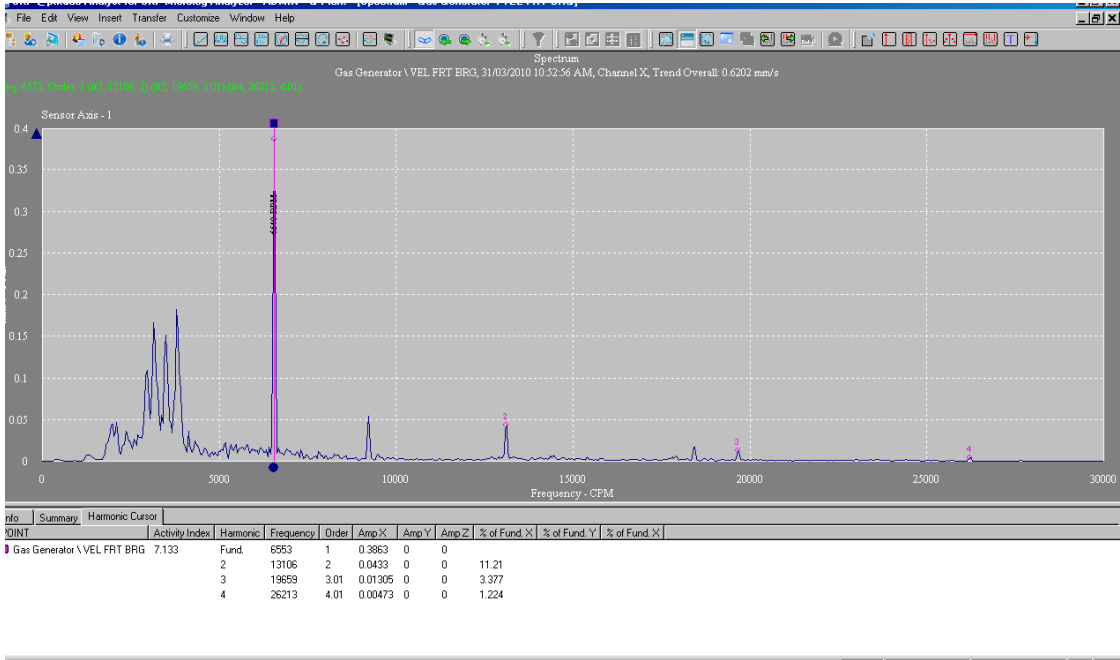
- In-house maintenance crews
- Level of expertise
- LTSA
- Factors to consider
  - maintenance window
  - Redundancy in system
  - Spare unit
  - Value of downtime



Maintenance

Condition Monitoring/Predictive Maintenance

- Detection of early-stage problems
- Vibration analysis
- Fluid analysis
- avoid costly failures



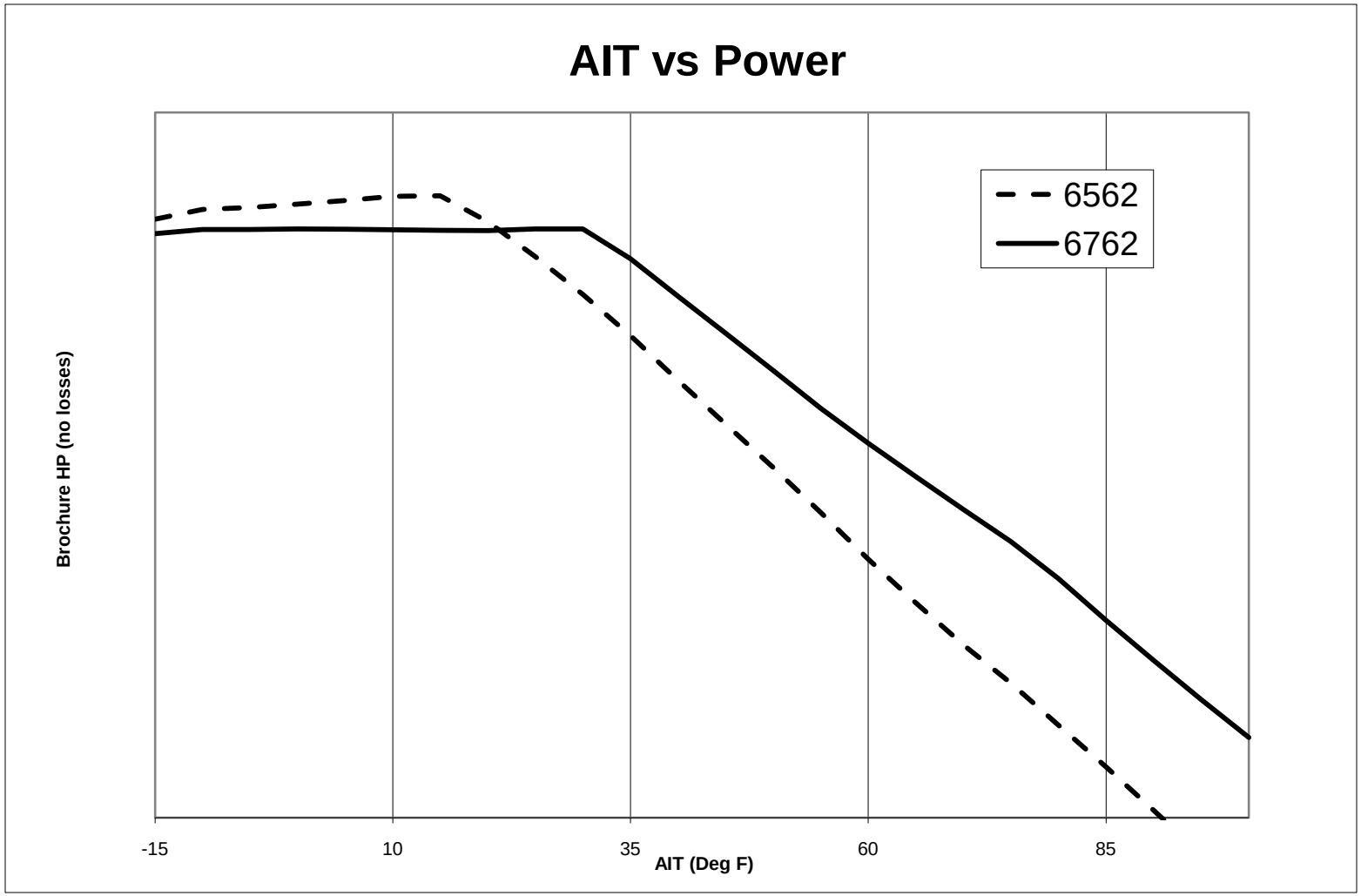
CASE STUDY 1

Gas Compressor for Storage Pool Injection/Withdrawal Service

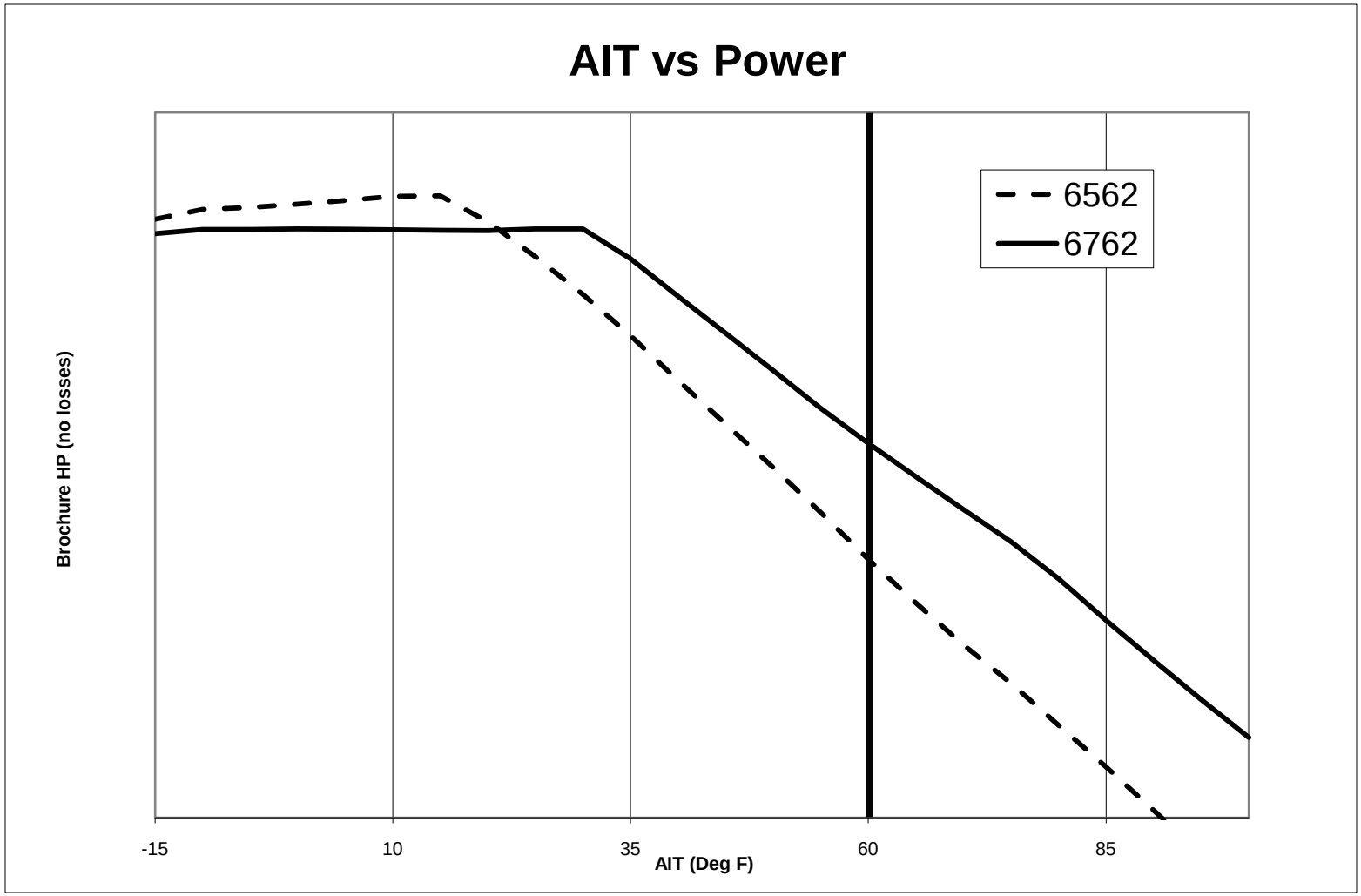
Case Study 1

- Design Parameters
  - Injection – May – September
  - Withdrawal – October – March
  - Large operating range
- Located in large compression facility
- Options
  - Rolls Royce 6561
  - Rolls Royce 6761
  - Rolls Royce 6762

Case Study 1


AIT vs Power
Brochure HP (no losses)
6562
6762
-15
10
35
60
85
AIT (Deg F)

Case Study 1


AIT vs Power
Brochure HP (no losses)
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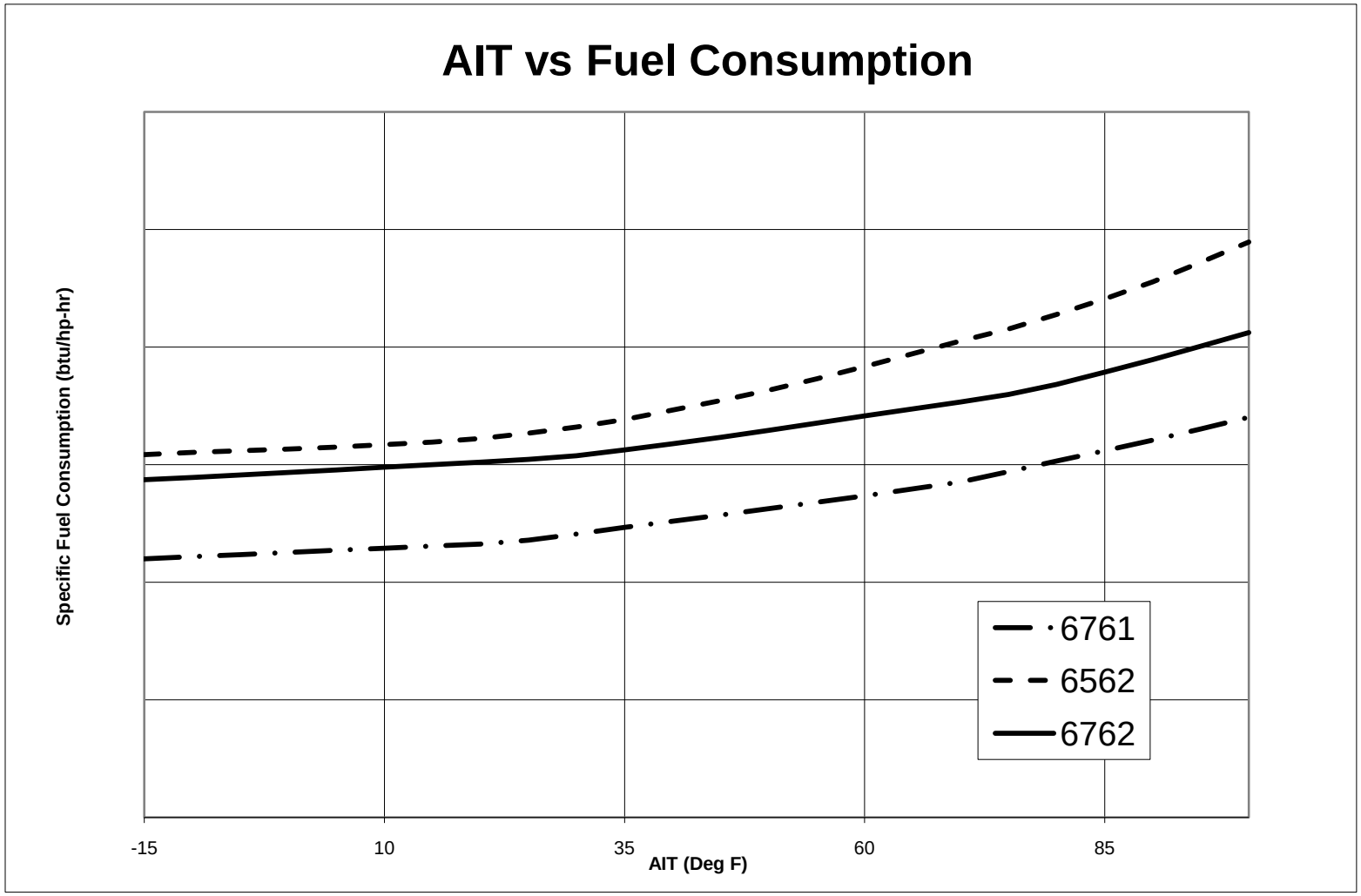
Case Study 1


AIT vs Fuel Consumption
Specific Fuel Consumption (btu/hp-hr)
-15
10
35
60
85
AIT (Deg F)
6761
6562
6762

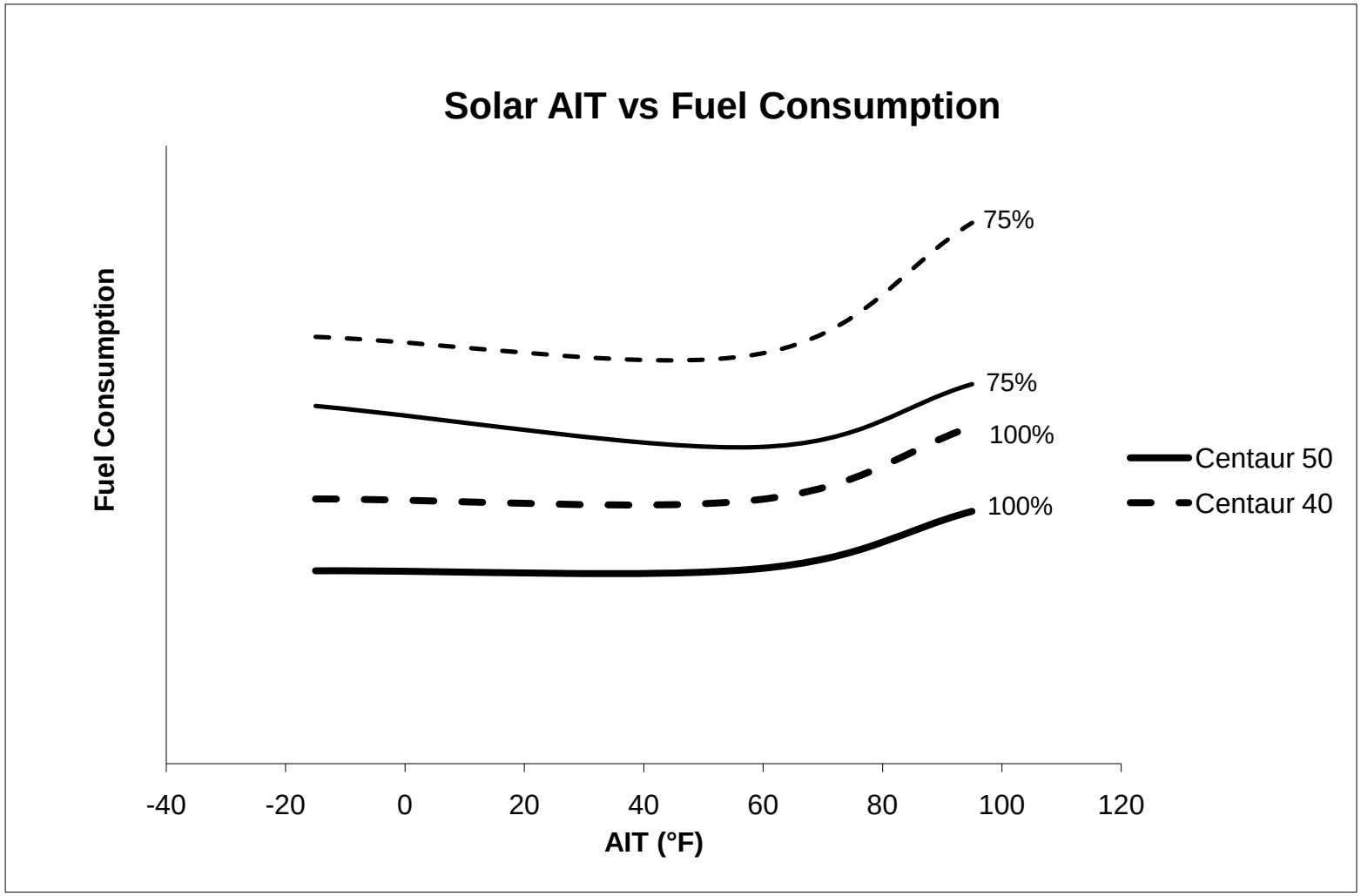
CASE STUDY 2

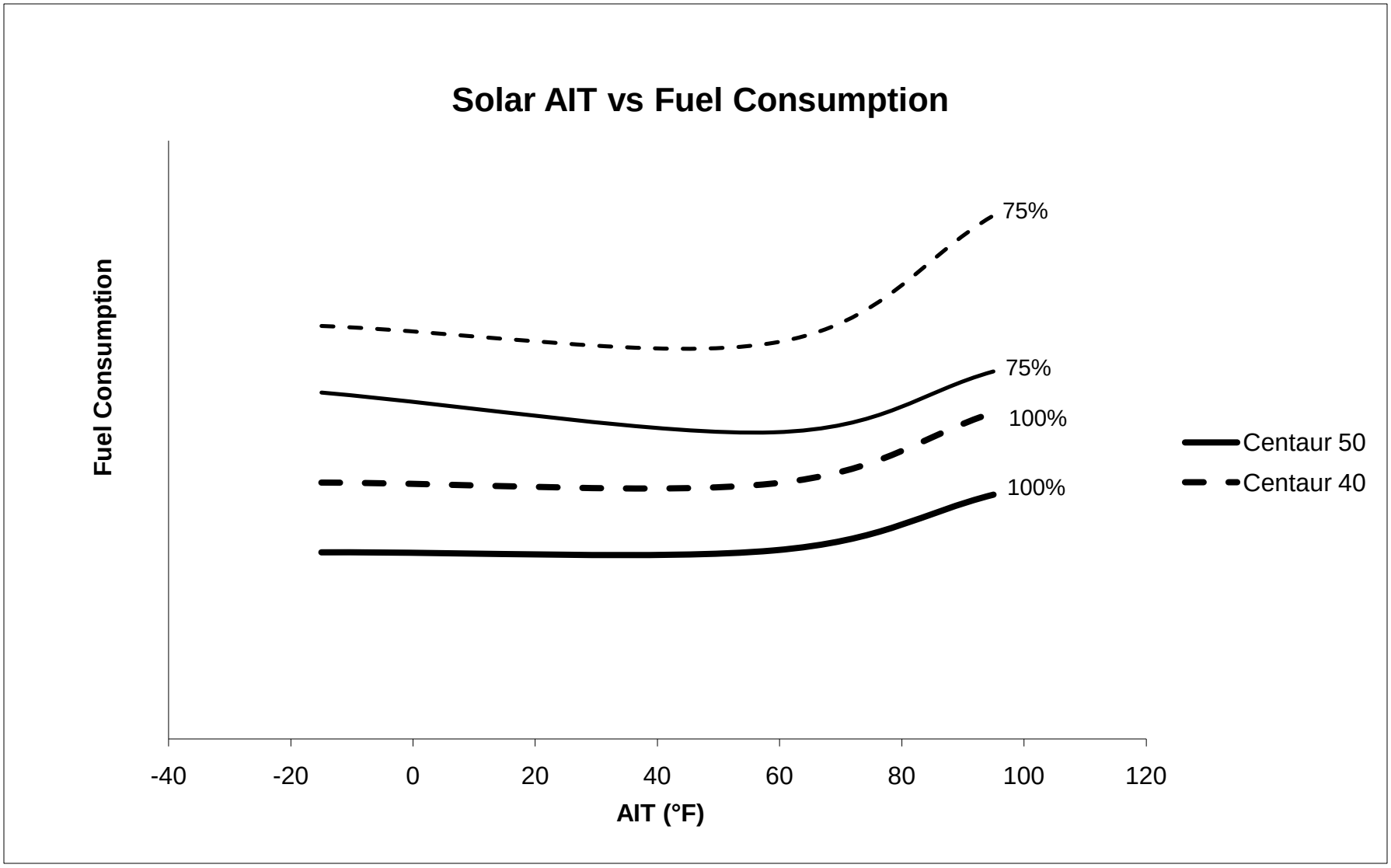
Remote Compressor for Storage Pool Injection/Withdrawal Service

Case Study 2

- Design Parameters
  - Injection – May – September
  - Withdrawal – October – March
  - Centralized compression for multiple pools
- Remote compression facility
- Options
  - Solar Centaur 40
  - Solar Centaur 50

Case Study 2


Solar AIT vs Fuel Consumption
Fuel Consumption
75%
75%
100%
100%
Centaur 50
Centaur 40
-40
-20
0
20
40
60
80
100
120
AIT (°F)


Solar AIT vs Fuel Consumption
Fuel Consumption
75%
75%
100%
100%
Centaur 50
Centaur 40
-40
-20
0
20
40
60
80
100
120
AIT (°F)

CASE STUDY 3

Generic Power Generating Station w/ Utility Fuel Supply

Case Study 3

Capital Investment by Owner

- Land for metering station
- Drainage facilities for metering station
- Power for metering station
- Additional gas compression (possibly provided by utility)

Case Study 3

Capital Investment by Utility

- Tap into pipeline/well
- Pipeline
- Metering station

Operating Costs for Utility

- Routine equipment maintenance/inspections
- Fuel to metering station
- Corrosion control and pipeline surveys

Case Study 3

Cost Sharing

- Establish ownership of costs in detail early on.
- Storage/delivery revenues rolled in with capital investment and O&M costs determine NPV
- NPV will determine “aid to construct”