

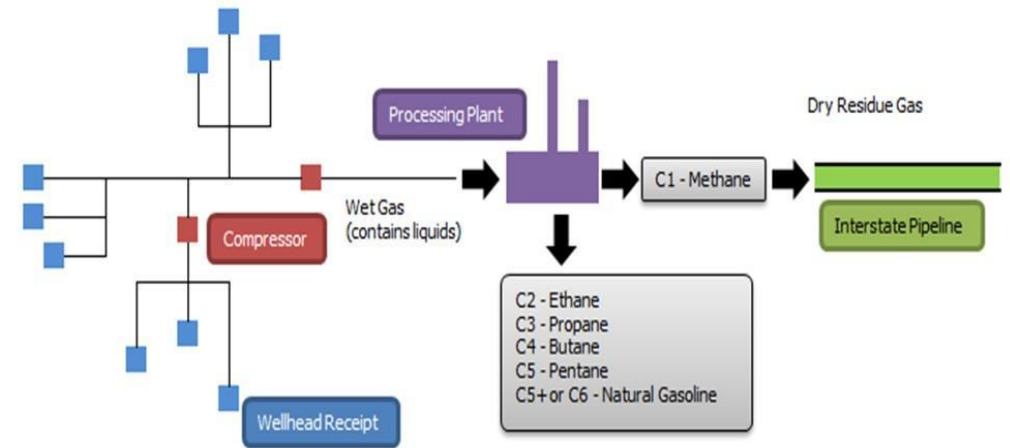


# Optimization, Predictive Analytics, & Real-Time Process Models

## Natural Gas Pipeline Solutions

# Gas Pipelines

- Pipelines transport gas across long distances to major consumers/end users
- Natural gas introduced into pipeline transmission system at various points
- Compressor stations provide power for transporting and usually contain more than one compression unit
  - Compression unit: Combination of a compressor and its engine



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# Operations Challenges

- Increasing pressure to
  - Make better decisions
  - Increase efficiency
  - Reduce operational risk
  - Provide true transparency about environmental impacts
- Meet performance requirements while minimizing objective function:
  - Minimize fuel consumption
  - Minimize emissions
  - Minimize operational cost
  - Maximize gas flow

# Technology Capabilities

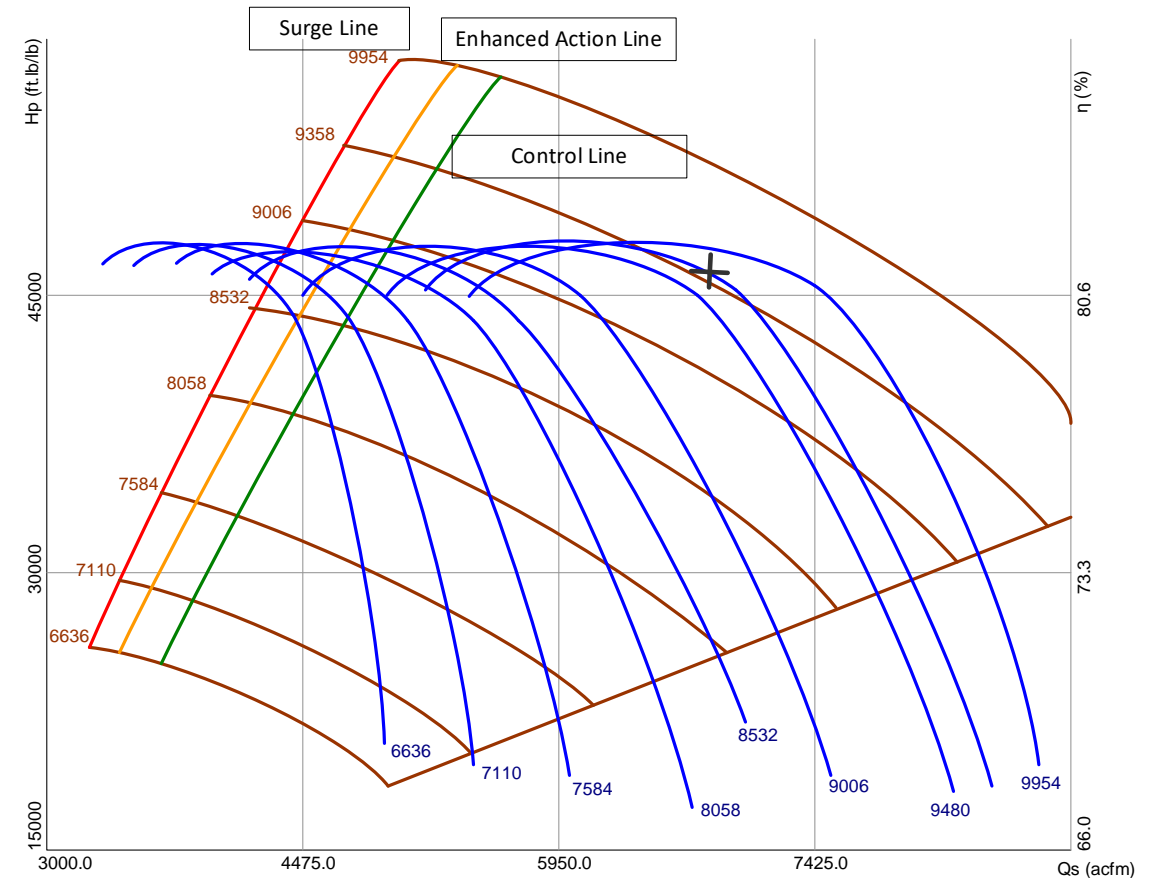
- Flow assurance
- Gas Compositional Mixing
- Validate, route, and size pipeline networks
- Strategic, operational, and capacity planning
- Rapidly assess unscheduled changes in operation
- Leak Detection
- Operational prognosis
- Compressor optimization
- “What if” scenarios, training
- Fuel consumption calculations
- Line pack management
- Assess storage requirements
- Surge analysis and optimization
- Liquid Holdup
- Condensate Detection

# Model the Process

- *OptiRamp* models all process elements
  - Offshore platforms/onshore gas fields
  - Pipes/pipelines
  - Engineering units
  - Field sensors
  - Pipeline gas consumption
  - Control, block, gate valves
  - Gas compositions from different sources
  - Compressors
  - Engines
- Process model simulates
  - Production & transportation of fluid flow, pressure, & temperature
  - Pipeline dynamic behavior
  - Large operational range to reliably replicate the process
  - Process response to disturbances
  - Gas composition changes in pipeline
  - Leak/rupture detection
  - Condensate detection

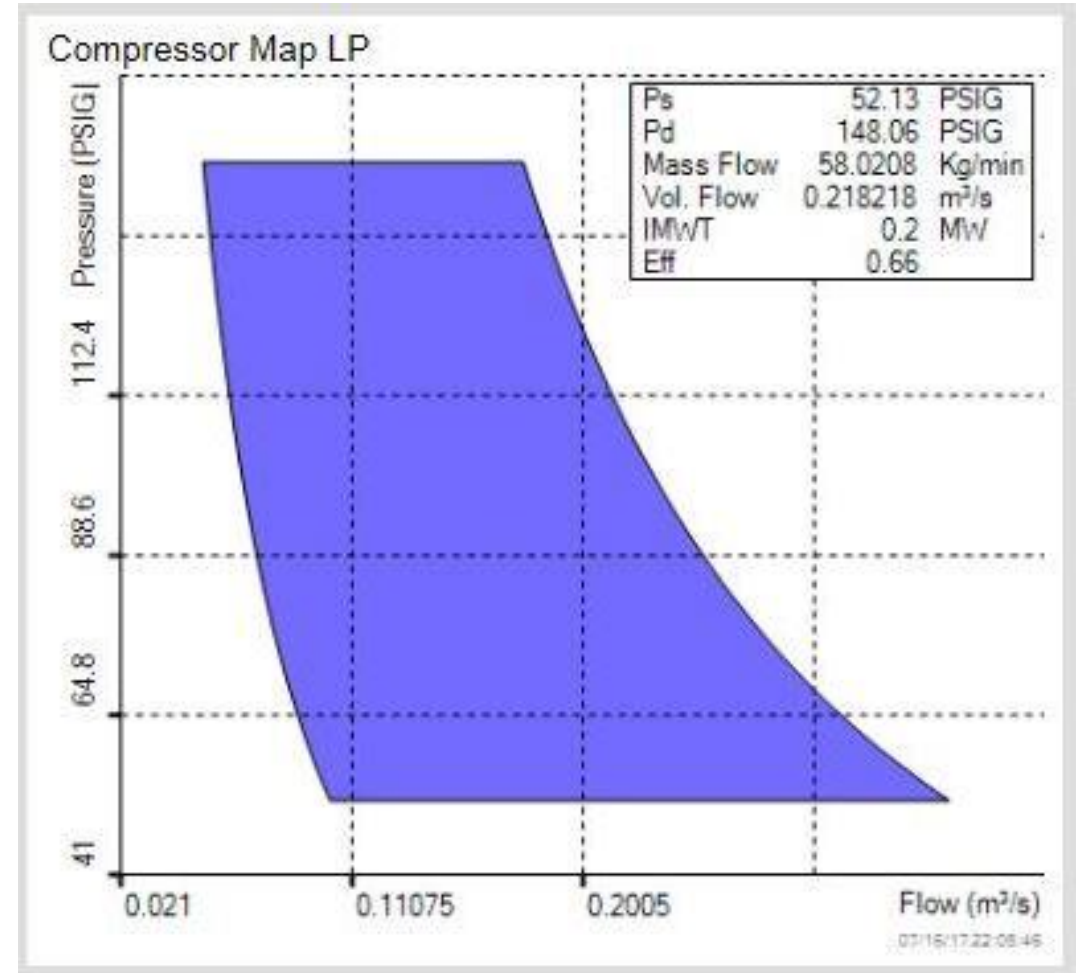
# Real-Time Gas Compressor Map

- Compressor Map
  - Shows current compressor performance
- Displays
  - Operating Point
  - Surge Limit Line
  - Surge Set Point
  - Power Limit Line
  - Performance Curves
  - Efficiency Curves



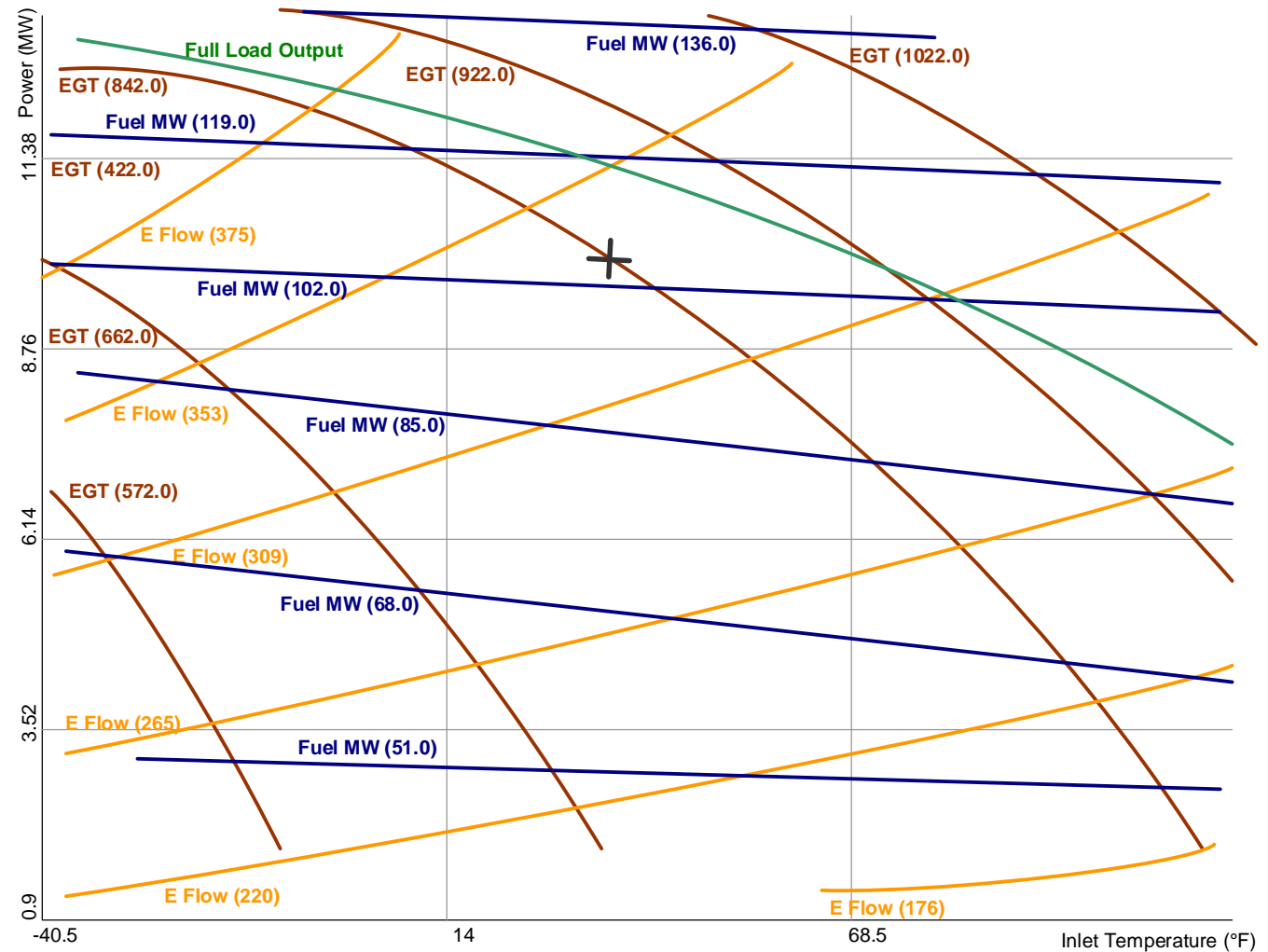
# Reciprocating Compressor Map

- Shows the p-V diagram for the compressor
- Compressor has 4 points from bottom left to right:
  - 1-2: Induction
  - 2-3: Compression
  - 3-4: Delivery
  - 4-1: Expansion
- Displays
  - Suction Pressure
  - Discharge Pressure
  - Mass Flow
  - Indicated Power on Shaft
  - Efficiency



# Gas Turbine

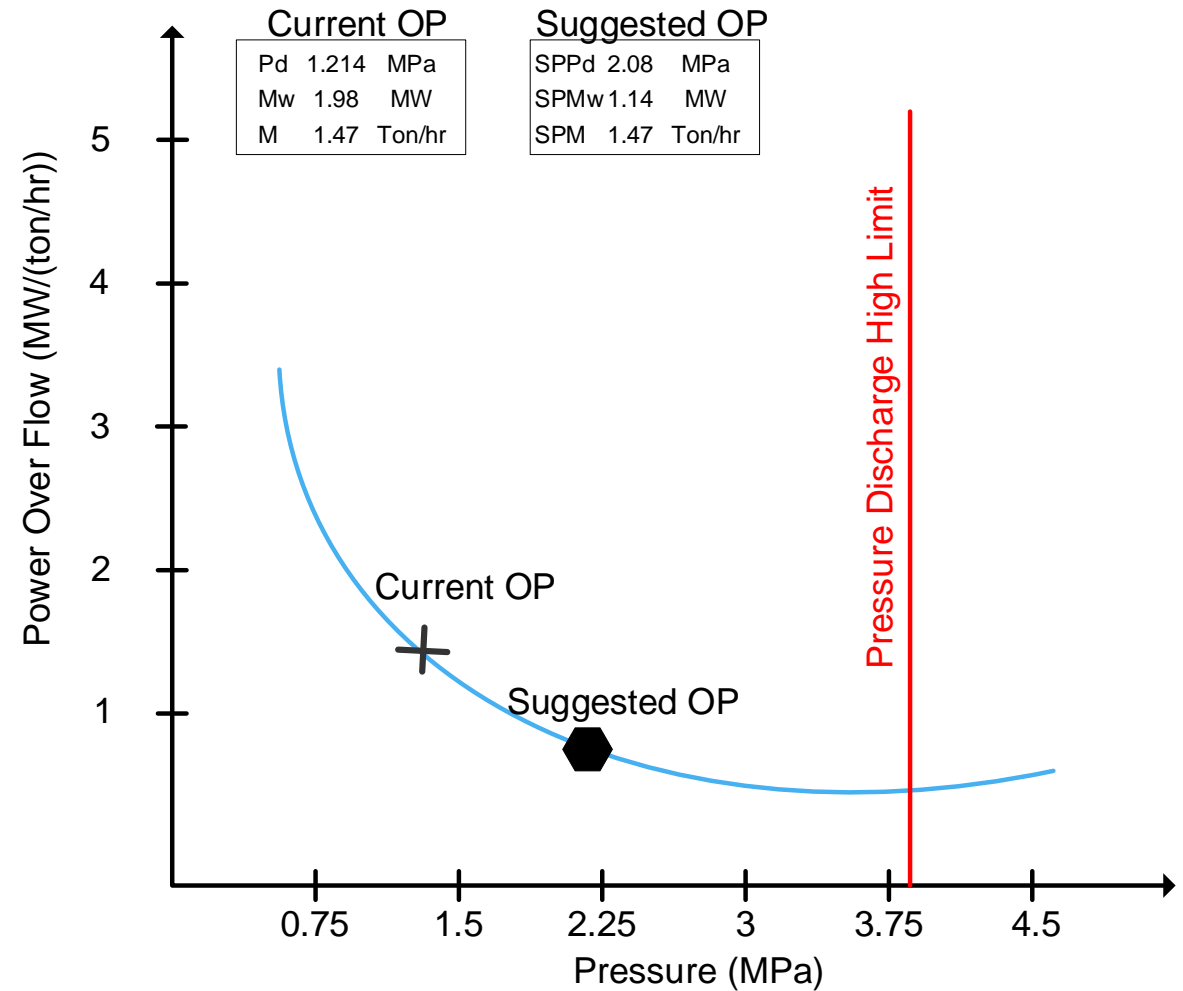
- Shows the power map for the gas turbine
- Available in single shaft and two-shaft gas turbine
- Displays
  - CDP curves
  - Fuel Curves
  - Power Turbine Inlet Curves
  - DLN Curves
  - Full Load Output





# Station Discharge Control & Optimization

- Control according to manufacturer's specifications
- Position fuel gas valve according to process requirements
- Built to handle manufacturer-specified control limits



# Pipeline Profile

- Visualizes pipeline properties
- Liquid tracking
- Gas composition changes
- Leak detection
- Pig tracking
- Energy consumed
- Phase Diagram

