



Optimizing Separation and Power Production
for
Two- and Three-Phase Well Flows

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Outline

- System Requirements
- System Description
- Component Experience

Axial Two-Phase Turbines

Two- and Three-Phase Separating Turbines

- Performance for Three-Phase Well Flow

Requirements for Viable Geothermal Energy Production In an Oil and Gas Setting

- Meet Oil & Gas Industry Standards – API Specifications
- Minimize Cost per Kilowatt Hour

Maximize Power Production for Produced Fluids

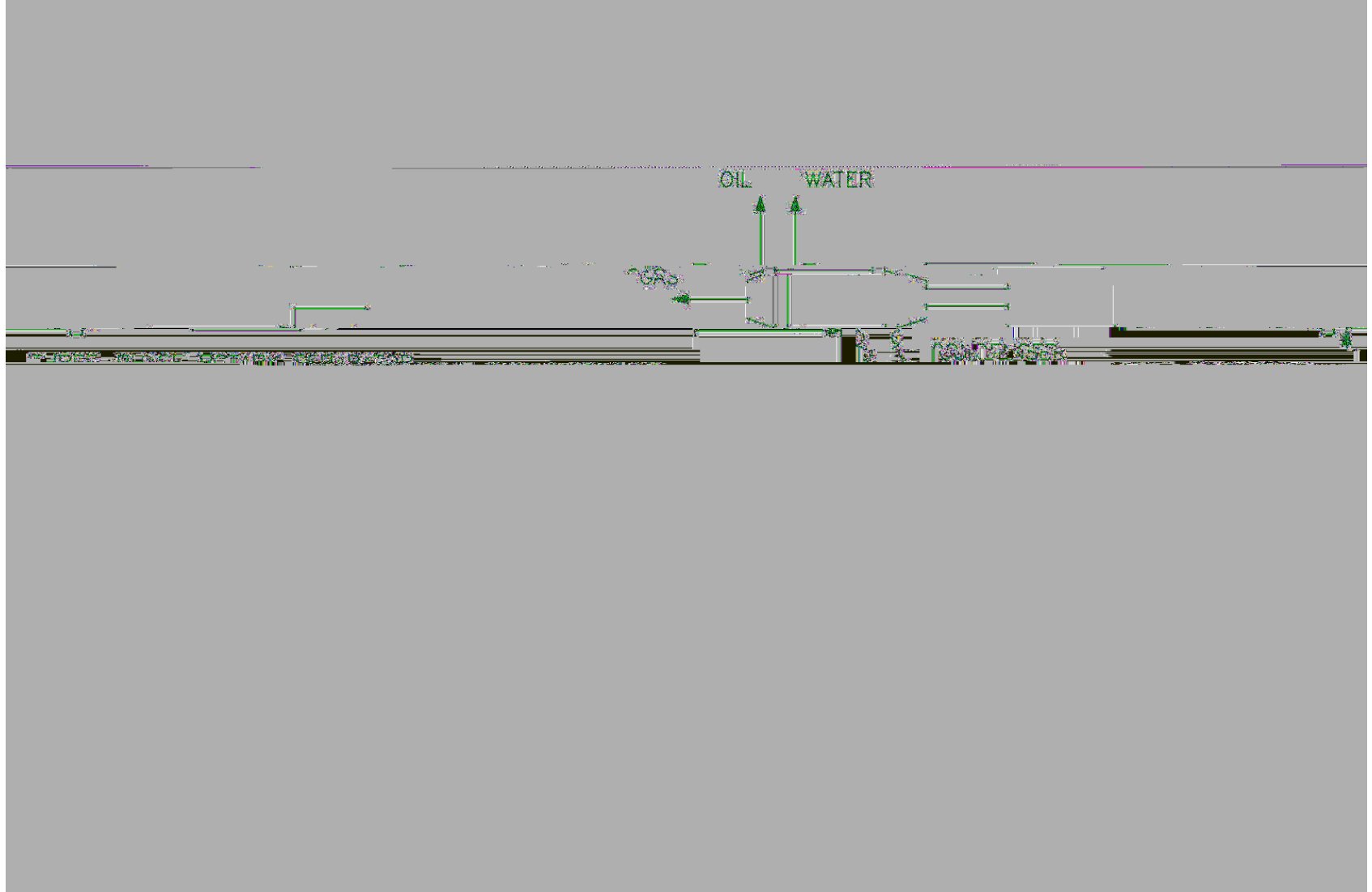
Minimize Equipment Cost

Minimize Installation Cost

Minimize O & M Cost

- Produce Dry Gas
- Produce Clean Water
- Produce Water Free Oil
- Portable Equipment
- Environmentally Benign

System Description

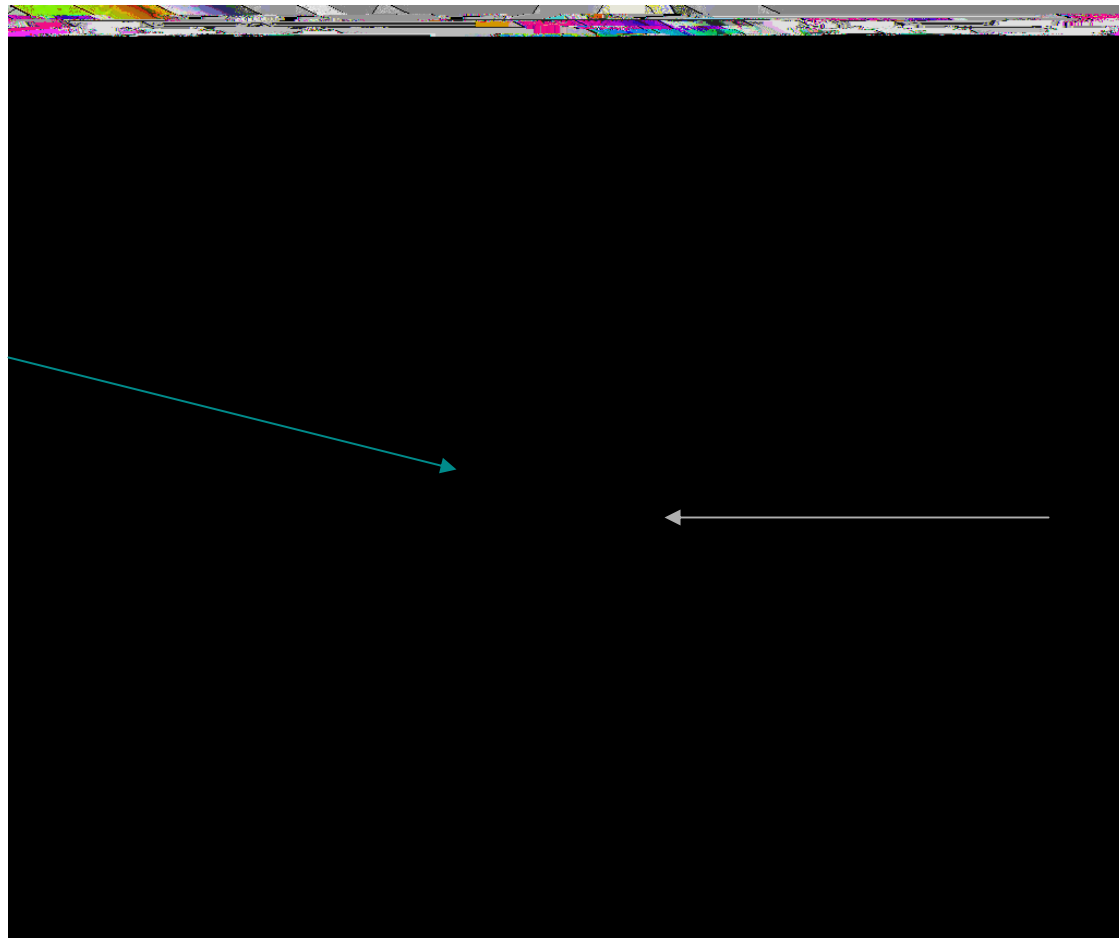


Schematic of Separating Power System for Three-Phase Well Flow

INLET NOZZLE



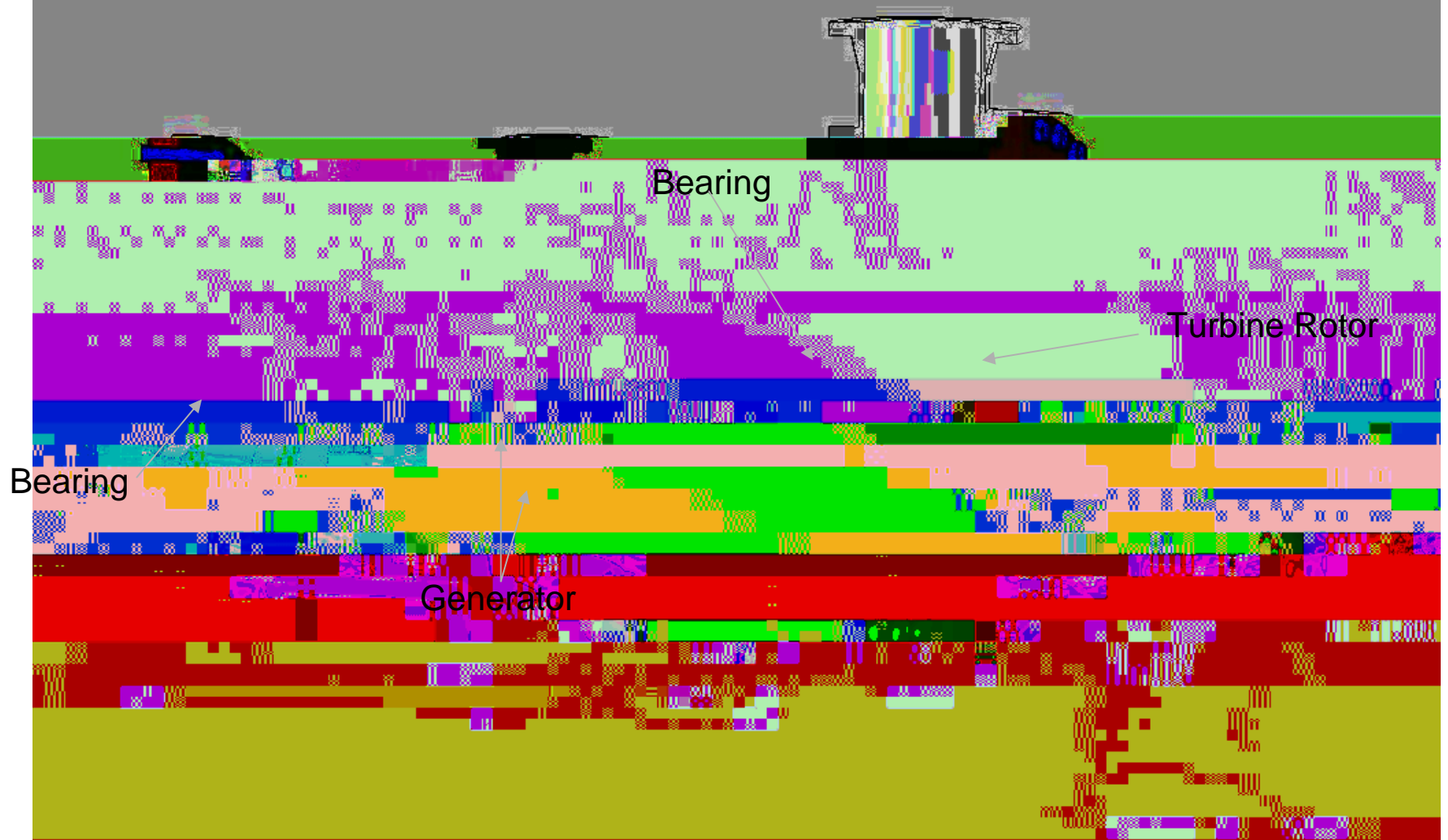
TWO-PHASE JET



Two-Phase Nozzle

bine

Variable Phase Turbine
Nozzle and Rotor Arrangement



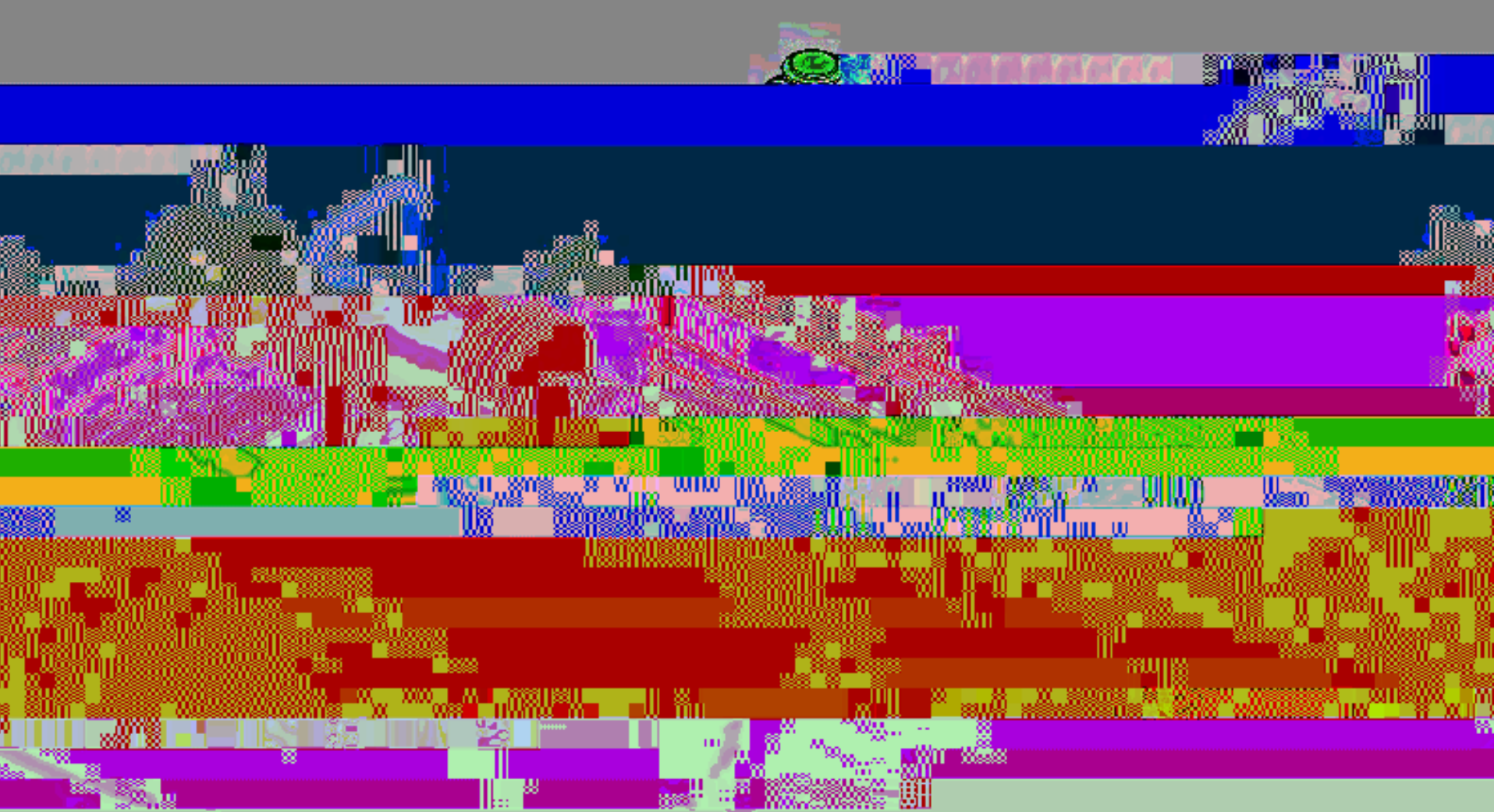
Bearing

Turbine Rotor

Bearing

Generator

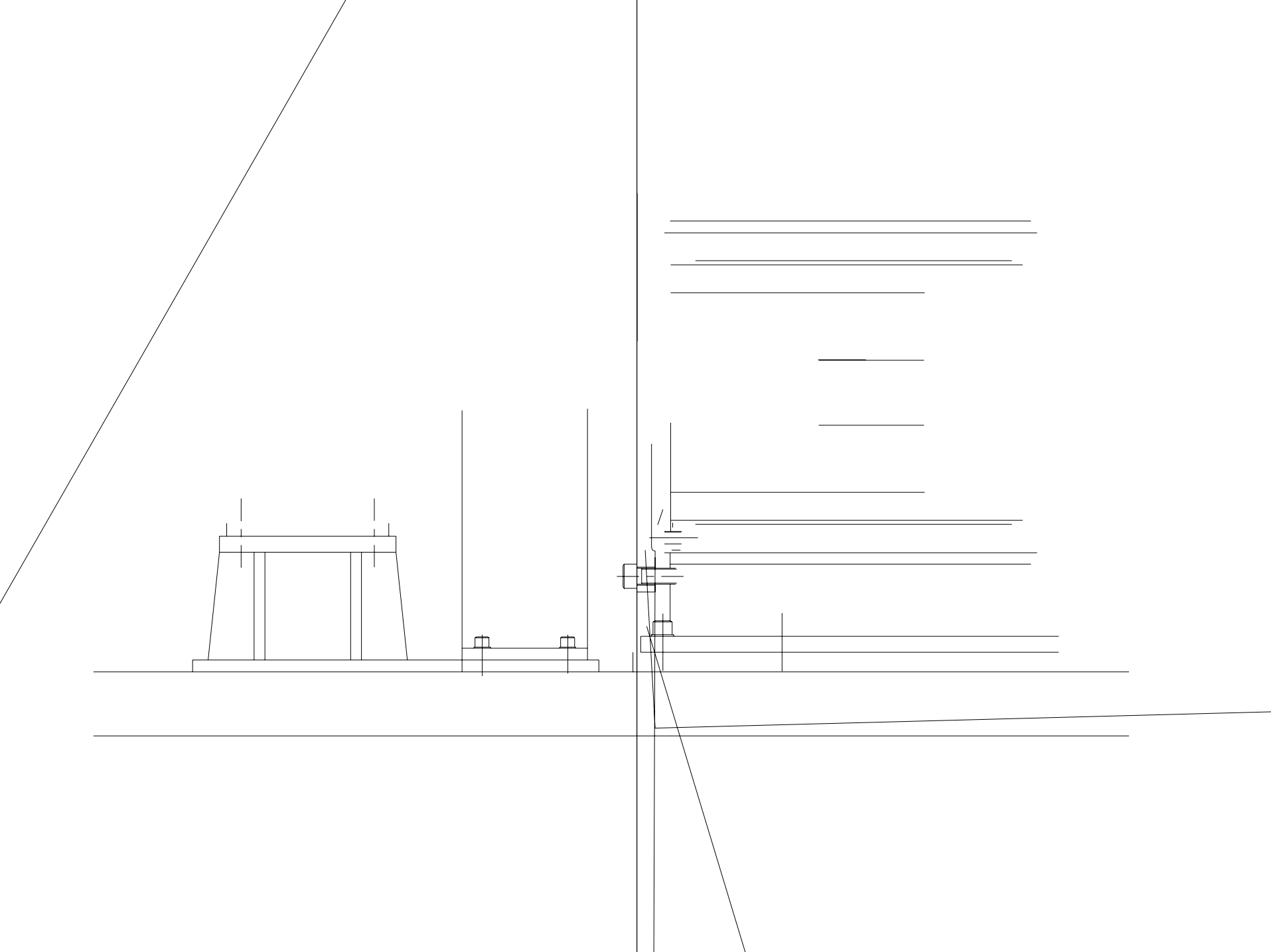
Hermetic Variable Phase Turbine-Generator



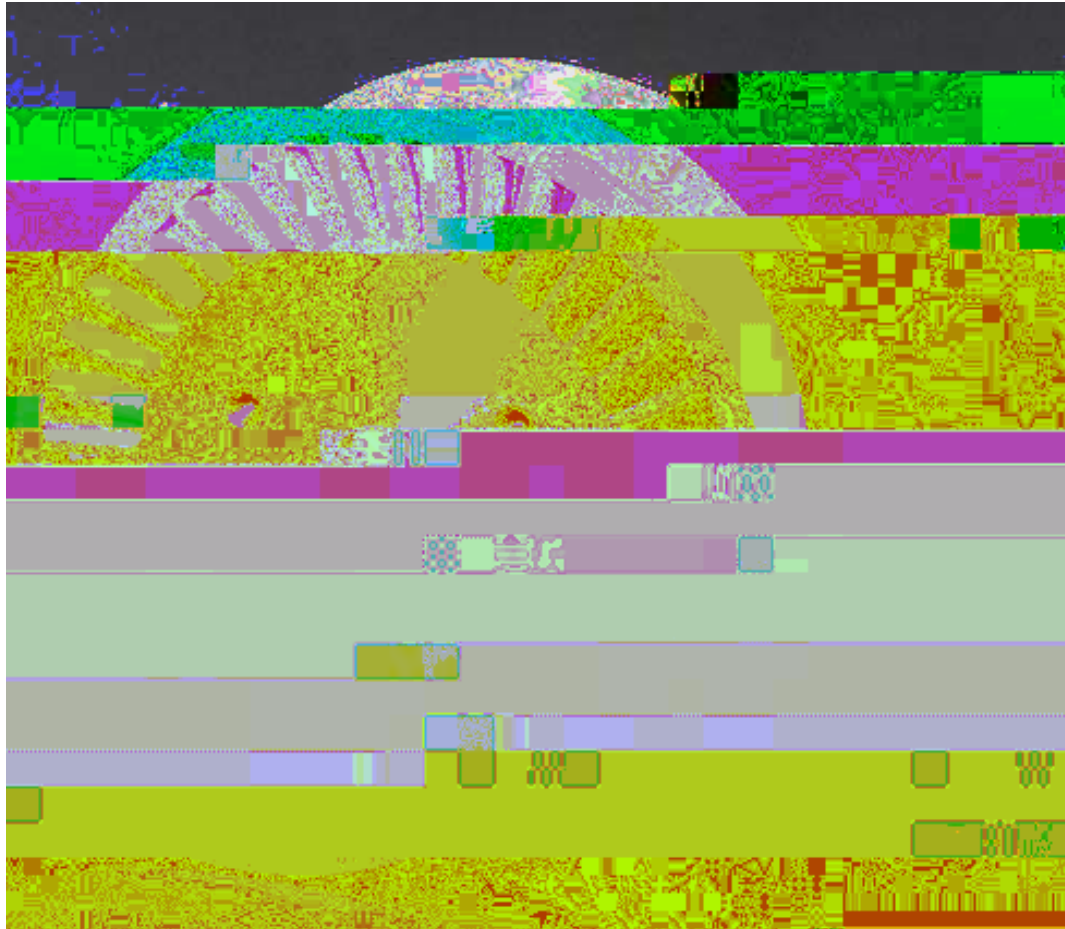
Refrigerant Condensate
Flow to Receiver Vessel

Pressurized Refrigerant
From Hermetic Pump

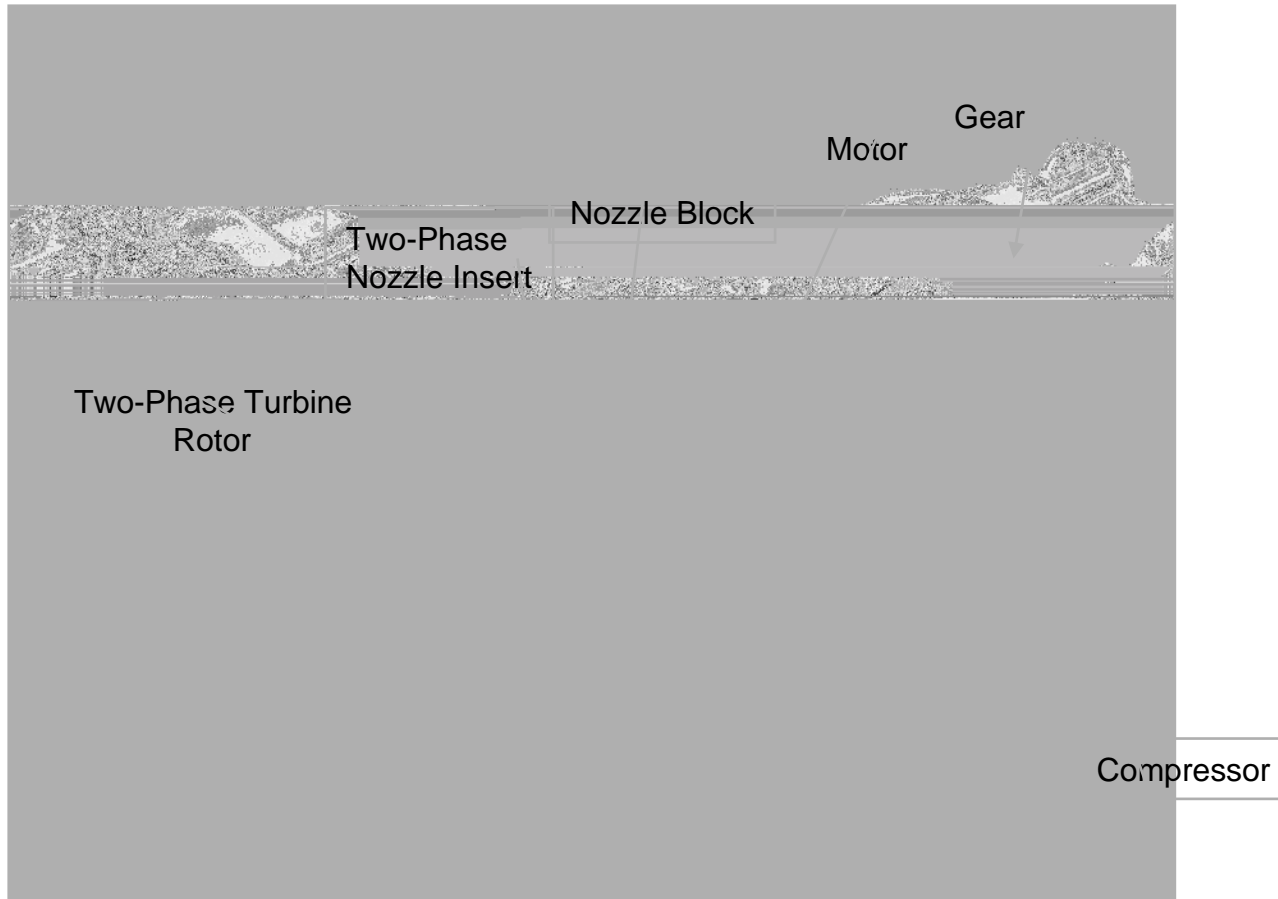
Arrangement of 1 Megawatt Variable Phase Power System



Component Experience

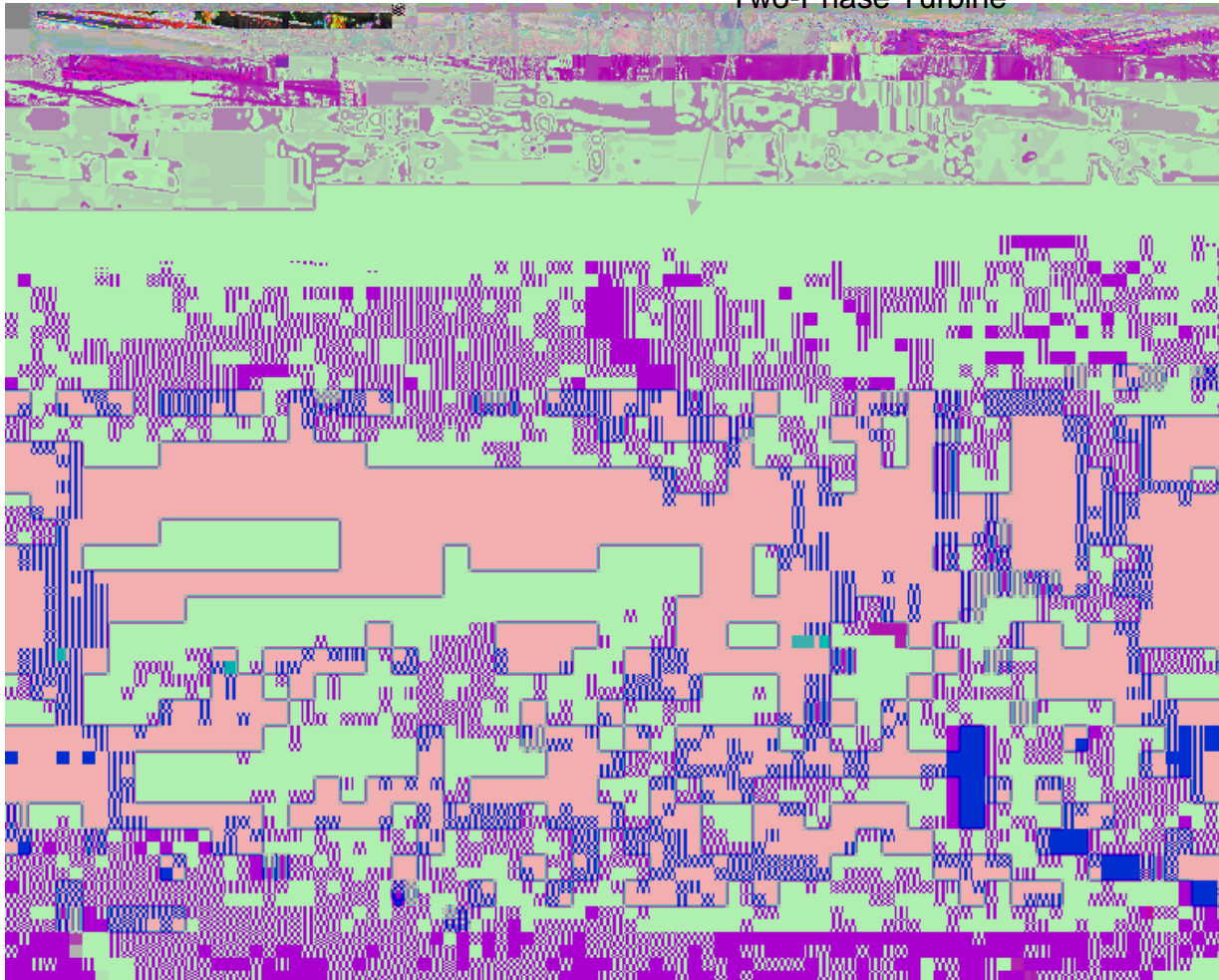


Commercial Two-Phase Refrigerant Rotor



Cutaway of Chiller with Two-Phase Turbine, after Carrier

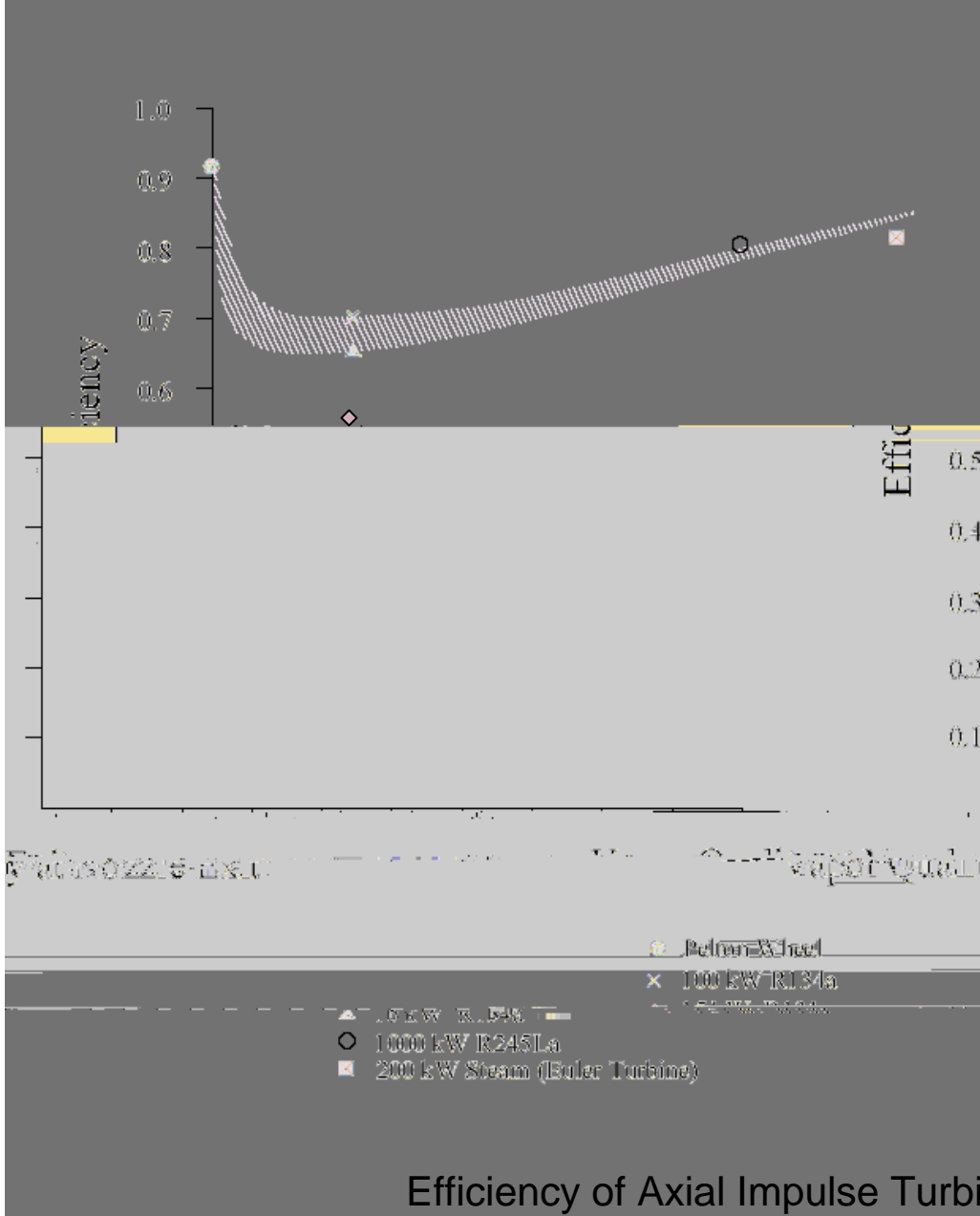
Two-Phase Turbine



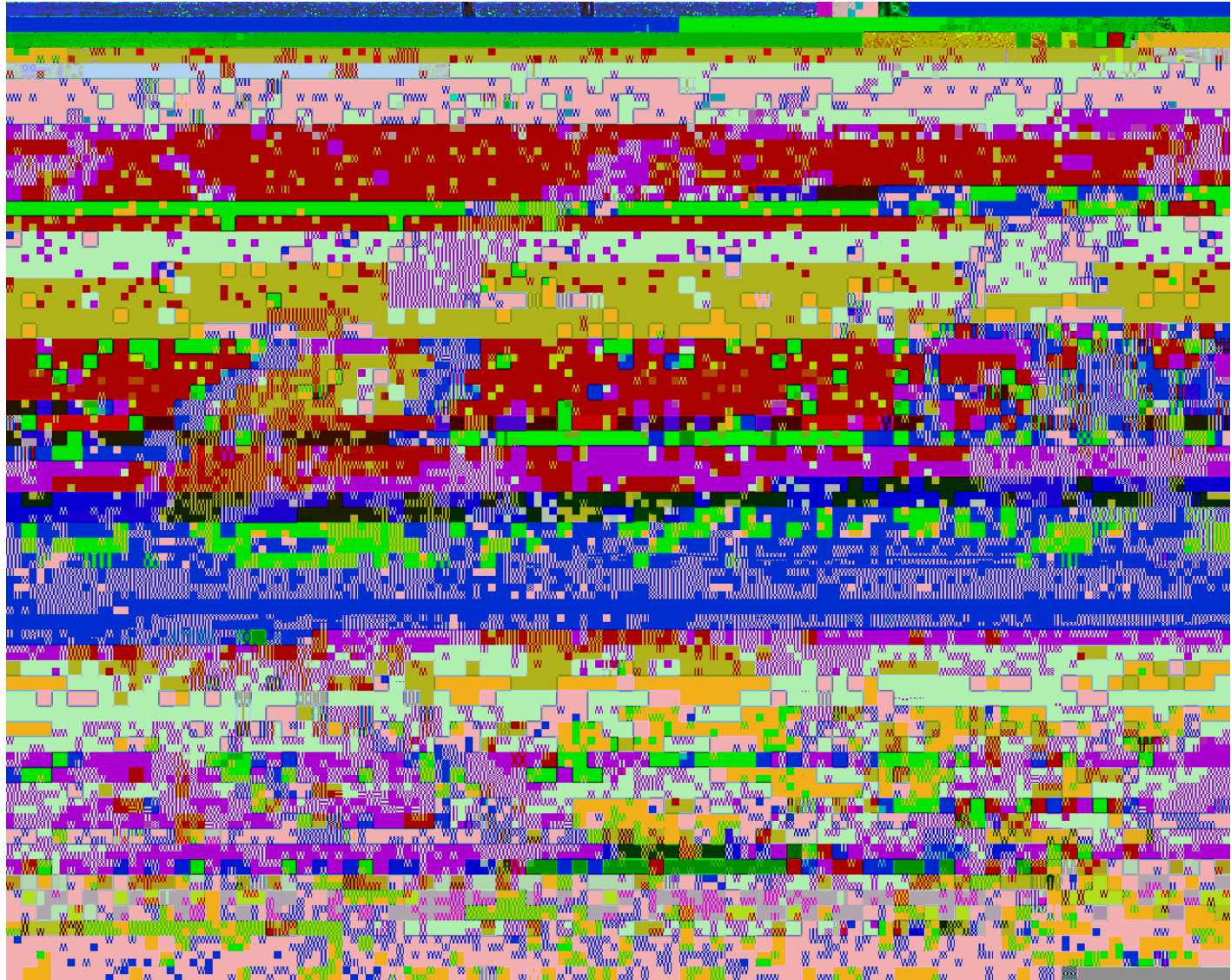
500 Ton Chiller with Two-Phase Turbine, after Carrier



100 kW Two-Phase Axial Turbine Components for Refrigerant Power Generation



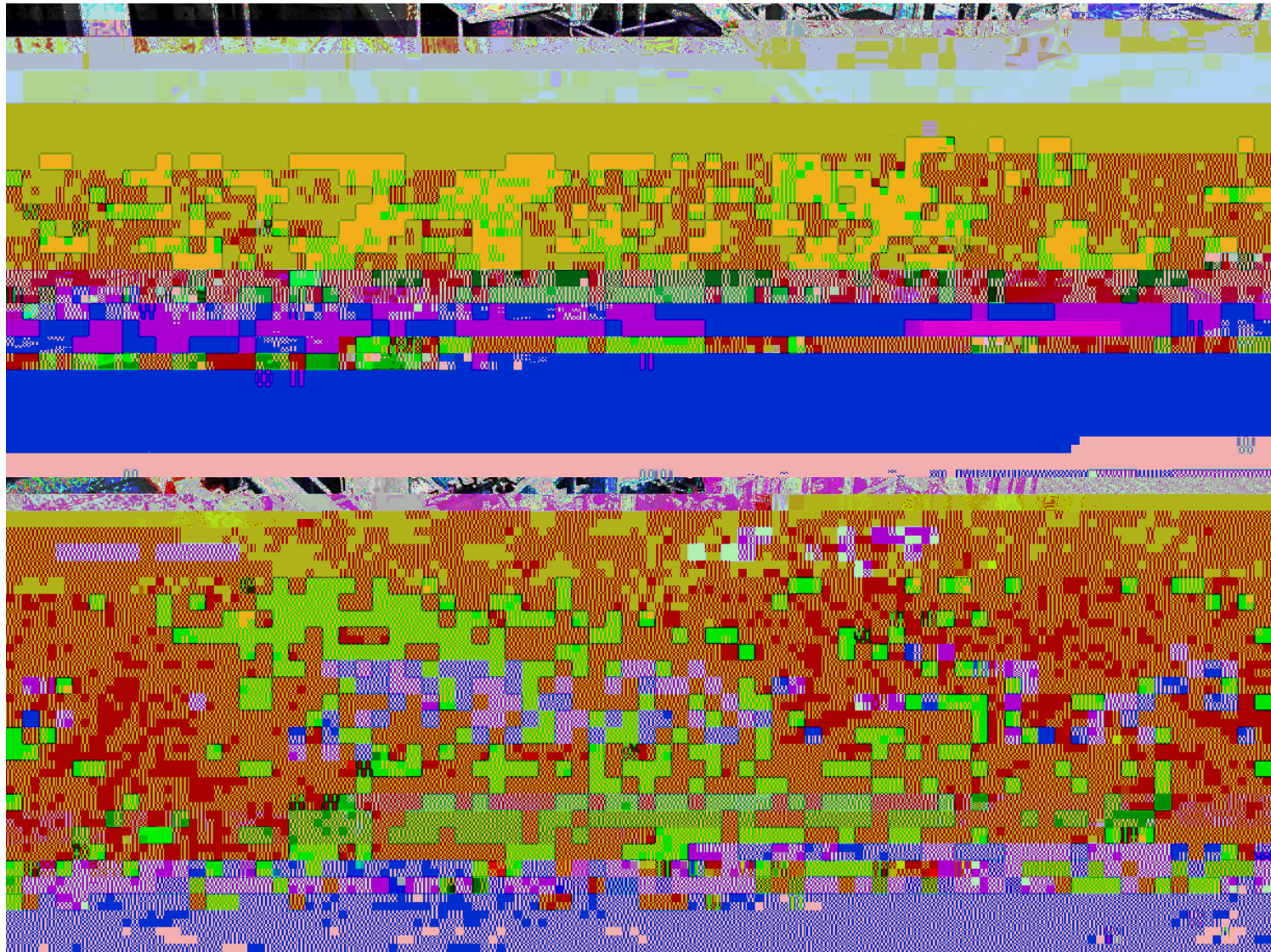
Efficiency of Axial Impulse Turbines



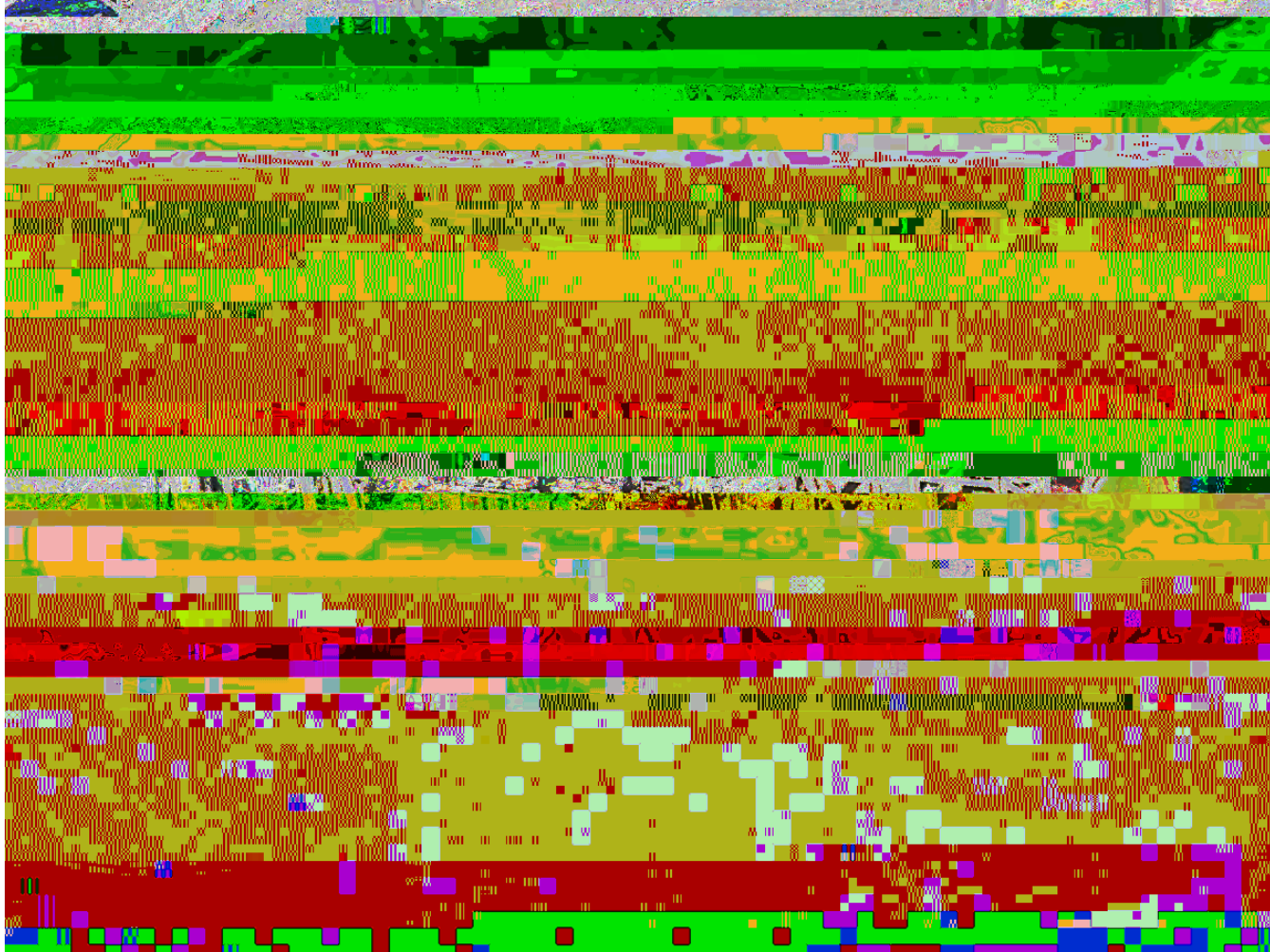
Hermetic LNG Pump, After ACD, Inc.



Inline Two-Phase Rotary Separator Operating at Laredo Gas Field
After Chevron



Two-Phase Separating Turbine on Ram-Powell Platform, after Dresser-Rand

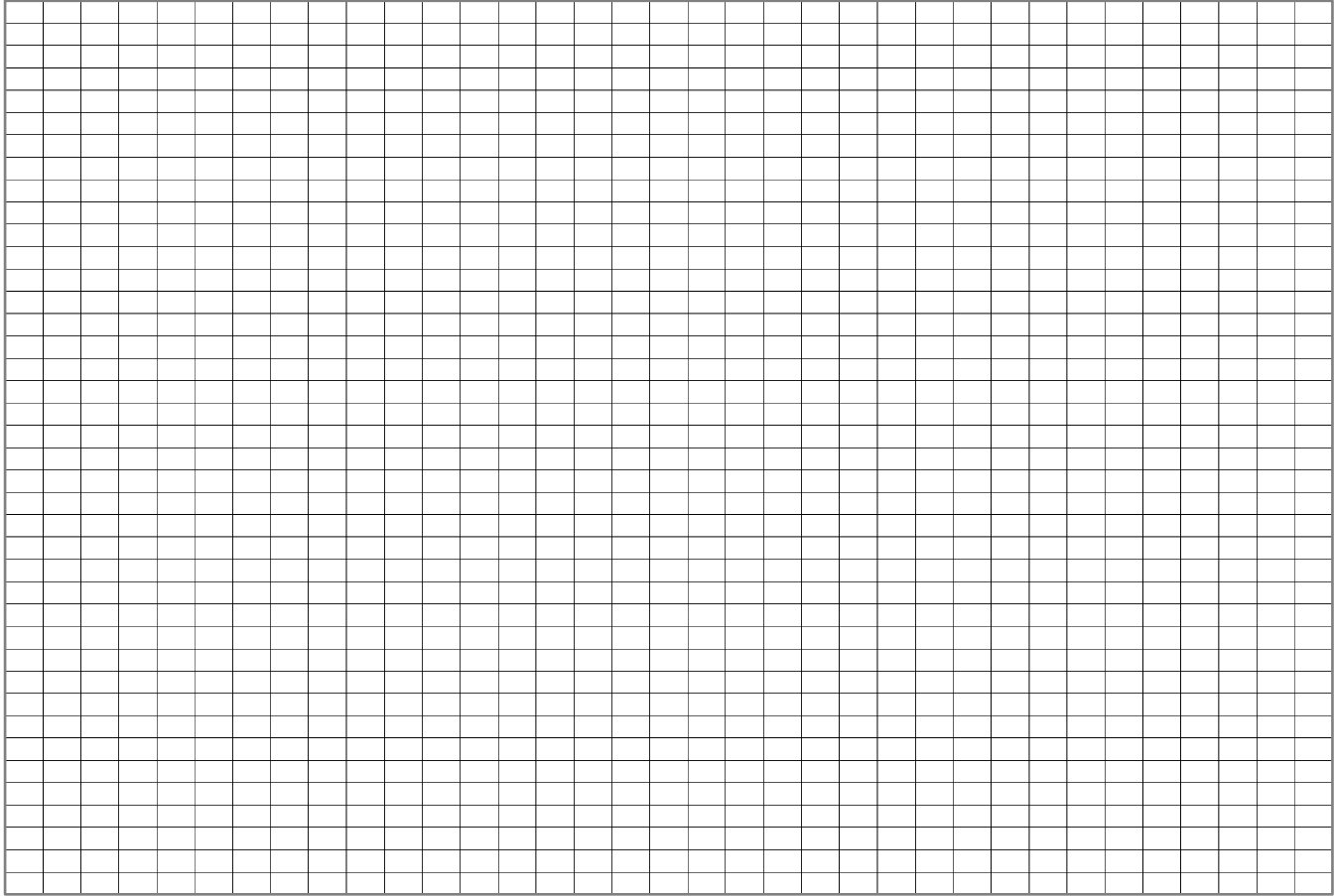


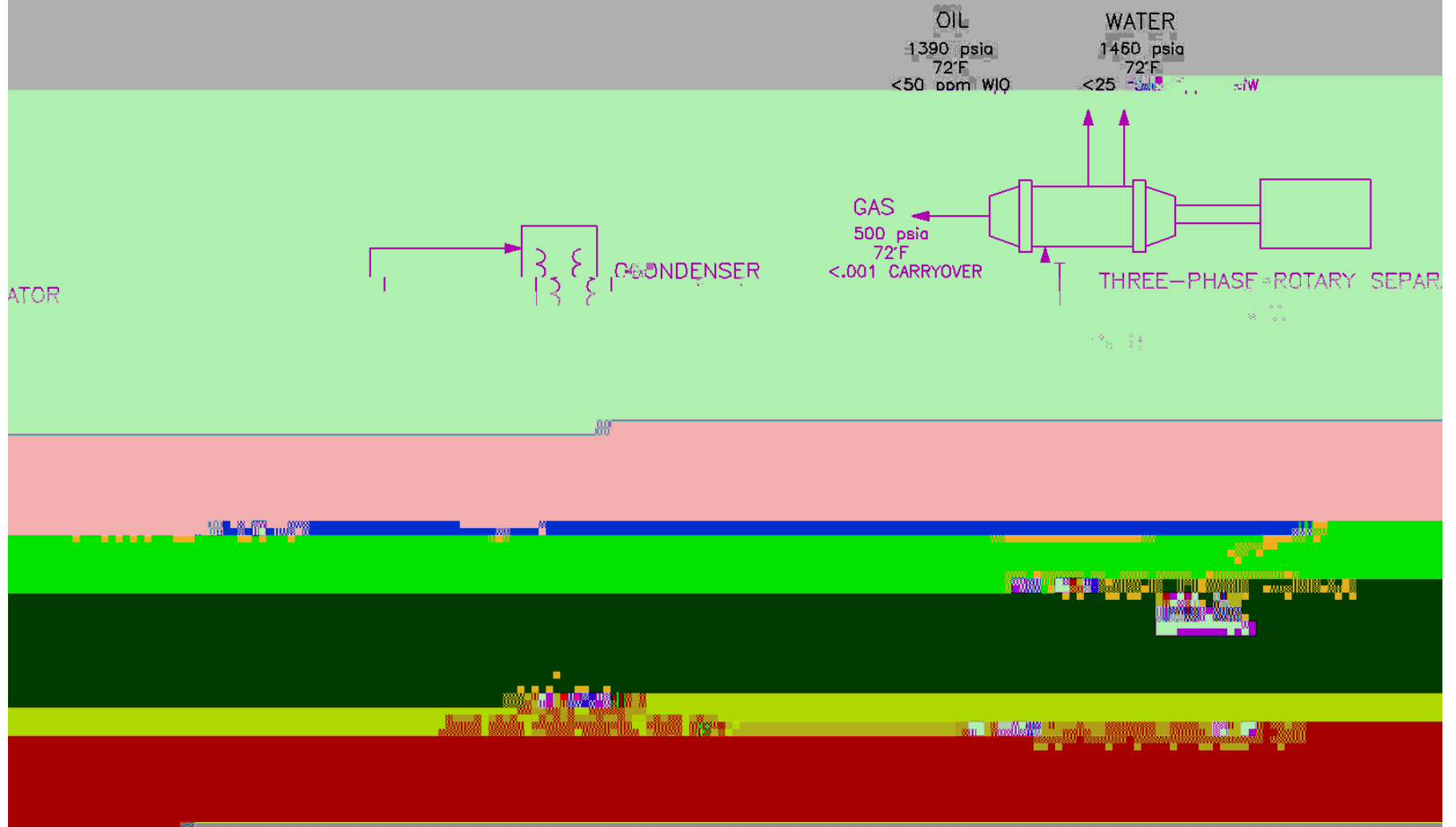
Ram-Powell Platform with Separating Turbine Installed, after Shell Deepwater



Three-Phase Separating Turbine on Ewing Banks Platform. After Dresser-Rand

System Performance





Performance of Separating Power System for Three-Phase Well Flow
1454 kWe vs **830** kWe for Rankine Cycle

Conclusions

- Application of Proven Two-Phase Refrigeration Technology and Proven Oil and Gas Two-Phase and Three-Phase Technology can Maximize Power Production and Separation for Two-Phase and Three-Phase Moderate Temperature Well Flows
- Production Advantages as Well as Power Production will Promote Early Acceptance by Oil & Gas Industry
- Experience by Technology Stakeholders in the Oil & Gas Industry Will Produce Systems Acceptable to that Industry