GAS TURBINE COMPRESSOR DRIVE INTEGRATED CONTROL SYSTEM

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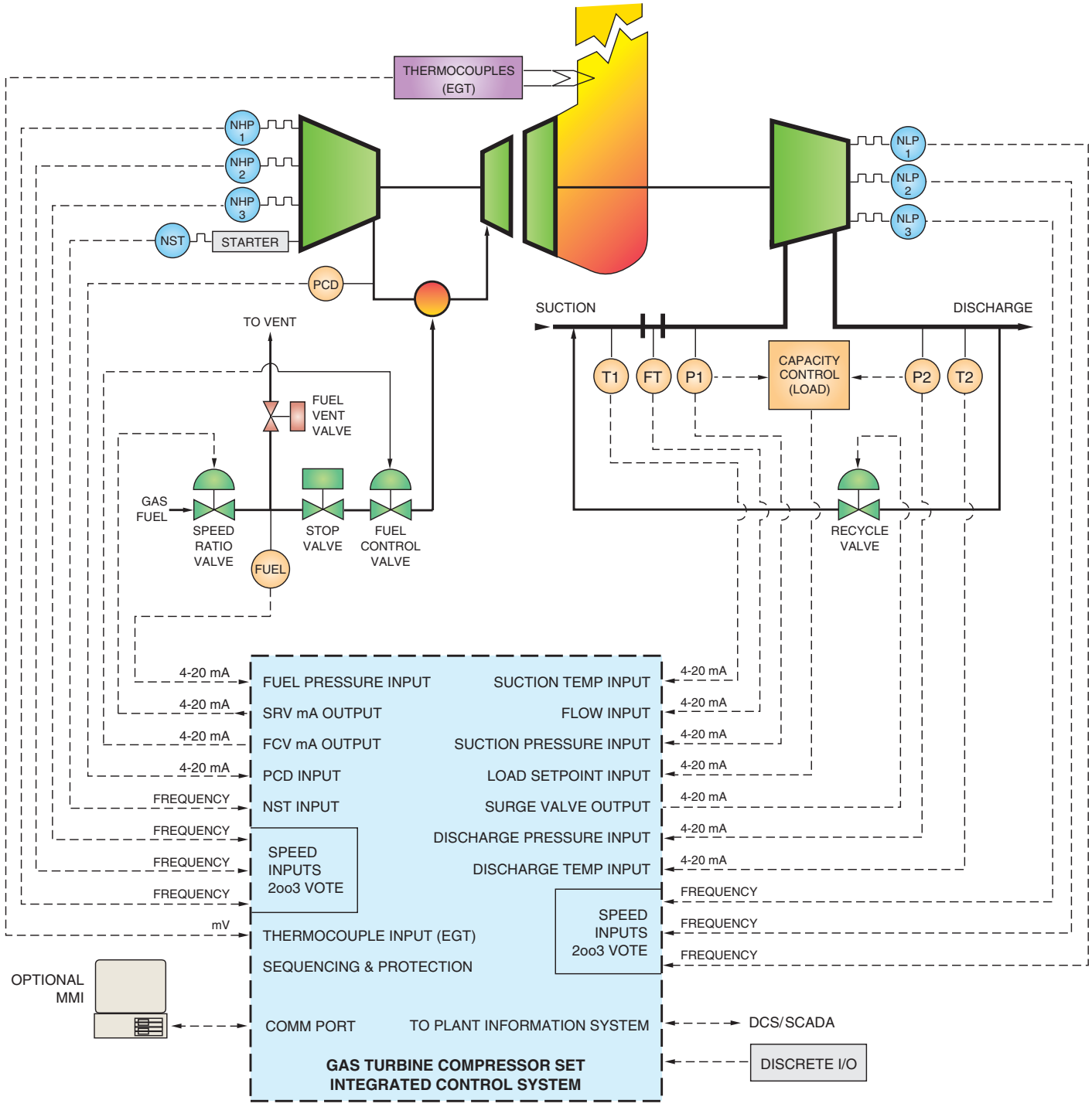

Simplified schematic showing a Petrotech advanced PLC-based integrated control system for a gas turbine compressor set. The system provides turbine fuel control, temperature control, anti-surge control, sequencing/protection, and communication interfaces.

APPLICATION

The Petrotech integrated control system provides cost-effective complete or partial control system retrofits for gas turbine driven compressor packages. The system provides replacement controls for outdated electro-hydraulic and analog-electronic controls. The PLC-based system typically includes complete turbine and compressor control, turbine and compressor sequencing, capacity control, DCS interface, and a graphic operator interface for system status, trending, and data logging.

ADVANTAGES

- **Integrated control capability:**
  Turbine fuel control, compressor anti-surge and capacity control, and sequencing/protection are integrated into a single platform. This eliminates the need for additional hardware and communication links, thereby providing a less complicated, more cost-effective solution.
- **Open architecture system:**
  Application control package's portability allows customer choice of hardware platform, reducing need for additional spare parts and training expenses. Available PLCs include General Electric 90-70 and 90-30, Siemens/TI, Modicon Quantum, and Allen-Bradley.
- **Fault tolerant:**
  Control package is available on fault tolerant controllers for critical control applications.
- **Standard industrial components:**
  Non-proprietary, commonly available parts are less costly and more easily serviced by customer's on-site personnel. Much longer time to obsolescence than proprietary systems.
- **Reliability:**
  ALL control functions are performed by tested and proven industrial PLC equipment, not by MS-DOS based computer equipment which is not designed to function as a "controller".
- **Simplified interface to DCS or SCADA:**
  Communication tasks are handled with a separate, dedicated module in the PLC, increasing data rate and simplifying network installation.
- **Non-proprietary interfaces:**
  Interfaces in the form of 4-20 mA, RTD, frequency, thermocouple, and dry contact I/O allow simple integration into existing sequence/protection logic controller, making very low-cost partial control upgrades simple and practical.

Replacement controls for two GE Frame 3, one Pratt & Whitney GG3, and two Solar Centaur gas turbine/compressors.

Replacement controls for two Allison 501K compressor sets in pipeline service

- **Improved fuel regulation:**
  Fast loop sampling rate, combined with modern digital control techniques improve steady-state setpoint control, and reduce overshoot during transients.
- **Improved start-up reliability:**
  Special "lean lightoff" procedure ignites all burners with essentially 100% reliability, and with greatly reduced thermal stress.
- **Improved exhaust temperature monitoring and control:**
  Advanced statistical algorithms detect turbine hot/cold spots and automatically reject failed thermocouples.
- **Advanced compressor control strategies enhance process stability:**
  Six (6) built-in, proven algorithms for every application, plus room for a customer-defined algorithm.

  Anticipation-based control and asymmetrically-damped control provide superior response to upsets, and improved compression process stability.

  Digital curve fit surge control line produces a constant safety margin for safe operation and reduced recycle.

  Adaptive control strategy continuously adjusts control safety margin to actual compressor operating conditions.

  Loop-gain linearization allows equal percentage valve trim for much improved stability at lower recycle, without requiring detuning for high recycle.

  Valve actuator preload control eliminates delay in surge valve response. Typically, Petrotech control systems have the valve full open on upsets in 3/4 second or less.

  PURGE/RUNUP/RUNDOWN coordination feature provides optimum sequence functions without field solenoids, timers, or additional field cables.
- **Fail-safe features:**
  Redundant overspeeds; open/short monitoring of mA and thermocouples; readback monitoring of outputs, and special self-check features improve safety.

- **Improved operator information with graphic interface:**
  Industrial workstation graphically displays start-up sequencing, speeds, temperatures, operating points, and alarm/shutdown status. Optional data logging and trending can be used as part of a preventative maintenance program.
- **Simple installation:**
  A dimensionally identical replacement of the control panel is possible, saving substantial architectural and installation cost. Control panels can be installed one at a time allowing other units to continue operating.
- **Rugged:**
  Control panels can be built Division 2, Nema 4X for installation in harsh local environments.
- **Flexibility:**
  The control system package can accommodate many different control strategies based on the customer's need and budget.

CONTROLLERS/SPECIAL FEATURES

The gas turbine application control package includes:

- Firing (soft lightoff) ramp.
- Startup controller.
- NHP controller.
- NHP acceleration controller.
- NLP controller.
- NLP acceleration controller.
- EGT controller.
- EGT rate of rise controller.
- Combustion monitoring system.

The compressor application control package includes:

- Main anti-surge controller.
- Backup anti-surge controller.
- Seven (7) anti-surge control algorithms.
- Safe auto/manual function.
- Asymmetrical damping.
- Variable inlet guide vane compensation.
- Molecular weight compensation.
- Adaptive control.

Explosion proof Division 2 replacement controls for Solar Centaur in offshore gas gathering service

CUSTOMER SELECTABLE COMPONENTS FOR THE CONTROL SYSTEM

Advanced Programmable controller:

- Siemens/TI 505.
- Allen-Bradley Series 5, Flex I/O, ControlLogix.
- GE Fanuc 90-70 and 90-30
- Modicon Quantum.

Application control package:

- Petrotech gas turbine control.
- Petrotech compressor anti-surge control.
- Petrotech compressor capacity control.
- Petrotech sequencing and protection.

Vibration Monitor:

- Bently Nevada 3300, 3500, and 2201 (for Allen-Bradley systems only).
- Vibrometer.
- Metrix.
- Vibrotec.
- Customer specified.

Man machine interface (MMI), alphanumeric display (low-end) plus panel meters for NHP, NLP, and EGT:

- NEMATRON.
- CTI Access 4000.
- Allen-Bradley Redi-Panel.
- Customer specified.

Man machine interface (MMI) package (high-end) display:

- MMI Hardware:
  Intecolor industrial computer and monitor.
  IBM industrial computer and monitor.
  Texas Microsystems industrial computer and monitor.
  XYCOM industrial computer and monitor.
  Nortech industrial computer and monitor.
  NEMATRON industrial computer and monitor.
  Customer specified.
- MMI Software:
  WonderWare InTouch.
  Citech.
  Intellution.
  Realflex.
  Customer specified.

Critical function redundancy for fail-safe action:

- Customer specified shutdowns in addition to NHP, NLP, EGT, and low lube oil pressure.

Communication interface for DCS or SCADA:

- MODBUS.
- Ethernet
- Customer specified.

Type of control panel enclosure:

- Front plate for existing control enclosure (common for GE gas turbine retrofits).
- Custom fabricated new control enclosure.
- Class I, Division II stainless steel purged panel enclosure for hazardous locations.
- Standard Rittal type panel enclosures.

AUXILIARY SYSTEMS FOR GAS TURBINE COMPRESSOR PACKAGES

The following auxiliary systems and components are also available for complete or partial system upgrades:

- Fuel control valve system upgrade can include replacement of fuel control valve, fuel speed ratio valve upgrade, addition of a fuel vent valve, compressor discharge pressure transmitter, and interstage fuel pressure transmitter.
- Hydraulic servo controls if applicable, such as second stage nozzle controls on a GE Frame 3 gas turbine, or inlet guide vane controls on a GE Frame 5 gas turbine.
- Complete second stage nozzle actuator and hydraulic system retrofit for GE Frame 3, with an increased capacity industrial RAM and servo with accumulator, pumps, and support components integrated into a complete system.

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