Energy Control Technologies

Major Advantages and Benefits of Energy Control Technologies (ECT) Turbomachinery Control System (Antisurge, Performance, Network/Loadsharing, Turboexpander, and Steam Turbine Control)

Major benefits and differentiators of the ECT control system for antisurge control, performance control, network/loadsharing control, turboexpander control, and steam turbine governor control (including extraction) with respect to legacy surge control vendors and OEM control solutions to justify using ECT Turbomachinery Control Systems for complex turbomachinery applications.

1. Software

- ECT's patented application software is designed using a proven firmware
- Designed by turbomachinery control engineers with collective industry experience of over 200 man-years.
- Easily integrated with the OEM's balance of logic programs
- Highly configurable (not programmable) turbomachinery control system that is standard in offering and customized to project-specific requirements.
- Turbomachinery Control Software implemented on over 1,000 installations and is field-proven on applications of varying complexities and compressor sizes

2. Control technology and advanced algorithms

- ECT's surge parameter based on equivalent head and flow variables from compressor maps and is proven to be invariant to changes in compressor inlet conditions.
- ECT's surge control technology is more advanced and start-of-the-art compared to competitive offerings in the market, summarized as follows:
  - **a) ECT control system is based on a patented linear surge parameter model**
    - Surge parameter "R" is linear to changes in compressor load
    - Competing turbomachinery control systems are based on a non-linear surge parameter (since the flow variable is in the denominator of calculations) making the control parameter non-linear to load changes
    - Advanced field engineers are required to commission such non-linear systems.
    - Control loop tuning is much easier and less time-consuming in the field with ECT's patented linear surge parameter
  - **b) ECT system is less susceptible to noisy flow measurement signals**
    - ECT's patented Surge Adapter® for variable surge margin response is less susceptible to a noisy surge flow measurement signal in the field due to ECT's linear surge model
    - ECT's algorithms provide self-adjusting dynamic responses in proportion to the severity of process disturbances

- Competing systems are sensitive to noisy flow measurement and invariably disable derivative features thereby rendering their control responses ineffective.

c) ECT advanced control algorithms are based on patented closed loop control technology

- ECT's Surge Preventer® response provides fast valve step response for large process upsets based on closed loop control method as opposed to open loop method used by competing systems
- ECT Surge Preventer® provides self-adjusting closed loop step responses that result in optimum opening of the recycle valve without over opening the valve. Competing open loop technology over opens the valve causing trips, damage to process equipment, and off-spec product.
- The tuning constants of the competitor's open loop response varies in time with changes in process gains and compressor loading. This means that the open-loop technology provider must be brought back onsite to re-tune the control system over its lifecycle.
- ECT's Surge Preventer® response is easier to tune in the field and adapts itself to varying process conditions giving the customer an optimally-tuned surge control loop for all load conditions

d) Advanced Interactive Control Responses, fallback strategies, and limiting loops

- Fault tolerant control action on loss of transmitters or communication failures are customized to ensure high availability of the turbomachinery
- Interactive control response for decoupling of performance and surge control loops will enhance controllability and give better surge protection without violating performance control requirements.
- Loadsharing algorithm is equidistant from the surge line which gives the optimum sharing of the load between networked compressors.
- Each ECT control application has five limit loops that can be used to ensure smooth turbomachinery control operation when operating near limits. These limit loops ensure the widest compressor operating envelope available and maximize production from the constraints imposed by the compressor map.

3. Hardware

- ECT exclusively utilizes open hardware platforms which eliminates use of "black box" proprietary hardware
- Speed of execution meets or exceeds the industry standards
- SIL2, SIL3 rating and TÜV certification
- Flexibility in hardware redundancy and configuration
- Ease of maintenance and troubleshooting—customer can rely on their own I&E resources for maintenance and troubleshooting

- Spare parts management is much simpler and more cost-effective—no "black box" parts required
- Training programs are available, more streamlined, and standardized, capitalizing on in-house expertise to work with the various open architecture hardware systems

4. Ease of Integration: cost-savings and space savings

- ECT implements all control applications on open hardware platforms which are used by OEMs. The OEMs integrate ECT's control system into their overall control panel realizing significant benefits
- ECT's engineering model is OEM independent and will work with any OEM due to the seamless integration of the unit control panel. The benefits realized are:
  - **a)** Elimination of a dedicated additional control panel to house a competing "black box" system – only one common OEM/ECT panel is necessary by integrating the ECT system with the OEM-supplied PLC logic system
  - **b)** Elimination of dedicated HMI PC and "proprietary" HMI system – only one common PC-based HMI is required by integrating ECT-supplied HMI ActiveX components (for controller faceplates and dynamic compressor maps) into the OEM-supplied HMI. There will be a common look and feel for the operator interface, reduced number of PC's, elimination of proprietary HMI software licensing, and ease of maintenance
  - **c)** Common spare parts with the OEM supplied PLC system – use of the same hardware for OEM and ECT compressor control results in elimination of special spares otherwise required with a black box system
  - **d)** Use of the same PLC system hardware results in a common DCS interface for the OEM & ECT-supplied control system

5. Simulation technology support and engineering analysis capability

- Simulation executed by EPC and OEM will be supported by ECT with the following activities during FEED and detailed engineering phase:
  - **a)** Hot gas bypass valve necessity and recycle valve sizing
  - **b)** Integrated approach will result in optimum valve sizing whereas competitor's methods tend to result in oversized valves.
  - **c)** Start-up and controllability review and driver overloading on start-up, choke prevention
  - **d)** Using ECT Emulator technology and a model-based engineering approach for pre-configuration of tuning parameters can reduce the field commissioning time significantly.

6. Quality control

- ECT is an ISO-9001-certified company

- Various OEMs and end users have done an in-depth qualification and evaluation of ECT's business processes, quality control procedures and measures, and employee review to conclude that ECT's products are designed and engineered based on world-class standards.

7. **Engineering services, Field commissioning service, and aftermarket support**
   - ECT Field Engineers are highly experienced and have successfully started over 1,000 installations worldwide
   - ECT customers are very satisfied with the quality of services offered by ECT for project engineering, support and field commission work. More than 50% of new projects are from existing customers that have vetted ECT's technology and continue to use ECT advanced turbomachinery control for new projects.
   - ECT's closed loop control technology results in shorter field commissioning testing times due to ease of tuning a linear control system.
   - Competing systems are more difficult to tune and are more time consuming
   - ECT has successfully used remote support capabilities for both FAT and for field start-up activities.