AUTOMATED START/STOP SYSTEM FOR LOCOMOTIVES

INTRODUCTION

As fuel prices increase the need for systems that can reduce the fuel consumption of the locomotive fleet becomes essential. One of the simplest ways to reduce fleet fuel consumption is to shut down the locomotive engine when it is not being actively used. In order to be effective any system for shutting down locomotives while not in use must eliminate any inconvenience to the locomotive's crew and must allow the crew to rapidly restart the locomotive when required. This becomes even more important when there are several locomotives in consist. Additionally, the system must prevent the pitfalls that can occur when the engine is shut down; such as battery run-down or dumping of the cooling system due to low temperatures.

DESIGN CHALLENGES

The primary challenge in designing an automated system that will shut down the locomotive engine is to determine when it is appropriate and safe to do so. This must be accomplished by monitoring the status of the key systems within the locomotive and making a determination that the engine can be shut down. The various parameters that are monitored should be easily configurable so that different operating environments can be easily accommodated.

Once the engine is shut down, the system must continue to monitor the locomotive systems in order to insure that the locomotive can be restarted when desired. Systems that must be monitored include the charge status of the battery, the air pressure level and the temperature of the engine cooling system. In order to guarantee that the locomotive can be restarted when required, the system must be capable of automatically restarting the locomotive when certain critical limits are approached.

The system design must account for the practical problems that can be encountered when restarting the locomotive engine. For example, the system must deal with the possibility that the Engine Protector Device may trip and prevent the engine start. Also, the system must deal with the possibility that an older engine may not be able to develop sufficient oil pressure to allow the governor to begin operation during startup.

In order to further increase fuel savings, the system should be capable of working in conjunction with an auxiliary engine/generator set. This generator set will provide the necessary electrical power that will allow the locomotive main engine to remain shut down for longer periods of time. The power from the generator set is used to keep the battery charged, to run a heater which will keep the engine coolant warm, and possibly an air compressor that will maintain air pressure in the main reservoir.

Finally, the design of the system must allow for easy and flexible application to the various styles of locomotives that exist. Easier application translates directly into a lower actual cost for the system. Flexibility means that a fleet can be equipped with a standard system that will reduce maintenance and training costs for the crews.

ELCON'S SOLUTION

Elcon's design approach was to leverage as much existing product technology as possible for the Automated Start/Stop system. This would greatly enhance reliability and minimize overall risk since these products have already been deployed and have experienced the normal reliability growth and refinement that occurs with any product in the field. To this end, it was decided to incorporate the technology from three existing products – Elcon's Electronic Engine Protector, Elcon's Reverser Start System, and Elcon's Generic Controller.

The Elcon solution is a distributed solution. This minimizes the wiring required to install the system, and allows for a great deal of flexibility in deciding where the system components are installed. The system consists of three components: the Operator Interface, the Engine Protector, and the Start/Stop Controller. The components are located near the devices and sensor that they must interface with – thus reducing the amount of wiring that must be done to install the system. Each component is responsible for a portion of the overall system – but they are all coordinated by the Operator Interface.

The Engine Protector component is typically installed in the AC control cabinet near the rear of the locomotive in EMD applications. It is responsible for replacing the function of the mechanical Engine Protector (which is disabled when the system is installed). Additionally, the governor valves are controlled so that the engine can be shutdown and started as required. Interface with sensors that provide coolant temperature is provided so that the system can monitor this critical parameter. Warning devices installed in the Engine Room that alert the crew that the engine is about to be started are also controlled. Optionally, the Governor Assist pump is driven by this component when one is installed.

The Start/Stop controller is typically installed in the High Voltage cabinet in the Cab of the locomotive for EMD applications. This controller provides control of the various relays and contactors used in starting the locomotive. It is also responsible for controlling additional contactors that are used to shed electrical loads that are not required or desired when the engine is shut down. Monitoring of the battery charge status is performed along with monitoring of the throttle and reverser handles. Additional optional features such as monitoring of main reservoir air pressure and control of the engine purge function is provided.

The Operator Interface is installed in the locomotive Cab. This device acts as the coordinator for the other system components. The display is used to inform the crew of the status of the Automatic Start/Stop system. The operator interface also provides a START and STOP button to facilitate manual starting and shutdown of the main engine. During installation or maintenance, the operator interface provides a means for the various parameters of the system to be configured.

SYSTEM OPERATION

The automated start/stop system logically divides into two functional blocks, startup and shutdown. Startup starts a non running locomotive, shutdown stops a running locomotive. Each function evaluates the locomotive signals and operates the control devices that will startup or shutdown the locomotive as required by the specific conditions and limits of the system programming.

SHUTDOWN PROCESS

The shutdown process is controlled by combination of signals. There are a set of signals that will indicate it is safe to shutdown the locomotive, a set of signals that will initiate the shutdown process, and a set of signals that will inhibit the shutdown process.

When all of the following conditions are met, it will be safe to shutdown the locomotive.

- The locomotive is running.
- The Operator Interface is not set to LOCKOUT.
- The reverser handle is in the center position.
- The throttle handle is in the idle or low idle position.

Any one of the following signals will initiate the shutdown process.

- The STOP button on the Operator Interface is pushed.
- The Engine Shutdown timer has expired. The Engine Shutdown timer is started every time the engine is started. This timer is used to prevent excessive shutdown/startup cycles by enforcing a minimum time limit between successive engine shutdowns.
- When the engine was started due to low battery charge, it will be shut down when battery recharge is complete.
- Optional – when the engine was started due to low main reservoir air pressure, it will be shut down when the compressed air recharge is complete.

Any one of the following signals will inhibit the shutdown process.

- The Operator Interface is set to LOCKOUT.
- The ambient air temperature is at or below the configured temperature limit.
- The battery charge state is at or below the configured charge limit.
- Optional – The main reservoir pressure is at or below the configured low pressure limit.

STARTUP PROCESS

The startup process is controlled by combination of signals. There are a set of signals that will activate locomotive startup, a set of signals that will cancel the startup process, and a set of signals that will inhibit the locomotive startup. The inhibit signals are used to prevent unsafe operation of the locomotive or to override the system.

Any one of the following signals will initiate the startup process.

- The START button on the Operator Interface is pushed.
- The reverser handle is moved to forward from center position.
- The reverser handle is moved to reverse from center position.
- The throttle handle is moved to power from an idle position.
- The ambient air temperature falls to the configured temperature limit.
- The battery charge falls to the configured low charge limit.
- Optional – The main reservoir pressure falls to the configured low pressure limit.

Any one of the following signals will cancel the startup process when the signal occurs during the startup process.

- The STOP button on the Operator Interface is pushed.
- The reverser handle is moved from forward or reverse to center position.
- The throttle handle is moved from power to idle or low idle position.

Any one of the following signals will inhibit the locomotive startup process.

- The Operator Interface is set to LOCKOUT.
- The locomotive was not shutdown by the Automated Start/Stop system.
- The number of startup retry attempts was exceeded.

CONCLUSION

The Elcon Automated Start/Stop system meets all the design challenges using a unique combination of hardware and software design. The system can be easily installed with a minimum of locomotive down time. It can easily accommodate various locomotive types and operating environments. Leveraging existing proven technology means that the system is robust and reliable. The software driven approach for the operating logic produces a system that is flexible, configurable and can be easily extended to include new features and options.