

Fuel flexibility and reliability in Combined Cycle gas turbine applications

Schuyler McElrath

Gas Turbine Consultant

JASC: Jansen's Aircraft Systems Controls, Inc

schuyler@jasc-controls.com

www.jasc-controls.com

Fuel flexibility and reliability in Combined Cycle gas turbine applications

Issues facing dual fuel gas turbine system operation

- Liquid fuel check valve associated failures due to fuel carbonization (coking) when the turbine is operating on gaseous fuel
 - Check valve inability to open or close at factory preset pressure
 - Trips due to excessive fuel flow faults
 - Trips due to high temperature exhaust spreads
 - Inability to successfully transfer from gas to liquid fuel or start the turbine reliably on liquid fuel
 - Flow divider, fuel pump, fuel filter and other component failures

Fuel flexibility and reliability in Combined Cycle gas turbine applications

JASC System Specific Integral Valve solutions

Fuel System Components

- Liquid fuel check valves
- Water Cooled Liquid Fuel Check Valves
- 3-way purge valve
- Water cooled 3-way Purge Valve
- Thermal Relief Valve
- Combining Valve
- Copper crush gaskets

Purge Air System

- Purge air check valve

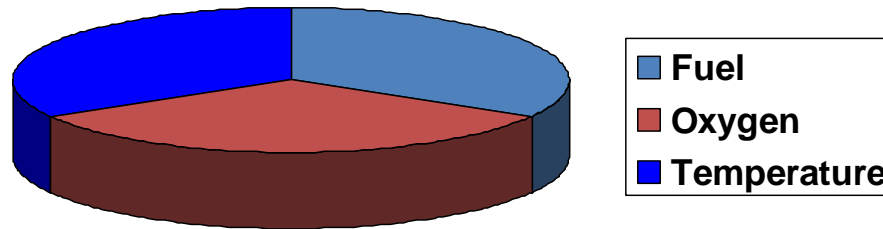
Water Injection System Components

- Water injection check valve
- Water injection flow proportioning valves

Monitoring/Protection Systems

- Smart Fluid Monitor 3000
 - Cooling water
 - Flame detector

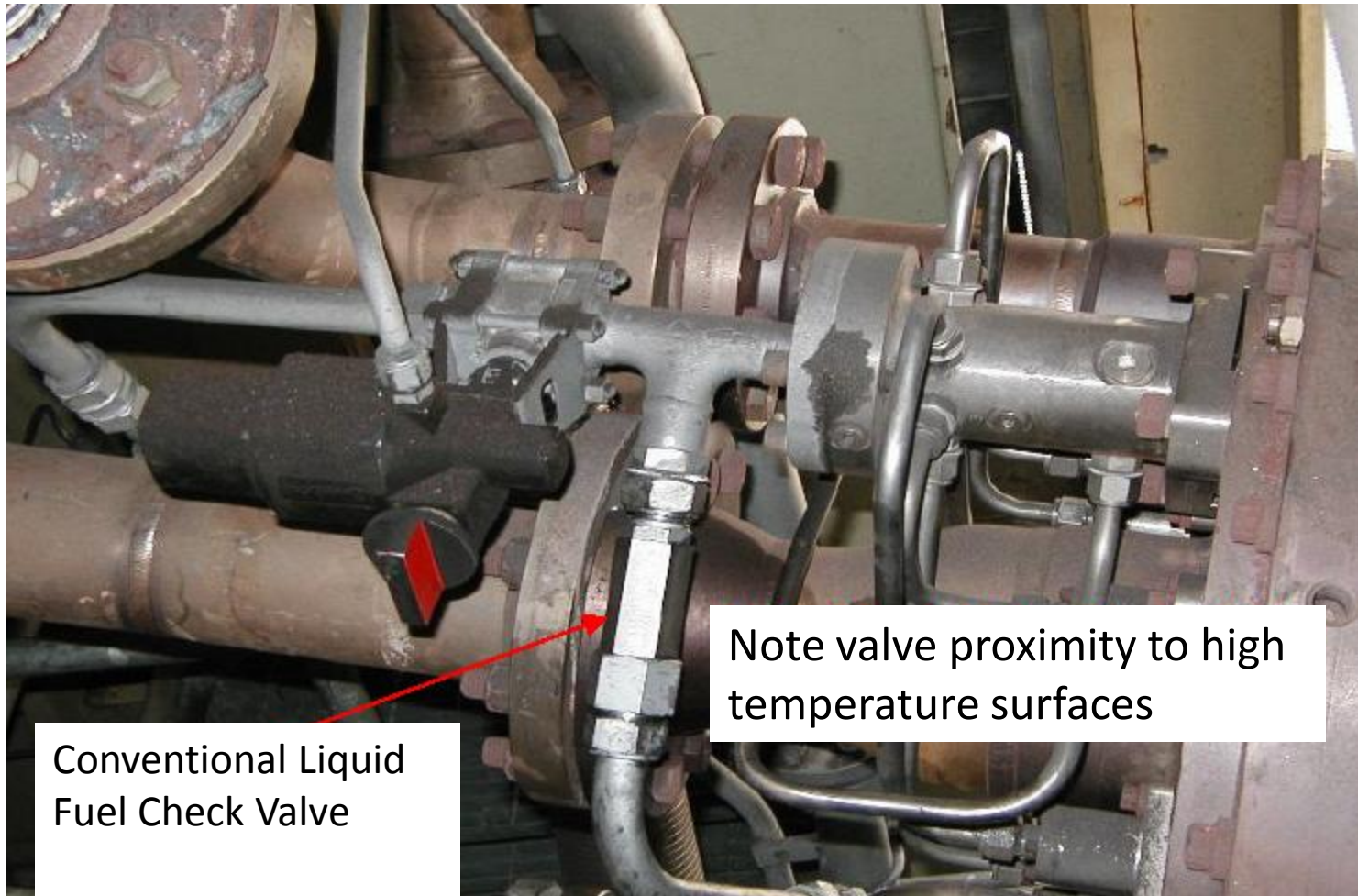
High Temperatures cause coking!



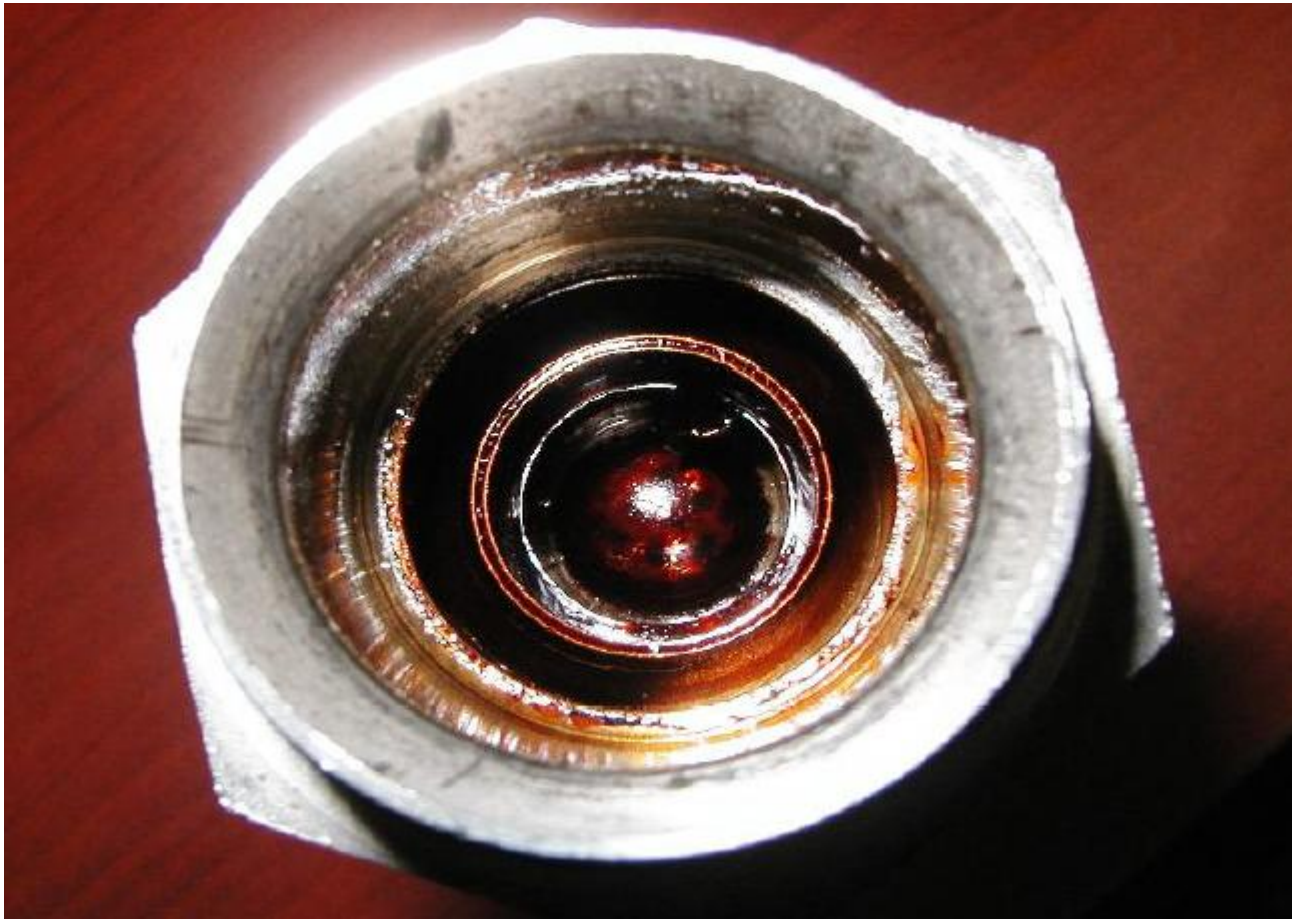
When operating a dual fuel turbine on gaseous fuel the liquid fuel system is idle. Stationary fuel in close proximity to the combustor is exposed to high temperatures, above 250 degrees “F”, which oxidize the fuel and turn it into a hard substance which coats the internal surfaces of the check valve components, restricting their movement. Once this occurs, the check valve will not open and close properly.

Lower the temperature and eliminate coke formation!

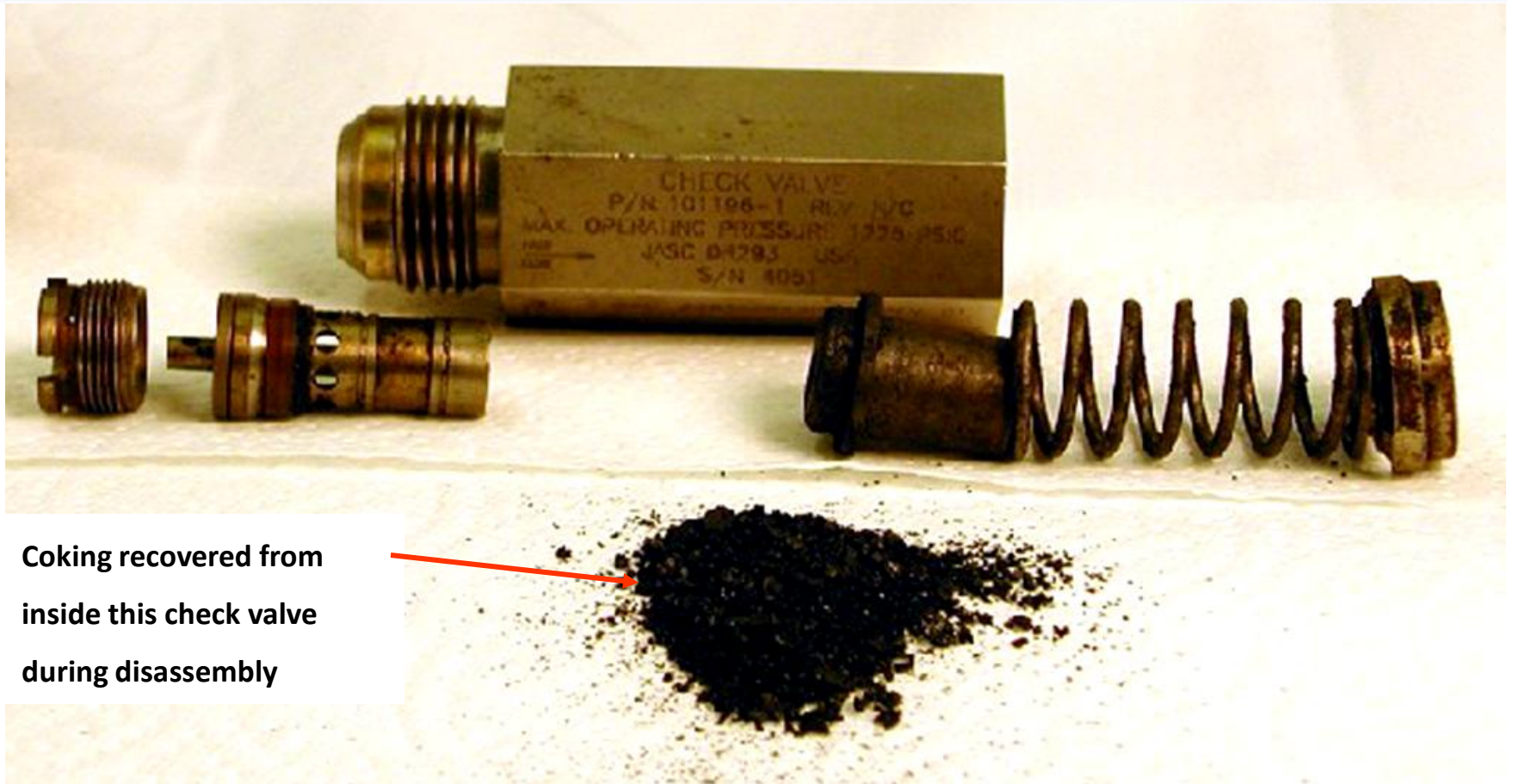
Standard Liquid Fuel Check Valve Installation



Example of coking in ball & spring check valve design



Coking – Primary Cause for Failed Transfers

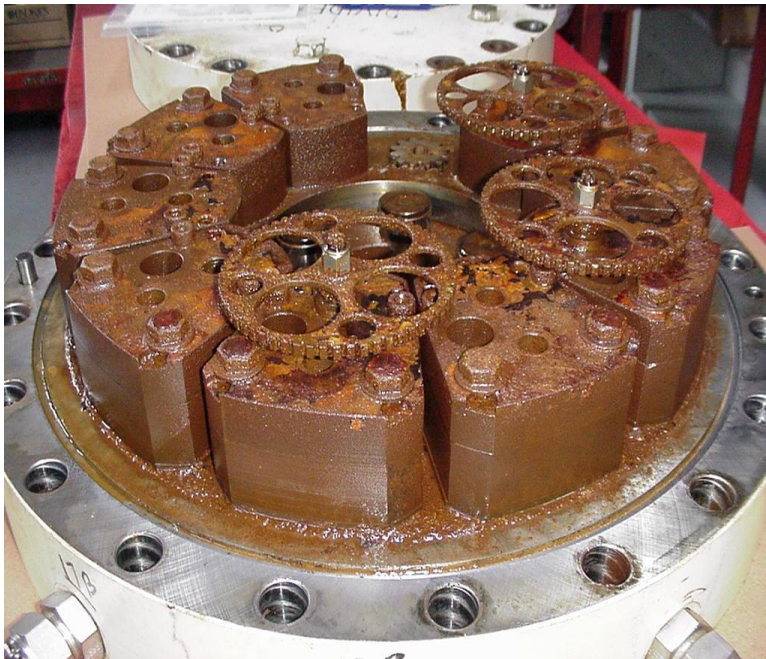


Coking recovered from
inside this check valve
during disassembly

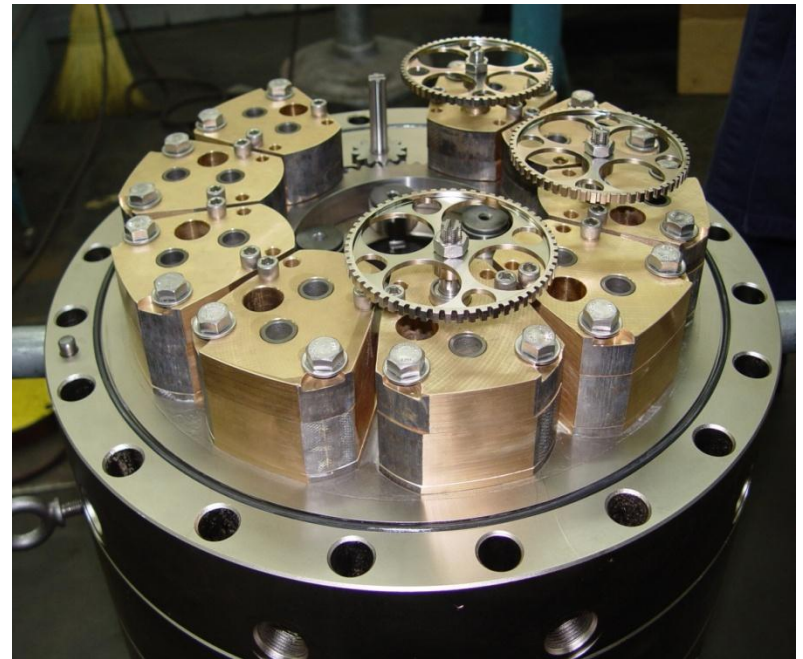
A standard Liquid Fuel Check Valve showing the realized coking potential.

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Flow divider after extended exposure to condensation when fuel system evacuated by combustion gas backflow



New flow divider design using exotic metals to prevent corrosion. Does not resolve fuel evacuation.



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Liquid Fuel Check Valve

Fuel line

Purge Air

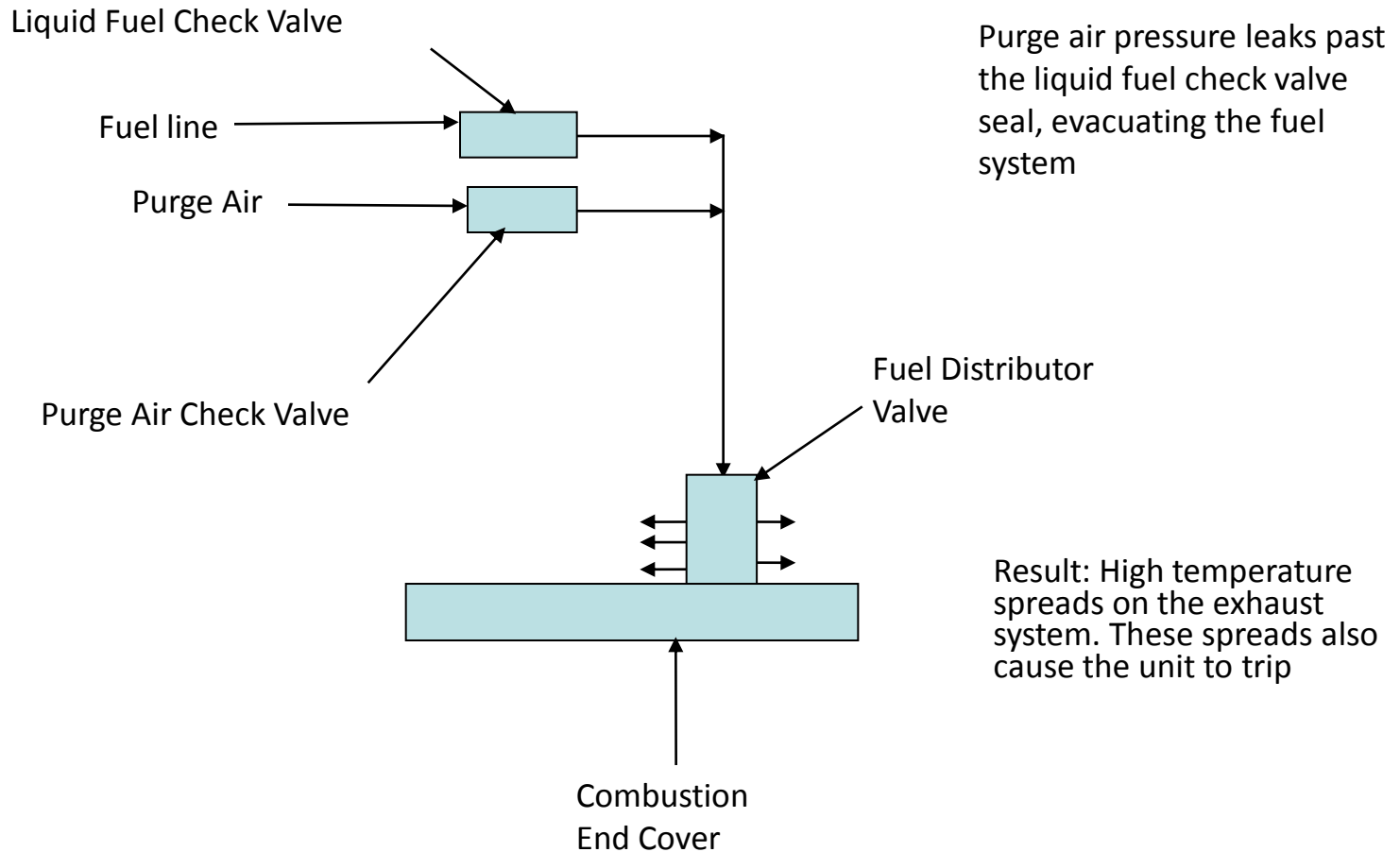
Purge Air Check Valve

Purge air pressure leaks past the liquid fuel check valve seal, evacuating the fuel system

Fuel Distributor Valve

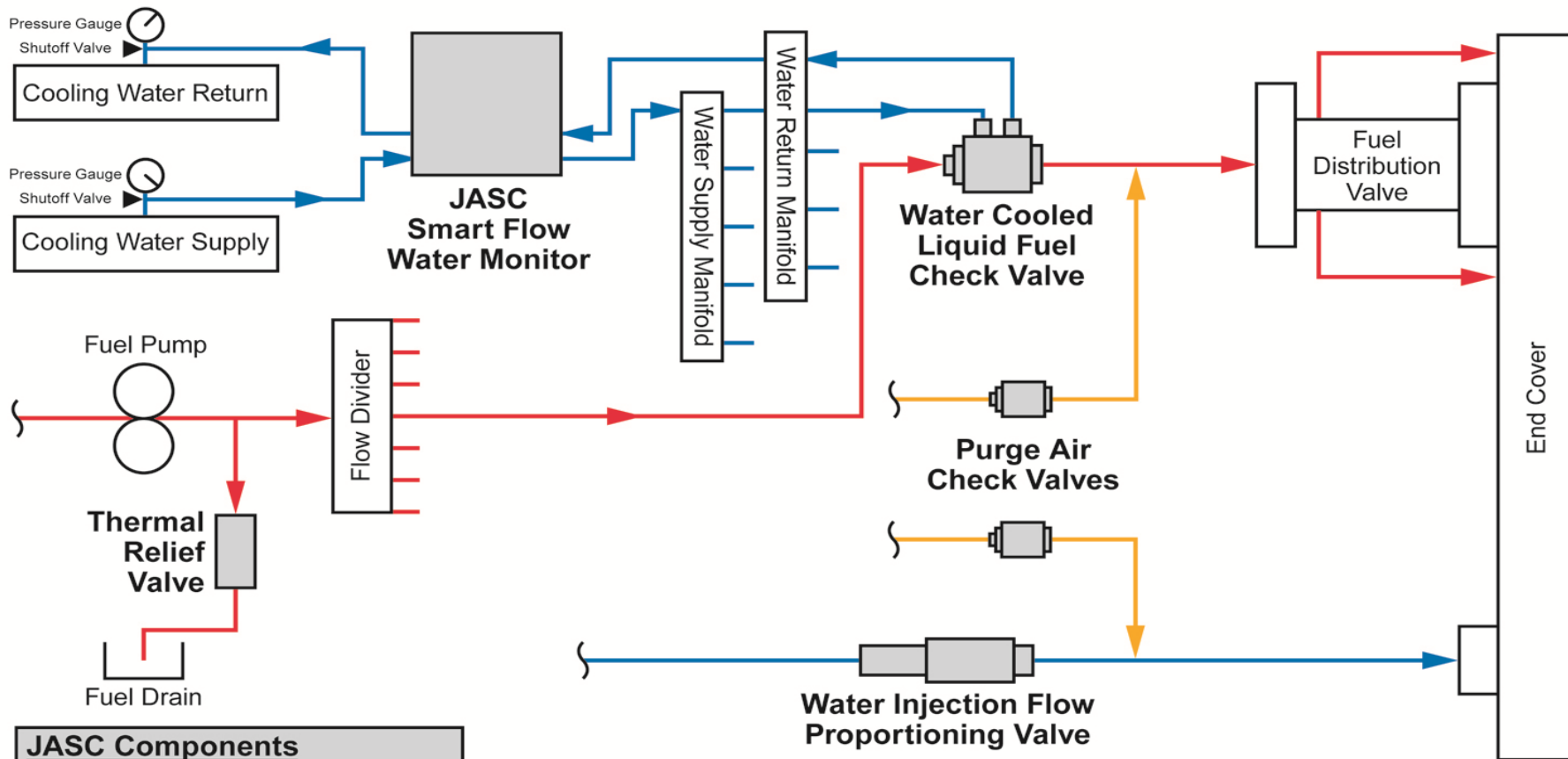
Combustion End Cover

Result: High temperature spreads on the exhaust system. These spreads also cause the unit to trip



Water Cooled Liquid Fuel Check Valve Schematic

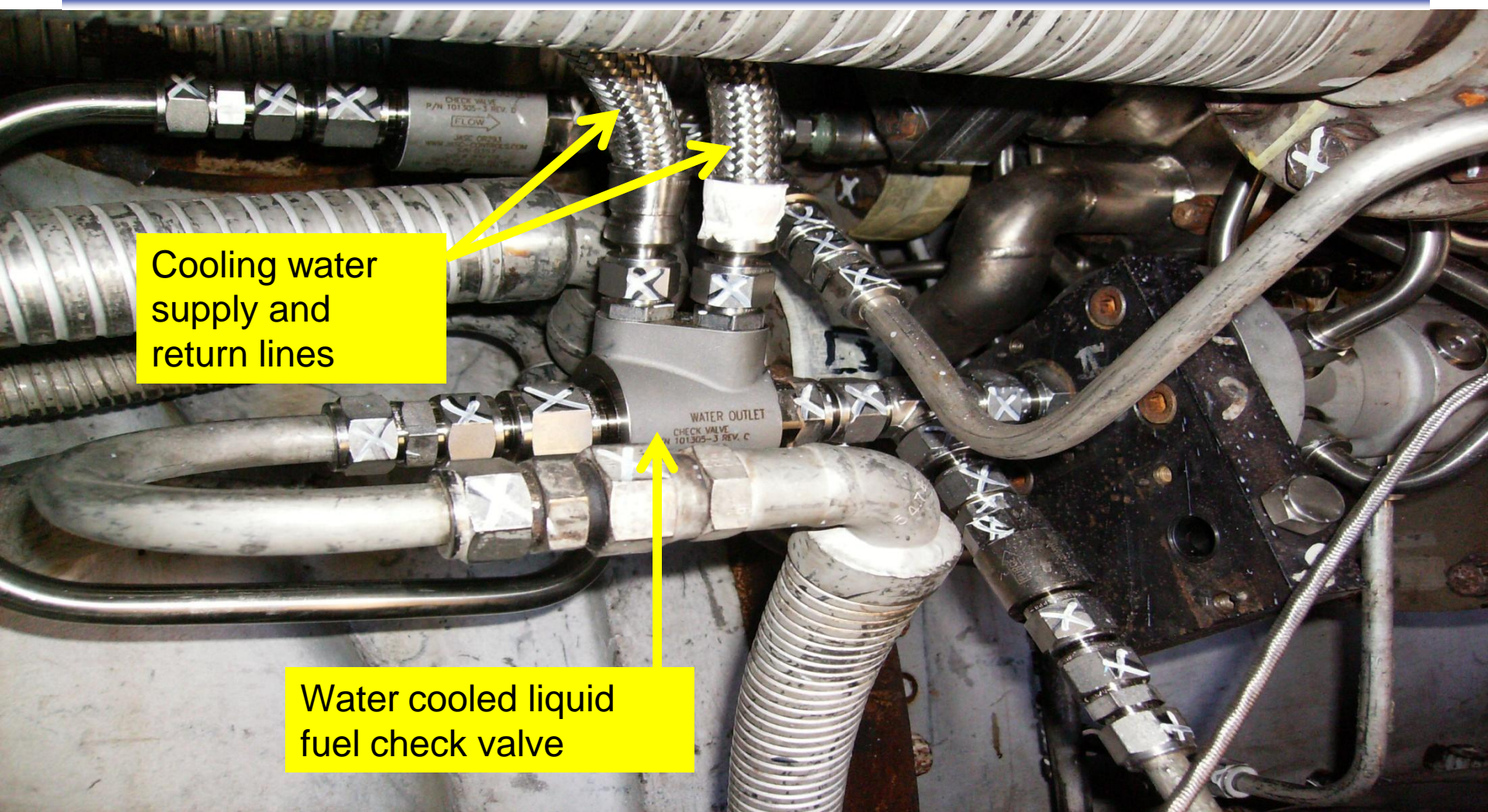
Frame 6FA, 7FA and 9FA Liquid Fuel System with Fuel Distribution Valve



JASC Components

- Water Cooled Liquid Fuel Valves
- Water Injection Flow Proportioning Valve
- Purge Air Check Valves
- Smart Flow Water Monitor
- Thermal Relief Valve

Water cooled liquid fuel check valve installation in a DLN application



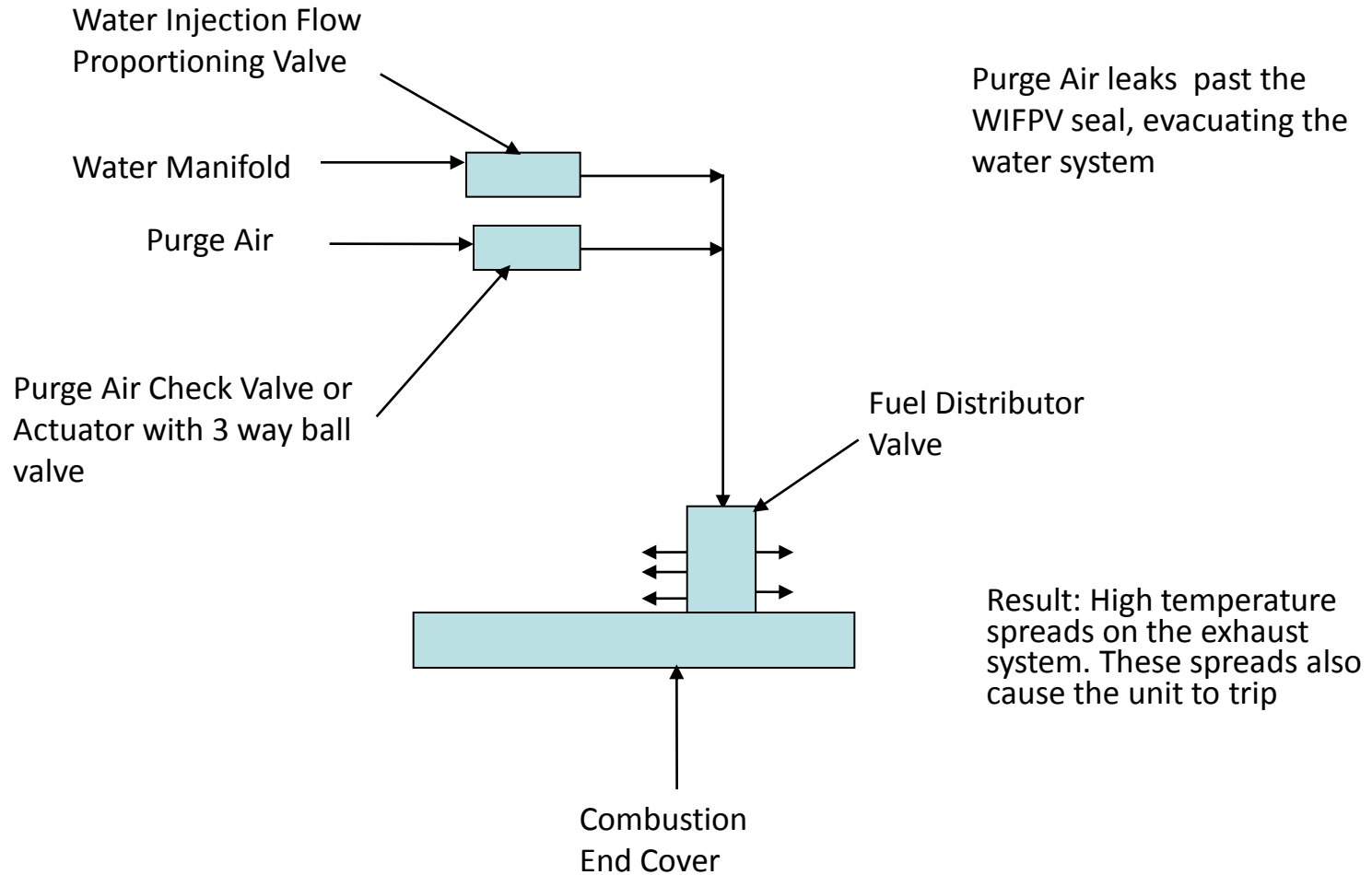
Cooling water supply and return lines

Water cooled liquid fuel check valve

Actively Cooled Fuel Controls: Enhancing Liquid Fuel System Reliability

1. 10 years of successful Gas Turbine Operation
2. JASC water cooled liquid fuel check valves address all previous check valve failure modes and the most recent, coking.
3. Eliminate high exhaust temperature related trips due to sticking or leaking check valves. Service liquid fuel check valves at planned intervals.
4. Eliminate the need for multiple starts in order to purge air from your liquid fuel system.
5. Ability to exercise your liquid fuel system monthly or quarterly without the risk of trips

Water Injection Flow Proportioning Valve



Water Injection Flow Proportioning Valve



Water Injection Flow Proportioning Valve

Installation for most applications is a drop-in replacement.

Maintenance only required during major outages.

Elimination of contamination related failures.

Enhance start capability of the water injection system after extended periods of operation on gas fuel or after long periods of inactivity.

Thermal Relief Valve



Thermal Relief Valve

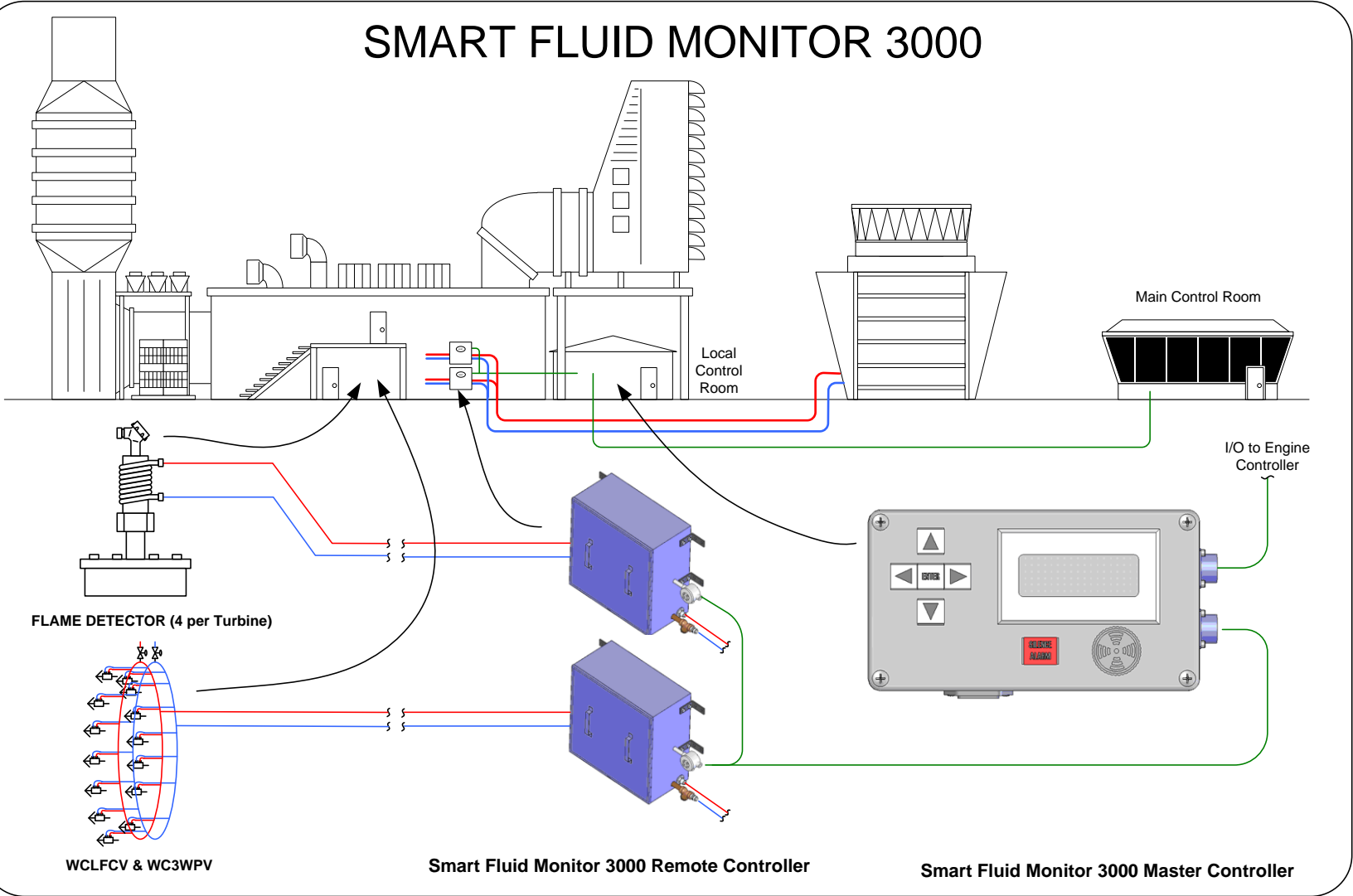
Thermal expansion of fuel oil occurs when high turbine temperatures inside the turbine compartment enclosure heats the fuel oil trapped in the lines between the liquid fuel stop valve and check valves.

Pressure buildup of trapped fuel can exceed 300 psi.

Relief of fuel pressure caused by thermal expansion causes coking of check valves and fuel nozzles as fuel sprays into the combustion zone.

Simple installation: screw into an “NPT” fitting on the fuel piping and route the tubing to the fuel sump.

SMART FLUID MONITOR 3000



FLAME DETECTOR (4 per Turbine)

WCLFCV & WC3WPV

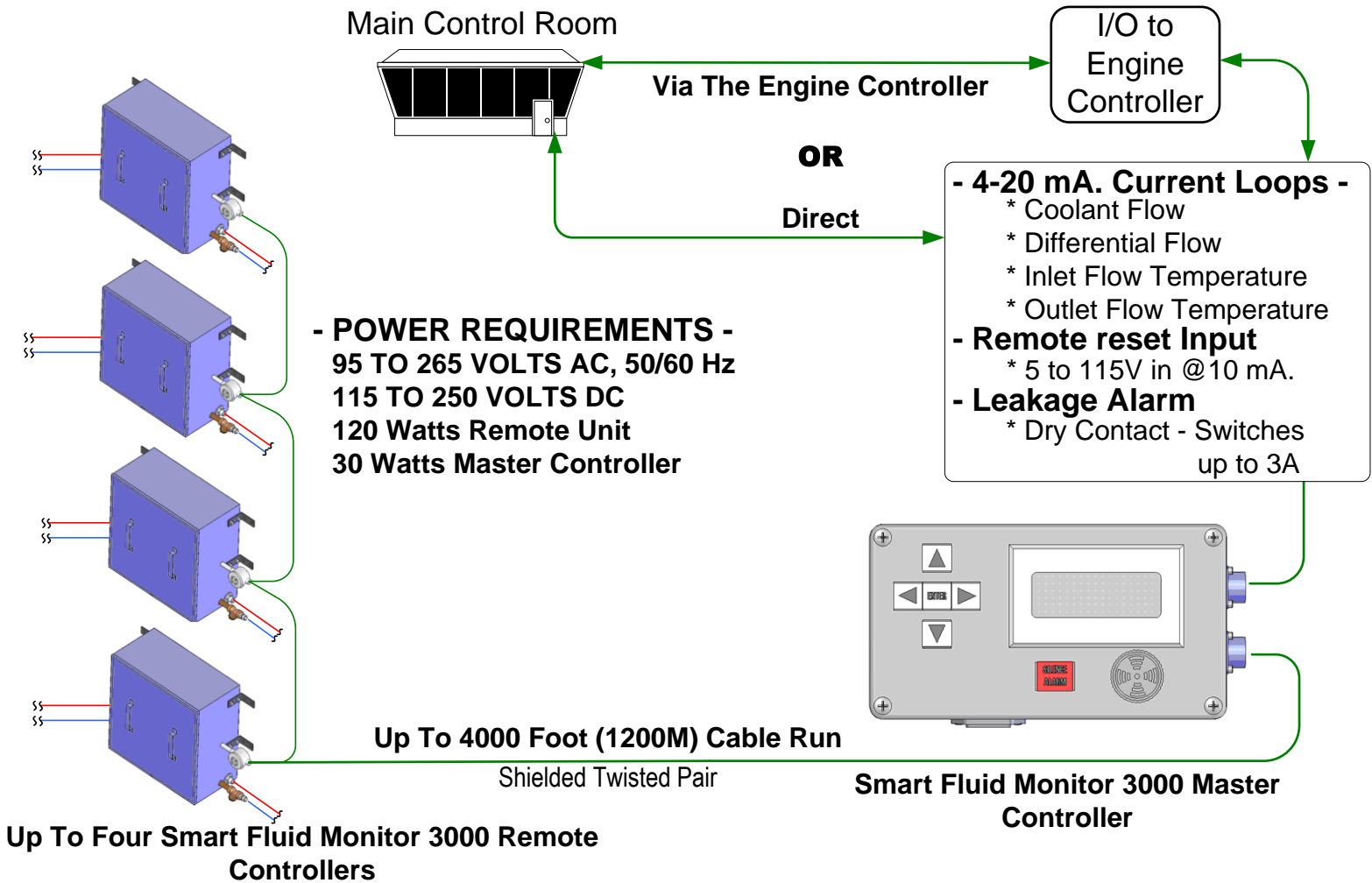
Smart Fluid Monitor 3000 Remote Controller

Smart Fluid Monitor 3000 Master Controller

What Does The Smart Fluid Monitor 3000 Do?

- Detects cooling system leaks and shuts down coolant flow
- Controls the temperature of water cooled devices including check valves, 3-way purge valves and flame detectors
- Uses water from the existing cooling system
- Communicates monitored system parameters like flow and temperature to the control room

SMART FLUID MONITOR 3000



- The Smart Fluid Monitor 3000 protects gas turbines and their components from potentially damaging water leaks
- The Smart Fluid Monitor 3000 is an economical and viable solution for monitoring the temperature and coolant flow of water cooled system
- The Smart Fluid Monitor 3000 eliminates coking or waxing of water cooled fuel components and eliminates condensation on flame detectors

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Conclusion:

- JASC solutions for gas turbine back up liquid fuel systems are operating at better than 98% reliability and availability.
- As turbine efficiency continues to rise and combustion hardware maintenance intervals increase, fuel control technology must also continue to improve.
- Consequently, addressing system inadequacies via the development of new technology is a fundamental part of improving the overall reliability of the liquid fuel and related systems.
- Innovations such as the water cooled liquid fuel check valve, water cooled 3-way purge valve, combining valve and Smart Fluid Monitor were designed to provide options which are appropriate for any gas turbine system application or operational parameter.