Requirements Matrix Example
USC Boiler Application Needs

Application: Ultrasupercritical (USC) Boiler

Design Goals: Archive steam conditions of 300 bar (400 psi) and temperature of 700/760 ºC (1300/1400 ºF)

Modes of Operation:
- First of a Kind (FOAK) design Validation (F)
- Startup Commissioning and Performance Testing (s)
- Continuous Monitoring (C)

Source:

Requirements Matrix Example
USC Sensor Environmental Details

Placement:
The USC boiler monitoring will require that sensors be placed on the steam (inside) and fireside (gas side) of components locations. Monitoring will also occur in the penthouse region as well as at headers outside the boiler.

Components:
The monitored components will include superheater and reheater panels as well as upper furnace waterwalls, piping and thick walled components.

Radiant conditions:
The monitored components will be primarily in indirect radiant locations. However the routing of the sensor network will include boiler radiant zone locations.

Operating Environment:

Temperature: - Fire side gas temperatures 1550ºC (2800ºF).
- Metal temperature 810ºC (1500ºF)

Pressure: - Fireside gas pressure: atmospheric to +/- 1 bar
- Steamside pressure 350 bars (5500psi)

Chemical: - Fireside : A reducing environment with a variable level of fuel based sulfur oxides.
- Steam side: pH 7-9
- Iron hydroxide dissolved oxygen 0-100ppb

Requirements Matrix Example
USC Sensor Performance Requirements

Temperature
- Temperature range 50 - 800ºC
- FOAK and Startup <1450ºF (800ºC)
- Continuous <1200ºF (600ºC)
- Response time < 5 seconds (90% step response time)
- Accuracy +/- 2.5 ºC (5ºF)
- Drift < +/- 2.5 ºC (5ºF)/yr @ 500-600ºC

Strain
- Range 5 – 10,000 micro-strain
- Accuracy 50 $\mu\varepsilon$
- Temperature sensitivity < 1 $\mu\varepsilon$/ 100ºC
- Response time < 5 seconds (90% step response)
- Drift < 50 $\mu\varepsilon$/year at 760ºC
- Differential Pressure via diaphragm strain
- Accuracy 0.02 psia (0.5"WC)

Pressure:
- High Pressure Range 350 bar
- Accuracy +/- 1% FS
- Response time < 2 seconds (90% step response)
- Stability < 2 bar/year at 500ºC
- Temperature Sensitivity: +/- 10 psi / 100ºC

Requirements Matrix Example
USC Sensor Network Requirements

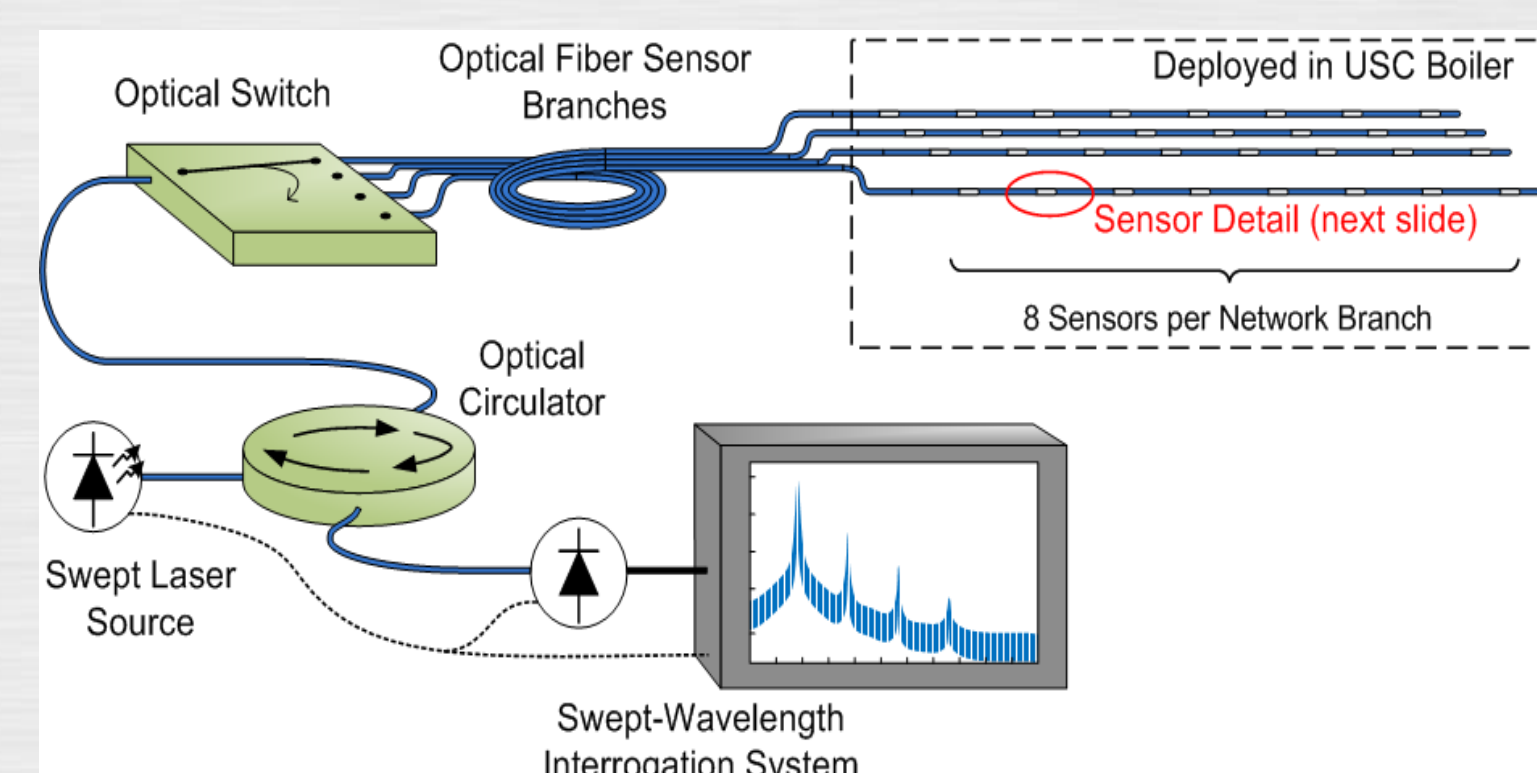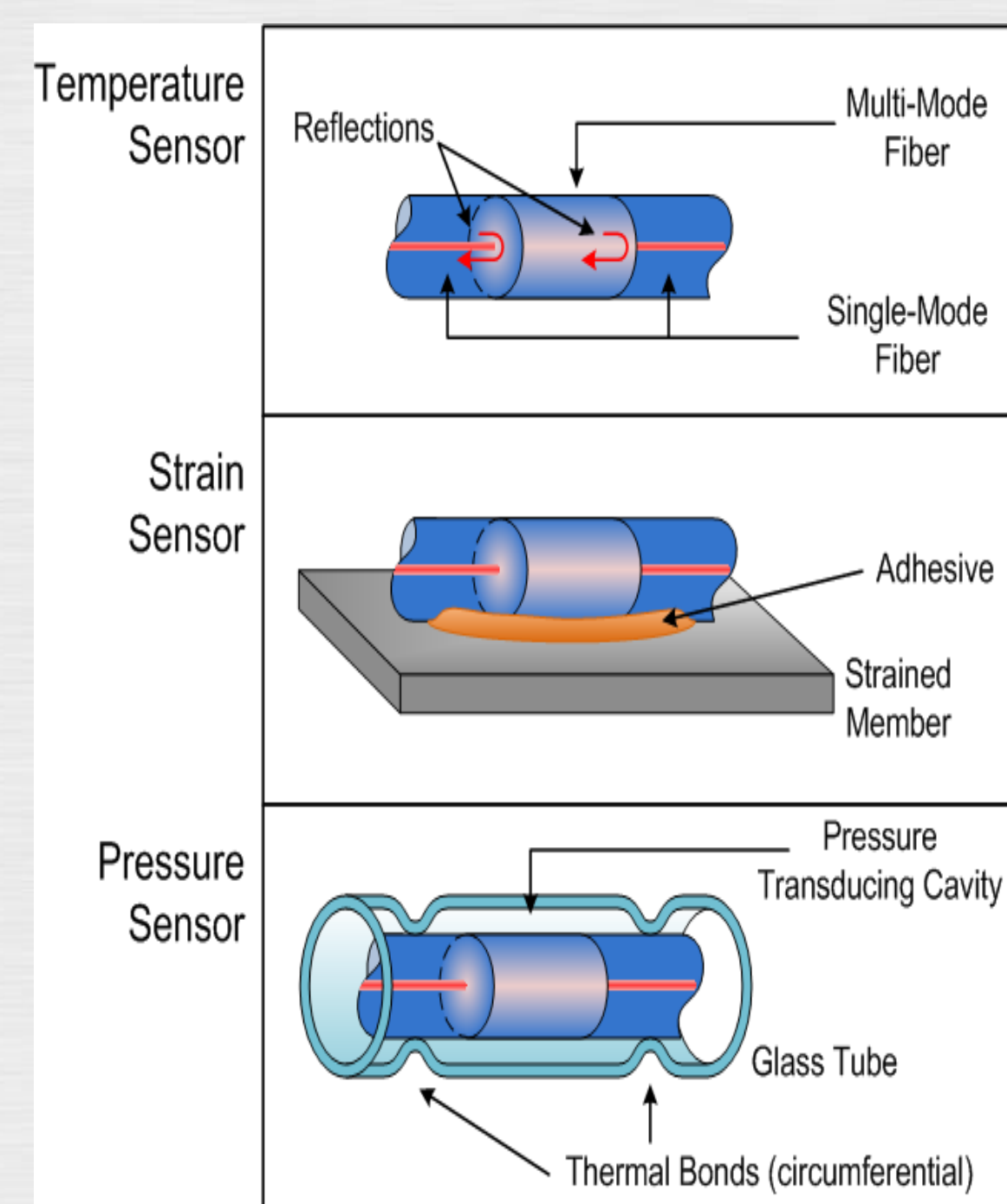**Network Configuration:** Sensor Branch: minimum of 8 sensors distributed over 20 meters.

This Temperature Sensitivity specification is currently under review and may be subject to change.

- System Up to 8 sensor branches per network branch
- Each branch can be different sensor type utilizing one set of optical
- Scan Time: Single Sensor branch (burst mode) < 5 seconds
- Complete Network Scan: (8 branches @ 8 sensors each 64 sensor) < 60 seconds

Network Configuration: Sensor Branch: minimum of 8 sensors distributed over 20 meters.

This Temperature Sensitivity specification is currently under review and may be subject to change.

- System up to 8 sensor branches per network branch
- Each branch can be different sensor type utilizing one set of optical
- Scan Time: Single Sensor branch (burst mode) < 5 seconds
- Complete Network Scan: (8 branches @ 8sensors each 64 sensor) < 60 seconds

System Requirement Needs

SYSTEM	
Application: Ultrasupercritical (USC) Boiler	
Design Goals: Achieve steam conditions of 300 bar (4000 psi) and temperature of 700/750°C (1300/1400°F)	
Modes of Operation: - First of a Kind (FOAK) design Validation (F) - Startup Commissioning and Performance Testing (S) - Continuous Monitoring (C)	

SUB-SYSTEM / COMPONENT	
Component: Water Wall Tube	**Component:** Boiler Exit Gas Profile
Measurement: Heat Flux	**Measurement:** Temperature Grid
Mode: F (1400°F), S, C (1200°F)	**Mode:** F, S (1500°F)
Target Parameter: Required Accuracy of Temperature: 5°F	**Target Parameter:** Temperature Imbalance
High Risk Aspect: Crown Temp	**Required Accuracy:** 5°F
Mechanical Placement: Lower to mid elevation Comment: Chordal approach, Thin wall tube	**High Risk Aspect:** High Gas Temperature
	Comment: Improvement over TC, Mechanical grid structure for a 6 x 6 matrix

SENSOR / MEASUREMENT NEEDS
Placement: The USC boiler monitoring will require that sensors be placed on the steam (inside) and fireside (gas side) of components locations. Monitoring will also occur in the penthouse region as well as at headers outside the boiler.
Components: The monitored components will include superheater and reheater panels as well as upper furnace waterwalls, piping and thick walled components.
Radiant conditions: The monitored components will be primarily in indirect radiant locations. However the routing of the sensor network will include boiler radiant zone locations.
Operating Environment:

PARAMETERS	TECHNOLOGY NEED
Temperature: Fireside	1500°C (2750°F)
Temperature: Metal	800°C (1500°F)
Pressure: Fireside	Atmospheric - 1 bar
Pressure: Steamside	300 bars (5000 psi)
Chemical: Fireside	Reducing environment with variable levels of fuel-based sulfur-pH 7-9
Chemical: Steamside	Iron hydroxide Dissolved oxygen 0-100ppb