

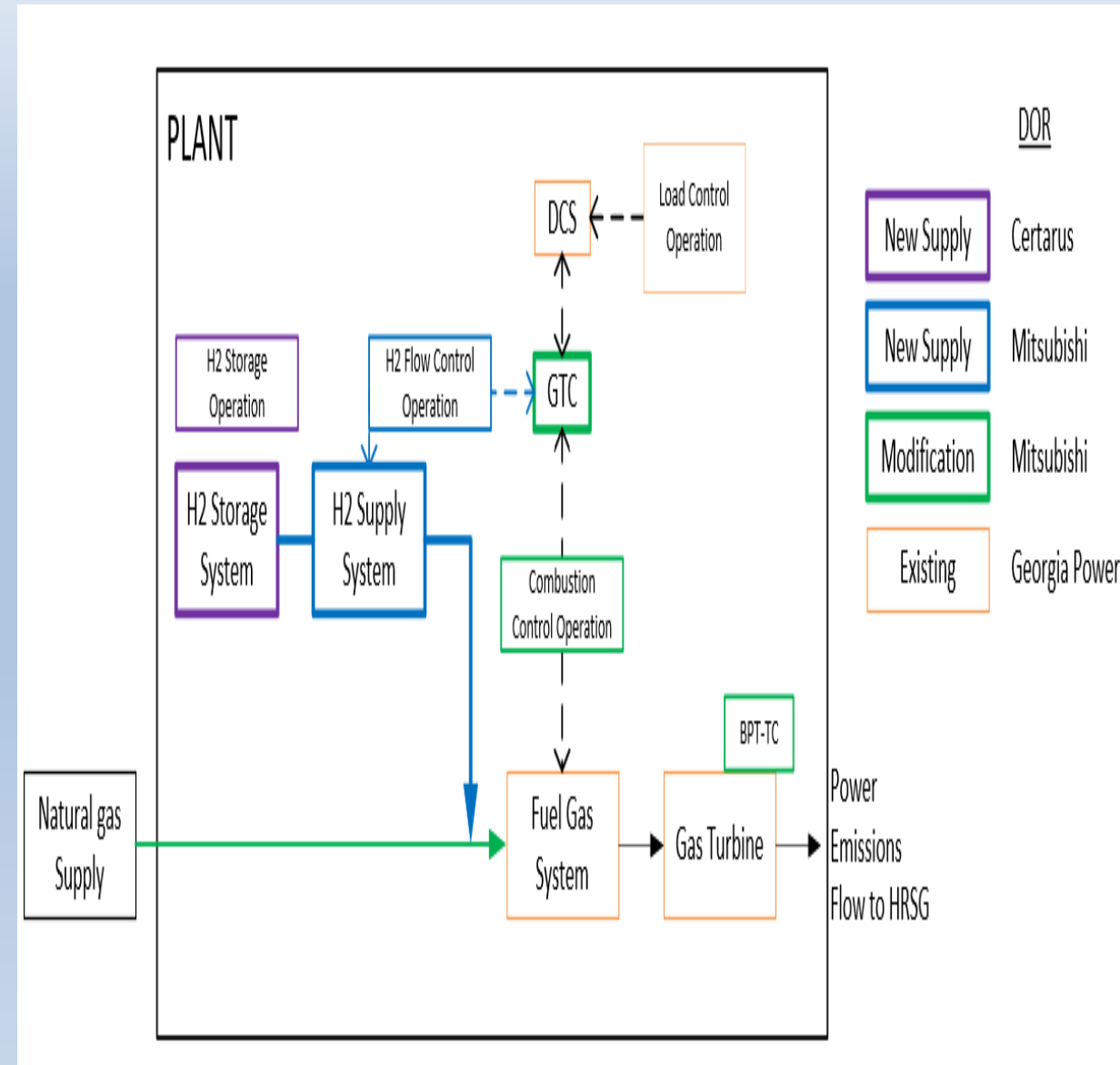
Hydrogen Co-Firing Demonstration Georgia Power Plant McDonough

June 2022

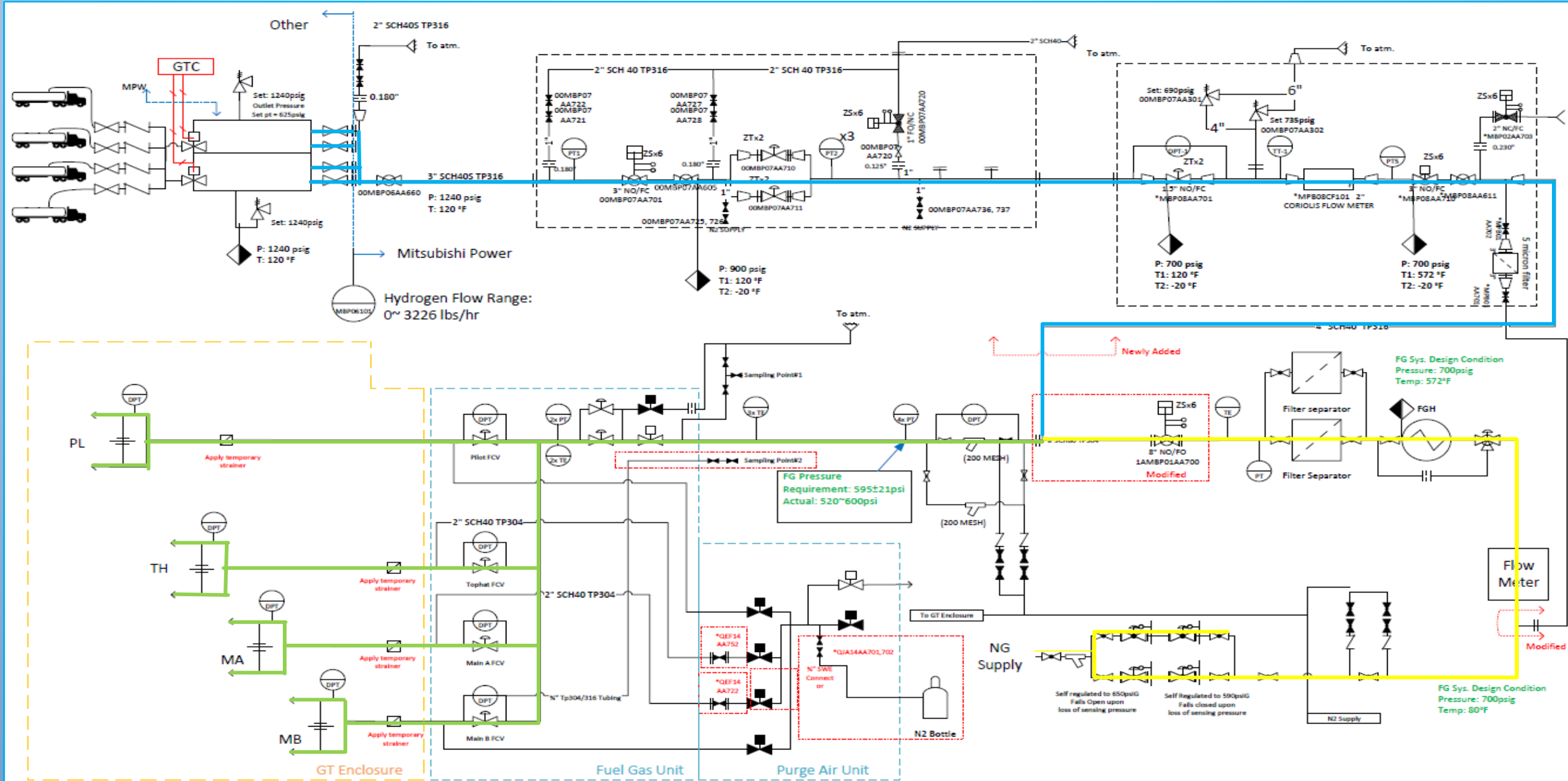


McDonough Hydrogen Blend - Project Overview

- **Objective:**
Safely demonstrate ability to burn up to 20% Hydrogen by volume in a Mitsubishi M501G1 gas turbine at base load and at reduced turndown while remaining emissions compliant.
- **Requirements:**
 - Personnel safety-no injuries, near misses or safety events.
 - GT and Plant Safe Operation – no reliability issues and no damage to components from testing.
 - At baseload, achieve H2 blends up to 20%.
 - Study Turndown characteristics with Hydrogen co- firing (Goal to reduce minimum compliant turndown by 10% load).



McDonough Hydrogen Blend



McDonough Hydrogen Blend

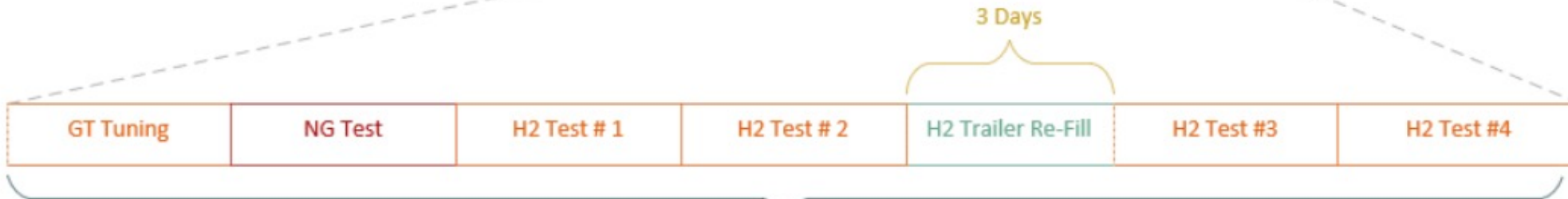
Demonstration Test Sequence Using Hydrogen Supplied by Truck



- Equipment Delivery
- H2 System Construction

- GT Borescope Inspection
- Tie-in to existing FG system
- GT Instrument Scope
- Control Logic Changes
- Commissioning in-to service

- Commissioning Out of Service
- Demobilize H2 System equipment
- Execute restoration plan of existing FG system
- GT Borescope Inspection

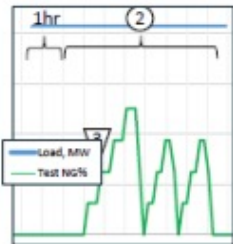


- Check Points**
- Combustion Margin
 - GT Parameter Check (CPF, DCT, Vibr, Etc)
 - Flashback - BPT Trend change

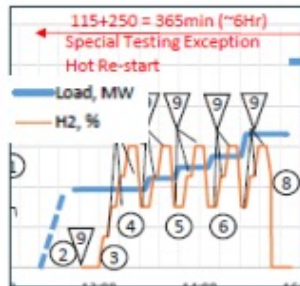
- GT Exhaust Emissions**
- Absolute Value of H2 Ratio
 - Change rate of H2 Ratio
 - Fluctuation of H2 Ratio Control
 - Verification of H2 Shut-off Interlock Function
 - Mixing Ratio Verification
 - Gas Leak Monitoring



- GT Tuning
- Low FGT Test



- System Trial on CNG, 75% load

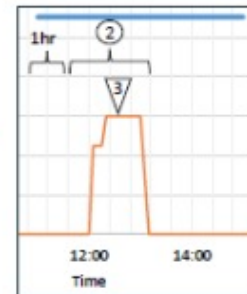


- Turndown Test, 35%, 40%, 45%, 50%, 60% load

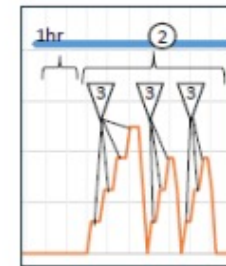


- Baseload – 5, 10, 15% H2

- Control Parameter adjustment for mixing ratio



- Baseload – 20% H2



- 75%load – 15% H2, PI Control Test

Test Results

- Base Load Hydrogen co-firing > 20% achieved on June 2, 2022
 - Hydrogen Fuel Concentration independently confirmed by third party gas chromatograph – repeated test results 20.9% Hydrogen by volume.
- Turndown increased by > 10 percentage points
 - From 50% to 40%
- NOx control same or slightly better
 - Increased flame stability (reduced low band dynamics can reduce pilot fuel flow).
- Hydrogen fuel trip logic successfully activated
 - Prevented over-firing as a result of heat content differences of hydrogen (274 Btu/scf) and natural gas (900 Btu/scf).
- Commissioning and operating procedures were successfully implemented
 - No hydrogen leaks were detected
 - No unintended ignition of hydrogen air mixtures
 - No nozzle clogging resulted from the new system installation

SampleName		P2-15A
Approximate Sample Time		06/03/22 13:05
Report ID:		22055-P2-15A
Methane (xCH4)	Mole %	74.657
Ethane (xC2)	Mole %	2.9585
Propane (xC3)	Mole %	0.17
Iso-Butane (xIC4)	Mole %	0.0189
N-Butane (xNC4)	Mole %	0.0189
Iso-Pentane (xIC5)	Mole %	0.005
N-Pentane (xNC5)	Mole %	0.0089
N-Hexane (xC6)	Mole %	0.0109
Carbon Dioxide (xCO2)	Mole %	0.8142
Nitrogen (xN2)	Mole %	0.4185
Oxygen (xO2)	Mole %	0
Helium (xHe)	Mole %	0
Hydrogen (xH2)	Mole %	20.9192

McHale & Associates, Inc.