

Ammonia Fuel Firing Technology Development Update

2024 Ammonia Energy Association
Conference

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1. Ammonia Fueled Gas Turbines

2. Ammonia System Safety Measures

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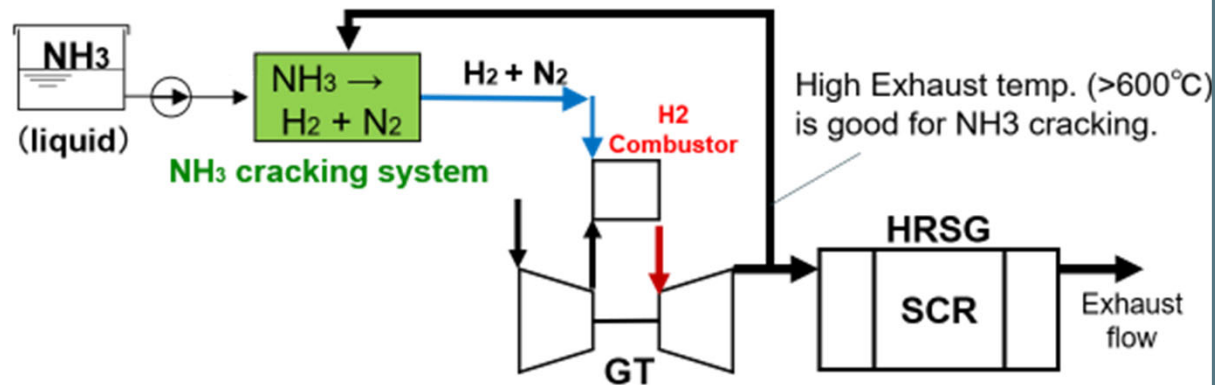
Ammonia Fuel Applications for Gas Turbines

Ammonia(NH3)

- Hydrogen can be efficiently transported long distances and be stored as ammonia
- Ammonia can then be used as a carbon free source of energy
- Direct firing of Ammonia results in high NOx generation (Fuel NOx)

High efficiency large frame GT

Ammonia cracking cycle gas turbine system



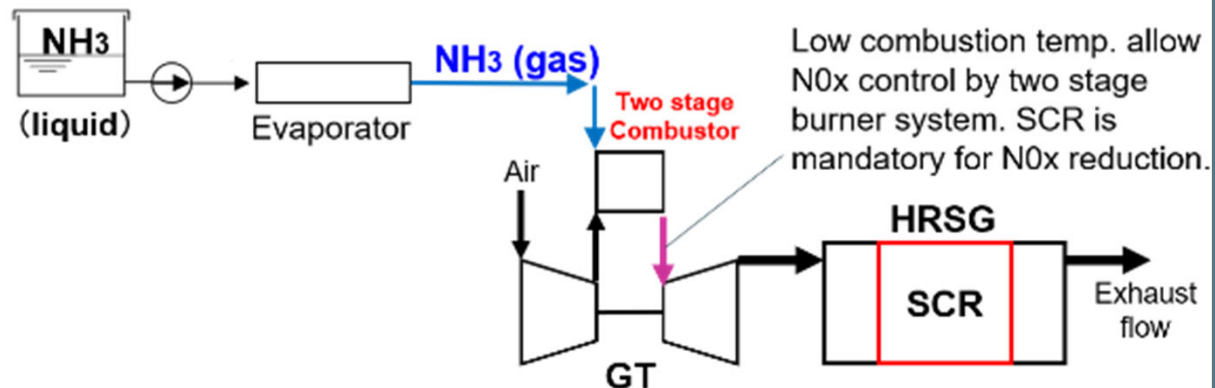
Cracking System
Standalone
Verification Test : 2025~



GTCC Combination

Middle&Small Frame GT

Ammonia direct combustion gas turbine system



Small Frame
Combustor Test : 2023~
Engine Verification: 2025~

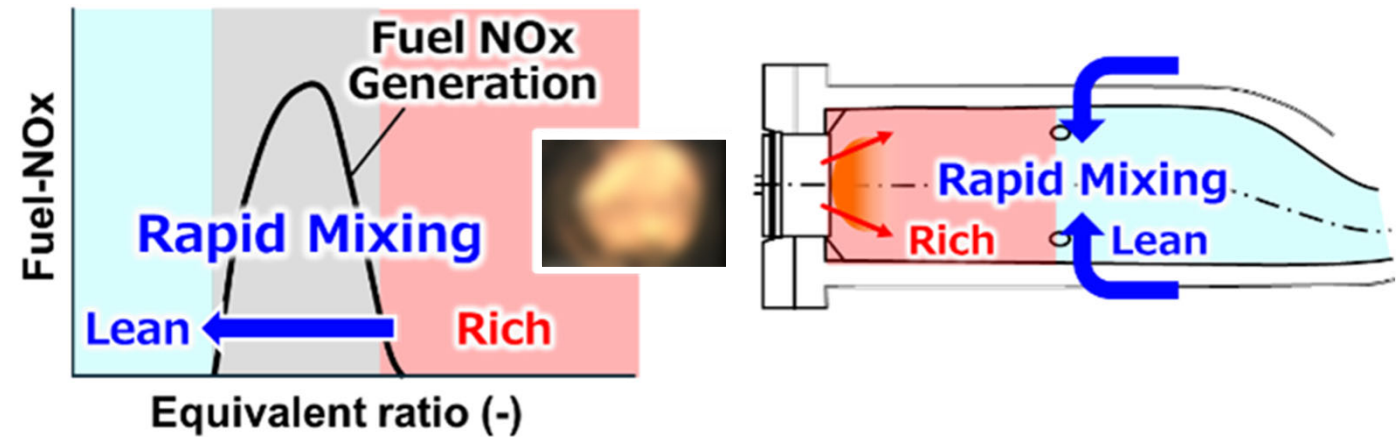


Large Frame GT
combustor development

Direct Ammonia Firing Gas Turbine

Key challenges of Ammonia combustion
Optimization of NOx emission control
 (due to high fuel bound nitrogen) and
 flame stability

Solution
Rich/Lean Combustion

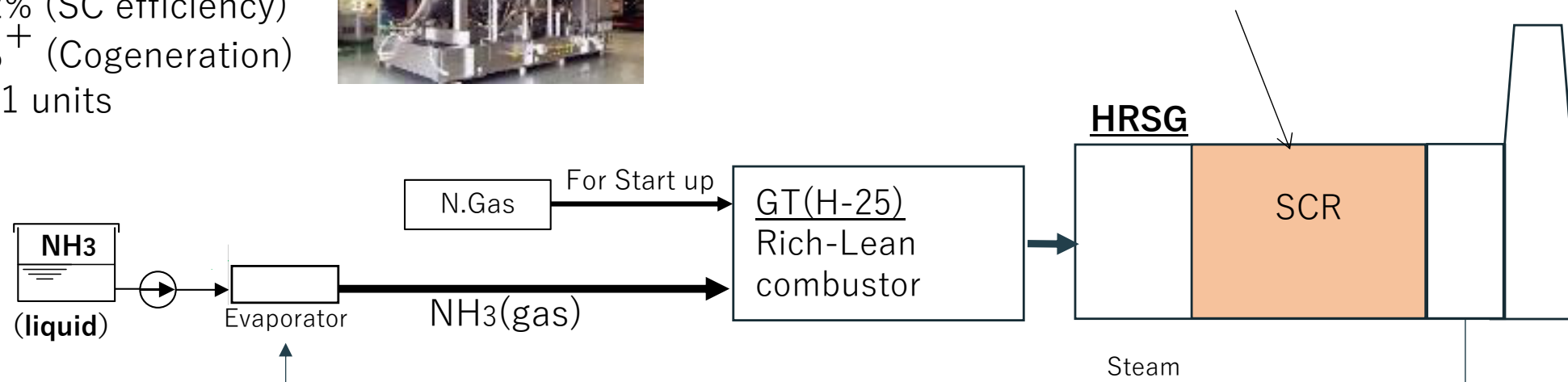


H25 Gas Turbine

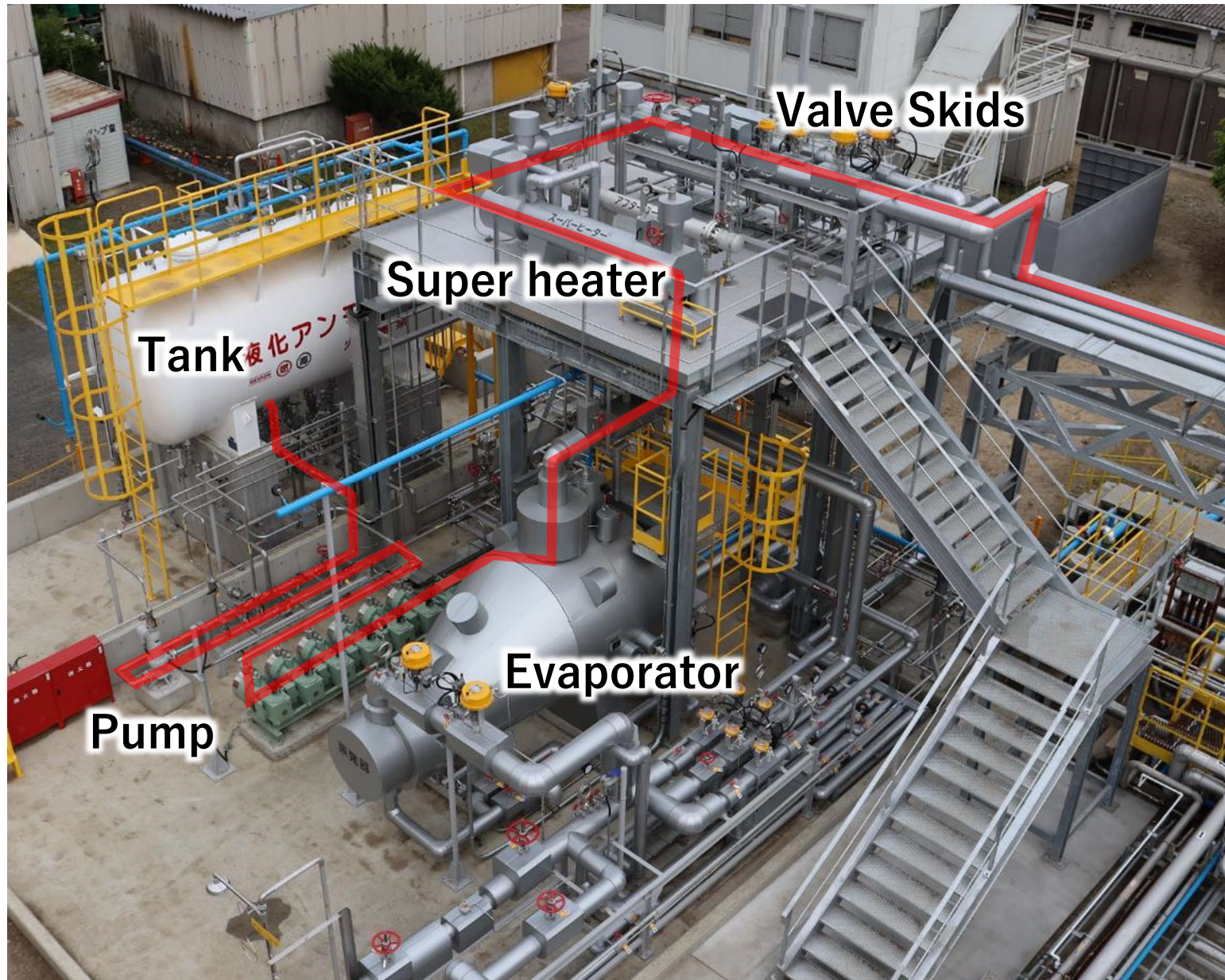
- 41MW (Output)
- 36.2% (SC efficiency)
- 80%⁺ (Cogeneration)
- ~191 units



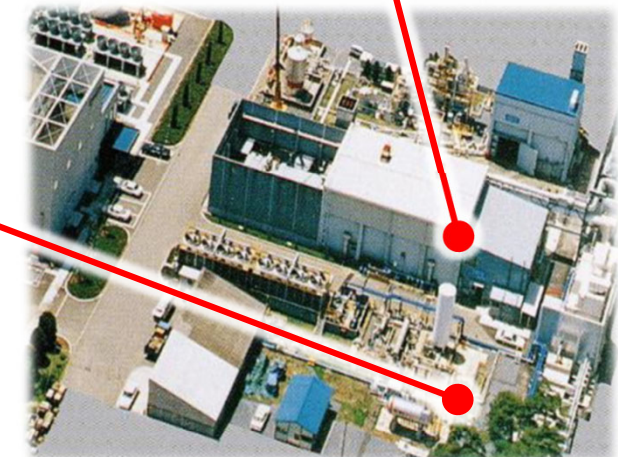
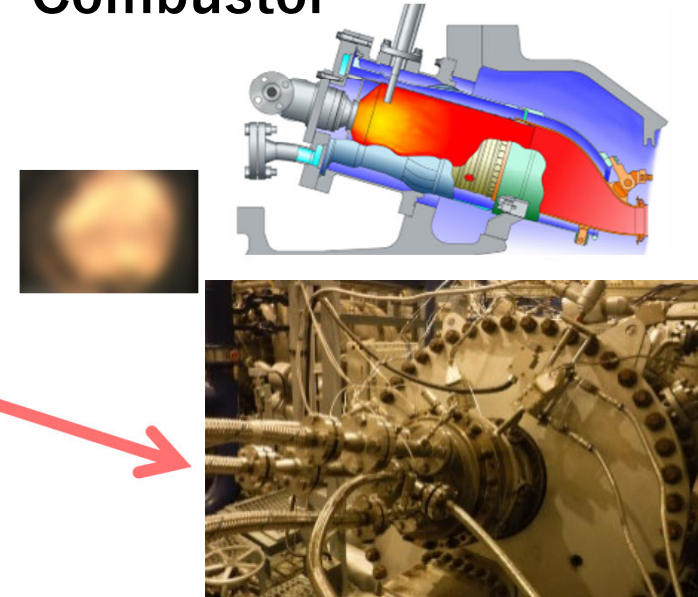
Ultra High efficiency SCR
 (Selective Catalytic Reduction) Required



Overview of High-Pressure Ammonia Combustion Test Facility



Combustor



Katsuta GTD Overview

*; Gas Turbine Demonstration Facility

Safety Consideration Summary

- Sensitivity to Ammonia by humans (*Source: National Laboratory of Medicine*):
 - 5 ppm – Odor detection
 - >30 ppm – Irritation to nose, eyes and throat
 - >80 ppm – Moderate to high intensity irritation
- The Katsuta Test Facility is located in an industrial complex with others working within close proximity and with residential properties within 1 km of the test rig
- **Objective:** Limit Ammonia emissions to < **1 ppm** at the test facility boundaries
- Safety provisions were enhanced during the testing sequences to control ammonia releases.



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