
Requirements for Water and Steam Purity for Injection in Aero Derivative Gas Turbines

1.1 Scope

This document establishes the purity requirements for water for NOx suppression and SPRINT[®] injection into gas turbine engines and for Steam for injected into the gas turbine whether for NOx suppression or power augmentation.

1.2 Definitions

For the purpose of this specification, the following definitions shall apply:

NOx Suppression Water - Water introduced into the engine combustor for the purpose of suppressing the oxides of nitrogen (NOx) in the engine exhaust gases.

SPRINT[®] Water – Water introduced into the engine inlet or into the high pressure compressor inlet for purpose of power enhancement.

2. Applicable Documents

2.1 American Society of Testing and Materials Publications.

ASTM D512 Standard Test Method for Chloride Ion in Water

ASTM D516 Standard Test Method for Sulfate Ion in Water

ASTM D859 Standard Test Method for Silica in Water

ASTM D1066 Standard Practice for Sampling Steam

ASTM D1125 Standard Test Method for Electrical Conductivity and Resistivity of Water

ASTM D3370 Standard Practices for Sampling Water from closed Conduits

ASTM D4191 Standard Test Method for Sodium in Water by Atomic Absorbtion
Spectography

ASTM D4192 Standard Test Method for Potassium in Water by Atomic Absorbtion
Spectography

ASTM D5907 Standard Test Method for Filterable and Non-Filterable Matter in Water

ASTM D5464 Standard Test Method for pH of Water with Low Conductivity

2.2 Environmental Protection Agency (EPA) Test Methods

| | |
|-----------|----------------------------------------------------|
| EPA 160.3 | Residue, Non-Filterable and Total Suspended Solids |
| EPA 150.1 | pH Electrometric |
| EPA 120.1 | Conductance, Specific Conductance at 25°C |
| EPA 200.7 | Metals & Trace Elements |
| EPA 325.3 | Chloride, Titrimetric Mercuric Nitrate |
| EPA 375.4 | Sulfate, Turbidimetric |

3. Water Requirements

3.1 Water Sampling Requirements

The sampling shall be in accordance with ASTM D3370. A minimum of one (1) gallon or four (4) liters shall be supplied.

3.2 Water Purity Requirements

The water shall meet the following requirements when tested in accordance with the designated test method:

| | Limit | Test Method |
|--------------------------------------------------------------|-----------|-----------------------------------------|
| Total Suspended Solids and Total Dissolved Solids, mg/L, max | 5 | ASTM D5907 or EPA 160.3 |
| pH | 6.0 - 8.0 | ASTM D5464 or EPA 150.1 |
| Conductivity, $\mu\text{S}/\text{cm}$ at 25°C | < 1.0 | ASTM D1125 or EPA 120.1 |
| Sodium + potassium, ppm, max | See 3.3 | ASTM D4191 and D4192 or EPA 200.7 |
| Silica (SiO_2), mg/L, max. | 0.1 | ASTM D859 or EPA 200.7 |
| Chlorides, mg/L, max | 0.5 | ASTM D512 or EPA 325.3 |
| Sulfates, mg/L, max | 0.5 | ASTM D516 or EPA 375.4 |

3.3 Sodium & Potassium Limits in Water or Steam

The maximum amount of Na + K allowed in the water or steam injected into the engine depends upon the total Na + K contamination from all sources; i.e., from the fuel, air, water and steam. The maximum Na + K allowed is determined from the equation:

$$(\text{ppmFuel}) + (\text{ppmAir}) * A/F + (\text{ppmWater}) * W/F + (\text{ppmSteam}) * S/F = 0.2 \text{ ppm}$$

Where:

| | | |
|----------|---|-----------------------------------|
| ppmFuel | = | Parts per million Na + K in fuel |
| ppmAir | = | Parts per million Na + K in Air |
| ppmWater | = | Parts per million Na + K in water |
| ppmSteam | = | Parts per million Na + K in steam |
| A/F | = | Air/Fuel Ratio (Wt. Basis) |
| W/F | = | Water/Fuel Ratio (Wt. Basis) |
| S/F | = | Steam/Fuel Ratio (Wt. Basis) |

3.4 Water Filtration Requirements

The water shall contain no particles larger than 20 microns absolute.

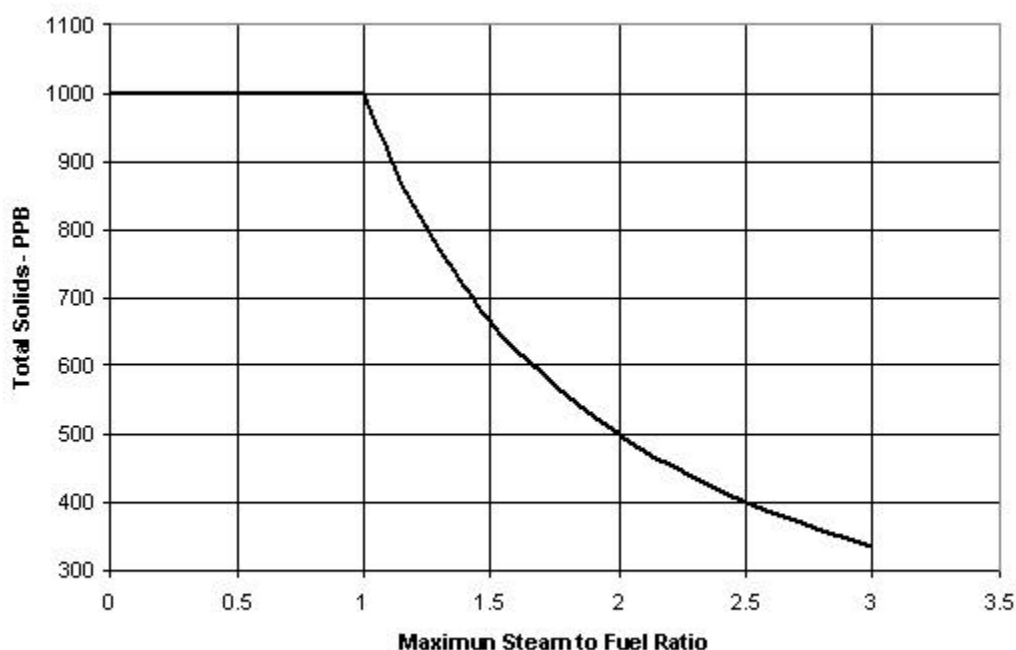
4.0 Steam Requirements

4.1 Steam Purity

The Steam shall meet the following requirements when tested in accordance with the designated test method:

- Sodium + Potassium (Na +K) – See paragraph 3.3
- Total Conductivity (Cation + Anion)
Normal: <1.5 $\mu\text{S}/\text{cm}$ (95% of operation time)
Abnormal: < 2.0 $\mu\text{S}/\text{cm}$ (5% of operating time)
- Total Solids

The maximum total solids depends on the steam/fuel weight ratios at which the gas turbine is to operate in the specific application. The value is determined from the following figure. Contaminant size shall not exceed 250 microns. With the exception of silica, there is no differentiation between types of solids as long as other limitations of this section are met. Silica in the steam is limited to 20 ppb.



4.2 Steam Sampling

Steam samples should be taken in accordance with ASTM D1066.