# Federal Facility
# Emergency Generator Fuel Quality Study
# Multi-State

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## INTRODUCTION AND BACKGROUND

Sierra Piedmont, Inc. (Sierra) was contracted by a federal agency to complete a multi-faceted engineering project at 11 federal facilities. The project included (1) a regulatory compliance assessment, (2) completion of Spill Prevention, Control and Countermeasures (SPCC) plans at four facilities and (3) fuel quality assessment at each of the facilities where bulk fuel is stored.

The government felt that (due to infrequent usage) the stored fuel could be degrading while in storage. As a result, the fuel might prevent the equipment utilizing the fuel (typically a boiler or emergency power generator) from functioning properly during emergency events.

## PROBLEM STATEMENT

How can facilities storing fuel for emergency operations ensure the fuel is consistently usable?

## STRATEGY

Sierra identified two elements in assessing stored fuel conditions:

- Determine the fuel condition with respect to applicable quality parameters
- Estimate the fuel residence time (storage duration) and compare it to the maximum recommended fuel shelf life

The information gathered above was analyzed and recommendations were provided for each facility.

## SOLUTION

Shortly after award, Sierra developed a plan to physically sample and laboratory analyze fuel at each facility for critical parameters and to determine the approximate fuel shelf life. In coordination with federal officials, Sierra scheduled site visits to each of 11 federal facilities during two mobilizations, less than two weeks apart.

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The solution entailed:

1. Fuel samples were collected from the tank bottom at each of the facilities. These fuel samples were analyzed for critical parameters: cloud point, flash point, water and sediment, water content, oxidation stability and percent residue.
2. Facility personnel were interviewed in person by Sierra to determine fuel utilization rates based on equipment at each site. The utilization rate, together with facility fuel storage capacity was used to determine the approximate fuel residence time, which was then compared to the recommended fuel shelf life.

**Fuel Analysis:** Located throughout the Rocky Mountain west and upper Midwest, the facilities are situated in areas that experience some of the most severe temperature fluctuations in the lower 48 states. Fuel storage at the facilities includes #1 fuel oil and #2 fuel oil. Sierra factored this into its selection of critical parameters, as shown in Table 1:

**Table 1: Fuel Analysis Parameters**

| Parameter | Target Values (Source) |
|---|---|
| Cloud Point | N/A(1) |
| Flash Point | > 126˚F (ASTM) |
| Water and Sediment | < 0.05% (ASTM) |
| Water Content | < 200 ppm (ASTM) |
| Oxidation Stability | < 15 mg/L (EMA)(2) |
| Percent Residue/Distillation | N/A(3) |

*Notes:*
*(1) No standard exists; cloud point impacts low temperature operability. Typical minimum value is approximately 10˚ F for the Rocky Mountain Region and upper Midwest*
*(2) Engine Manufacturers Association provides guidelines for #2 Diesel Fuel*
*(3) No standard exists; typical acceptable value is less than 3%*

Samples were collected from each tank bottom using a stainless steel, bottom-filling sampling device. The fuel analysis results for each of the 11 facilities are summarized in Table 2 below:

**Table 2: Fuel Analysis Results**

| Location | Result (Pass/Fail) | Comments |
|---|---|---|
| 1 | Pass | No fuel issues |
| 2 | Fail | Failure due to: Flashpoint, sediment and water content |
| 3 | Fail | Failure due to: Water content |
| 4 | Pass | No fuel issues |
| 5 | Marginal | Marginal due to: Water content and percent residue/distillation |
| 6a | Fail | Failure due to: Sediment and water content |
| 6b | Pass | No fuel issues |
| 7 | Pass | No fuel issues |
| 8 | Marginal | Marginal due to: Percent residue/distillation |
| 9 | Pass | No fuel issues |
| 10 | Fail | Failure due to: High cloud point |
| 11 | Pass | No fuel issues |

Based on the fuel analysis results, four out of the 11 facilities had unacceptable fuel. Of these, all but one had issues with water content, which usually results from condensation before or after delivery and water intrusion. The facility exhibiting most severe moisture was Location 6, Tank 1, which had a water/sediment content of 74%. It is well known that most fuel tanks have a small amount of water at the bottom (specific

gravity of fuel is approximately .7 - .85). This is significant since the presence of water at the bottom of the tank can encourage microbial growth at the fuel/water interface. This microbial growth has been linked to internal tank corrosion, known as microbiologically influenced corrosion or MIC, at the fuel/water interface and fuel break-down. One facility, located in the Rocky Mountain west, had an issue with a high cloud point, which could result in premature fuel gelling during periods of cold weather.

The fuel analysis at two of the 11 facilities indicated marginal fuel quality. Fuel samples from both of these facilities had a high residue content, which may be due to tank age, tank condition or dust (both facilities are located in dusty areas). One of the two facilities with marginal fuel also had a water content issue.

**Fuel Residence Time:** The fuel residence time at each of the 11 facilities was estimated by taking into account the maximum fuel storage capacity and the annual fuel utilization rate (as described by facility personnel during interviews), as follows:

*Residence Time (years) = [Maximum fuel storage capacity (gal)] / [Annual fuel utilization rate (gal/year)]*

The estimated fuel residence time, defined as how long it takes to consume one tank full of fuel, is summarized in Table 3:

**Table 3: Estimated Fuel Residence Time**

| Facility | Estimated Fuel Residence Time (years) |
|---|---|
| 1 | 24.0 |
| 2 | 8.5 |
| 3 | 33.0 |
| 4 | 17.9 |
| 5 | 22.0 |
| 6a | 20.0 |
| 6b | 8.3 |
| 7 | 7.2 |
| 8 | 21.0 |
| 9 | 61.4 |
| 10 | 24.0 |
| 11 | 9.0 |

In all cases, there is a high potential for the fuel to exceed maximum recommended shelf life (approximately one to two years for #1 and #2 fuel oil). While it bears noting that shelf life was calculated assuming no emergency fuel utilization, most facilities reported that they "top off" their fuel approximately once per year and only activate the generators or boilers for approximately one hour per month during testing. Given the results in Table 3, it is not difficult to understand why some facilities have unacceptable or marginal fuel.

## CONCLUSION

Sierra provided recommendations to the government agency based on the results in Tables 2 and 3. Recommendations were customized for each facility's specific requirements, addressing the root cause of the fuel issues: a high residence time in the fuel storage tanks.