EXAMPLE COMPLIANCE ASSURANCE MONITORING PLAN:
CATALYTIC CONVERTER FOR CONTROL OF NOx AND CO

I. Background

A. Emissions Unit
   Description: Rich burn natural gas compressor engines
   Identification: C1, C2, C3, C4
   Facility: Facility P
   Anytown, USA

B. Applicable Regulation, Emission Limit, and Pre-CAM Monitoring Requirements
   Regulation: Construction Permit CT-001
   CAM Emission limits: NOx: 2.0 g/hp-hr
   CO: 3.0 g/hp-hr
   Pre-CAM monitoring requirements: Quarterly NOx and CO monitoring using the Division’s Monitoring Protocol

C. Control Technology, Capture System, Bypass, PTE
   Controls: Non-selective catalytic reduction
   Capture System: N/A
   Bypass: none
   PTE before controls: NOx: 104 TPY  CO: 197 TPY
   PTE after controls: NOx: 12 TPY  CO: 31 TPY (Based on manufacturer’s stated removal efficiency and original design specifications.)

II. Monitoring Approach

The key elements of the monitoring approach are presented in the attached table. Additionally, within 60 days of installing a fresh catalyst (new or washed), portable analyzer emissions monitoring will be performed to demonstrate compliance with emission limits. Catalyst inlet temperature and the pressure differential across the catalyst shall be simultaneously measured and recorded.

(Note: This is a sample CAM plan and should be customized to reflect actual site conditions. Indicators and indicator ranges included in the monitoring approach should be determined during emissions testing and refined during subsequent testing and/or periodic monitoring. As always, it is also acceptable to use alternative monitoring methods if there is solid documentation demonstrating a link between proper operation, emissions, and the proposed monitoring. For catalytic converters, other indicators proposed have included oxygen concentration at the inlet of the converter.)

III. Response to Excursion

A. Excursions of the inlet temperature range, pressure differential across the catalyst, or NOx or CO levels during semiannual emission testing, will trigger an inspection, corrective action, and reporting. Maintenance personnel will inspect the compressors within 24 hours of receiving notification and make needed repairs as soon as practicable. Operation will return to normal upon completed corrective action.

B. QIP Threshold: Any excursion of NOx or CO levels during semiannual emission testing, while inlet temperature or pressure differential are within the ranges of this plan, shall trigger a QIP. (Note: Proposing a QIP threshold in the CAM submittal is not required.)
## MONITORING APPROACH: Facility P Catalytic Converters C1, C2, C3, C4

<table>
<thead>
<tr>
<th>Indicator No. 1</th>
<th>Indicator No. 2</th>
<th>Indicator No. 3</th>
<th>Indicator No. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Indicator</td>
<td>Temperature of exhaust gas into the catalyst.</td>
<td>Pressure differential across the catalyst.</td>
<td>NO\textsubscript{x} and CO measurement.</td>
</tr>
<tr>
<td>Measurement Approach</td>
<td>Exhaust gas temperature is monitored continuously using in-line thermocouples.</td>
<td>The pressure differential between the inlet and outlet of the catalyst is measured with a differential pressure gauge.</td>
<td>NO\textsubscript{x} and CO are measured using either the Division’s portable monitoring protocol or Reference Methods.</td>
</tr>
<tr>
<td>II. Indicator Range</td>
<td>Temperature at the inlet of the catalyst shall be maintained between 750°F and 1250°F.</td>
<td>An excursion is defined as a pressure differential change of more than 2 inches of water as compared to the pressure differential measured during the most recent NO\textsubscript{x} and CO emission measurement that showed compliance with limits.</td>
<td>NO\textsubscript{x} above 3.0 lb/hr, or CO above 7.0 lb/hr.</td>
</tr>
<tr>
<td>III. Performance Criteria</td>
<td>A. Data Representativeness</td>
<td>Temperature is measured at the inlet of the catalyst by a thermocouple. The minimum accuracy is ±1 percent.</td>
<td>Pressure differential is measured at the inlet and outlet of the catalyst. The gauge has a minimum accuracy of 0.25 inches of water.</td>
</tr>
<tr>
<td>B. QA/QC Practices and Criteria</td>
<td>Thermocouple calibrated per manufacturers specifications, at least quarterly.</td>
<td>The pressure gauge is calibrated per manufacturer’s specifications, at least quarterly. Pressure taps are checked monthly for plugging.</td>
<td>As stated in reference method and portable monitoring protocols.</td>
</tr>
<tr>
<td>C. Monitoring Frequency</td>
<td>Temperature is monitored continuously.</td>
<td>Pressure differential is monitored at least once per calendar month. No monitoring is required for months when engine is not operated.</td>
<td>Semiannual testing to verify compliance with permitted emission limits.</td>
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<tr>
<td>Data Collection Procedures</td>
<td>Temperature data will be recorded once per day. No observation required for days when engine is not operated.</td>
<td>Pressure differential data will be recorded at least once per month. A note will be made on months when engine is not operated.</td>
<td>As specified in method and portable monitoring protocols.</td>
</tr>
<tr>
<td>Averaging period</td>
<td>None.</td>
<td>None.</td>
<td>None.</td>
</tr>
</tbody>
</table>

*Values listed for accuracy specifications are specific to this example and are not intended to provide the criteria for this type of measurement device in general.*
I. **Background**

The monitoring approach outlined here applies to the three-way non-selective reduction catalyst system used on four natural gas fired compressor engines (C1, C2, C3, and C4). The catalyst system is a passive unit and does not have mechanical components. The reduction reaction does not take place properly if the temperature of the engine exhaust gas into the catalyst system is too low or too high. A significant change in pressure drop across the catalyst can indicate damage or fouling to the catalyst.

II. **Rationale for Selection of Performance Indicators**

Temperature into the catalyst unit is measured because temperature excursions can indicate problems with engine operation that can prevent the chemical reaction from taking place in the catalyst bed. Too low of an exhaust gas temperature reduces the activity of the intended chemical/catalyst reaction. Too high of an exhaust gas temperature can indicate engine problems which can damage the catalyst unit. Daily monitoring of inlet gas temperature to the catalyst will help assure proper operation of the catalyst.

Pressure differential across the catalyst can indicate if the catalyst unit is damaged, resulting in channeling or other problems, or if there is fouling/plugging in the catalyst. Both conditions would result in reduced catalyst performance.

Implementation of the IPM related to the operation of the engines and catalyst system provides assurance that they are in good repair and operating properly. Items on the daily IPM checklist include oxygen concentration at the engine exhaust, inspecting the fuel/air ratio controller, visual inspection of probes to detect clogging, and inspection of thermocouples. Operation at high oxygen concentrations can inhibit proper chemical reaction and cause fouling of the catalyst. *Note: the IPM plan must include a schedule for replacing oxygen sensors, usually at least every 2000 hours of operation.*

Semiannual NOx and CO emissions testing will demonstrate continued compliance with emission limits and the link between the temperature indicator range, pressure differential, implementation of the IPM plan, and proper operation of the engines and catalyst.

III. **Rationale for Selection of Indicator Ranges**

An exhaust gas temperature range of 750°F to 1250°F has been selected based upon the catalyst manufacturer’s suggested operating parameters for optimal chemical reaction and this company’s field experience. This is also the temperature range that is a required operating limitation for rich burn, catalytically controlled engines subject to the reciprocating internal combustion engine (RICE) NESHAP. A pressure differential change of more than 2 inches of water is based on information from the catalyst vendor which indicated that such a change should trigger catalyst inspection for damage or fouling. This indicator range is also consistent with operating limitations in the RICE NESHAP. The IPM checklist was developed based on manufacturer’s recommendations and the company’s operating experience with similar units.

The most recent emissions testing, using the Division’s approved portable monitoring protocol, was conducted on July 8-9, 2000. During this test, the average measured NOx emissions were 1.6 g/hp-hr for engines C1 and C3, 1.7 g/hp-hr for engine C2, and 1.5 g/hp-hr for engine C4 (all below the compliance limit of 2.0 g/hp-hr). Average measured CO emissions were: 1.9 g/hp-hr for C1; 2.1 g/hp-hr for C2; 2.0 g/hp-hr for C3; and 2.3 for C4 (the compliance limit is 3.0 g/hp-hr). Temperature at the inlet to the catalyst averaged 1000°F, with a pressure drop over the catalyst bed of 6 inches of water. The complete test results are documented in the test report.