ESC Spectrum

HYDROCARBON ENGINEERING®

Bridging the RSR Compliance Gap, Part 1

The US refining industry is one year into the US Environmental Protection Agency (EPA) 40 CFR Part 63 CC (MACT CC) requirement via the Refinery Sector Rule (RSR). This rule forces refineries to make flare minimization a priority, as well as monitor and report when regulated material does flow to the flare and the destruction and removal efficiency (DRE) at which the elevated flares operate (96.5% combustion or 98% DRE). The RSR also requires active monitoring and immediate response to maintain these minimum efficiencies, therefore increasing (on average quadrupling) data collection and reporting requirements. Making the necessary monitoring improvements to comply with RSR has proven to be operation, employee, and data intensive.

With with the introduction of RSR and the copious amounts of data now required for compliance, many refineries are turning to a data acquisition system (DAS) to meet regulatory requirements.

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Introduction

Practices for monitoring, capturing and reporting points of data have historically been handled via a distributed control system (DCS), historian and spreadsheet development method. With the introduction of RSR and the copious amounts of data now required for compliance, turning to a data acquisition system (DAS) is an alternative that many refineries are exploring.

A DAS or DAHS (data acquisition and handling system) offers a set of tools for continuously collecting and validating emissions data for air compliance reporting. Flares are the most complex pieces of equipment inside a refinery to measure and meet environmental compliance standards, and refineries can no longer just measure operational efficiencies. They are now required by law to develop a process and adopt a system that is configured for monitoring and reporting regulatory compliance of their flares. Without a DAS, calculations are spread across the DCS, historian and spreadsheets. With no centralization, visibility to calculations is lacking and the risk of errors increases. Plus, this process makes calculations performed by operations and processes invisible to environmental engineers/specialists who have no access to equations.

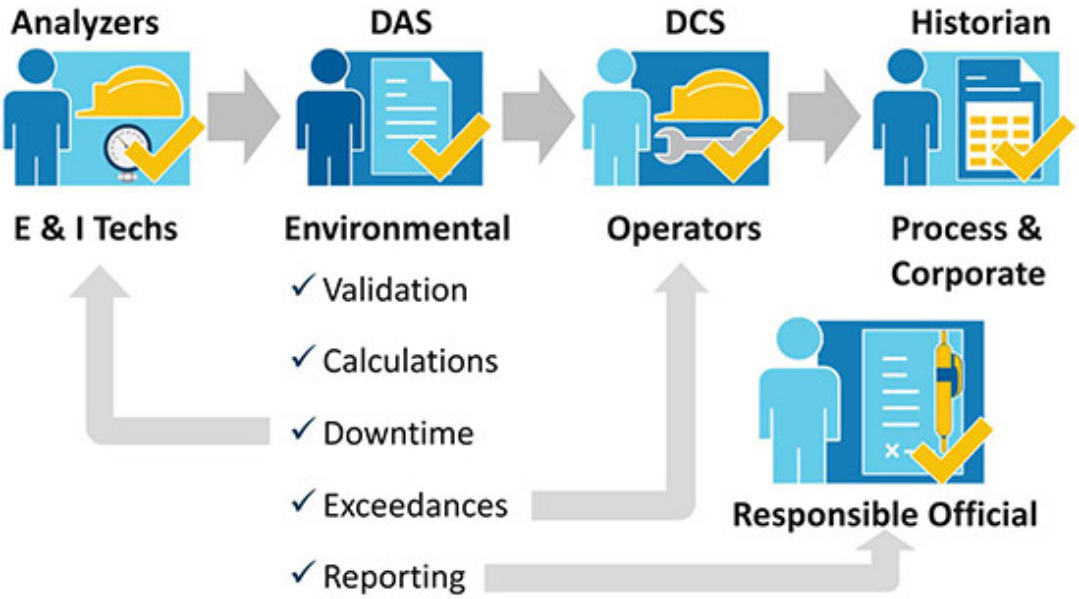

Figure 1. Data acquisition systems (DAS) vs DCS/historian/spreadsheets.

Data Monitoring Challenges of RSR

Challenge One – 15-minute block averages and documentation

The monitoring, collecting and reporting of data via RSR presents challenges to the refining industry as a whole and, more importantly, the flare operators and environmental compliance engineers/specialists responsible for this data. The EPA requires key parameters to be

measured and reported including: net heating value of the combustion zone (NHVcv); net heating value dilution parameter (NHVdil) (when perimeter assists air is used); flare tip velocity (Vtip); pilot flame presence and visible emissions (VE) §63.670(b)-(h). The operating limits of NHVcv, NHVdil and Vtip are based on 15-minute block averages, which is when regulated material is routed to the flare for at least 15 minutes with compliance being determined at the end of each 15-minute block.

What does this mean for the amount of data monitored? Multiple monitored operating parameters including flows (cumulative), temperatures, pressures and net heating value of the flare vent gas must be provided, as well as the calculations for each. It is also important to note that for compliance to be achieved, average calculations must exclude invalid data (out of control, maintenance, continuous parameter monitoring system (CPMS) breakdowns and calibration checks). Thus, the amount of data monitored is increased to a minute-by-minute perspective.

For each of these blocks, the EPA also requires the refinery to provide: “A copy of the data acquisition system algorithm used to reduce the measured data into the reportable form of the standard and to calculate the applicable averages. §63.671(b)(4)(i).” If the refinery is not using a data acquisition system, then documentation of the procedure for identifying and excluding this data must be provided.

Challenge Two – Increases in Quality Control Requirements

Prior to RSR, environmental compliance regarding flaring was based upon the discretion of the refinery (within parameters) to provide reporting that gave the EPA a synopsis of what the specific refinery was emitting during a designated timeframe. With the introduction of RSR, refineries are now required to report how the flare was operated and demonstrate that operation of the flare complies with regulatory parameters including proper recording and proof of instrument accuracy as indicated in reporting.

To meet these operating standards, many refineries have chosen to install multiple flow meters, analyzers, temperature and pressure monitors based on the different streams being monitored. Many refineries are opting to use gas chromatograph or mass spectrometer to determine net heating value of the vent gas. Under RSR, these require daily calibration checks using the modified performance standard 9 (PS-9).

PS-9 requires a refinery to continuously measure the individual components of the flare vent gas using one of the following methods: gas chromatograph (GC), mass spectrometer, grab sample system or continuously measure the net heating value of the flare vent gas using a calorimeter.

Calibration option 1 §63.171(e)(2)(i)

The owner or operator must use a calibration gas or multiple gases that include all of compounds listed in paragraphs (e)(2)(i)(A) through (K) of this section that may be reasonably expected to exist in the flare gas stream and optionally include any of the compounds listed in paragraphs (e)(2)(i)(L) through (O) of this section. All the calibration gases may be combined in one cylinder. If multiple calibration gases are necessary to cover all compounds, the owner or operator must calibrate the instrument on all the gases.

(A) Hydrogen. (B) Methane. (C) Ethane. (D) Ethylene. (E) Propane. (F) Propylene. (G) n-Butane. (H) iso-Butane. (I)Butene (general). It is not necessary to separately speciate butene

isomers, but the net heating value of trans-butene must be used for co-eluting butene isomers. (K) n-Pentane. Use the response factor for n-pentane to quantify all C5+ hydrocarbons. Optional – (L) Acetylene. (M) Carbon monoxide. (N) Propadiene. (O) Hydrogen sulfide.

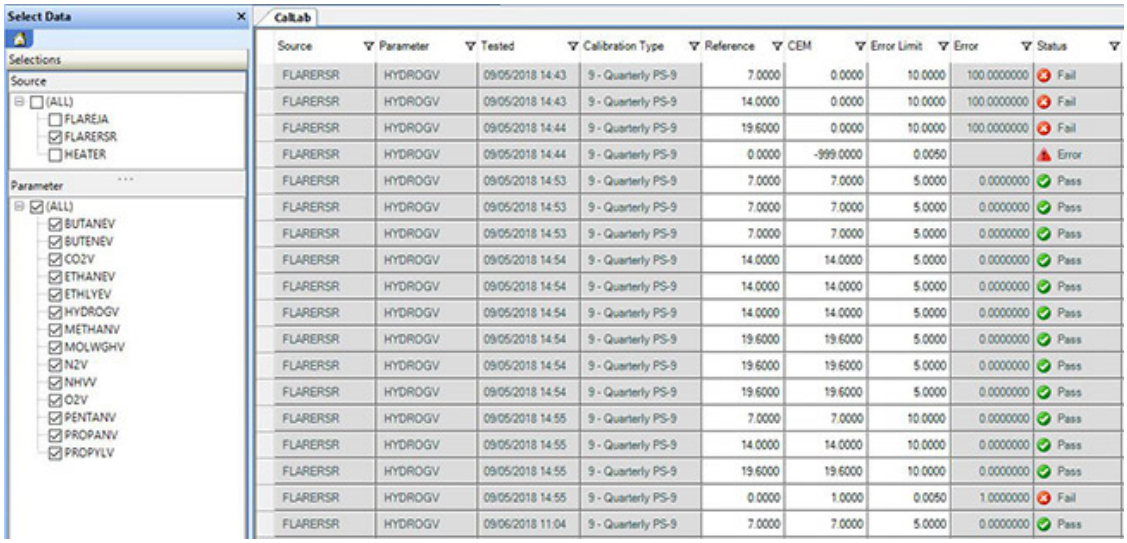

Figure 2. DAS real-time testing results dashboard.

Calibration option 2 §63.171(e)(2)(ii)

The owner or operator must use a surrogate calibration gas consisting of hydrogen and C1 through C5 normal hydrocarbons. All the calibration gases may be combined in one cylinder. If multiple calibration gases are necessary to cover all compounds, the owner or operator must calibrate the instrument on all the gases.

(3) If the owner or operator chooses to use a surrogate calibration gas under paragraph (e)(2)(ii) of this section, the owner or operator must comply with paragraphs (e)(3)(i) and (ii) of this section.

(i) Use the response factor for the nearest normal hydrocarbon (i.e., n-alkane) in the calibration mixture to quantify unknown components detected in the analysis.

(ii) Use the response factor for n-pentane to quantify unknown components detected in the analysis that elute after n-pentane.

Although RSR does present choices in the methods for maintaining compliance as PS-9 applies, due to the amount of data monitored and state environmental requirements that are often more stringent than EPA requirements, many refineries are adopting option 1. Although more technically challenging than option 2, this option presents process engineering and valuable data from operations that helps troubleshoot process upset. Recognizing ‘out of compliance’ based on granular level data, which is instantly available, adds value and offers operators the ability to find the root cause of the upset faster.

When using a DAS, refineries can automatically capture GC, calorimeter or mass spectrometer status codes and access ‘out of compliance’ issues in real-time. With 11 required individual components to be tested daily, a non-DAS process presents 11 daily opportunities for compliance failure and downtime.

Depending upon process type and specific real-time data monitoring parameters, the DAS can also generate alarms for offline instruments, saving time and decreasing the potential for fines.

Challenge Three – Requirement to Report, Retain and Make Data Available

Finally, RSR has introduced various reporting instances including emergency flaring events and deviations from the allowed operating limits §63.655(g).

Refineries are required to keep all reported values for five years, with many refineries adopting a 10-year industry standard approach and producing voluminous amounts of big data. Additional data must also be retained with contextual information per §63.655(i).

- Each 15-minute block average operating parameter for V_{tip}, NHV_{vg}, NHV_{cz}, NHV_{dil} – 5 years.
- All 15-minute block cumulative flows for every flow that feeds into the reported averages – 5 years.
- Multiple monitoring locations feeding into any of the flows – those 15-minute block averages – 2 years.
- Compositional analyses – individual component concentrations from each analysis – 2 years.
- For calorimeters – each result – 5 years.
- All pilot and VE recorded monitoring – 2 and 3 years, respectively.
- Time periods where operating values are outside of limits with regulated material flowing – 5 years.
- Time periods without flare monitoring as described in § 63.670(g) through (j) – 5 years.
- Time periods of flaring without regulated material – 5 years.
- Time periods where vent gas flow exceeds the smokeless capacity – 5 years.

It is important to note that EPA requirements indicate that all data must be available for inspection within 24 hours upon request during the stated period. Use of a DAS enables the refinery to store and retrieve not only reported data, but also compositional data for the RSR required 5-year blocks, making it on-hand and accessible.

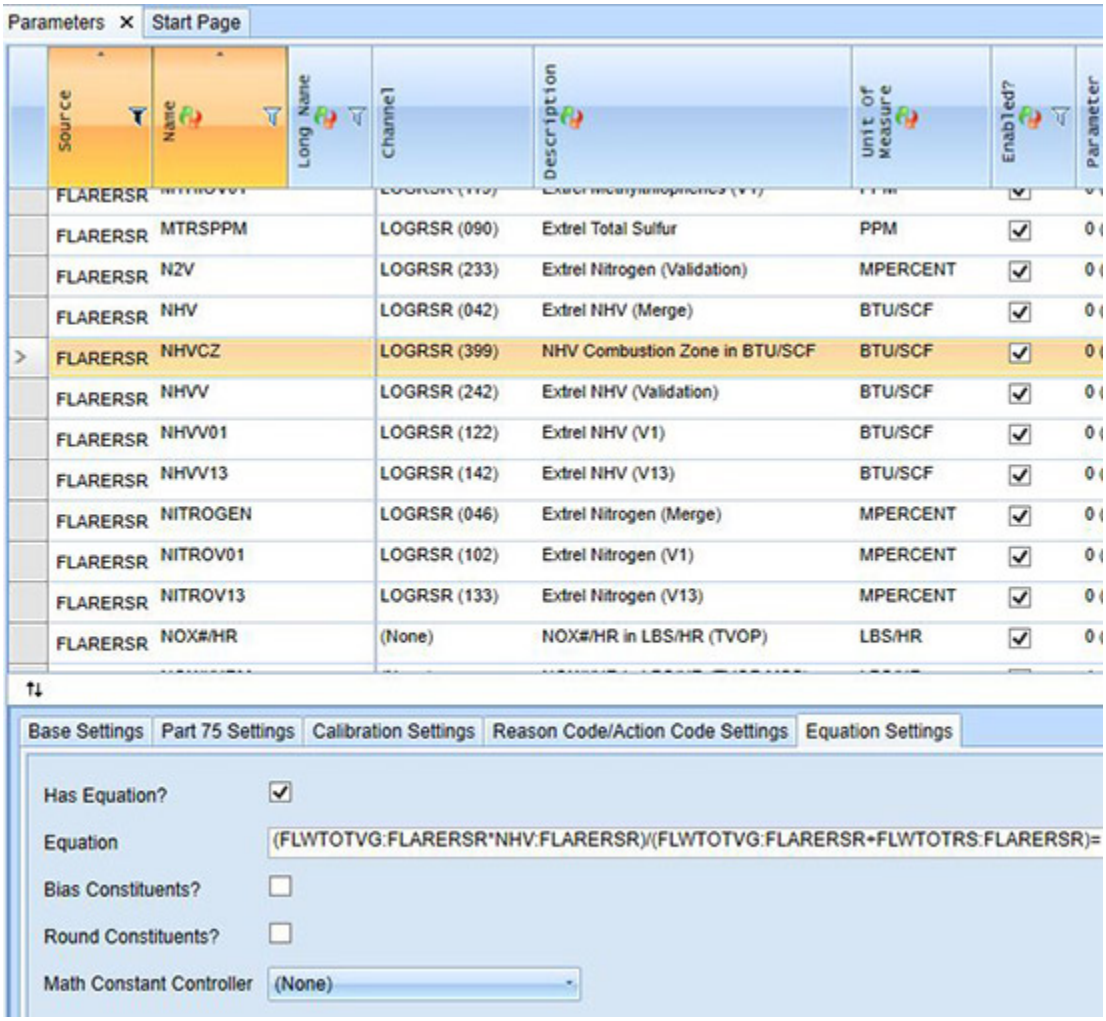

Figure 3. StackVision setup and calculation configurability.

Monitoring Managed Efficiently

The DCS, historian and spreadsheet methods are not designed for the compliance side of the operational equation. Refineries can no longer just measure operational efficiencies: they must also consider and abide by the operational requirements and reporting set forth by the RSR. Historians compress data and give representations, but not the actual discreet points that are now required. Some historians and DAS systems currently in use are not capable of storing minute level data for the extended time periods now required.

ESC Spectrum has developed the StackVision™ DAS to bridge the RSR compliance gap. This technology is configured for a refinery's exact system. The configuration feature of StackVision enables the refinery to maintain and manage its own system. It allows the end-user the ability to take control of their program and the data collected without relying on the vendor, therefore enabling accurate reporting.

This solution can exclude invalid data in real-time as it is acquired. StackVision also captures or determines status codes and provides a complete chain of all calculations, data handling and

reduction. With the ability to run hands-off automated calibration checks, technician safety is also addressed.

Conclusion

The EPA's RSR requires a complex process of active monitoring, immediate response, and detailed reporting to maintain environmental compliance. It is recognized that many US refineries have received extensions on the 30 January 2019 compliance date and are still in the implementation process of DAS used for RSR compliance; this includes many refineries who have previously and currently chosen to use the DCS, historian, spreadsheets process to manually capture, calculate, and report environmental emissions.

RSR has initiated a new level of scrutiny placed on data and the refinery itself. With the usage and transparency of RSR data to local state agencies and other environmental compliance organizations, the need for accuracy is at an all-time high. Unfortunately, the popularly implemented spreadsheet process lends itself to issues including human error and the additional time and resources needed to analyze data to execute the various state and federal reports.

Refineries are coming to realize they are unable to provide the necessary level of traceability, which is crucial during audits with state or federal regulators. Implementing a DAS can make quality assured data available for immediate response as well as for later reporting. DASs are purpose-built to collect, quality assure and manage data. With similar RSR-like regulations expected to be extended by the EPA to other industries including petrochemical, monitoring data will soon become mandated for compliance and reporting and no longer just used to monitor and increase operational efficiency. Regulatory drivers are increasing the amount of big data necessary to operate within the realm of compliance and the use of current DCS, historian, spreadsheet processes must be evaluated.