Sage ATC Environmental Consulting

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Refinery Sector Rule Focus on Flare Combustion Control Parameters

IPEC Conference
New Orleans, LA
November 2016

Discussion Overview

- Rule History Overview
- Combustion Zone Parameters
- Rapid Release Scenario
- Slow Release Scenario
- Water Seal Release Scenario

Rule History Overview

- The Federal requirements were found in
  - the New Source Performance Standards (NSPS) Subpart A at 40 CFR §60.18 and in
  - the National Emission Standards for Hazardous Air Pollutants (NESHAPs) Subpart A at 40 CFR §63.11.
- These regulations contained similar requirements for proper flare operation and were utilized by refineries as a means to show that a 98% destruction removal efficiency (DRE) was achieved.

Rule History Overview

- On June 30, 2014, the USEPA published the proposed Petroleum Refinery Sector Rule (RSR) which included changes to 40 CFR 63 Subpart CC (Refinery MACT 1) and Subpart UUU (Refinery MACT 2).
- Changes to the regulations included the requirement for affected units that utilized flares as control devices must meet certain operating criteria in order to demonstrate 98% DRE.
- The changes proposed were modified and finalized in the rule published on December 1, 2015. The requirements that a flare must meet were included in 40 CFR 63 Subpart CC (MACT CC) in sections §63.670 and §63.671.

Old vs. New

- No visible emissions (5 minutes in 2 hours)
- Flame present at all times
- Meet heat content requirements for vent gas (variable)
- Operate below the exit velocity requirements (variable)

60.18 and 63.11

- No visible emissions (5 minutes in 2 hours) when below its smokeless capacity
- Pilot flame present at all times regulated material sent to the flare
- Meet combustion zone operating limits
- Operate below the exit velocity limits when regulated material is sent to the flare.

MACT CC

Old vs. New

- If a refinery flare is meeting the flare requirements as provided in MACT CC, the flare does not need to meet the requirements in §60.18 or §63.11.

- However, if the flare operates in a State with its own specific flare operating requirements, the flare will be required to continue to comply with those requirements as well.

Combustion Zone Parameters

- Direct Method

$$NHV_{cz} = \frac{Q_{vg} * NHV_{vg}}{(Q_{vg} + Q_s + Q_{a,premix})}$$

Where:

NHV_{cz} = Net heating value of combustion zone gas, Btu/scf.

NHV_{vg} = Net heating value of flare vent gas for the 15-minute block period, Btu/scf.

Q_{vg} = Cumulative volumetric flow of flare vent gas during the 15-minute block period, scf.

Q_s = Cumulative volumetric flow of total steam during the 15-minute block period, scf.

$Q_{a,premix}$ = Cumulative volumetric flow of premix assist air during the 15-minute block period, scf.

Combustion Zone Parameters

- Feed Forward Method

$$NHV_{cz} = \frac{(Q_{vg} - Q_{NG2} + Q_{NG1}) * NHV_{vg} + (Q_{NG2} - Q_{NG1}) * NHV_{NG}}{(Q_{vg} + Q_s + Q_{a,premix})}$$

Where:

NHV_{cz} = Net heating value of combustion zone gas, British thermal unit (Btu)/ standard cubic feet (scf).

NHV_{vg} = Net heating value of flare vent gas for the 15-minute block period, Btu/scf.

Q_{vg} = Cumulative volumetric flow of flare vent gas during the 15-minute block period, scf.

Q_{NG2} = Cumulative vol. flow of supplemental natural gas to the flare during the 15-min. block period, scf.

Q_{NG1} = Cumulative vol. flow of supplemental natural gas to the flare during the previous 15-minute block period, scf. For the first 15-minute block period of an event, use the vol. flow value for the current 15-minute block period, *i.e.,* $Q_{NG1}=Q_{NG2}$.

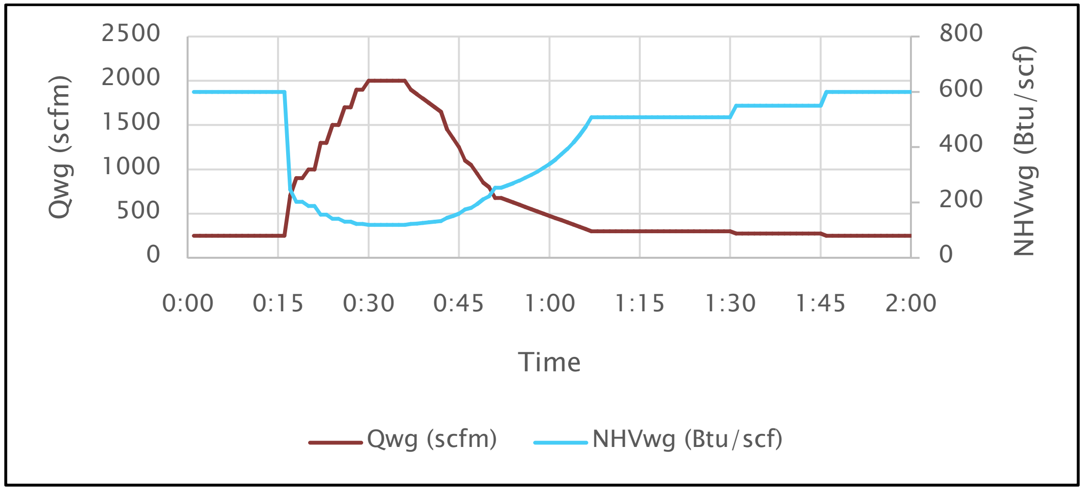
NHV_{NG} = Net heating value of supplemental natural gas to the flare for the 15-minute block period determined according to the requirements in paragraph (j)(5) of this section, Btu/scf.

Q_s = Cumulative volumetric flow of total steam during the 15-minute block period, scf.

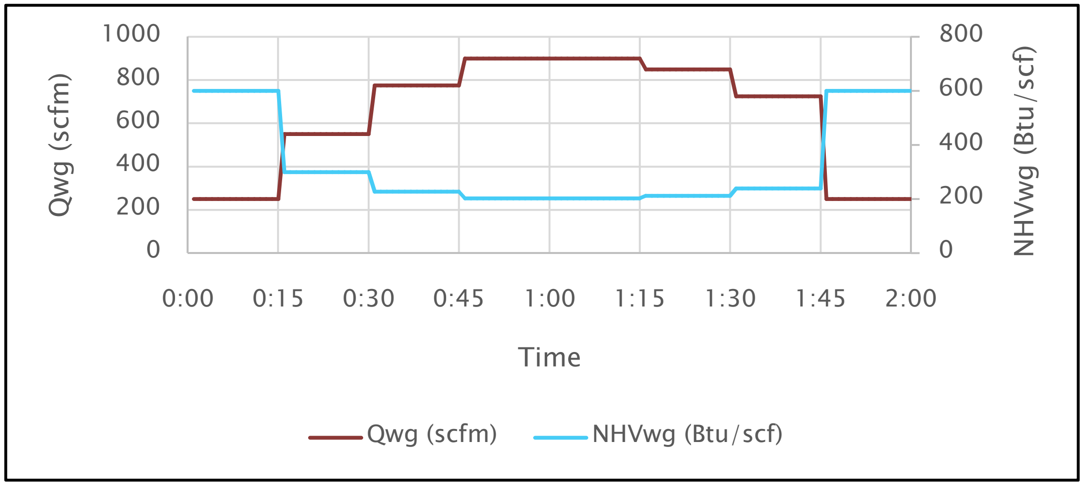
$Q_{a,premix}$ = Cumulative volumetric flow of premix assist air during the 15-minute block period, scf.

Scenarios

- Rapid Scenario

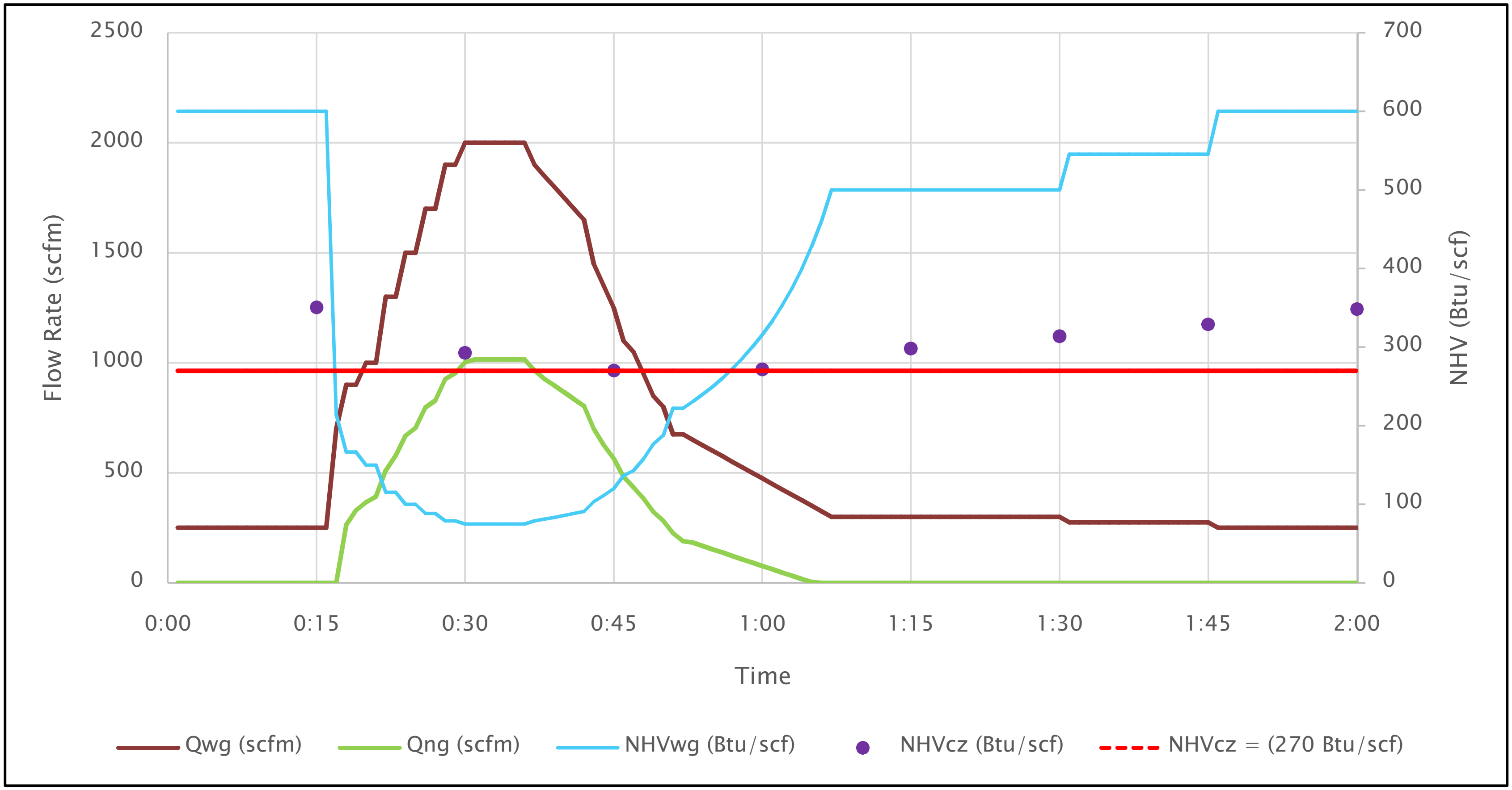


- Slow Scenario



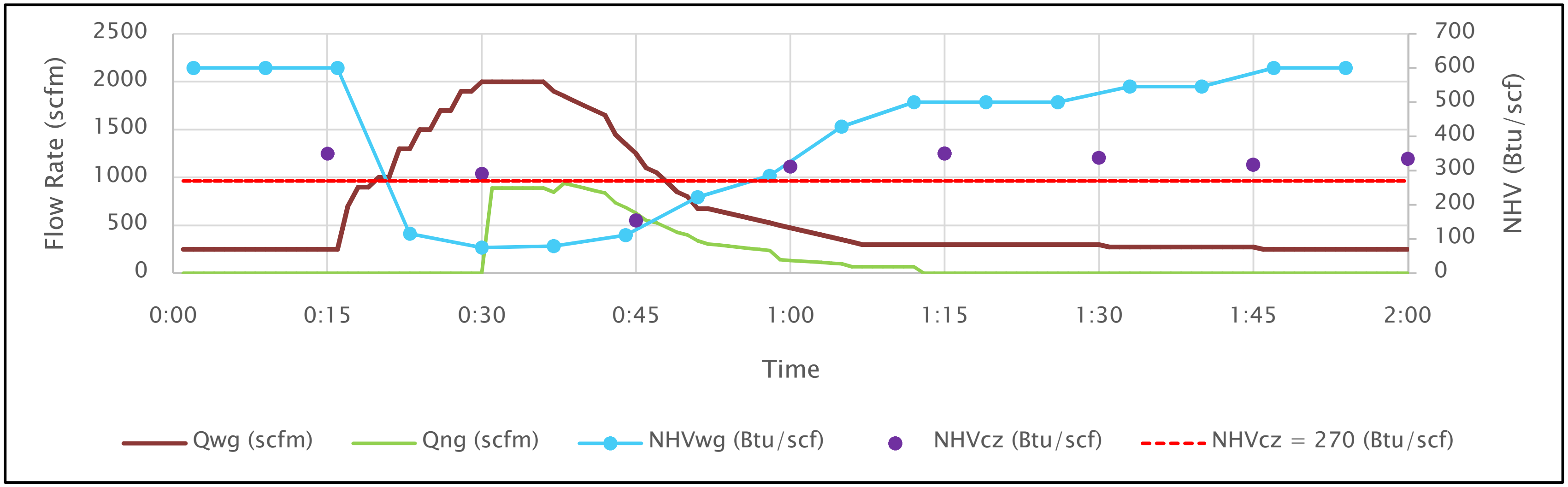
48,000 scf @ 50 Btu/scf

Rapid – Direct – 1 Minute



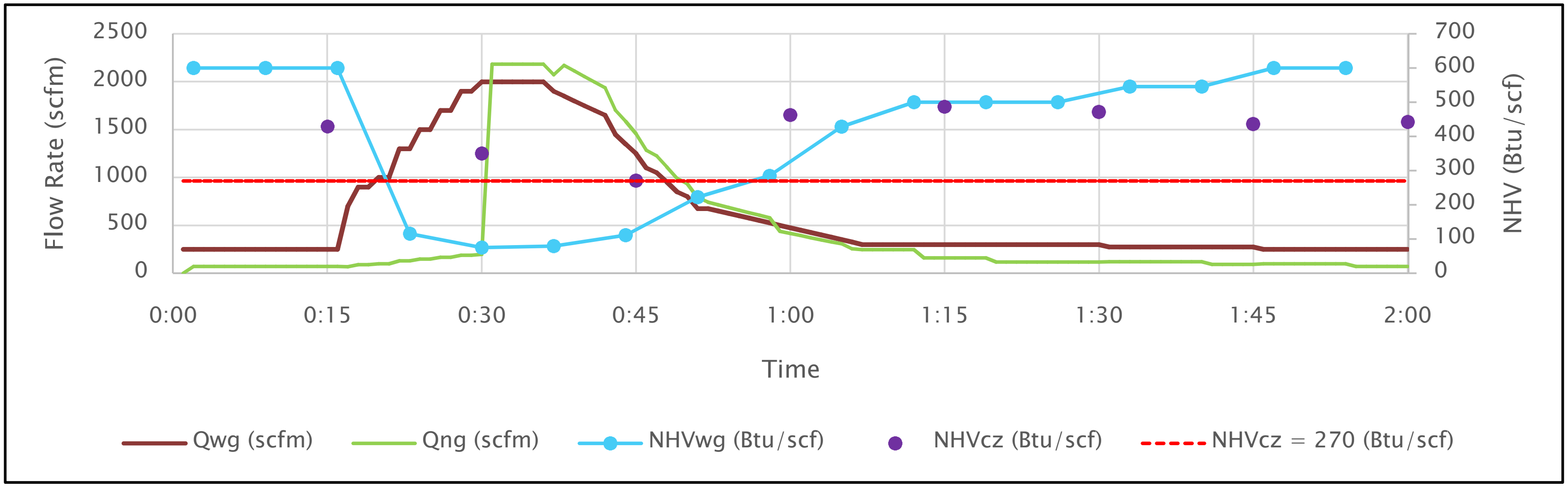
Rapid – Direct – 7 Minute

270 Btu/scf



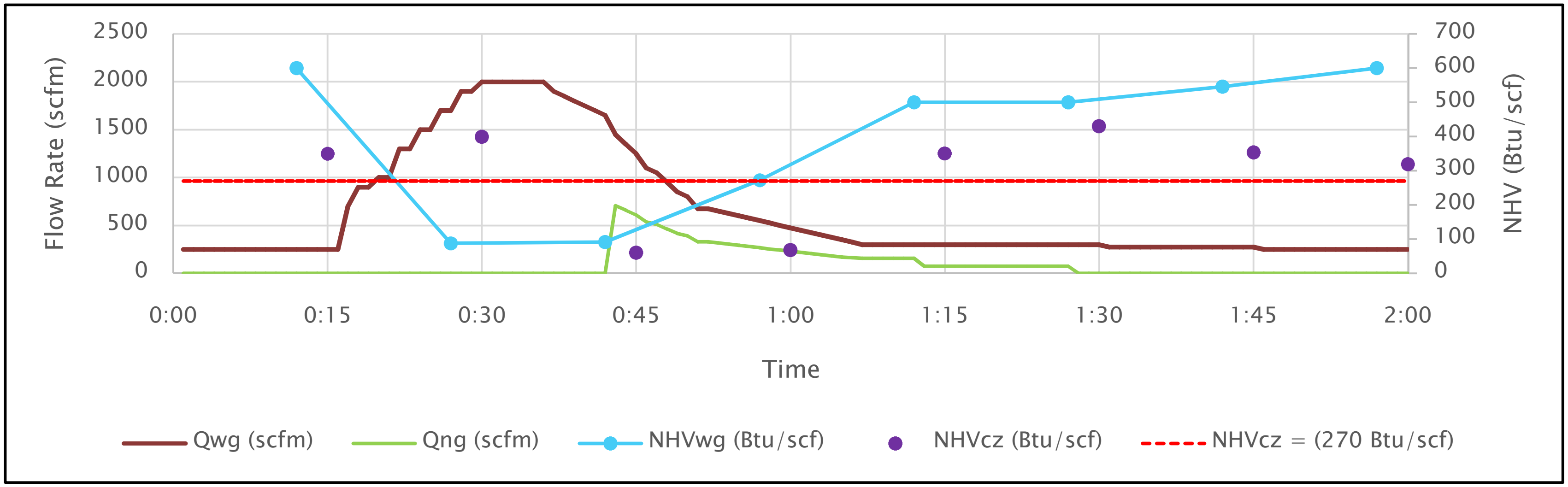
vs.

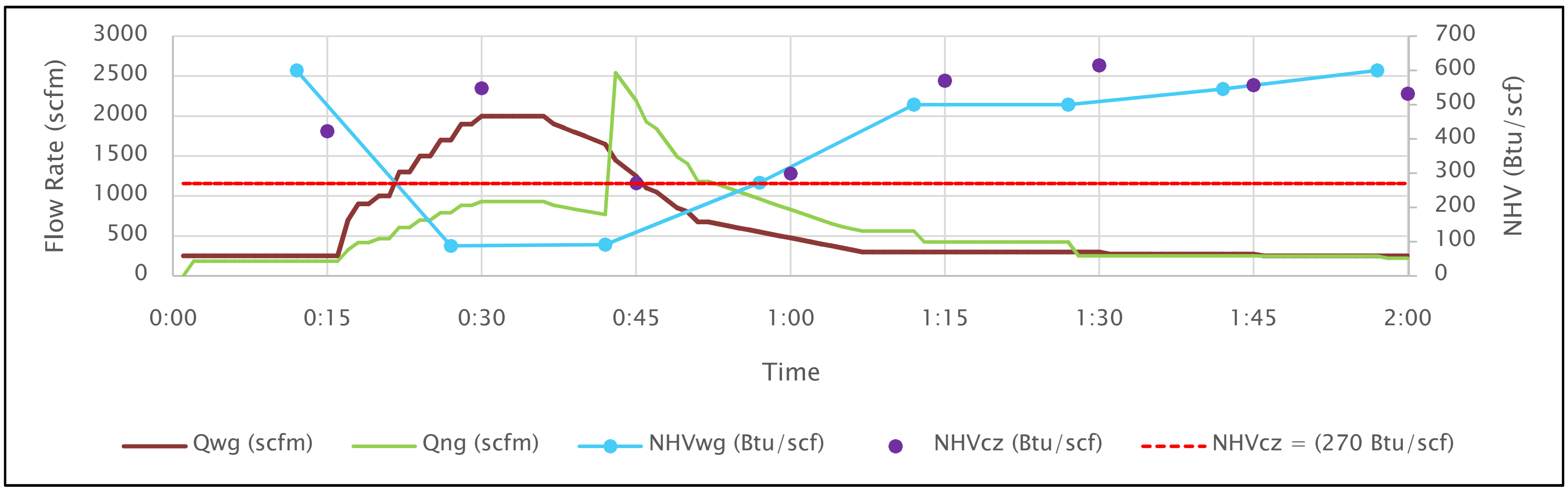
432 Btu/scf



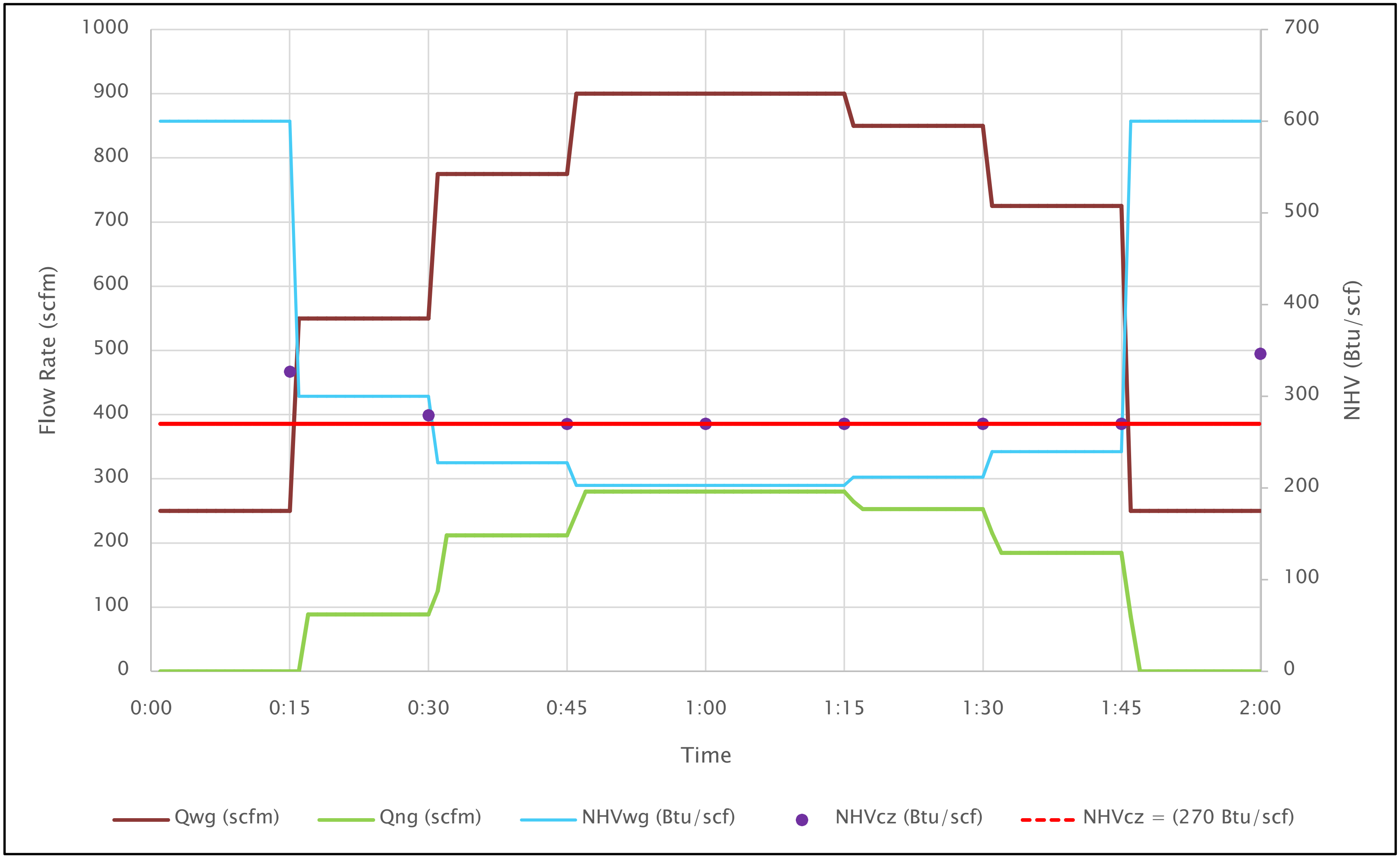
Rapid – Direct – 15 Minute

270 Btu/scf vs. 523 Btu/scf



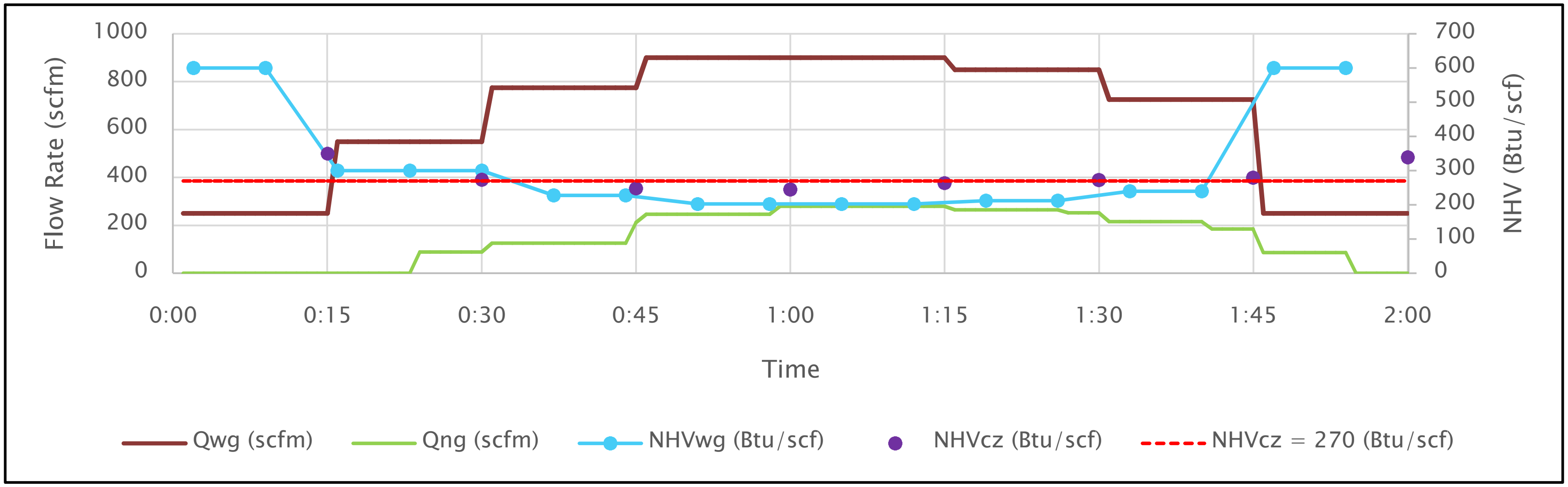


Slow – Direct – 1 Minute

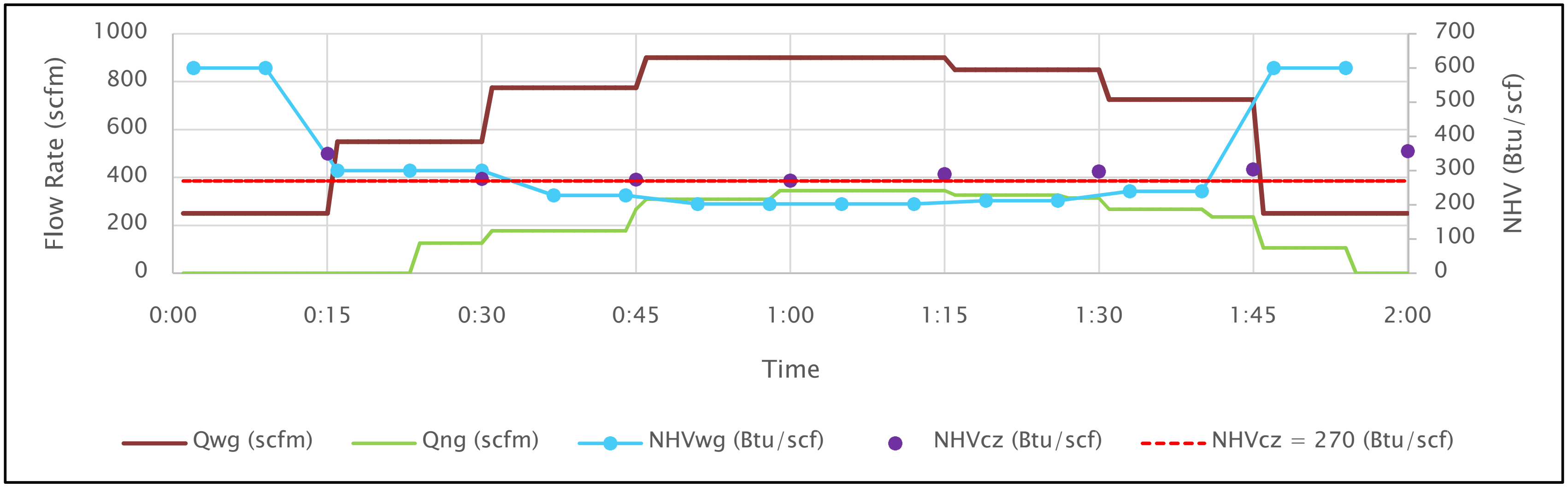


Slow – Direct – 7 Minute

270 Btu/scf vs.

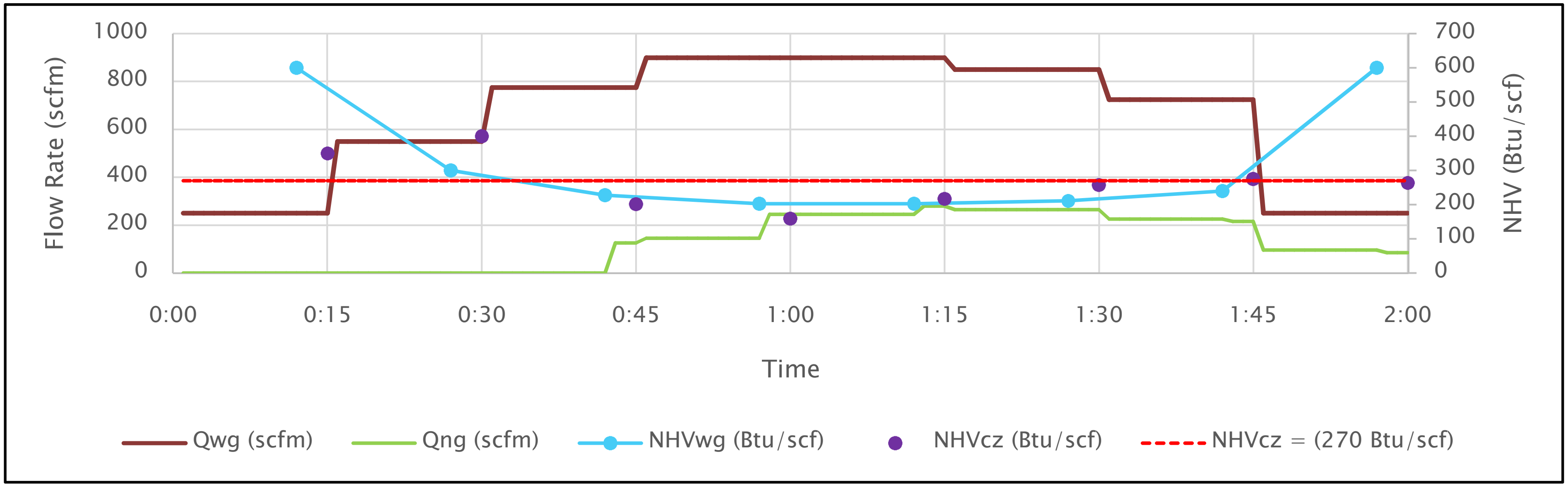


295 Btu/scf



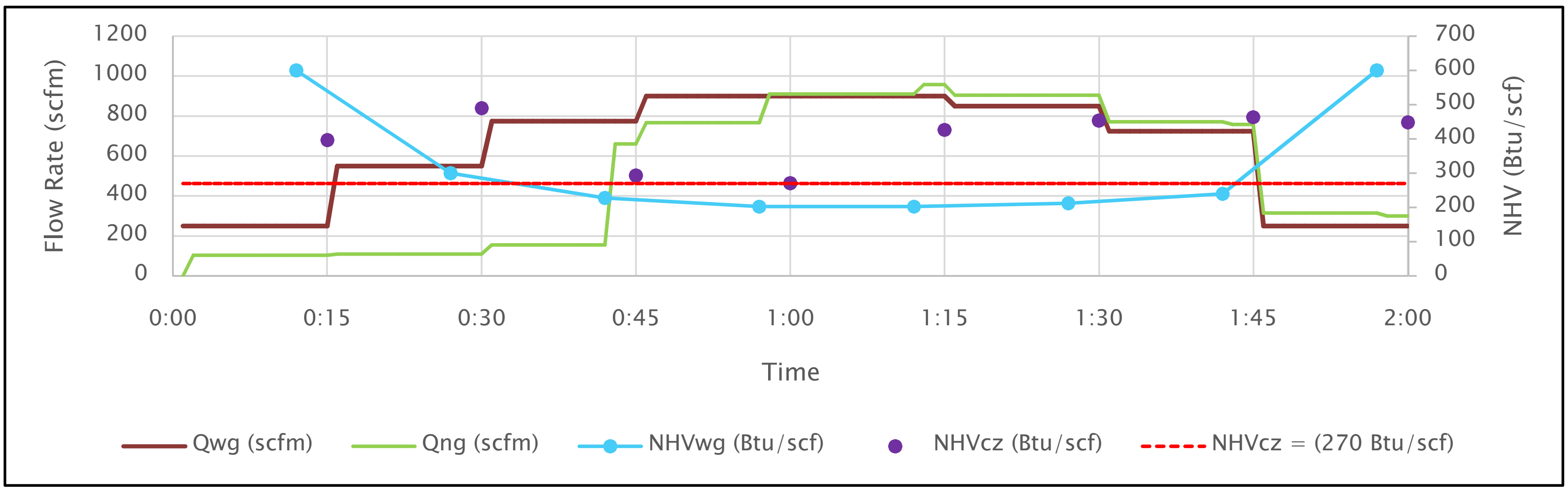
Slow – Direct – 15 Minute

270 Btu/scf



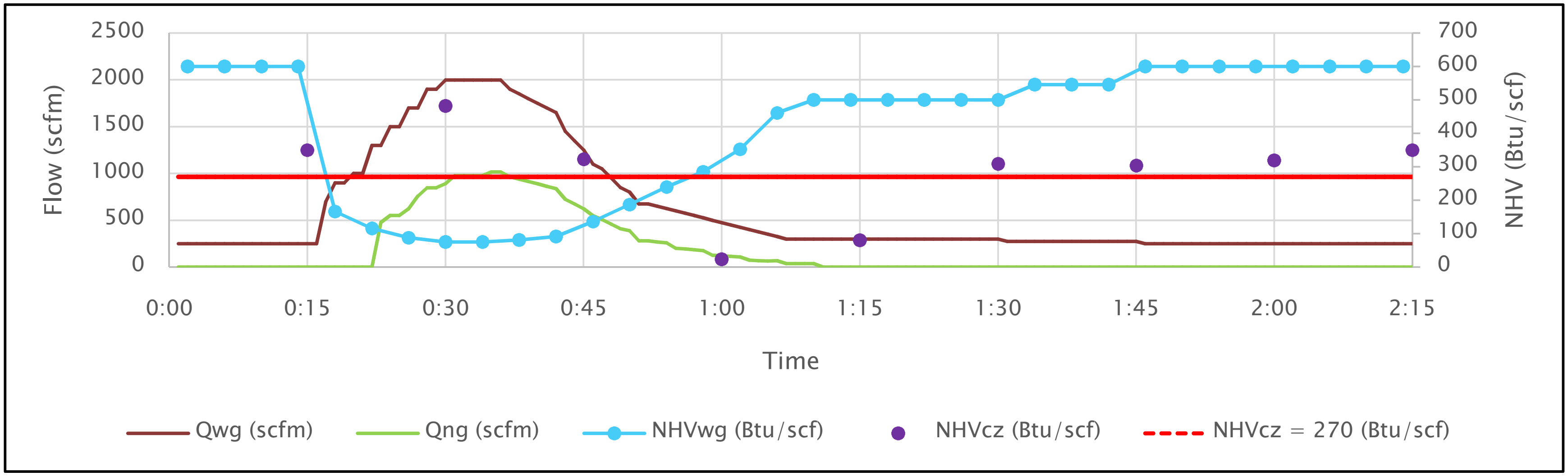
vs.

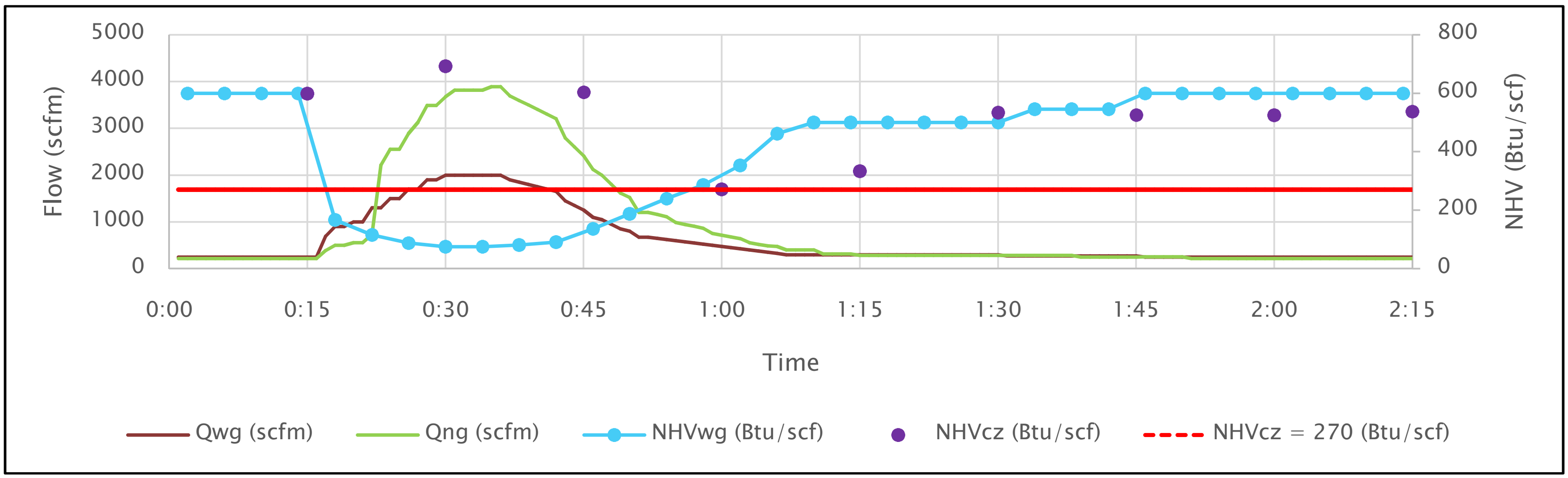
461 Btu/scf



Rapid – Feed Forward – 4 Minute

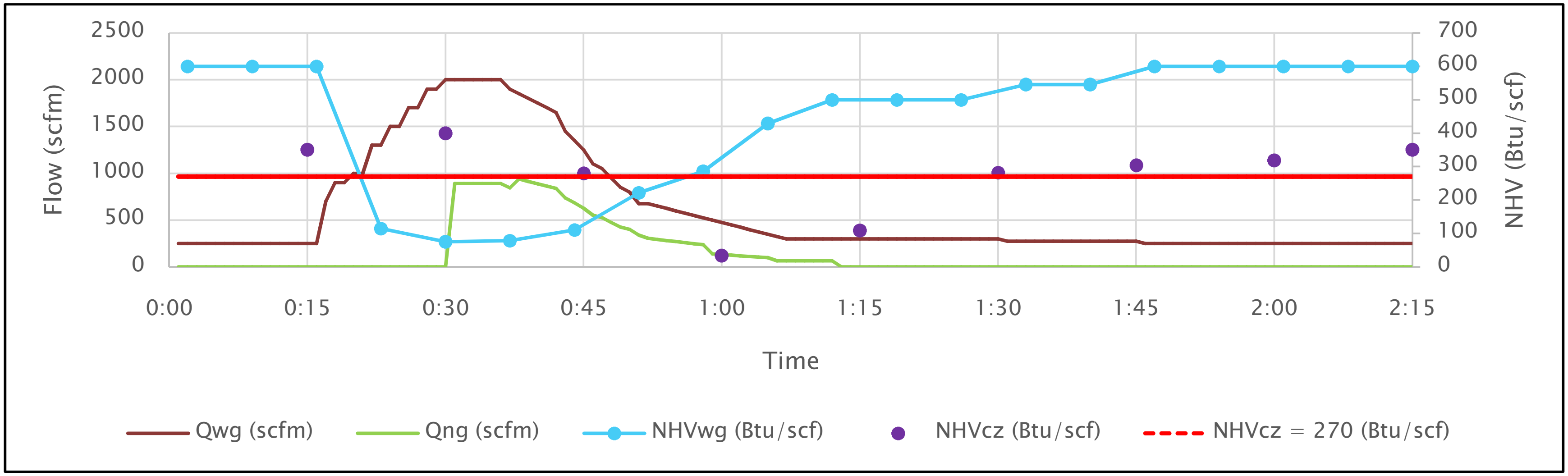
270 Btu/scf vs. 541 Btu/scf



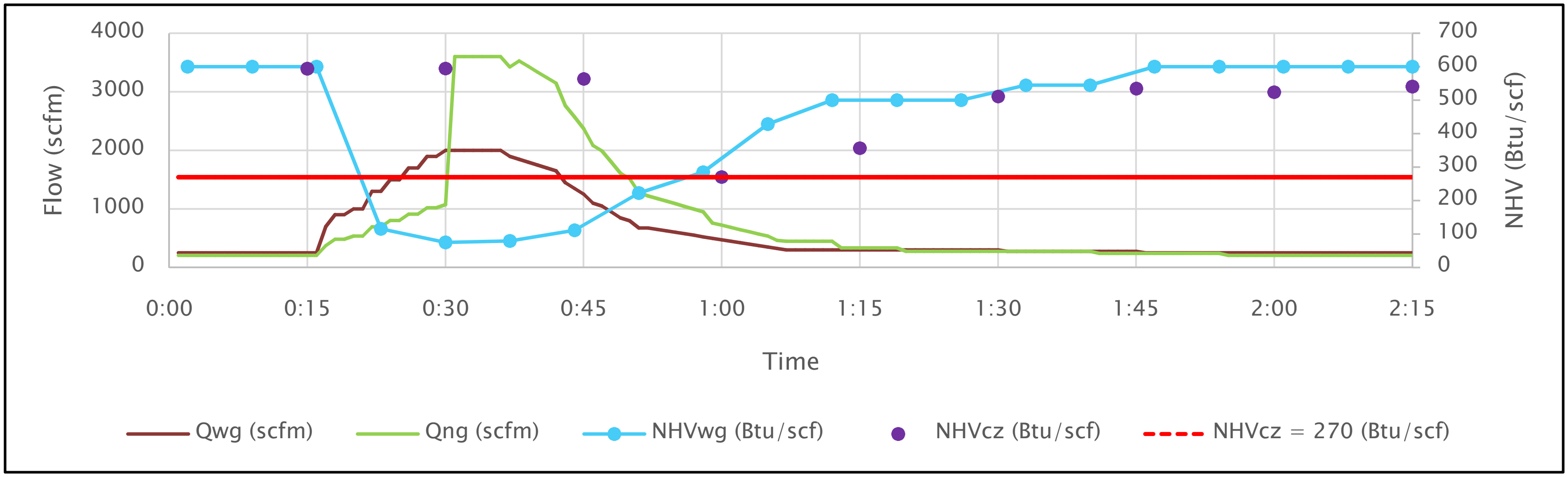


Rapid – Feed Forward – 7 Minute

270 Btu/scf vs.



537 Btu/scf

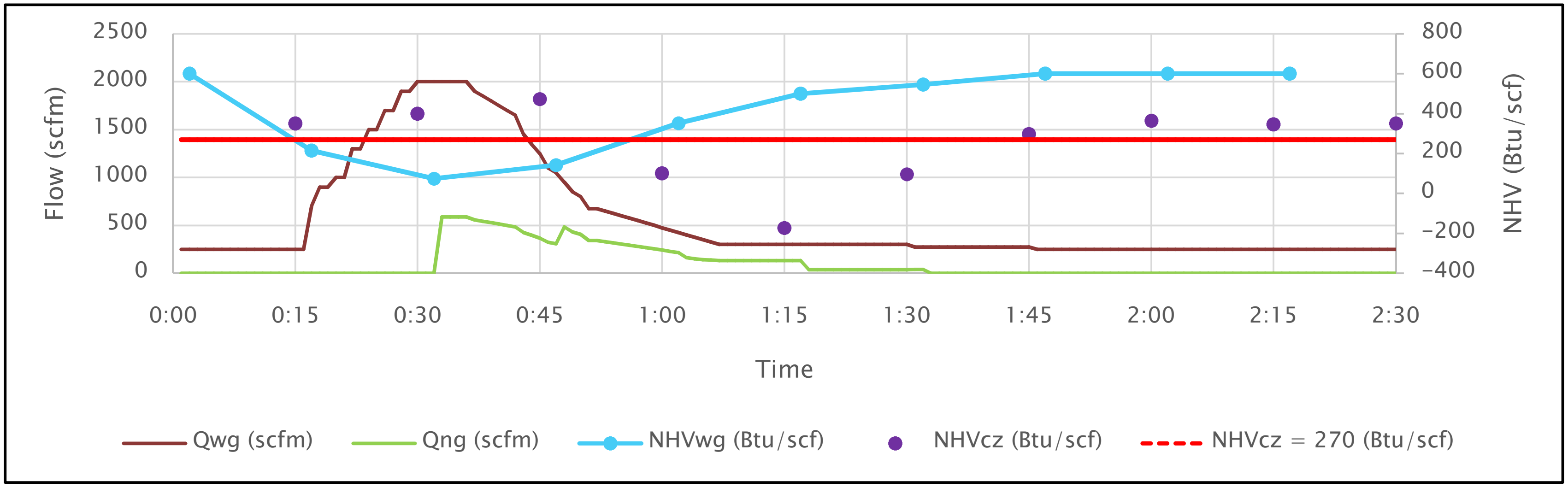


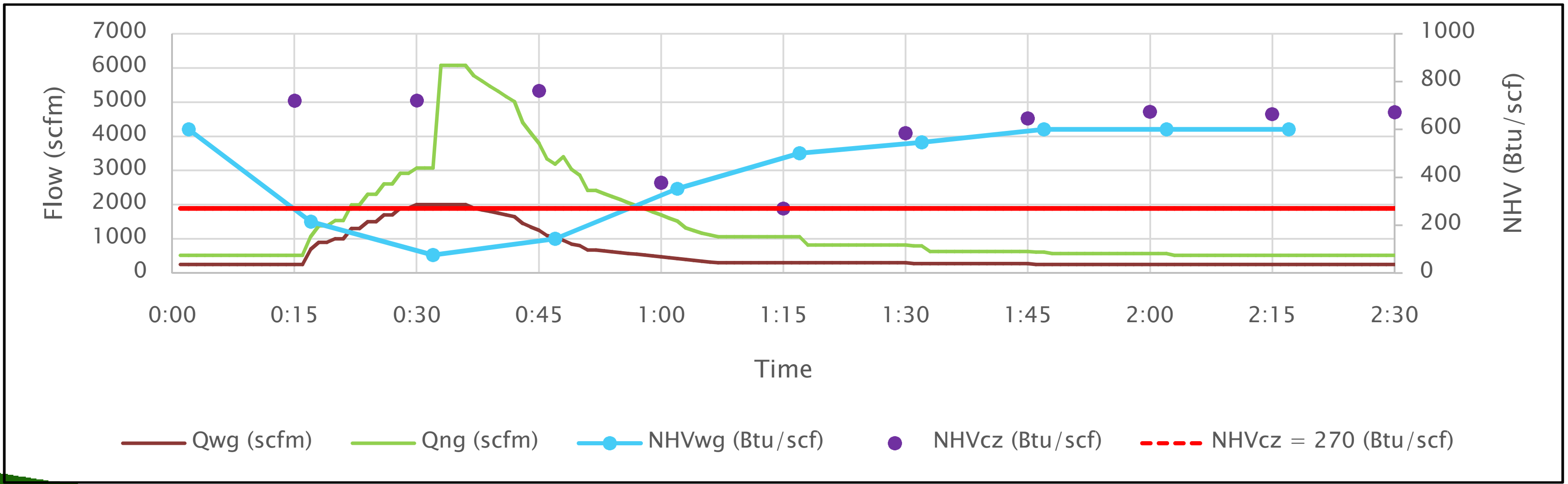
Rapid – Feed Forward – 15 Minute

270 Btu/scf

vs.

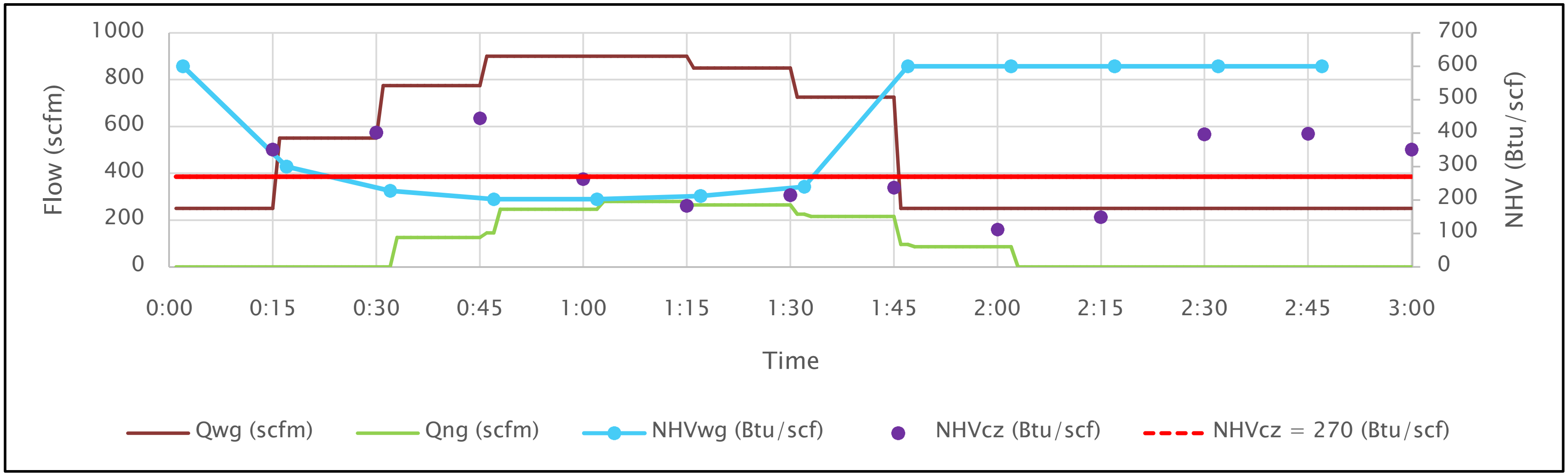
663 Btu/scf

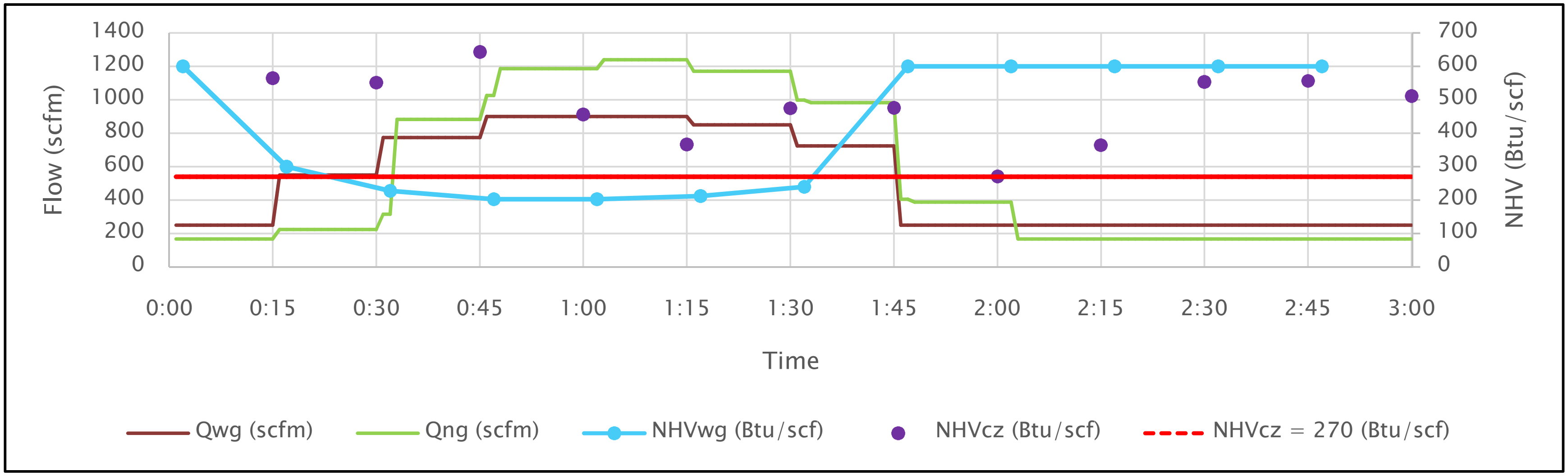




Slow – Feed Forward – 15 Minute

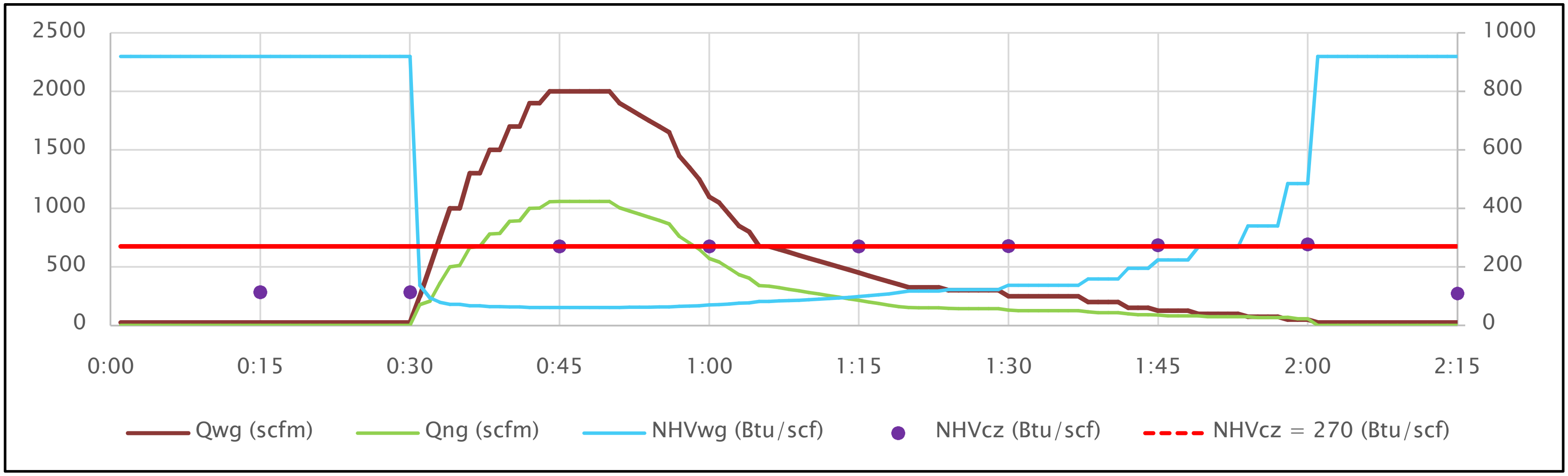
270 Btu/scf vs. 511 Btu/scf





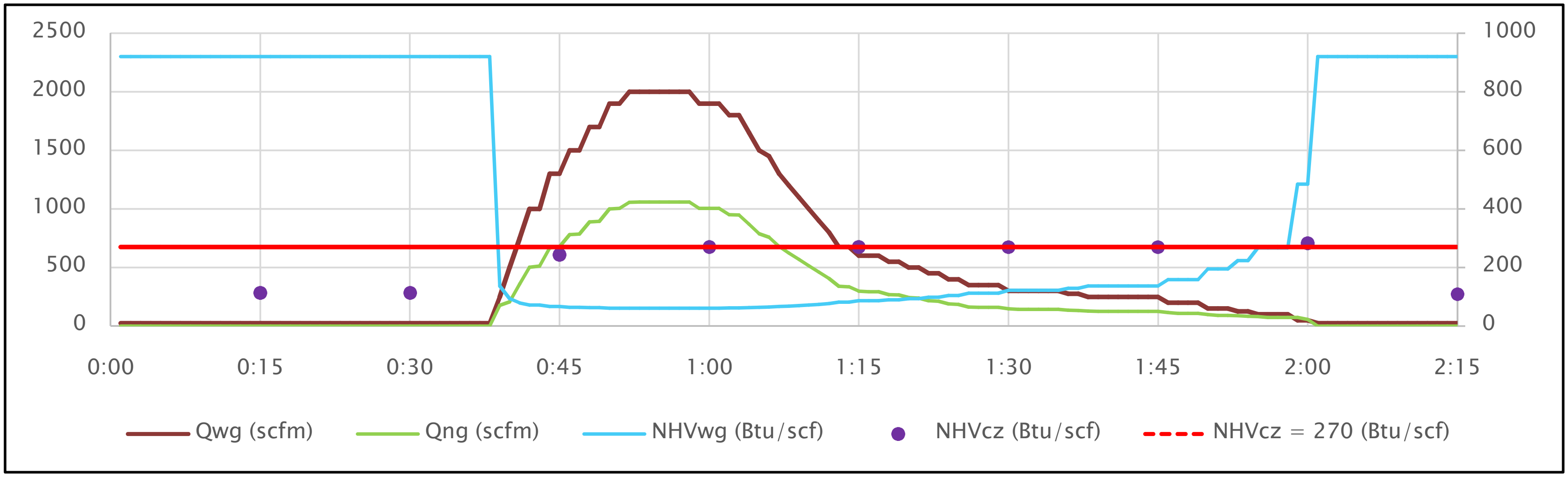
Water Seal – Direct – 1 Minute

Early in Block



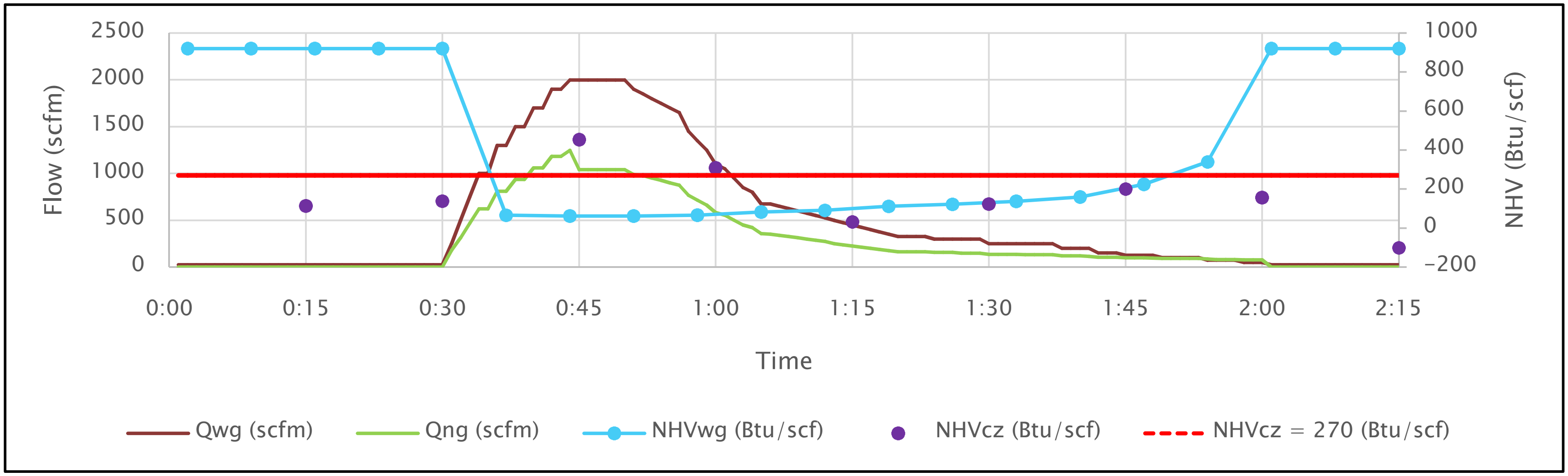
vs.

Late in Block

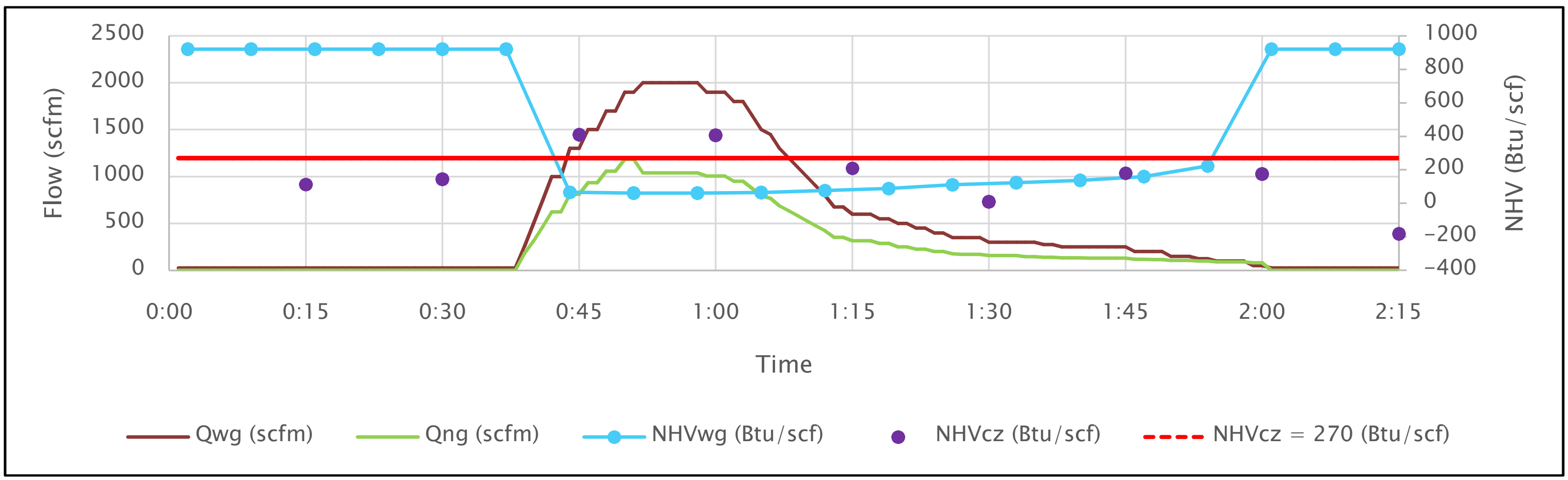


Water Seal – Feed Forward – 7 Minute

Early in Block vs.



Late in Block



Conclusions – Direct Method

- The direct method was able to remain in compliance for the scenarios used for all the 15-minute blocks in the scenario.

- As the analysis time increases, the number of 15-minute blocks that are out of compliance increases with a set point at the required NHVcz of 270 Btu/scf. The amount of supplemental fuel the system attempts to add decreases as the interval increases, leading to a conclusion that there is not enough data in order to add sufficient supplemental fuel. One possible solution to overcome these blocks of non-compliance is to increase the set point to add a "cushion" for the system to absorb the changes in flow and NHV. Again, as the analysis time increases, the set point needs to be increased in order to stay in compliance.

- Depending on the magnitude of the event (both in magnitude of flow and NHV of the waste gas) and the NHVcz that the continuous flare operates at under routine conditions, elevating the set point will cause supplemental fuel to be added at all times once that normal operation NHVcz is exceeded. This will cause the annual cost of supplemental fuel to greatly increase in importance.

Conclusions – Feed Forward Method

- Based on the scenarios utilized, using a set point for the NHV_{cz} of 270 Btu/scf resulted in 15-minute blocks that were out of compliance.
- As the analysis time increases, the number of 15-minute blocks that are out of compliance increases with a set point at the required NHV_{cz} of 270 Btu/scf. The amount of supplemental fuel the system attempts to add decreases as the interval increases, leading to a conclusion that there is not enough data in order to add sufficient supplemental fuel. One possible solution to overcome these blocks of non-compliance is to increase the set point to add a "cushion" for the system to absorb the changes in flow and NHV.
- For the rapid event, as the analysis time increases, the set point needs to be increased in order to stay in compliance. Conversely, for the slow event, the set point did not increase as the analysis time increased.
- For the scenarios simulated, for both the rapid and slow event, using the feed-forward method requires supplemental fuel to be added at all times.

Conclusions – Water Seal Scenario

- Based on the scenarios utilized, using a set point for the NHV_{cz} of 270 Btu/scf resulted in 15-minute blocks that were out of compliance, with the exception of the direct calculation method with a 1-minute analysis time.
- As the analysis time increases, the number of 15-minute blocks that are out of compliance increases with a set point at the required NHV_{cz} of 270 Btu/scf. The amount of supplemental fuel the system attempts to add decreases as the interval increases, leading to a conclusion that there is not enough data in order to add sufficient supplemental fuel.
- The feed-forward method resulted in a greater number of blocks out of compliance and required a larger amount of supplemental fuel to show compliance under the same scenario and with the same sample time as the direct method.

Questions?

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