Message

From: Zuniga, Mario [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=1A9939B0E013475D956F6D6564AAE48B-ZUNIGA, MAR]
Sent: 7/13/2020 7:48:18 PM
To: Daniel Dodd [ddodd@sierraenergy.com]
CC: Johan Van Walsem [jvanwalsem@sierraenergy.com]; Meredith Roberts [mroberts@sierraenergy.com]; Michael Kleist [mkleist@sierraenergy.com]
Subject: RE: Applicability Determination Questions

Daniel,
Thank you for the summary.
From the call, we understand that Sierra Energy use system feedback and controls to avoid combustion of the feedstock inside the FastOx Gasification system, so as to maximize syngas production.
As mentioned during the call, the current rules do not define combustion, gasification, pyrolysis, or oxidation. This can create problems when terms other than "gasification" are used to explain a gasification process as such terms can be interpreted to mean "combustion." Therefore, to concur a system is gasifying and not combusting feed, we need to have sufficient written information that clearly explains that combustion is prevented. We appreciate the additional information and clarification you have been providing.

For the record, during the call, it was agreed that the "Partial Oxidation Zone" is better characterized as the "Gasification Zone." This language is also included in the email you provided below. The change of terminology helps clarify that the purpose of the zone is further gasification of the bed material (or char in this zone), and not combustion. As such, going forward we will refer to the third zone of the FastOx Gasifier as the "Gasification Zone." Can you confirm we understand this correctly and that the zone is indeed a "Gasification Zone?" Please correct any misunderstanding in this paragraph.

Thank you.

Best regards,
Mario Abraham Zuñiga
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From: Daniel Dodd <ddodd@sierraenergy.com>
Sent: Friday, July 10, 2020 9:28 AM
To: Zuniga, Mario <zuniga.mario@epa.gov>
Cc: Johan Van Walsem <jvanwalsem@sierraenergy.com>; Meredith Roberts <mroberts@sierraenergy.com>; Michael Kleist <mkleist@sierraenergy.com>
Subject: RE: Applicability Determination Questions

Mario, thanks for setting-up the call with your team.

To confirm what was discussed during the call on Wednesday, see below a summary of the key operations:

- *The FastOx Gasifier*
  - The FastOx gasifier is designed to convert waste materials into a clean, high-energy content synthesis gas that can displace natural gas in producing sustainable energy products such as hydrogen, liquid fuels (diesel and jet fuels) and electricity.
  - The gasification reactions take place within a single, refractory-lined chamber, with no internal moving parts. The waste materials are fed into the vessel through an airlock at the top and form a packed-bed where the reactions occur. The height of this bed is maintained via the controls system to ensure that it stays within the acceptable range **Ex. 4 CBI** and that there is complete conversion and consumption of gasification agents, oxygen and steam.

- The zones are idealized graphically in marketing material, but the "Drying Zone", "Devolatilization Zone" (or "Pyrolysis Zone"), the main "Gasification Zone" and the "Melting Zone" exist in a continuum within the packed-bed of solid waste material, not in separate reactors as with other technologies. The syngas produced during gasification rises slowly through the bed, without fluidization, resulting in efficient countercurrent heating and drying. The bed material moves slowly downwards by gravity at a rate of approximately one inch per minute.
- Combustion of residual char requires a reaction 1-mol of carbon with a minimum of 1-mol of O2. In most incineration or even modern 2-stage combustion incinerators, there is far in excess of this amount of reactant injected. The amount varies from 150 to 400% of the minimum air required, leading to very high equivalence ratios (as their technologies are focused on the complete elimination of material, and simultaneously minimize the carbon monoxide exiting with the exhaust gases)
  - In contrast, the FastOx gasifier has a typical Equivalence Ratio, ER = (mol-O2 / mol-C) = ~0.50. An ER of 1.00 would be 100% production of CO2, while an ER of 0.50 would be 100% production of CO, an important syngas product for gasification technologies.
- The FHL FastOx gasification system has over 1,400 sensors monitoring process variables in real-time. The measurement of process temperatures and the FastOx Gasifier syngas composition (including two (2) analyzers for O2 concentration), are utilized by the process control system and operators to adjust for and maximize the syngas yield and syngas energy content. Any small increase in CO2 with a corresponding decrease in CO and H2 observed by the controls system triggers adjustments to key inputs such as oxygen to avoid deviating far from the 'optimum syngas generation operating setpoints'. Deviations are mitigated well before reaching anything close to combustion conditions (ER = 1.00).

- *The FastOx Polisher*
  - The FastOx Polisher is a unit operation that employs non-catalytic thermal cracking and steam reforming, controlled by steam and oxygen injection.
  - The FastOx Polisher converts any trace amounts of condensable hydrocarbons (waxes, aromatics etc.) and organic solids into additional non-condensable, syngas products. This unit operation increases the availability/uptime of the system (as it minimizes the potential for blockage due to condensation of hydrocarbons in piping), and also maximizes the syngas yield, particularly CO and H2 content, thus increasing overall system efficiency.

V/R,
DMD

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From: Zuniga, Mario <zuniga.mario@epa.gov>
Sent: Tuesday, June 30, 2020 5:10 PM
To: Daniel Dodd <ddodd@sierraenergy.com>
Subject: RE: Applicability Determination Questions

Hi Daniel,
Thank you again for the call last week and for the additional information you provided in the email below. Our Office of Air Quality Planning and Standards staff is interested in having a call to discuss a few technical things with you. Since we have a large team working on the applicability determination, it may be difficult to schedule a call with everyone. I wanted to check with you to see if you will be available on Wednesday July 8th at 12PM PST for a call with us. If that does not work, we have a less desirable time of Thursday at 1PM PST (not all our team would be able to join).

FYI, although the call will focus on technical aspects of the applicability determination, one of our attorneys from Region 9 (from the Office of Regional Counsel) will most likely be in the call to become more familiar with the process. I don't expect him to ask legal questions but wanted to give you the heads up.

Other EPA staff potentially to be in the call include:
HQ – Office of Enforcement and Compliance Assurance
HQ – Office of Land and Emergency Management (not likely to join)
R9 – Enforcement and Compliance Assurance Division
R9 – Air and Radiation Division

Please let me know if the times proposed above work for you and your team.

Best regards,

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From: Daniel Dodd <ddodd@sierraenergy.com>
Sent: Thursday, June 25, 2020 11:27 PM
To: Zuniga, Mario <zuniga.mario@epa.gov>
Cc: Dancher, Nathan <Dancher.Nathan@epa.gov>; Batchelder, Amber <Batchelder.Amber@epa.gov>; Yannayon, Laura <Yannayon.Laura@epa.gov>; MGiraudo@mbard.org; Johan Van Walsem <jvanwalsem@sierraenergy.com>; Meredith Roberts <mroberts@sierraenergy.com>
Subject: RE: Applicability Determination Questions

Mario, thanks for your time earlier to discuss, as requested, here are those main points/notes. See attached the Memo SE/MBARD had sent over in August 2019 too that I was referring to.

1) We would like to clarify if the formal NSPS Subpart EEEE Applicability Determination request is specifically for the FastOx Gasification Biorefinery at Fort Hunter Ligget (which includes the demonstration equipment), and not the FastOx Gasification process/technology in general. Our intent is to review the site-specific information you have provided and respond to the site-specific request. We intend to respond to the request specifically for the FHL FastOx Gasification Biorefinery system that operates continuously (as explained in your email below) with a waste input capacity of 10 metric tonnes per day. If the gasification process changes at FHL such that it no longer meets the description in the current applicability determination, a new applicability determination will be required.
   << Indeed, this Applicability Determination can be limited/focused on the FastOx system/plant deployed at FHL if it helps limit the scope of what's being requested. In addition to the system being mechanically-constrained, SE are also limited by our Air and Waste permits to only be able to convert a maximum of 10 tonnes per day of solid feed materials, year-round. SE are NOT going to 'ramp-up' the operations beyond these physical and permit limits we already have in place.

2) Do you have a schematic of the partial oxidation zone readily available? We would like to clarify whether the partial oxidation zone is a combination of two zones (i.e. 1. oxidation of char and 2. gasification of the waste bed). More information on this would be helpful, if you have it readily available. If you do not have a schematic or more information readily available, we can move forward with what you have provided so far.

<< As explained, all of the lower gasifier's core reactions (partial oxidation of char and auxiliary fuel, as well as the other 'gasification reactions') all take place within Ex. 4 CBI there aren't separate physical reaction zones (or reaction vessels for that matter) where these are occurring. This can be compared to other multi-stage/multi-chamber gasification technologies (such as fluidized-bed gasifiers that may have a separate reactor downstream of the main gasifier, where char that's adhered to the fluidizing media (typically an olivine or sand) is 'burnt' off (with air or oxygen that's injected), heating the fluidizing and heat-transfer media before being returned back to the main gasifier vessel and an exhaust stream from this char combustion is vented to atmosphere). SE's FastOx process has a different reaction set and physical configuration, and has no such separate char combustion chamber and/or exhaust flue/stack.

Again, we're happy to make some time available to discuss with your team or the folks in DC if further clarifications are required beyond what's been provided to-date.

V/R,
DMD

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From: Zuniga, Mario <zuniga.mario@epa.gov>
Sent: Wednesday, June 24, 2020 2:08 PM
To: Daniel Dodd <ddodd@sierraenergy.com>
Cc: Dancher, Nathan <Dancher.Nathan@epa.gov>; Batchelder, Amber <Batchelder.Amber@epa.gov>; Yannayon, Laura <Yannayon.Laura@epa.gov>; MGiraudo@mbard.org; Johan Van Walsem <jvanwalsem@sierraenergy.com>; Meredith Roberts <mroberts@sierraenergy.com>
Subject: RE: Applicability Determination Questions

Hi Daniel,
I've called a few times these past days to quickly discuss a few things over the phone. Im emailing you to follow up on the voicemail I left you yesterday. We would like to respond to your request by early July and believe a quick phone call is sufficient to address two things:

1) We would like to clarify if the formal NSPS Subpart EEEE Applicability Determination request is specifically for the FastOx Gasification Biorefinery at Fort Hunter Ligget (which includes the demonstration equipment), and not the FastOx Gasification process/technology in general. Our intent is to review the site-specific information you have provided and respond to the site-specific request. We intend to respond to the request specifically for the FHL FastOx Gasification Biorefinery system that operates continuously (as explained in your email below) with a waste input capacity of 10 metric tonnes per day. If the gasification process changes at FHL such that it no longer meets the description in the current applicability determination, a new applicability determination will be required.
2) Do you have a schematic of the partial oxidation zone readily available? We would like to clarify whether the partial oxidation zone is a combination of two zones (i.e. 1. oxidation of char and 2. gasification of the waste bed). More information on this would be helpful, if you have it readily available. If you do not have a schematic or more information readily available, we can move forward with what you have provided so far.

Unfortunately, our phone system at our San Francisco office is currently down. Please feel free to give me a call at your earliest convenience to the phone number I provided in yesterday's voicemail. You may also email me when available so I may call you. I work from 8:30 am to 5:30 pm from Monday to Friday.

Thank you,

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From: Daniel Dodd <ddodd@sierraenergy.com>
Sent: Thursday, June 18, 2020 9:43 PM
To: Zuniga, Mario <zuniga.mario@epa.gov>
Cc: Dancher, Nathan <Dancher.Nathan@epa.gov>; Batchelder, Amber <Batchelder.Amber@epa.gov>; Yannayon, Laura <Yannayon.Laura@epa.gov>; MGiraudo@mbard.org; Johan Van Walsem <jvanwalsem@sierraenergy.com>; Meredith Roberts <mroberts@sierraenergy.com>
Subject: RE: Applicability Determination Questions

Mario, see responses in blue below:-

1) Clarify Purpose of Pilot Demonstration
   a. Is Sierra Energy requesting an applicability determination for a pilot demonstration FastOx Gasification Biorefinery (FastOx Gasifier) that will be converted into a full-time operation?
      << SE: The FastOx Gasification Biorefinery system at Fort Hunter Liggett (FHL), is a demonstration project at a commercially relevant scale, with multiple stakeholders and test and validation goals. Historically, it has been operated in short, 2-week campaigns, up to six (6) campaigns per year. In the future, SE will be increasing the team/staff size and driving it towards more-continuous operations to further define technology, engineering and key economic metrics in support of future commercial projects. The FHL demonstration plant is currently self-funded by Sierra Energy and it is not operated for commercial profit. The plant has sufficient capacity and end-to-end integration to generate data that is fully relevant to future commercial projects with 3rd parties.
   b. Is the applicability determination for a pilot demonstration that is not expected to be modified/ramped-up?
      << SE: See above. We will be increasing the system uptime/hours of continuous operation, but do not foresee increasing the system's 10 metric tonne per day capacity. SE may add redundant small equipment items (such as pumps, blowers etc.) to facilitate increasing the system 'uptime', and SE may consider producing other 'end-products' (such as hydrogen, methanol, ammonia) from the syngas for demonstration, validation and optimization purposes only, not for commercial revenue.
   c. If the FastOx Gasifier will be converted from a pilot demonstration to a full-time operation, how will the process change?
      << SE: As described previously, this project is not a commercial operation. While SE will be driving the uptime/availability of the system upward (to assist with long-term data capture and future system sales), it will not be converted into a commercial 'for-profit' plant.

2) Origin of waste fed to FastOx Gasifier
   a. Is all the wasted used in the FastOx Gasifier generated at the Fort Hunter Liggett (and is therefore "institutional waste" (IW))?
      << SE: The system at FHL will be receiving and converting waste materials both generated by/on FHL, and also waste materials generated offsite. The system may also receive and convert non-waste

products-of-commerce (for example clean paper products, clean plastics) for certain test, validation and optimization campaigns.

b. Does the FastOx Gasifier also take in Municipal Solid Waste (MSW) from outside FHL? If so, what are the percentages of MSW and IW that are fed into the FastOx Gasifier?
<< SE: As mentioned above, indeed, materials (waste and non-waste) can be received from outside FHL. Depending on the goals of each specific testing campaign, there may be anywhere from 0 to 100% materials generated onsite at FHL being converted; the balance being materials generated offsite. Materials received from offsite must conform to all conditions of our solid waste facility permit exemption and comply with CA law. Offsite waste materials are processed by a 3rd party waste processor to recover recyclable materials and remove any hazardous materials that are not approved (which subsequently, would be sent to landfill) before being received at FHL. This allows SE to test a broader range of materials, including those from interested commercial partners to verify the technology performance on the actual material of interest for the commercial project.

3) Oxygen levels in reaction zones

a. Do the multigas analyzer and/or the paramagnetic analyzer measure O_2? Note 2 from your February 28, 2020 email says the combined syngas (from all zones) is sampled and analyzed as it exits the gasifier.
<< SE: Both the multigas analyzer* and the dedicated O2-only measurement analyzer (using paramagnetic measurement technology) do indeed continuously measure O2 concentrations from a slipstream of process gas that is removed continuously from the FastOx Gasifier outlet.

*(that contains an Electrochemical detector (ECD) for O2 measurement, as well as Thermal Conductivity Detector (TCD) for H2 measurement and Non-Dispersive Infrared (NDIR) sensors for CO, CO2, CH4 and C3H8 measurement)

b. The FastOx Gasifier uses a real-time control system. How often is the sampling and analysis completed? E.g. is it once every 15 minutes?
<< SE: The Rockwell Automation system has over 1,400 input-output measurements and parameters being monitored and/or controlled at rates up to 'once per second'.
The continuous gas analysis subsystem is reporting changes in gas composition every one (1) second. This subsystem has been designed to 'respond' to (observe) changes in gas composition in less than 30-seconds (from the process change, to it being registered by the gas analyzer (including delays in the gas sampling equipment and the instrument's own inherent 'response time'), to it being reported to the plant controls system and control board operators).

c. Note 2 mentions the combined syngas is analyzed at the exit of the FastOx Gasifier. How is the O_2 content at each zone measured/determined?
<< SE: The FastOx gasification vessel is a simple, refractory-lined cylinder, and all major gasification reactions take-place within this single vessel, within the bed of waste materials being converted.
The 'zones' that were described previously (in the memo submitted August 2019 and in the February 2020 correspondence) are actually all present mere inches apart within the solid feed bed that maybe only 6ft tall by 3ft in diameter. These idealized zones presented before are not separate reaction chambers as may be the case with other processes. In fact, this is one of the key benefits of updraft gasification technologies; their simplicity and high thermal efficiencies as all reactions are taking place in a single, small volume.
It is not practical to attempt to measure the O2 concentration within the bed given that these idealized zones do not match precise geometric positions coupled to the harsh conditions with temperatures up to 4000 °F that would melt any sampling device.
Therefore, it is in the cooler region where the syngas is exiting the FastOx gasifier vessel that it is possible to continuously sample the 'Final FastOx Gasifier Syngas' for continuous analysis and process control. The residence time of syngas in the gasifier is on the order of seconds, so any changes occurring in the reaction zones results in very rapid response of the exit gas composition.

4) Details on Polisher process

a. Can you please provide more details regarding the process of the FastOx Polisher?

<< SE: The purpose of the FastOx Polisher is to increase the temperature of the Final FastOx Gasifier Syngas (exiting the FastOx Gasifier vessel, as described above) to break-down condensable hydrocarbon components (for example acetic acid, ethanol, wax etc.) and convert it into additional gaseous syngas components. The FastOx Polisher achieves this by injecting steam, oxygen, and auxiliary fuel under very controlled conditions (see below response to 4)b. below for further details).
Not only does this FastOx Polisher unit operation decrease/mitigate these condensable hydrocarbons causing issues with blocking downstream piping and equipment (if they were to cool, condense out and build-up), but it also maximizes the amount of clean, dry syngas for conversion to the final end-products, so the overall system yield/efficiency increases.

b. Are temperature and oxygen content monitored and/or controlled in the polisher process? If so, how?
<< SE: Indeed, it is imperative to monitor the temperature and Polisher-Outlet Syngas composition continuously.
There are five (5) thermocouples on, and inside, this refractory-lined vessel.
A slipstream of 'Post-Polisher Syngas' is continuously removed from the exit pipework, conditioned, and sent to a near-identical set-up as described above for the FastOx Gasifier Syngas analysis:-
    - One (1) continuous multigas analyzer (with a ECD-TCD-NDIR configuration described above that has the ECD for O2 analysis)
    - One (1) continuous paramagnetic O2 analyzer.

One important clarification: continuously monitoring the temperatures and more-importantly process gas compositions, ensures that optimum syngas quality is being produced, and therefore the overall system yield and efficiency are both being maximized. If these parameters were not monitored (and used for process control and optimization), the CO and H2 could decrease and CO2 and H2O could subsequently increase, greatly decreasing the FastOx Biorefinery's end-product yields, at significant detriment to any operating economics required to make a project financially viable. Our entire process is predicated on, and incentivized to, maximize the energy stored in products, versus generating heat as would be the case with an incineration process.

V/R,
DMD

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From: Zuniga, Mario <zuniga.mario@epa.gov>
Sent: Wednesday, June 10, 2020 3:47 PM
To: Daniel Dodd <ddodd@sierraenergy.com>
Cc: Dancher, Nathan <Dancher.Nathan@epa.gov>; Batchelder, Amber <Batchelder.Amber@epa.gov>; Yannayon, Laura <Yannayon.Laura@epa.gov>; MGiraudo@mbard.org
Subject: Applicability Determination Questions

Hi Daniel,

Thank you for providing additional requested information for this applicability determination in a timely manner. We are working on your applicability determination and require additional information.

Please answer the following questions in detail.

1) Clarify Purpose of Pilot Demonstration
    a. Is Sierra Energy requesting an applicability determination for a pilot demonstration FastOx Gasification Biorefinery (FastOx Gasifier) that will be converted into a full-time operation?
    b. Is the applicability determination for a pilot demonstration that is not expected to be modified/ramped-up?
    c. If the FastOx Gasifier will be converted from a pilot demonstration to a full-time operation, how will the process change?
2) Origin of waste fed to FastOx Gasifier
    a. Is all the wasted used in the FastOx Gasifier generated at the Fort Hunter Liggett (and is therefore "institutional waste" (IW))?
    b. Does the FastOx Gasifier also take in Municipal Solid Waste (MSW) from outside FHL? If so, what are the percentages of MSW and IW that are fed into the FastOx Gasifier?
3) Oxygen levels in reaction zones
    a. Do the multigas analyzer and/or the paramagnetic analyzer measure O_2? Note 2 from your February 28, 2020 email says the combined syngas (from all zones) is sampled and analyzed as it exits the gasifier.
    b. The FastOx Gasifier uses a real-time control system. How often is the sampling and analysis completed? E.g. is it once every 15 minutes?
    c. Note 2 mentions the combined syngas is analyzed at the exit of the FastOx Gasifier. How is the O_2 content at each zone measured/determined?
4) Details on Polisher process
    a. Can you please provide more details regarding the process of the FastOx Polisher?
    b. Are temperature and oxygen content monitored and/or controlled in the polisher process? If so, how?

We are looking into the information you have previously provided and are consulting with expert staff in the region and headquarters. We hope to finalize the applicability determination within a few weeks after your response. We will let you know if we need additional information.

Again, thank you for reaching out to EPA regarding this matter. We appreciate your patience and the additional information you have provided thus far.

Best regards,

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