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May 26, 2016

Via Federal Express/Electronic Mail

Todd Anthony Bianco, EFSB Coordinator
RI Energy Facilities Siting Board
89 Jefferson Blvd.
Warwick, RI 02888

Re: Invenergy Docket No. SB-2015-06

Dear Mr. Bianco:

On behalf of Invenergy, enclosed please find an original and ten copies of Invenergy Thermal Development LLC's Responses to The Town of Burrillville's 9th Set of Data Requests.

Please let me know if you have any questions.

Very truly yours,

ALAN M. SHOER
ashoer@apslaw.com

Enclosures

cc: Service List

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
ENERGY FACILITY SITING BOARD

IN RE:	**INVENERGY THERMAL DEVELOPMENT LLC**	:	
	APPLICATION TO CONSTRUCT AND	:	
	OPERATE THE CLEAR RIVER ENERGY	:	**SB-2015-06**
	CENTER, BURRILLVILLE, RHODE ISLAND	:	

INVENERGY THERMAL DEVELOPMENT LLC's RESPONSES TO THE TOWN OF BURRILLVILLE'S 9th SET OF DATA REQUESTS

9-1 Please see the article attached hereto, especially the highlighted sections, and provide more information regarding the proposed hydrogen tube trailer/generation, and all related safety issues, including responses to the claims set forth in the attached article and whether Invenergy has considered any alternatives in addition to utilizing truck trailer mounted hydrogen tube racks or a hydrogen generator.

RESPONSE: 9-1 Hydrogen cooling of electric generators is a well-established technology that has been in use in the power industry for decades. The electric generators to be installed at the Clear River Energy Center ("CREC") will utilize hydrogen gas for cooling the generator rotor and windings. The hydrogen gas is circulated through an internal heat exchanger in the generator where the heat in the hydrogen is transferred to a cooling water system. A small amount of hydrogen will leak through the shaft seals of the generator over time, requiring that additional hydrogen gas be fed to the generator. The hydrogen gas will be supplied from a bank of compressed gas cylinders or, alternately, larger tube cylinders mounted on a truck trailer.

It is important to note that the CREC is a new power generation facility and will be constructed in accordance with all current codes and National Fire Protection Agency ("NFPA") recommendations regarding the storage and handling of hydrogen gases and the avoidance of hazardous conditions in the equipment, systems, and applicable areas of the plant. The referenced article (published in 2008) accurately discusses the hazards associated with the use hydrogen for generator cooling and also describes appropriate safety measures and standards to address these hazards. These safety measures and standards are incorporated into the design of new power generation facilities.

Of the alternates for supply of hydrogen (i.e. use of hydrogen generators or compressed storage of hydrogen gas delivered to the site), the CREC will not utilize hydrogen generators. Given the volume of hydrogen to be used and the frequency of delivery, the use of compressed gas cylinders or tube trailers is more economical. Hydrogen generators require

additional operation and maintenance requirements and also increase the possibility of hazards by introducing another process step within the hydrogen system.

Fire and explosion hazards are controlled by appropriate design and operating procedures. These include prevention of the formation of combustible fuel-oxidant mixtures and removing potential sources of ignition (electric spark, static electricity, open flames, etc.) in areas where the hydrogen will be used. Designing enclosures and buildings contain hydrogen with adequate ventilation will reduce the possible formation of flammable mixtures in the event of a hydrogen leak.

To prevent the formation of flammable mixtures, the generator will be purged of hydrogen before opening the system to atmosphere, and purged of air, oxygen, or other oxidizers prior to admitting hydrogen into the system. The hydrogen control system will automatically purge the generator using carbon dioxide gas (a non-oxidant inert gas) to remove the hydrogen. When the generator is in operation, the hydrogen storage and supply system is designed to automatically maintain the correct hydrogen pressure and purity of hydrogen. The hydrogen purity will be controlled to a level where an explosive mixture is not present, (i.e. 99.99 percent pure) which is greater than the explosive mixture range of hydrogen and oxygen, thus providing a measure of safety.

Pressure relief devices ("PRDs") are employed in the compressed gas storage system to reduce the likelihood of cylinder and tube failures during the unlikely event of a fire. These devices often include frangible disks, fusible metal plugs or pressure relief valves to relief the pressure in a controlled manner through a vent system to avoid a rupture of the container and release of the hydrogen.

As recommended by codes, the hydrogen cylinders will be located away from high traffic areas and normally occupied spaces. A dedicated concrete pad will be constructed next to the cylinders for a tube trailer (hydrogen delivery truck) as a back-up source of hydrogen. Protective bollards will be installed around the cylinders and the tube trailer pad for protection from vehicular traffic. Hazard signage will be placed around the hydrogen storage containers to emphasize safe practices in these areas.

RESPONDENT: Daniel W. Mitas, PE, HDR, Inc.

DATE: May 26, 2016

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9-2 In particular, please provide all safety plans and designs concerning possible problems that could arise with the hydrogen. For example, the attached article claims:

a. A typical tube trailer has the equivalent of 5,585 pounds of TNT;
b. Hydrogen is especially dangerous because the explosive range of hydrogen in the air is from 4% to 74%;
c. Hydrogen has a wide flammability range;
d. Ignition of the hydrogen takes little energy;
e. All hydrogen cooled generators leak;
f. There is no shortage of ways to cause a hydrogen fire; and
g. It is estimated that perhaps five hydrogen fires a year occur at power plants with hydrogen cooled generators.

RESPONSE: 9-2 The following is a list of design features and safety measures that will be incorporated into the design of the CREC systems to mitigate the hazard potential of hydrogen:

a. In accordance with NFPA requirements, the systems will be designed and installed to prevent sources of ignition such as sparks from electrical equipment, static electricity, open flames, or extremely hot objects. This will include use of properly rated equipment in the hydrogen storage and handling systems to limit potential ignition sources.

b. The hydrogen purity will be controlled to a level where an explosive mixture is not present, (i.e.99.99 percent pure) which is greater than the explosive mixture range of hydrogen and oxygen, thus providing a measure of safety. To prevent mixing of hydrogen with oxygen in air that would create explosive mixtures, a control system is provided that purges the generator with an inert gas such as carbon dioxide before filling the generator with hydrogen. Similarly, when hydrogen is removed from the generator, it is once again purged with carbon dioxide. This control system allows safe and efficient filling and purging of hydrogen to avoid an explosive mixture in the generator.

c. The generator is equipped with end shields that are designed to

withstand a hydrogen explosion in the unlikely event of such a mishap and direct the blast away from possible occupied spaces around the perimeter of the generator.

d. Enclosed spaces such as the generator neutral terminal enclosure will be furnished with hydrogen sensors to monitor the enclosure for hydrogen leaks.

e. To remove hydrogen that is absorbed or entrained in the generator seal oil, a hydrogen detraining tank is provided in the seal oil system to remove hydrogen. The seal oil system control is automated.

f. The generator hydrogen seal oil system is equipped with emergency pumps that are powered by the plant emergency power system to maintain the hydrogen seal in the generator in the event of a loss of the normal power supply.

g. The hydrogen system is furnished with a dedicated control panel that monitors hydrogen purity to ensure maximum efficiency and safety. To maintain hydrogen purity in the generator casing, a small quantity of hydrogen is continuously scavenged from the seal oil drain and discharged to atmosphere. The function of the hydrogen control panel is to control the rate of scavenging, analyze the purity of the hydrogen gas and to monitor the gas composition during a generator purge cycle. The electrical feed to the hydrogen control system is backed up by the plant uninterruptible power supply so that operation is maintained in the event of a power loss.

h. Hydrogen is supplied to the generator casing through a hydrogen gas manifold. The hydrogen gas manifold includes a gas control valve assembly and instrumentation that ensure safe operation and control of the hydrogen supply to the generator. The system monitors generator hydrogen gas pressure for alarm, trip, and safety functions, as well as the hydrogen supply pressure.

i. The following design features will be incorporated to prevent accumulation of hydrogen in buildings and enclosures:

    - For indoor installations, building design will prevent the accumulation of hydrogen either by natural or forced ventilation of high points. Building ventilation flow will be sufficient to ensure there is no hydrogen gas build-up within the structure at all times of the year and in all weather conditions. Where needed, a forced ventilation system using redundant fans will be

used that will prevent the accumulation of hydrogen.

- When hydrogen is purged from the generator, it will be piped and vented to an elevated point outside of the generator building. The low density gas will rise and disperse quickly from the vents.

- A hydrogen sensor will be installed in all battery rooms with an externally mounted alarm and control panel outside of each room (Sensidyne SensAlarm Plus or equal). High hydrogen levels or loss of ventilation will be alarmed on the local panel.

RESPONDENT: Daniel W. Mitas, PE, HDR, Inc.

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9-3 Please explain whether and how you intend to use monitors to make this safer, and which monitors you propose to use.

RESPONSE: 9-3 See Items d) and i) in the response to Question 9-2 for areas of the plant that will use hydrogen monitors.

RESPONDENT: Daniel W. Mitas, PE, HDR, Inc.

DATE: May 26, 2016

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9-4 Please explain the safety measures that will be put in place for the hydrogen being transported by Town roads to the plant.

RESPONSE: 9-4 The hydrogen delivery trucks are expected to follow the Department of Transportation (DOT) guidelines for safe transportation of hydrogen to the CREC facility. Compliance with applicable Dangerous Goods regulations is required for all shipments by motor freight. These regulations describe the marking, labeling, placarding, and the shipping documentation required for these types of shipment.

The hydrogen tubes in the trailer mounted tube racks are designed and manufactured according to DOT-3A or DOT-3AA specifications. The tubes are hydrostatically tested when manufactured and tested periodically thereafter at 5/3 times the service pressure as required by DOT regulations. These safety measures are to ensure safe transportation of hydrogen on roadways

RESPONDENT: Daniel W. Mitas, PE, HDR, Inc.

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9-6 Please confirm that you are proposing to comply with the supply and siting requirements of the National Fire Protection Association, and provide specifics.

RESPONSE: 9-6 The hydrogen storage and supply system at CREC will be designed to meet requirements of NFPA 55 – Compressed Gases and Cryogenic Fluids Code.

The cylinders and/or tube trailers will be located outdoors and away from normally occupied areas. The location of the storage system will be based on guidelines set forth in NFPA 55 Table 10.4.2.2.1(a), Table 10.4.2.2.1(b), or Table 10.4.2.2.1(c). The exact location will be determined as the plant arrangement is finalized and system specific design parameters are defined including the total volume of gas stored, the pressure at which the gas is stored, and the supply line size.

Guidelines provided in NFPA Table G.2(a) will also be followed e.g. if the size of the hydrogen system is between 3,000 to 15,000 scf, the containers will be located as least 50-feet from occupied areas of the plant.

RESPONDENT: Daniel W. Mitas, PE, HDR, Inc.

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9-7 Please explain how you will have the installation site become a classified area limited in use pursuant to the National Fire Protection Association.

RESPONSE: 9-7 As part of the design of the CREC, a hazards review will be conducted to identify specific hazards in the various areas of the plant which will establish the classification of each area. The classification of an area will establish the criteria to be used in the design of the equipment in each area. The hydrogen storage and supply system at CREC will be designed to meet requirements of NFPA 55 – Compressed Gases and Cryogenic Fluids Code.

Hazard identification signs will be placed at all entrances to locations where the hydrogen cylinders and/or tube trailers are stored and handled. In addition, the area will have signs as follows:

WARNING: HYDROGEN — FLAMMABLE GAS
NO SMOKING — NO OPEN FLAMES

RESPONDENT: Daniel W. Mitas, PE, HDR, Inc.

DATE: May 26, 2016

INVENERGY THERMAL DEVELOPMENT LLC
By its Attorneys,

/s/ Alan M. Shoer

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Dated: May 26, 2016

CERTIFICATE OF SERVICE

I hereby certify that on May 26, 2016, I delivered a true copy of the foregoing responses to the Energy Facilities Siting Board via electronic mail to the parties on the attached service list.

/s/ Alan M. Shoer