

**STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS  
ENERGY FACILITY SITING BOARD**

**IN RE: INVENERGY THERMAL DEVELOPMENT LLC's  
APPLICATION TO CONSTRUCT THE  
CLEAR RIVER ENERGY CENTER IN  
BURRILLVILLE, RHODE ISLAND**

**DOCKET No. SB-2015-06**

**PRE-FILED DIRECT TESTIMONY OF  
MICHAEL HANKARD**

**(JUNE 30, 2017)**

## **SUMMARY**

Michael Hankard is the owner and President of Hankard Environmental, Inc., an acoustical consulting firm and testifies regarding the noise analyses performed on the Project and the surrounding area. Specifically, he explains the noise evaluation studies performed with regard to noise and the Town of Burrillville's Noise Ordinance. He also addresses concerns raised by the Town of Burrillville's Planning Board and Zoning Board Advisory Opinions and other Advisory Opinions as it relates to noise concerns. Mr. Hankard, relying on his experience and expertise, the application as supplemented, his studies and analysis performed, responses to data requests and agency opinions, applicable ordinances of the Town of Burrillville, and relevant analysis he conducted, opines that the Clear River Energy Center ("CREC") has been designed with an extensive set of noise mitigation measures such that it meets the Town's stringent 43 dBA noise limit, and that the noise generated by the CREC Project will conform to applicable laws and regulations and will thereby not cause unacceptable harm to the environment or the public health.

## **LIST OF EXHIBITS**

MH-1          November 22, 2016 Letter from the by-pass valve manufacturer

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OF MICHAEL HANKARD, HANKARD ENVIRONMENTAL, INC. (NOISE)**

1

2 **I. INTRODUCTION**

3

4 **Q. PLEASE STATE YOUR NAME, BUSINESS TITLE AND BUSINESS ADDRESS.**

5

6 **A.** My name is Michael Hankard. I am owner and President of Hankard Environmental, Inc.,  
7 an acoustical consulting firm, located at 211 East Verona Avenue, Verona, Wisconsin 53593.

8 **Q. ON WHOSE BEHALF ARE YOU TESTIFYING?**

9

10 **A.** My testimony is on behalf of the applicant, Invenergy Thermal Development LLC  
11 (“Invenergy”), in support of its application (the “Application”) for a license from the Rhode Island  
12 Energy Facility Siting Board (“EFSB” or “Board”) to construct the Clear River Energy Center  
13 project in Burrillville, Rhode Island (“Clear River” or “CREC” or “Project”).

14 **Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND AND**  
15 **PROFESSIONAL EXPERIENCE.**

16

17 **A.** I earned my Bachelor of Science degree in electrical engineering, with a specialization in  
18 acoustics, from the University of Maine in 1990. Since that time, I have practiced exclusively in  
19 the field of noise control engineering (twenty-seven (27) years). I have conducted hundreds of  
20 noise analyses for proposed projects such as power plants, commercial facilities and highway  
21 infrastructure. I have conducted noise analyses for approximately twenty (20) projects involving  
22 simple-cycle and combined-cycle power plants across the U.S., including equipment noise level  
23 measurements, noise level modeling and mitigation design. A detailed description of my

1 educational background and professional experience is included in my CV, which was filed with  
2 the Board on September 12, 2016.

3 **Q. PLEASE DESCRIBE YOUR EXPERIENCE PROVIDING TESTIMONY TO**  
4 **REGULATORY COMMISSIONS, BOARDS, AGENCIES OR AS AN EXPERT**  
5 **WITNESS.**

6  
7 **A.** I have testified as an acoustical expert before state utility boards in New York and  
8 Wisconsin; before county and municipal boards in Pennsylvania, Nebraska, Illinois, Indiana,  
9 Michigan, Colorado, South Dakota and Utah; and in courts of law in Colorado and Wisconsin.

10 **II. ANALYSIS**

11  
12 **Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?**

13  
14 **A.** My testimony is intended to support and explain the noise evaluation studies performed for  
15 CREC. It is also intended to demonstrate that noise from the CREC will meet the Burrillville  
16 Town (“Town”) Noise Ordinance, and to address the limitations and/or conditions mentioned in  
17 the Town Planning Board’s Advisory Opinion and the Zoning Board’s Advisory Opinion. Finally,  
18 it is intended to address noise issues raised by the Rhode Island Department of Environmental  
19 Management (“RIDEM”) and the Department of Health (“RIDOH”) in their respective advisory  
20 opinions to date.

21 **Q. PLEASE EXPLAIN YOUR KNOWLEDGE OF CREC?**

22  
23 **A.** I was engaged by Invenergy in April 2015 to assist with the noise studies in support of  
24 Invenergy’s EFSB Application. I spent four days touring the Project area, both during daytime  
25 hours and in the middle of the night, observing existing noise sources and levels. In October of  
26 2015, I conducted an extensive review of the baseload operations acoustic model and noise level  
27 evaluation study for CREC, which is attached to Invenergy’s EFSB Application as Appendix E.  
28 In March of 2016, I assisted with the “Transient Operation Noise Level Evaluation” for CREC,

1 evaluating noise levels from startup and shutdown operations, which was submitted to the EFSB  
2 on August 2, 2016 as a supplement to Invenergy’s Response to EFSB Data Request No. 1-1. I  
3 testified before the Town Planning Board as to the validity of the acoustical modeling conducted  
4 to date and that the noise mitigation measures committed to by Invenergy are sufficient to ensure  
5 compliance with the Town’s 43 dBA standard during both normal operations and start-up. Finally,  
6 I assisted in providing responses to noise-related data requests and the Town’s Peer Review  
7 Recommendations regarding noise issues.

8 **Q. WHAT MATERIALS DID YOU REVIEW WHEN CONDUCTING YOUR**  
9 **ANALYSIS?**

10  
11 **A.** I reviewed all laws, ordinances and standards governing noise emissions for CREC,  
12 particularly the Town’s noise ordinance. I also reviewed the proposed CREC site plan, equipment  
13 layout and equipment noise emission factors. I reviewed data requests addressing noise submitted  
14 by the Town and the Rhode Island Depart of Environmental Management. I also reviewed the  
15 reports submitted by the Town’s noise consultant, David M. Hessler, Hessler Associates, Inc.,  
16 entitled (1) “Invenergy Clear River Energy Center – Facility Noise and Community Impacts,”  
17 dated May 26, 2016, (2) “Invenergy Clear River Energy Center – Additional Comments on Facility  
18 Noise issues,” dated July 12, 2016, and (3) “Invenergy Clear River Energy Center – Invenergy  
19 Peer Review Responses on Noise and Community Noise Impacts,” dated August 8, 2016. All of  
20 these latter documents are attached to the Town Planning Board’s Advisory Opinion. Finally, I  
21 reviewed the advisory opinions to date from RIDEM and RIDOH.

22 **Q. AFTER CONDUCTING YOUR ANALYSIS, IS IT YOUR EXPERT**  
23 **PROFESSIONAL OPINION THAT INVENERGY WILL MEET THE TOWN’S 43**  
24 **dba NOISE ORDINANCE REQUIREMENT?**

25  
26 **A.** Yes. The Project has spent considerable effort in the modeling of noise and the design of  
27 a set of acoustical mitigation measures that will ensure that CREC operates in compliance with the

1 Town's 43 dBA ordinance requirement. Our detailed model confirms that the 43 dBA limit will  
2 be met at all nearby residences for both typical operations and start-up. The noise mitigation  
3 measures committed to are described in the Application noise analysis, the March 2016 transient  
4 operations noise analysis and my prior testimony (June 20, 2016 Burrillville Town Planning Board  
5 Meeting, Tr. p. 28). These measures, if needed, include: all combustion and steam turbines will  
6 be located inside an acoustically treated building; high performance silencers will be used on the  
7 intake of air for the combustion turbine; silencers on turbine compartment fans; low noise air  
8 cooled condenser and closed cooling water heat exchangers; diffuser noise walls; low noise  
9 transformers; high performance exhaust stack silencers; auxiliary boiler fan silencers; treated  
10 boiler transition ducts and main body; acoustical treatment of duct burner skirts; buildings  
11 enclosing the auxiliary boiler, gas compressors, boiler feed water pumps, and water treatment  
12 equipment; low-noise steam by-pass valves and discharge devices; lagging along the air cooled  
13 condenser duct; silencers on start-up vents, blowdown and drains tank vents, and safety release  
14 vents. This list of measures is based on the current design of the CREC. As more detailed noise  
15 emission information becomes available, and as the design of the CREC evolves, the list of noise  
16 mitigation measures may change.

17         Invenergy will hire an Engineering, Procurement and Construction ("EPC") contractor to  
18 design and construct CREC. The contract with the EPC firm will obligate them to design and build  
19 CREC such that the Facility meets the Town's noise ordinance under start-up and baseload  
20 operations. The contract will include a mandatory noise compliance test to measure the noise from  
21 the operation of the Facility and demonstrate that CREC is meeting the 43 dBA ordinance  
22 requirement. If there are any demonstrated exceedances of the Town's 43 dBA limit during initial

1 start-up and testing of the CREC, the EPC contractor will be required to correct the cause of the  
2 exceedance and ultimately to demonstrate compliance through additional noise testing.

3 **Q. ARE YOU AWARE OF THE TOWN CONSULTANT'S OPINION REGARDING**  
4 **WHETHER INVENERGY CAN COMPLY WITH THE TOWN'S NOISE**  
5 **ORDINANCE?**

6 **A.** Yes. Based on his testimony at the Burrillville Planning Board meeting in June 2016 and  
7 his reports and communications that were attached to the Planning Board's Advisory Opinion, Mr.  
8 Hessler agreed that if CREC is designed with the noise mitigation measures described above, noise  
9 from baseload operation of CREC will meet the Town's 43 dBA noise ordinance. In his May 26,  
10 2016 report and at the June 20, 2016 meeting, Mr. Hessler voiced concern over noise from steam  
11 by-pass during plant start-up. After being provided additional information, Mr. Hessler states in  
12 his July 12, 2016 letter to the Town that he is "convinced that this noise [start-up steam by-pass]  
13 will be adequately brought under control."

14 **Q. IN AUGUST OF 2016, MR. HESSLER DISCUSSED CONSTRUCTION NOISE. DO**  
15 **YOU HAVE AN OPINION REGARDING HIS STATEMENT?**

16  
17 **A.** Mr. Hessler brings up the issue of steam blow down, which is the process of using high  
18 pressure steam to clean out pipes after construction is complete, but prior to initial plant operation.  
19 This operation can last anywhere from a few days to a week. Mr. Hessler notes that it is common  
20 practice for EPC contractors to rent silencers for this operation. I agree with this statement.

21 **Q. MR. HESSLER ALSO STATED THAT THE BEST TEMPORARY SILENCERS**  
22 **SHOULD BE USED TO MINIMIZE NOISE IMPACTS FROM STEAM BLOW**  
23 **DOWN. DO YOU KNOW IF THE PLAN IS TO UTILIZE THESE TEMPORARY**  
24 **SILENCERS?**

25  
26 **A.** Mr. Hessler suggests that the EPC contractor "use the best silencer they can get." I agree  
27 in principal with this recommendation, but am leery of the use of the word "best". I think that the  
28 matter should be quantified in some way. For example, it would be prudent to specify a noise limit  
29 for this operation, which being part of construction is technically exempt from the Burrillville

1 noise ordinance provided that it is conducted during the daytime. If not limited to the daytime, a  
2 reasonable limit to apply to this temporary operation would be Burrillville’s daytime limit of 53  
3 dBA, which can be met by high performance rental silencers having a noise insertion loss of  
4 approximately 50 dBA. Invenergy should require its EPC contractor to use such a silencer, or an  
5 equivalent.

6 **Q. MR. HESSLER ALSO DISCUSSES EMERGENCY STEAM RELEASES. DO YOU**  
7 **HAVE AN OPINION REGARDING HIS STATEMENTS?**

8  
9 **A.** As described in the March 2016 report entitled *Transient Noise Level Evaluation for the*  
10 *Clear River Energy Center*, CREC will have silencers on all steam release vents. Noise levels are  
11 predicted to be, at most, only marginally (3 to 6 dBA) above the 43 dBA limit during these brief,  
12 rare and emergency events, and only at two of the nearest residences. Noise levels at more distant  
13 residences will be 43 dBA or less even during emergency release events.

14 **Q. HAVE YOU READ THE PLANNING BOARD’S ADVISORY OPINION?**

15  
16 **A.** Yes.

17 **Q. PAGE 19 OF THE ADVISORY OPINION STATES THE FOLLOWING: “[W]E**  
18 **ARE UNABLE TO RENDER AN OPINION AS TO WHETHER THE CREC**  
19 **FACILITY WILL BE ABLE TO COMPLY WITH OUR NOISE ORDINANCE.**  
20 **R.I.G.L. § 45-23-63(F) REQUIRES 5 AFFIRMATIVE VOTES OF OUR 9 MEMBER**  
21 **BOARD FOR A MOTION TO SUCCEED. . . . DESPITE A NUMBER OF**  
22 **MOTIONS ON NOISE COMPLIANCE, ALL FAILED BECAUSE WE WERE**  
23 **UNABLE TO OBTAIN 5 VOTES ON ANY OF THESE MOTIONS” DO YOU**  
24 **HAVE AN OPINION FAILURE TO ISSUE A POSITIVE RECOMMENDATION**  
25 **THAT INVENERGY CAN COMPLY WITH THE TOWN’S NOISE ORDINANCE,**  
26 **THE 43 DBA?**

27 **A.** In their opinion, the Planning Board states that Invenergy’s noise consultant and the  
28 Town’s noise consultant both testified that the 43 dBA limit could and would be met. In that regard,  
29 the Planning Board confirms that the Facility will comply with the limit. The primary reason for  
30 not rendering an opinion on noise was, at least on the surface, “concerns about possible low  
31 frequency noise effects on wildlife”, which relates to the Town’s octave band limits. Board

1 Opinion, pg 19. This decision is in contrast to the information provided to the Board on this matter.  
2 Mr. Hessler informed the Board that the “CREC won’t substantially change or increase low  
3 frequency sound levels in any meaningful way.” Board Opinion, pg 19. Furthermore, the Town’s  
4 noise ordinance does not pertain to wildlife.

5 **Q. DO YOU HAVE AN OPINION REGARDING THE CONDITIONS MENTIONED**  
6 **IN THE BURRILLVILLE PLANNING BOARD’S ADVISORY OPINION TO THE**  
7 **EFSB RELATING TO NOISE?**

8 **A.** Yes. Condition 3 asserts that there should be “continuous” monitoring and reporting of  
9 noise. Continuous monitoring of noise is not typically required during construction and operation.  
10 What has been committed to by Invenergy is to require the EPC contractor to conduct a noise test  
11 during commissioning of CREC to demonstrate that the Facility is operating within the Town’s  
12 noise standard. Also, during construction, the Project will maintain communication with residents  
13 of the area, will respond to reasonable noise complaints, and will derive a solution within a  
14 reasonable timeframe. Note, according to the Town’s Ordinance (Section 16-35 (b)), noise from  
15 permitted construction activities is exempt from the Town’s 43 dBA standard during the daytime  
16 except on Sunday. After commissioning, CREC will always be subject to the Town’s ordinance  
17 in that a complaint can be lodged, testing conducted, mitigation applied if necessary and  
18 compliance demonstrated.

19 Condition 10 requires the Project to follow the recommendations set forth in RIDOH’s  
20 Draft Advisory Opinion dated July 8, 2016. That recommendation was for “the facility to work in  
21 conjunction with Algonquin to minimize neighborhood noise impacts to the extent possible and  
22 that such actions should include ... equipment and operational modifications, sound proofing of  
23 impacted residences, ... [and] the purchase of properties.” These recommendations are open-ended  
24 and difficult to quantify. In their Final Advisory Opinion, dated September 12, 2016, RIDOH  
25 recommends “the EFSB establish clear noise limitations and require the CREC facility, if

1 constructed, to work in conjunction with Algonquin to ensure that neighborhood noise impacts are  
2 minimized to the fullest extent possible.” I agree that Invenergy and Algonquin should both strive  
3 to minimize noise from their respective facilities. Invenergy has done so by implementing  
4 significant noise reduction measures in the design of CREC to meet the Town’s stringent 43 dBA  
5 limit. Invenergy has no control over Algonquin’s facility and that facility is subject to Federal  
6 noise regulations, not the Town’s.

7 Condition 14 asks the Project to meet all of the conditions specified by Mr. Hessler,  
8 including those of his May 26, July 12, August 10, August 16 and August 22, 2016 letters and  
9 emails. In summary, these recommendations include (1) all of the noise mitigation measures that  
10 Invenergy has committed to (as described above), (2) noise compliance testing, (3) measurement  
11 of steam by-pass noise at an existing, similar facility and (4) to have a “noise enclosure or other  
12 appropriate retrofit mitigation ... pre-designed and ... ready to install immediately” in the event  
13 that the noise standard is not met during start-up noise testing. I agree with all of these  
14 recommendations, with one exception: it should be left up to the EPC contractor to determine if  
15 they need to pre-design an enclosure for the air cooled condenser duct.

16 **Q. INVENERGY ASKED THE PLANNING AND ZONING BOARDS TO WAIVE**  
17 **THE TOWN’S OCTAVE BAND NOISE ORDINANCE REQUIREMENT. WHAT**  
18 **IS YOUR OPINION REGARDING THE OCTAVE BAND LIMITS?**

19  
20 **A.** As described in the Noise Level Evaluation Report (EFSB Application Appendix E, pg 10-  
21 12), the Town’s octave band limits are 10 to 16 dB lower than other U.S., state and local  
22 regulations, particularly in the lower bands (31 to 250 Hertz). It is extremely difficult, if not  
23 technically infeasible in some cases, to meet all of the Town’s low frequency octave band limits  
24 at the closest residences, even with all of the noise mitigation measures in place to meet the 43  
25 dBA limit. More importantly, the predicted low frequency noise levels from CREC are well below

1 commonly used standards such as 75 dBC (Noise Level Evaluation Report, pg 12) and lower than  
2 existing low frequency noise levels from the simple-cycle gas compressor station units  
3 (Algonquin). Thus, my opinion is that there is no benefit in requiring CREC to further reduce low  
4 frequency noise levels and that the octave band waiver should be approved by the Board.

5 All of this pertains to impacts to residents (humans). The Town and RIDEM also brought  
6 up the issue of low frequency noise, but with regard to its impact on wildlife. The Town's  
7 relatively low noise level limit of 43 dBA requires CREC to be designed with a host of significant  
8 noise reduction measures, for both start-up and baseload operation. These measures also lower  
9 CREC noise levels in the adjacent forest, in some cases and at some frequencies to levels below  
10 that which exist today either from natural sources or the existing compressor station. If the concern  
11 is wildlife, the issue becomes more complex and there are many more unknowns. One of the most  
12 recent and most applicable studies of the impact of manmade noise on wildlife, is *The Effects of*  
13 *Highway Noise on Birds*, Robert J. Dooling and Arthur N. Popper, Environmental BioAcoustics  
14 LLC, which was prepared for The California Department of Transportation in 2007. This report  
15 describes how 60 dBA is often used as a threshold for the impact of noise on bird communications.  
16 However, this is based on an assumed background noise level of 45 to 55 dBA. Assuming the  
17 average of this (50 dBA), this is 15 dBA louder than the ambient sound levels in the forest south  
18 of the CREC. Thus, the 60 dBA impact threshold should be reduced accordingly to 45 dBA. Noise  
19 levels from the CREC are predicted to exceed this level about 2,000. In other words, within  
20 approximately 2,000 feet of the center of the CREC, noise levels could be high enough to  
21 potentially impact bird communication, but not beyond this distance. Note, however, that bird  
22 communications take place in the 2,000 to 4,000 Hz portion of the frequency spectrum. In the  
23 2,000 Hz octave band, existing noise levels measured south of the CREC are approximately 25

1 dBA at their lowest. CREC noise levels in this frequency band are predicted to range from 12 to  
2 24 dBA (lower than existing levels). In the 4,000 Hz octave band CREC noise levels are predicted  
3 to be much lower than ambient levels. Thus, CREC noise would not likely affect bird  
4 communication at all. *See* Letter from Michael Hankard, Hankard Environmental, Inc. dated  
5 August 19, 2016, filed with the EFSB when Invenergy Supplemented its Response to the Rhode  
6 Island Department of Environmental Management’s Data Requests, Nos. 3-23, 3-25, 3-28 and 3-  
7 29.

8 **Q. ARE YOU AWARE OF THE TOWN CONSULTANT’S OPINION REGARDING**  
9 **WHETHER INVENERGY CAN COMPLY WITH THE TOWN’S NOISE**  
10 **ORDINANCE ADDRESSING OCTAVE BAND LIMITS?**

11 **A.** Yes. Mr. Hessler recommended that Invenergy receive a waiver. In fact, he testified before  
12 the Burrillville Planning Board that “it [the Town’s octave band limits] is particularly onerous and  
13 lower frequencies, the ordinance limits are so low that the background level out there right now is  
14 probably in violation and that is even if the compressor station were not operating. So, they are  
15 unusually low and unnecessarily low. So, what I’m suggesting is that a waiver on that *and I think*  
16 *that is a legitimate request and there is no need to make those octave band limits.* [Emphasis  
17 added]” See Portion of David M. Hessler June 20, 2016 Burrillville Planning Board Testimony, p.  
18 10.

19 **Q. DID THE PLANNING BOARD RECOMMEND TO THE ZONING BOARD THAT**  
20 **THE LOW OCTAVE BAND LIMIT BE WAIVED?**

21 **A.** Yes. On page 19 of their Advisory Opinion, the Planning Board states: “we recommend  
22 that the Zoning Board grant the octave band noise waiver/special use permit and exempt the CREC  
23 from the octave band limits of the noise ordinance, provided all of the conditions set forth in  
24 paragraph 3 (page 20) below are strictly complied with.” I discuss the Zoning Board’s Advisory  
25 Opinion below.

1 **Q. BEFORE WE MOVE TO THE OTHER ADVISORY OPINIONS, I'D LIKE TO**  
2 **DISCUSS THE RECOMMENDATIONS MADE BY THE TOWN'S EXPERTS.**  
3 **THE PLANNING BOARD ASKED INVENERGY TO STATE WHETHER IT**  
4 **WOULD COMPLY WITH THOSE RECOMMENDATIONS. LET'S FOCUS ON**  
5 **THE RECOMMENDATIONS THAT YOU SPECIFICALLY RESPONDED TO,**  
6 **THE FIRST BEING THE TOWN'S REQUEST TO EXTEND THE TURBINE**  
7 **BUILDING. PLEASE ADDRESS THIS.**

8  
9 **A.** It is known that one of the primary noise issues associated with combined-cycle power  
10 plants with air cooled condensers ("ACC") is that from the by-passing of steam into the ACC  
11 supply duct during start-up. Noise is generated within the steam flow by the by-pass valve and at  
12 the point of discharge into the ACC duct, and this noise is then radiated through the walls of the  
13 duct into the atmosphere. Modeling conducted by the Project confirms that the 43 dBA limit will  
14 be achieved during by-pass if low-noise valves, low-noise discharge devices and lagging of the  
15 ACC duct are included in the design (in addition to all of the other noise mitigation measures  
16 described above for other equipment). Based on his experience with other projects, Mr. Hessler  
17 contends that the Project may be under-estimating noise emissions from the steam by-pass system,  
18 that our proposed mitigation measures may not be enough, and that a building may need to be  
19 constructed over the ACC duct in order to achieve compliance. The Project stands by its  
20 assessment, and will contractually obligate the Project's EPC contractor to (1) conduct the final  
21 design of noise mitigation for the steam by-pass system; (2) conduct a noise test of steam by-pass  
22 during commissioning; and (3) rectify any noise problems and ultimately demonstrate compliance  
23 through measurements. Therefore, I do not agree that a building over the ACC duct is necessary  
24 at this point. I have also reviewed a letter sent to Invenergy by the by-pass valve manufacturer,  
25 confirming that they can meet the noise limits assumed in our analysis. A copy of that letter is  
26 attached as **Exhibit MH-1**.

1 **Q. NEXT, RECOMMENDATION CONCERNING THE TOWN'S REQUEST FOR**  
2 **HEAVY LAGGING. WHAT IS YOUR OPINION REGARDING THAT**  
3 **RECOMMENDATION?**

4  
5 **A.** ACC ducts are relatively thin-walled and in their standard configuration, effectively radiate  
6 noise created by the steam flow out into the atmosphere. Lagging consists of adding a layer of  
7 insulation around the duct and then a layer of mass over that (e.g. steel). Mr. Hessler may have  
8 been unaware of the Project's commitment to this mitigation measure when he made this  
9 recommendation. Regardless, I agree with Mr. Hessler that lagging is appropriate.

10 **Q. RECOMMENDATION REGARDING THE REQUEST TO USE LOW-NOISE**  
11 **VALVES, WHAT IS YOUR OPINION REGARDING THAT**  
12 **RECOMMENDATION?**

13  
14 **A.** I agree with Mr. Hessler on this. The design of CREC currently calls for low-noise valves,  
15 as well as low-noise discharge devices. The Project had discussions with the valve/discharge  
16 supplier regarding the importance of meeting the Town's 43 dBA noise level limit and what is  
17 expected of the valve/discharge noise levels to this end. The valve manufacturer confirmed the  
18 noise levels that could be met using their design, and in turn achieving the 43dBA noise level limit.  
19 (*See Exhibit MH-1*) This process will be carried through with the EPC contractor as well.

20 **Q. REGARDING THE RECOMMENDATION REQUESTING FIELD TESTING,**  
21 **WHAT IS YOUR OPINION REGARDING THAT RECOMMENDATION?**

22  
23 **A.** Mr. Hessler recommends identifying an existing power plant with a similar steam by-pass  
24 system, measuring noise emissions from that steam by-pass system and using these results to judge  
25 the efficacy of CREC by-pass acoustical design. I agree with this recommendation and am  
26 currently working with Invenergy and the valve supplier to accomplish this.

27 **Q. REGARDING THE RECOMMENDATION THAT SUGGESTS IGNORING THE**  
28 **GUARANTEE AND ASSUMING THAT THE STEAM DUCT SOUND LEVEL**  
29 **WILL BE A CERTAIN RANGE, WHAT IS YOUR OPINION REGARDING THAT**  
30 **RECOMMENDATION?**

31

1 A. Mr. Hessler recommends that if measurements of an existing facility cannot be  
2 accommodated, then the modeling analysis should assume higher noise emissions from the steam  
3 by-pass system. I respectfully disagree with this recommendation. All the different components of  
4 a plant are uniquely designed to meet the requirement of that particular project and may not be  
5 available at other plants, and not specific to just the bypass valves. Therefore, it would not be  
6 prudent to arbitrarily utilize a higher value for the bypass valves in calculating the noise emission  
7 levels. Furthermore, the noise emission factors used in our analysis will be made contractual  
8 obligations of the valve supplier, and/or EPC contractor, and a noise test will be required to  
9 demonstrate compliance.

10 **Q. REGARDING THE RECOMMENDATION THAT ADDRESSES HOW CREC**  
11 **SHOULD BE BUILT, WHAT IS YOUR OPINION REGARDING THAT**  
12 **RECOMMENDATION?**  
13

14 A. Mr. Hessler recommends that a building be constructed around the ACC duct if “field  
15 testing [at an existing facility] or design assumptions suggest an enclosure”. Again, I respectfully  
16 disagree. That recommendation is, at a minimum, premature. The Project’s design assumptions  
17 and analyses currently confirm that no enclosure is required. If the EPC contractor, who will  
18 conduct its own independent acoustic analysis, determines that additional mitigation measures are  
19 required for the steam by-pass system, it will be up to the EPC contractor to design and construct  
20 those measures. Those measures may or may not include an enclosure.

21 **III. ZONING BOARD ADVISORY OPINION**

22 **Q. HAVE YOU READ THE ZONING BOARD’S ADVISORY OPINION?**

23 A. Yes.

24 **Q. DO YOU HAVE AN OPINION REGARDING THE DECISION OF THE ZONING**  
25 **BOARD NOT TO GRANT A WAIVER OF THE OCTAVE BAND LIMITS, EVEN**  
26 **AFTER THE PLANNING BOARD RECOMMENDED GRANTING THE OCTAVE**  
27 **BAND WAIVER?**

1 A. The only mention of a discussion by the Zoning Board about the octave band issue in their  
2 Advisory Opinion is mention of Board member John Patriarca feeling that “the board should not  
3 grant a waiver from the low level octave band requirement,” because they were not given enough  
4 information. The opinion does not explain what information was not provided. However, their  
5 own consultant informed the Town that the octave band requirements are not necessary, and their  
6 Planning Board advised granting the waiver. Therefore, I do not comprehend how they came to  
7 their conclusion. In any event, I am recommending that the Board accept the Town Planning  
8 Board’s recommendation for a waiver of the application of the octave band.

9 **Q. DOES THE TOWN ORDINANCE ALSO ALLOW FOR AN EXEMPTION FROM**  
10 **THE TOWN NOISE ORDINANCE WHEN ANOTHER STATE OR FEDERAL**  
11 **AGENCY HAS JURISDICTION TO SET A NOISE STANDARD?**

12 A. Yes. As explained in Section 6.9 of the Application, the EFSB ultimately establishes the  
13 applicable limits for noise. Further, the Burrillville Zoning Ordinance is not applicable where the  
14 facility generating the noise has been granted a permit or license by a federal and/or state agency  
15 and the federal and/or state agency specifically sets noise limits. *See* Section 16-32 of the Town’s  
16 Zoning Ordinance (“This article shall apply to the control of all noise originating within the limits  
17 of the town, except when: (1) The facility generating the noise has been granted a permit or license  
18 by a federal and/or state agency and the authorization to operate within set noise limits”).

19 **IV. RIDEM ADVISORY OPINION**  
20

21 **Q. ON PAGE 13, BULLET NUMBER 4, RIDEM STATES THAT “IMPACTS ARE**  
22 **DEPICTED IN TOO LARGE OF A SCALE TO SHOW THEIR FULL EXTENT,**  
23 **BUT IT APPEARS THAT NOISE FROM TYPICAL DAILY OPERATIONS**  
24 **WOULD EXTEND IN THE VICINITY OF 8000 FEET FROM THE PROPOSED**  
25 **PLANT, WITH DAILY NOISE LEVELS OF 45 dBA AND ABOVE EXCEEDING**  
26 **SEVERAL THOUSAND FEET FROM THE PLANT.” HOW DOES THAT**  
27 **STATEMENT AFFECT YOUR CONCLUSION THAT CREC WILL STAY**  
28 **BELOW 43 dBA?**

1    **A.**     It must be understood that RIDEM is referring to noise levels in the forest directly adjacent  
2    to CREC, not at the residences that are located approximately 2,300 feet from the CREC. So, yes,  
3    noise levels will be greater than 45 dBA within parts of the forest very near the CREC, but no  
4    more than 43 dBA at any residences. Also, RIDEM’s statement that “... noise from typical daily  
5    operations would extend in the vicinity of 8000 feet from the proposed plant” is true. Noise from  
6    any source continues to propagate for many 1,000’s of feet before losses created by spreading and  
7    by the atmosphere or the presence of other sounds render it inaudible. It should be pointed out that  
8    the noise model I prepared did not take any credit for noise attenuation that will occur by  
9    propagation through the forest, so the analysis is conservative. Finally, RIDEM commented that  
10   the noise level contour figures shown in the March 2016 transient noise report were printed at too  
11   large a scale to be able to see noise impacts in the forest adjacent to the CREC. To address this,  
12   the figures have been reproduced at a smaller scale. A copy of the figures were included in  
13   Invenergy’s Responses to RIDEM’s 4<sup>th</sup> Set of Data Requests as Exhibit 4-6.

14   **Q.**     **RIDEM ALSO STATES THAT “WHAT IS CLEAR IS THAT THE PROPOSED**  
15    **LOCATION OF THIS FACILITY AND THE FOREST CLEARING WOULD**  
16    **EXTEND NOISE IMPACTS FURTHER INTO THE SURROUNDING INTACT**  
17    **FOREST TO THE SOUTH[.]” DO YOU AGREE?**

18   **A.**     Again, RIDEM is referring to the forested land directly adjacent to the proposed CREC  
19    site, not at the location of residences. They are also referring to what happens to noise as the result  
20    of the operation of both CREC and the Algonquin compressor station. The operation of CREC in  
21    its proposed location will *reduce* compressor station noise to the south, because it will act as a  
22    large barrier. The CREC will also add the noise that it generates. The compressor station and CREC  
23    have different noise signatures, noise levels and cycles of operation. At the edge of the forest close  
24    to the fence of CREC to the south, noise levels could be higher than they are today given proximity  
25    to CREC. Further back into the forest, however, noise levels would be lower in places where CREC

1 is reducing the propagation of compressor station noise more than it is adding noise to the  
2 environment. *See also* Exhibit 4-6 to Invenergy’s Responses to RIDEM’s 4<sup>th</sup> Set of Data Requests.

3 **V. RIDOH ADVISORY OPINION**

4 **Q. HAVE YOU REVIEWED THE RIDOH ADVISORY OPINION?**

5 **A.** Yes.

6 **Q. DO YOU HAVE AN OPINION REGARDING ITS NOISE ANALYSIS AND**  
7 **CONCLUSIONS?**

8 **A.** I have a number of comments regarding RIDOH’s Advisory Opinion, Final, dated  
9 September 9, 2016. First, RIDOH states that modeled CREC noise levels exceed the World Health  
10 Organization’s (“WHO”) annual average nighttime standard of 40 dBA. In my response to  
11 RIDOH’s draft opinion, I noted that the CREC noise levels they cite are maximum noise levels  
12 (full operation and atmospheric conditions conducive to efficient sound propagation in all  
13 directions), while the WHO standard is the annual average of the 8-hour nighttime average.  
14 RIDOH concedes as much in their final opinion (pg 10, footnote 1). Yet they still compare the two  
15 and this is incorrect. Based on the fact that the very maximum noise level expected from CREC is  
16 43 dBA during start-up and 42 dBA under full baseload operation, then any reasonable estimation  
17 of annual average CREC noise levels would be less than 40 dBA when one accounts for (1) CREC  
18 either not operating at all or operating at less than baseload conditions; (2) that the 43 dBA  
19 maximum level pertains to start-up, which only lasts for approximately 30 minutes per night; (3)  
20 a given residence not always being downwind of CREC; and (4) a temperature inversion not being  
21 present every night.

22 Second, RIDOH states that the CREC noise analysis did not include noise from the  
23 additional turbine that has been approved for the Algonquin compressor station, but has yet to be  
24 installed. In my response to RIDOH’s draft opinion, I noted that the new station would likely be

1 quieter than the existing station, because the new equipment (turbines) would be quieter than the  
2 equipment being replaced (reciprocating engines). In fact, the report from Algonquin’s acoustical  
3 consultant’s analysis of noise from the proposed station modifications shows that the new station  
4 would be no louder than the existing one (Hoover and Keith Report 2976, February 2014). Thus,  
5 because noise from the existing compressor station was taken into account in both the  
6 measurement of ambient noise levels and the assessment of CREC noise impacts, and because the  
7 existing station and proposed modified station are acoustically equivalent, the modified station  
8 was effectively taken into account.

9 RIDOH’s Table 2 lists short-term (20 minute) measured noise levels from the Application,  
10 combines those with maximum CREC predicted levels to calculate “Total Nighttime Noise  
11 Levels”, and compares these results to the annual average WHO standard. It is not appropriate to  
12 combine these levels in any way because they are different metrics, and they are not representative  
13 of the same conditions. RIDOH notes this based on my comments to their draft opinion (pg 11  
14 footnote 11), but makes the comparison anyway.

15 In Table 3 of their final opinion, RIDOH makes a similar calculation and comparison for  
16 daytime noise levels. It concludes that the total noise levels, which for all but one of the locations  
17 are in the 51 to 53 dBA range, would “exceed the serious annoyance threshold and may cause a  
18 slightly increased risk of hypertension for nearby residents.” This conclusion is based on a  
19 comparison to the WHO daytime standard of 50 dBA (moderate annoyance) and 55 dBA (serious  
20 annoyance, low range for hypertension). Again, the comparison of short-term, maximum, and  
21 average levels is not appropriate. This is particularly true of CREC predicted levels, which apply  
22 to maximum sound propagation conditions that are generally not present during the daytime, such  
23 as a temperature inversion. Also, this is an inappropriate conclusion given that many of the noise

1 levels in Table 3 are the result of natural sounds, such as birds, insects, stream flow, and wind  
2 blowing through the trees. For example, Location 5 is over one mile away from the existing  
3 compressor station, and all of the noise measured there was from natural sounds. WHO noise  
4 annoyance relationships are based on man-made noise such as traffic, aircraft and trains, and in no  
5 way relate to natural sounds.

6 Table 4 of RIDOH’s opinion conducts a similar analysis, this time using the day-night  
7 (Ldn) noise metric. My opinion here is the same, in that inappropriate comparisons are made, and  
8 the criteria on which they base their conclusions relate to man-made noise, not natural sounds.

9 Finally, in its conclusions section, RIDOH “strongly recommends that the EFSB establish  
10 clear noise limitations and require the CREC facility, if constructed, to work in conjunction with  
11 Algonquin to ensure that neighborhood noise impacts are minimized to the fullest extent possible.  
12 If noise levels from operation of the facility, by itself or in conjunction with Algonquin, cause  
13 neighborhood disturbances, all available actions to mitigate those impacts should be pursued,  
14 including, but not be limited to, equipment and operational modifications, soundproofing of  
15 impacted residences and, if indicated, the purchase of properties subject to noise levels that cause  
16 serious annoyance and/or sleep disruption.” In my opinion, the Town’s 43 dBA limit is very  
17 protective of the community, and serves the purpose which RIDOH seeks. Open-ended statements  
18 by RIDOH, such as, to ensure that neighborhood noise impacts are minimized to the “fullest extent  
19 possible” and to use “all available actions” if noise from the CREC causes a “neighborhood  
20 disturbance” are vague, open-ended and difficult to enforce. *See also* Exhibit B to Invenergy’s  
21 Responses to RIDOH’s 1<sup>st</sup> Set of Data Requests.

22 **VI. CONCLUSIONS**

23 **Q. BASED ON YOUR EXPERTISE IN THE FIELD OF NOISE CONTROL**  
24 **ENGINEERING, TO A REASONABLE DEGREE OF CERTAINTY, DO YOU**

1           **HAVE AN OPINION AS TO WHETHER CREC CAN AND WILL ACHIEVE THE**  
2           **DECIBEL LEVEL STATED IN THE TOWN'S NOISE ORDINANCE?**

3  
4   **A.**     I do. I am very confident that CREC will meet the Town's 43 dBA noise level limit. The  
5 Project's acoustical model of noise from CREC was constructed with great care, detail and  
6 engineering information and effort, and the model is based on our twenty (20) years of experience  
7 with combined-cycle power plants. The model demonstrates compliance under worst-case  
8 operational and atmospheric conditions. In fact, there will be many times when noise from the  
9 plant will be lower than those reported by the Project.

10           Invenergy has committed to a very significant amount of noise reduction. With regard to  
11 noise, no part of the Facility was left to chance. Invenergy is committed to making sure that noise  
12 compliance is achieved as the Project moves into final design, procurement, construction and  
13 operation.

14   **Q.**     **BASED ON YOUR EXPERTISE AND ANALYSIS, DO YOU HAVE AN OPINION**  
15           **WHETHER THE NOISE FROM THE PROJECT WILL CAUSE**  
16           **UNACCEPTABLE HARM TO THE ENVIRONMENT OR PUBLIC HEALTH?**

17  
18   **A.**     Because the noise will comply with the Town's Noise Ordinance and applicable standards  
19 set by the Board for previous projects, it is my opinion that the Project will not cause unacceptable  
20 harm to the environment or public health.

21   **Q.**     **DOES THAT CONCLUDE YOUR DIRECT TESTIMONY?**

22   **A.**     Yes.

# **EXHIBIT MH-1**

# IMI CCI's Experience in Low-Noise ACC Systems Applied to Invenergy Clear River Energy Center



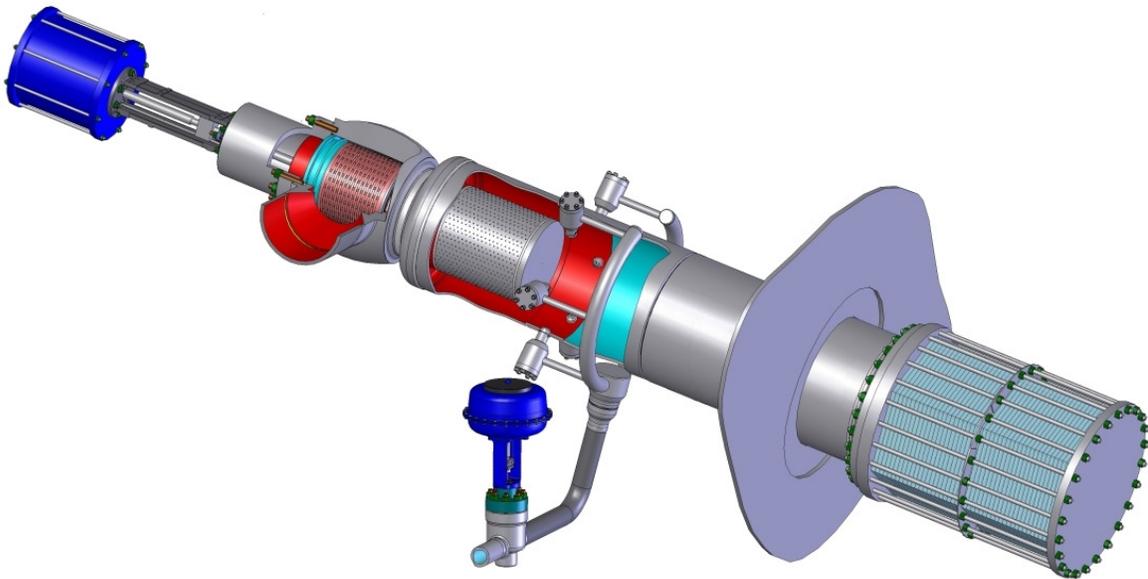
November 22, 2016

## To Whom It May Concern:

IMI CCI has been asked to provide a brief history of our experience in low-noise, air-cooled condenser (ACC) systems and demonstrate how that experience has translated to the proposed offering at Clear River Energy Center (CREC). This information has been summarized below.

## Introduction

IMI CCI has been providing low-noise solutions for turbine bypass systems and air-cooled condensers for nearly 20 years. These systems have two primary noise sources: the bypass valve, which controls the pressure and temperature of the steam from the boiler, and the condenser dump element, which discharges steam into the vacuum condenser (see Figure 1). Both of these noise sources can generate noise levels up to 115 dBA measured 3 feet from the ACC duct if the system is improperly designed.



*Figure 1 Turbine Bypass to Condenser System*

The noise generated by the bypass valve and condenser dump element at the ACC duct surface can be significantly reduced by using a combination of smaller passage sizes and multi-stage pressure reduction. Small passage sizes shift the peak frequency of jets discharging from the dump element to higher frequencies of the audible range where noise can be more easily controlled. Multi-stage pressure reduction reduces the discharge velocity of jets on the surface of the dump element. In some cases, both approaches must be applied in order to achieve the necessary noise performance. DRAG® multi-stage technology provides the best possible noise performance in bypass to condenser applications.

IMI CCI has provided low-noise bypass valves and condenser dump devices that generate noise levels of 85 to 90 dBA located 3 feet from the ACC duct. In our experience, these designs meet or

# IMI CCI's Experience in Low-Noise ACC Systems Applied to Invenergy Clear River Energy Center



exceed the requirements of many of our customers. IMI CCI's technology can be combined with other countermeasures to further limit plant boundary noise.

## IMI CCI's First Experiences with Air-Cooled Condensers

IMI CCI's first experience with high noise levels on bypass systems with ACCs was in 2001. The facility noise levels measured as A-weighted sound pressure levels for the 578 MW CCPP in California were not allowed to exceed 45 dBA (A-weighted decibels) at any residence. The originally measured noise levels 3 feet from the duct were 115 dBA and the noise levels measured at the nearest residences were in excess of the 45 dBA noise requirement. As with most bypass systems in combined cycle power plants (CCPP), the dominant source of noise was the Hot Reheat (HRH) bypass to condenser system.



Figure 2 Local Residences Near an ACC

IMI CCI provided a new multi-stage DRAG® resistor condenser dump element to replace the original single-stage device. The resistors reduced the noise 3 feet from the ACC duct from 115 dBA to 105 dBA. Through addressing only the condenser dump element in the duct by changing out the

# IMI CCI's Experience in Low-Noise ACC Systems Applied to Invenergy Clear River Energy Center



single-stage drilled-hole configuration with large passages to a 12 stage device with significantly smaller passages, IMI CCI was able to achieve 43 dBA at the nearest residences which corresponded to the 105 dBA measurement 3 feet from the duct. The conditions during each of these tests and a summary of noise levels are shown in Table 1.

Table 1 Summary of Operating Conditions (578 MW CCPP in CA)

	Original Test	Test after Upgrade
Inlet Flow Rate (lb/h)	450,000	490,000
Inlet Steam Pressure (psig)	223	217
Condenser Pressure (in. HgA)	4.43	3.51
Sound Pressure Level at 3 feet from ACC duct (dBA)	115	105

## Implementation of Lower Noise Systems

As the boom in the CCPP market continued, there was a shift in focus from the specification of far-field noise levels to near-field noise levels specifically around the ACC duct and determining what the achievable noise levels were. This would require changing not only the condenser dump elements but addressing noise at the different sources in the bypass valve by utilizing multi-stage trim to reduce fluid velocities and outlet pressure reducing stages with small passages to shift noise to higher frequency ranges. The use of multi-stage DRAG® technology in both the valve trim and the condenser dump element allowed noise levels of 87 to 93 dBA to be met in most bypass applications.

The 809 MW CCPP in Massachusetts was noise tested in 2005 where IMI CCI was able to meet 87 dBA when tested at a condenser pressure of 6.11 inches of HgA. IMI CCI met the specified noise levels at the condenser pressure specified by the client.

The project demonstrated the impact of low condenser pressures on secondary low-frequency noise generation, something that current industry standards for control valve noise from IEC/ISA still do not consider in their methodology. Table 2 summarizes the operating conditions and noise data for the HRH system at the 809 MW CCPP in MA.

Table 2 Noise as a function of Duct Pressure (809 MW CCPP in MA)

	Operating Conditions
Inlet Flow Rate (lb/h)	550,000
Inlet HRH Pressure (psig)	260
Condenser Pressure (in. HgA)	6.11
Sound Pressure Level at 3 feet from ACC duct (dBA)	87

In 2008, IMI CCI produced the lowest noise bypass system in its history at Keahole Generating Station in Hawaii. The system was a main steam bypass where near-field requirements were 65 dBA at 3 feet from the ACC duct. The plant fence-line requirement was 55 dBA at peak hours and 45 dBA off-peak due to the local residences. Using a combination of DRAG® trim in the bypass valve and a 12 stage DRAG® condenser dump element in series with an inline silencer, the plant has been able to consistently meet the 55/45 dBA requirements at the plant boundary. The maximum noise operating case is shown in Table 3. This project was a culmination of IMI CCI's progress in low-noise bypass systems made between the years of 2001 and 2008.

# IMI CCI's Experience in Low-Noise ACC Systems Applied to Invenergy Clear River Energy Center



Table 3 Summary of Start-up Conditions (Keahole Generating Station)

Maximum Noise Operating Case	
Inlet Flow Rate (lb/h)	82,064
Inlet Steam Pressure (psig)	866
Condenser Pressure (in. HgA)	4.07
Sound Pressure Level at 3 feet from ACC duct (dBA)	< 65

## Recommended Specifications for Clear River Energy Center

The proposed configuration for the Clear River bypass designs are as follows:

- *Multi-stage DRAG® bypass valve trim with small passages (<0.25"), < 70 psi trim exit energies*
- *Multiple pressure-reducing stages at the outlet with small passages(<0.25"), < 70 psi exit energies*
- *Multi-stage DRAG® resistor condenser dump element, 12 stages*
- *Average valve bore velocities of Mach 0.4 or less*

Table 4 shows a comparison of the particular bypass system that was the dominant source of noise at each of the various plants mentioned above:

- At the 578 MW CCGT, the single-stage cage valves generated noise levels in excess of 100 dBA at 3 feet from the ACC duct. Although the 578 MW CCGT hardware used multiple pressure-reducing stages at the outlet of the valve, the large passage sizes generated low-frequency noise that transmitted easily through the ACC duct. A DRAG® resistor with 12 stages was used to upgrade the condenser dump element.
- At the 809 MW CCGT, multi-stage DRAG® trim was introduced in the valve design along with a single outlet pressure-reducing stage, which utilized small passages. A DRAG® resistor with 12 stages was used as the condenser dump element.
- Keahole utilized both multi-stage DRAG® trim and multiple pressure-reducing stages at the outlet with small passages. A DRAG® resistor dump element with 12 stages was used in series with an inline silencer within the ACC duct.

# IMI CCI's Experience in Low-Noise ACC Systems Applied to Invenergy Clear River Energy Center



Table 4 Comparison of Equipment

		578 MW CCPP (Before Upgrade)	578 MW CCPP (After Upgrade)	809 MW CCPP	Keahole	CREC (Full- load)	CREC (Start- up)
GENERAL	Year	2001	2002	2005	2008	2016	2016
	System	HRH Bypass	HRH Bypass	HRH Bypass	HP Bypass	HRH Bypass	HRH Bypass
OPERATING CONDITIONS	Inlet Flow (lb/h)	450,000	490,000	550,000	82,064	1,155,511	594,100
	Inlet Steam Pressure (psig)	223	217	260	866	505	140
TRIM	Size	11.0"	11.0"	18"	2.5"	18"	18"
	Number of Stage(s)	1	1	2 to 4	20	4	4
	Passage Size	> 0.50"	< 0.25"	< 0.25"	< 0.25"	< 0.25"	< 0.25"
OUTLET	Number of Stage(s)	3	3	1	3	3	3
	Passage Size	> 0.25"	> 0.25"	< 0.25"	< 0.25"	< 0.25"	< 0.25"
	Average Mach	> 0.4	> 0.4	< 0.4	< 0.4	< 0.4	< 0.4
CONDENSER DUMP ELEMENT	Number of Stage(s)	1	12	12	12	12	12
	Passage Size	> 0.50"	< 0.25"	< 0.25"	< 0.25"	< 0.25"	< 0.25"
MEASURED NOISE LEVELS	Sound Pressure Level at 3 feet from ACC duct (dBA)	115	105	87	< 65	< 85 (Estimated)	< 85 (Estimated)

We hope the above information is in order. If further information is required, please do not hesitate to contact us.

Sincerely,

Farhan Ahmed, MSME  
Applications Engineer