DE 14-296

YEATON ASSOCIATES, INC.

NHPUC 5MAR'15 AM 10:57

March 3, 2015

State of New Hampshire
Public Utilities Commission
21 S. Fruit St, Suite 10
Concord, NH 03301-2429

Attn: Ms. Debra Howland, Executive Director

Re: Application Renewable energy Source Eligibility

Dear Ms. Howland:

On December 5, 2014, the New Hampshire Public Utilities Commission granted (DE 14-296) interim certification for Androscoggin Valley Hospital, thermal biomass facility as a Class I Thermal renewable energy source, effective as of March 21, 2014, through 90 days following the date of adoption of a final ruling, pursuant to N.H. RSA 362-F.

On December 5, 2014, the Commission adopted the Puc 2500 rules. In Part Puc 2505.02(g) of the adopted rules, the Commission holds that thermal facilities certified during the interim period (from January 15, 2015 through December 5, 2014) must submit updated materials that demonstrate compliance, within 90 days of the Ruling's effective date, thus by Thursday, March 5, 2015. The purpose of this letter is to provide such updated materials.

In our previous Application for Interim Certification, in addition to all other applicable requirements, we employed the methodology for measuring useful thermal energy set forth in Puc 2505.02(e)(2). In today's Application for Permanent Certification, we shall instead employ Puc 2506.06 Request for Alternative Method for Measuring Thermal Energy. In Attachment 1, we provide the information that is requested by the Commission for facilities utilizing an Alternative Method, per Puc 2505.06.

LINKED

Enclosed are two copies of the previous Application for Interim Certification, two copies of this cover letter, and two copies of Attachment 1.

Please let me know if you have any questions or need additional information.

Respectfully,

Wayne G. Fillion, P.E.

President

Enclosure

66 Jackson St, Littleton, NH 03561 | 40 So. River Rd #35, Bedford, NH 03110 | Ph: 603.444.6578 | www.yeatonassociates.com

YEATON ASSOCIATES, INC.

Attachment 1

Puc 2506.06: Request for Alternative Method for Measuring Thermal Energy
Required Information

(1) The name, mailing address, daytime telephone number, and e-mail address of the person requesting approval for the alternative method;

David Kyle, PhD, P.E.
66 Jackson Street, Littleton, NH 03561
(603) 444-6578
dkyle@yeatonassociates.com

(2) The name and location of the source at which the alternative method will be implemented;

Androscoggin Valley Hospital
59 Paige Hill Road
Berlin, NH 03570

(3) A description of the metering method otherwise required by these rules and the reasons it cannot be used with the applicant's facility;

From Puc 2506.04(m):

(1) "Q_g" means the thermal energy generated from biomass, stated in Btu;

(2) "dm_{out}/dt" means mass flow metered upstream of distribution and downstream of parasitic loads, stated in pounds per hour;

(3) "h_{out}" means the specific enthalpy at the metering point determined by temperature data and, for superheated steam, by pressure data, stated in Btu's per pound;

(4) "dm_{in}/dt" means mass flow of water into the feedwater or condensate pumps, stated in pounds per hour;

(5) "h_{in}" means the specific enthalpy at the metering point which will be a function of the enthalpy of incoming condensate and make-up water prior to the first condensate or feedwater pumps, stated in Btu's per pound;

(6) "t" means the intervals at which readings are recorded, stated in hours;

(7) All metering systems shall measure boiler feedwater flow, pressure and temperature as close to the first feedwater pump inlet as possible, thereby excluding the deaerator;

(8) Metering for systems that produce hot water shall include sensors for temperature and hot water mass flow placed as close as possible to the boiler hot water distribution header inlet;

(9) Metering for systems that produce steam shall include sensors for temperature, pressure and steam flow placed as close as possible to the steam distribution header inlet and thereby prior to distribution to process loads;

(10) For saturated steam systems, pressure and temperature shall be measured to verify the absence of superheat at the measurement point;

(11) For superheated systems, both pressure and temperature measurements shall be required;

(12) Regardless of phase, the enthalpy under the measured conditions shall either be calculated using International Association for the Properties of Water and Steam (IAPWS) Industrial Formulation 1997 (IF97) formulas, August 2007 revision, http://www.iapws.org/relguide/IF97-Rev.pdf, as specified in Appendix B, or taken from IAPWS or derivative steam tables; and

(13) Thermal sources using thermal biomass renewable energy technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm_{out}/dt, (h_{out}), and t, and subtract from that number the product of dm_{in}/dt, h_{in} and t, as stated in the formula below:

$Q_g = [dm_{out}/dt * (h_{out}) * t]-[dm_{in}/dt * (h_{in}) * t]$

<u>Reasons that it cannot be used at Androscoggin:</u>

The methodology which is used is the following:

Total Daily Thermal Energy = $[(\dot{m}_{out}) \times (h_{out}) - (\dot{m}_{in}) \times (h_{in})] \times (0.98)$.

- ($\dot{m}_{out}$) is the daily pounds of steam leaving the boiler
- (h_{out}) is the daily average specific enthalpy (Btu/lb) of steam leaving the boiler calculated using the steam temperature which is recorded once per day, and using the assumption that the steam is saturated.
- ($\dot{m}_{in}$) is the daily pounds of boiler feedwater into the boiler.

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- (h_{in}) is the daily average specific enthalpy (Btu/lb) calculated using the observed feedwater temperature.
- 0.98 is the assumed 2.0% loss in useful thermal energy due to parasitic loads, as required by draft PUC 2506.05(f).

By comparison with 2506.04(m.13) the calculation is similar to the prescribed methodology. An explanation for each exception follows.

- Mass flow rate of boiler feedwater, $\dot{m}_{in}$, is not measured directly as required by Puc 2506.04(m), because no feedwater flow meter was installed during construction. For the purposes of the calculation, we assume that it is equal to ($\dot{m}_{out}$), the measured supply steam flow rate. There exist no ancillary steam usages or parasitic loads between the steam flow meter on the steam supply line and the feedwater line, therefore the assumption is sound.

- The average daily specific enthalpy of entering feedwater (h_{in}) is assumed equal to that of saturated water at 195°F. The facility staff reports this to be the average temperature as monitored daily on an analogue thermometer positioned at the boiler feedwater just before entering the boiler. Note that a variation of ± 10°F has an effect on the order of approximately 1.0% on the calculated Useful Thermal Energy, which is well within the required 5% system accuracy.

- The temperature of the supply steam, and the mass flow rate, are measured directly, however there is no pressure measurement on the steam supply line as required Puc 2506.04(m). The average daily specific enthalpy of steam leaving the boilers (h_{out}) is assumed equal to saturated steam at the daily recorded supply temperature. This boiler model has no capability for producing superheated steam (no superheat coils).

- (h_{out}) and ($\dot{m}_{out}$) are daily values in the above equation, not hourly. The reason for this is that although the mass flow rate is measured hourly electronically, temperature is not recorded hourly, and so the (multiplicative) product (h_{out})x($\dot{m}_{out}$) can only be reported as a daily average value.

(4) <u>A description of the proposed alternative method;</u>

We are proposing that the methodology for measuring useful thermal energy continue to be exactly the methodology that has been used during the interim period. Please see the attached Application for a thorough description of this methodology.

(5) <u>Technical data and information demonstrating that the accuracy of the method otherwise required by these rules will be substantially achieved by the proposed alternative method, such data and information may include third party data such as product test results from independent test laboratories, performance data based on nationally recognized product test/certification programs,</u>

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published resource data for use in calculations, and examples of the use of the method by other organizations for similar purposes; and

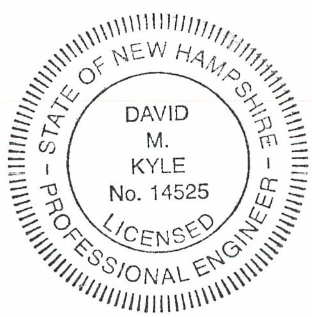
All sensor information has been provided on the Interim Application (enclosed), Part 3. Briefly,

1. Steam mass flow meter accuracy = 2.48%
2. Steam supply Temperature Sensor accuracy = 0.05% (typical thermistor)
3. Required system accuracy (= ± 5%)

(6) A statement from a professional engineer licensed by the state of New Hampshire and in good standing of the meter accuracy rate that will be achieved by the alternative metering method and that the proposed alternative method is technologically sound.

I, David Kyle, P.E., attest that the meter accuracy of 5.0% will be achieved by the alternative metering method given proper maintenance and repair practices, and that the proposed alternative method is technologically sound.

Name	Date
	03/03/2015



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YEATON ASSOCIATES, INC.

July 2, 2014

State of New Hampshire
Public Utilities Commission
21 S. Fruit St, Suite 10
Concord, NH 03301-2429

Attn: Ms. Debra Howland, Executive Director

Re: Application Renewable Energy Source Eligibility

Dear Ms. Howland:

Enclosed, please find a completed, original Application for Renewable Energy Source Eligibility for Class I Thermal Sources with Renewable Thermal Energy Capacity Greater than 150,000 Btu/hr, pursuant to New Hampshire Administrative Code PUC 2500 Rules.

Also enclosed are two copies of the Application, along with two copies of this cover letter.

Please let me know if you have any questions or need additional information.

Respectfully,

Wayne G. Fillion, P.E.
President

Enclosure

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State of New Hampshire
Public Utilities Commission
21 S. Fruit Street, Suite 10, Concord, NH 03301-2429

DRAFT

APPLICATION FORM FOR

RENEWABLE ENERGY SOURCE ELIGIBILITY FOR CLASS I THERMAL SOURCES WITH RENEWABLE THERMAL ENERGY CAPACITY GREATER THAN 150,000 BTU/HR

Pursuant to New Hampshire Administrative Code PUC 2500 Rules

- Please submit one (1) original and two (2) paper copies of the completed application and cover letter* to:

Debra A. Howland
Executive Director
New Hampshire Public Utilities Commission
21 South Fruit Street, Suite 10
Concord, NH 03301-2429

- Send an electronic version of the completed application and the cover letter electronically to executive.director@puc.nh.gov.

* The cover letter must include complete contact information and identify the renewable energy class for which the applicant seeks eligibility. Pursuant to PUC 2505.01, the Commission is required to render a decision on an application within 45 days of receiving a completed application.

If you have any questions please contact Barbara Bernstein at (603) 271-6011 or Barbara.Bernstein@puc.nh.gov.

Only facilities that began operation after January 1, 2013 are eligible.

Is this facility part of a Commission approved aggregation?
Yes ____ No x
Aggregator's Company Name: __________
Aggregator Contact Information: __________

Contents

Attachment Labeling Instructions

Please label all attachments by Part and Question number to which they apply (e.g. Part 3-7). For electronic submission, name each attachment file using the Owner Name and Part and Question number (e.g. Pearson Part 3-7).

Part 1. General Application Information

Please provide the following information:

Applicant

Name: Littleton Regional Healthcare

Mailing Address: 600 St. Johnsbury Road

Town/City: Littleton State: NH Zip Code: 03561

Primary Contact: Henri Wante, Director of Facilities

Telephone: 603-444-9261 Cell: ______

Email Address: hwante@lrhcares.org

Facility

Name: Littleton Regional Healthcare

Physical Address: 600 St. Johnsbury Road

Town/City: Littleton State: NH Zip Code: 03561

If the facility does not have a physical address, the Latitude: ______ & Longitude ______

Installer

Name: Daniel Hebert, Inc.

Installer License Number: State of New Hampshire Corporate ID: 12463

Mailing Address: 18 Pleasant Street

Town/City: Colebrook State: NH Zip Code: 03576

Primary Contact: Daniel Hebert

Telephone: 603.237.4454 Cell: ______

Email Address: DHebert@dhiqc.com

If the equipment was installed by the facility owner, check here: ☐

Facility Operator

If the facility operator is different from the owner, please provide the following:

Name: ______

Facility Operator Telephone Number: ______

Independent Monitor

Name: Wayne G. Fillion

Mailing Address: 66 Jackson Street

Town/City: Littleton State: NH Zip Code: 03561

Primary Contact: David Kyle

Telephone: 603.444 6578 Cell: ____

Email Address: dkyle@yeatonassociates com

NEPOOL/GIS Asset ID and Facility Code

In order to qualify your facility's thermal energy production for RECs, you must register with the NEPOOL – GIS. Contact information for the GIS administrator follows:

James Webb
Registry Administrator, APX Environmental Markets
224 Airport Parkway, Suite 600, San Jose, CA 95110
Office: 408.517.2174
jwebb@apx.com

Mr. Webb will assist you in obtaining a GIS facility code and an ISO-New England asset ID number.

GIS Facility Code # 15514 Asset ID # NON41354

1. Has the facility been certified under another non-federal jurisdiction's renewable portfolio standards?

Yes [ ] No [x]

If you selected yes, *please provide proof of certification in the form of an attached document as Attachment 1-1.*

2. Attach any supplementary documentation that will help in classification of the facility as Attachment 1-9

Part 2. Technology Specific Data

All Technologies

Fuel type (solar, geothermal, or biomass): biomass

Rated Thermal Capacity (Btu/hr): 12,000,000 Btu/hr

Date of initial operation using renewable fuels: January 15, 2014

Biomass

If a thermal biomass facility, provide proof of New Hampshire Department of Environmental Services approval that the facility meets the emissions requirements set forth in Puc 2500, as Attachment 2-1.

Solar Thermal

If a solar thermal facility, please provide the Solar Rating and Certification Corporation rating based on Mildly Cloudy C (kBtu/day): ______________________________

Geothermal

If a geothermal facility, please provide the following:

The coefficient of performance (COP): ______________________________

The energy efficiency ratio of the system: ______________________________

Part 3. Metering and Measurement of Thermal Energy and REC Calculations

This section deals with the thermal metering system including methods for calculation and reporting useful thermal energy. **A copy of PUC 2506.04 of the RPS rules is included as Appendix A.**

Using the table below, identify the thermal metering system or custom components (e.g., heat meters, flow meters, pressure and temperature sensors) used to measure the useful thermal energy and enter the accuracy of measurement for the entire system:

System or Component	Product name	Product Manufacturer	Model No.
Boiler feedwater mass flow rate	CMAG/EMAG-11 Electromagnetic FLowmeter converter CMAG-II-F/W Electromagnetic Flowmeter Detector		Manufacturer: Central Station Steam Company Model/Size: 2-inches.
Supply Steam Pressure Sensor/Transmitter	Ashcroft A2X Explosion/Flame Proof Pressure transmitter		Manufacturer: Ashcroft Model No: A2XBM0242C2300G-XCY
Total System Accuracy (Percent)	Please not that for the interim period we will use a methodology under 2505.02(a) which appears not to require calculation of "Total System Accuracy". That said, we offer the following data: *Mass Flow Meter: Manufacturer's guaranteed accuracy is 0.25% of rate. *Pressure Transmitter: Manufacturer's guaranteed accuracy for the A2XB is 0.5% of Range (range=300 psi)		

Attach component specification sheets (Accuracy, Operating Ranges) as Attachment 3-1. [x]

Attach a simple schematic identifying the location of each sensor that is part of the metering system as Attachment 3-2. [x]

Check the applicable standard for meter accuracy prescribed in Puc 2506.04 among the six choices below (compliance with Puc 2506.04 shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing):

If the facility is a large thermal source using a liquid or air based system, check the method that applies:

A. Installation and use of heat meters capable of meeting the accuracy provisions of European Standard EN 1434 published by CEN, the European Committee for Standardization. The heat meter shall have the highest Class flow meter that will cover the design flow range at the point of measurement and a temperature sensor pair of Class 5K or lower. [ ]

B. Installation and use of meters that do not comply with European Standard EN 1434, provided that the manufacturers' guaranteed accuracy of the meters is ±5.0% or better, [ ]

C. Use of an alternative metering method approved pursuant to Puc 2506.06. [ ]

If the facility is a large thermal source using a steam-based system, check the method that applies:

D. Installation and use of meters with accuracy of ±3.0% or better. [x]

E. Installation and use of meters with system accuracy that do not meet D but are ±5% or better. [ ]

F. Use of an alternative metering method approved pursuant to Puc 2506.06. [ ]

Please summarize the manufacturer's recommended methods and frequency for metering system calibration and provide reference for source document (e.g. owners/operators manual):

Please see attached "Littleton Regional Healthcare Attachment 3 3 - Calibration Remarks"

REC Calculation Discount factor for meter accuracy (Enter 0 if no discount is required): 0 %

If the meters used to measure useful thermal energy comply with the accuracy of the European Standard EN 1434 for liquid systems or use of meters with accuracy of ±3.0% or better for steam systems enter zero, for all other systems enter the sum total of the manufacturer's guaranteed accuracy of the meters used or the accuracy of the alternative method approved pursuant to Puc 2506.06.

REC Calculation Discount factor for operating energy and thermal energy losses: 2.0 %

Check the method used for determining the operating energy and thermal loss factor among the choices below:

Default Factor [2.0]

- For sources using solar thermal technology, the discount factor shall be 3.0% of the useful thermal energy produced;
- For sources using geothermal technology, the discount factor shall be 3.6% of the useful thermal energy produced;
- For sources using thermal biomass renewable energy technology, the discount factor shall be

2.0% of the useful thermal energy produced.

Actual Metering ☐

- Include a simple schematic identifying the operating energy and thermal energy losses and placement of the meters.

Interim Alternative Metering Method

Until such time as the Puc 2500 rule is finalized applicants may utilize an alternative method as described in the draft rule 2505.02(e)(2):

> *In lieu of the information required by Puc 2505.02 (d) (11) through (13), a thermal source may submit a detailed explanation of the methodology used to measure and calculate thermal energy and an attestation by a professional engineer that is licensed in New Hampshire and in good standing that the methodology for measuring useful thermal energy and calculating certificates is sound.*

Please see attachment, "Littleton Regional Healthcare Attachment 3.4 - Interim Alternative Metering Method"

Part 4. Affidavits

Owners Affidavit

The following affidavit must be completed by the owner attesting to the accuracy of the contents of the application pursuant to PUC 2505.02 (b) (14).

AFFIDAVIT

I, Henri Waite have reviewed the contents of this application and attest that it is accurate and is signed under the pains and penalties of perjury.

Applicant's Signature Henri Waite Director of facilities Date 7/2/14

Applicant's Printed Name HENRI WAITE

Subscribed and sworn before me this 2nd Day of July (month) in the year 2014

County of Grafton State of New Hampshire

Sarah Rickey

Notary Public/~~Justice of the Peace Seal~~

SARAH S. RICKEY MY COMMISSION EXPIRES JAN. 27, 2015 NOTARY PUBLIC NEW HAMPSHIRE

My Commission Expires 1-27-2015

NH Professional Engineer Affidavit

AFFIDAVIT

I, WAYNE G. FILLION attest that this facility meets the requirements of the thermal REC eligibility requirements of Puc 2500, including the thermal metering and measurement methodologies and standards and REC calculation methodologies.

Professional Engineer's Signature Wayne Fillion Date 7-1-14

Professional Engineer's Printed Name WAYNE G. FILLION

NH Professional Engineer License Number NH # 07427

PE Stamp

THE STATE OF NEW HAMPSHIRE WAYNE G. FILLION NO. 7427 LICENSED PROFESSIONAL ENGINEER

Application Checklist				
Application Section		Item Description	Attachment Required	Check box
Part 1-1		Applicant Information		☐
Part 1-2		Facility Location Information		☐
Part 1-3		Installer Contact Information		☐
Part 1-4		Equipment Seller Information		☐
Part 1-5		Facility Monitor Information		☐
Part 1-6		Regulatory Approvals for REC Requirements	Yes	☐
Part 1-7		Other REC Certifications		☐
Part 1-8		Facility Output Information		☐
Part 1-9		Facility Operator Information		☐
Part 1-10		Additional Facility Classification Information		☐
Part 1-11		Attestation that Building Codes are Met		☐
Part 2-1		Rated Thermal Capacity		☐
Part 2-2a		Thermal Biomass Facility, 3-99 MMBTu/hour Output		☐
Part 2-2b		Thermal Biomass Facility, 100+ MMBTu/hour Output		☐
Part 2-3		Solar Thermal Facility Solar Rating and Certification Corporation Rating		☐
Part 2-4a		Geothermal Facility Coefficient of Performance		☐
Part 2-4b		Geothermal Facility Energy Efficiency Ratio		☐
Part 3-1		Equipment and Meter Description		☐
Part 3-2		Recommended Methods for Meter Calibration		☐
Part 3-3		Attestation that Meters meet PUC 2506 Requirements		☐
Part 3-4		Guaranteed Accuracy of Meters		☐
Part 3-5a		Small Thermal Source- Calculating Useful Thermal Out		☐
Part 3-5b		Large Thermal Source- Calculating Useful Thermal Out		☐
Part 3-6		Meter Accuracy Discount Factor		☐
Part 3-7a		PUC 2506 Operating Energy and Thermal Loss Discount Factor		☐
Part 3-7b		Determining Operating Energy and Thermal Loss Discount Factor		☐
Part 4-1		Owner Affidavit		☐
Part 4-2		Professional Engineer Affidavit		☐

Appendix A. Excerpt from Puc 2500 – Certain Thermal Metering Provisions

For complete rules and requirements related to the RPS and REC eligibility, please refer to Puc 2500.

Puc 2506.04 Metering of Sources that Produce Useful Thermal Energy

(a) Sources producing useful thermal energy shall comply with this part in metering production of useful thermal energy.

(b) Sources shall retain an independent monitor to verify the useful thermal energy produced.

(c) Sources shall take data readings for the measurement of useful thermal energy at least every hour. The useful thermal energy produced shall be totaled for each 24 hour period, each monthly period, and each quarter.

(d) Sources shall install meters to measure thermal energy output in compliance with the manufacturer's recommendations and as noted in this part.

(e) Large thermal sources using a liquid or air based system shall measure the useful thermal energy produced using one of the following methods:

(1) Installation and use of heat meters with an accuracy that complies with European Standard EN 1434 published by CEN, the European Committee for Standardization, and that complies with paragraph (k), (l) or (m). The heat meter shall have the highest Class flow meter that will cover the design flow range at the point of measurement and a temperature sensor pair of Class 5K or lower. Compliance shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing;

(2) Installation and use of meters that do not comply with subparagraph (e) (1), provided that the manufacturers' guaranteed accuracy of the meters is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the meters were installed and operate according to the manufacturers' specifications and in accordance with paragraph (k), (l) or (m); or

(3) Use of an alternative metering method approved pursuant to Puc 2506.06, provided that the accuracy of any such method is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the source implemented the alternative method as approved by the commission and certifies that the alternative method achieves the stated accuracy of ±5.0% or better.

(f) Large thermal sources using a steam-based system shall measure the useful thermal energy produced using one of the following methods:

(1) Installation and use of meters with accuracy of ±3.0% or better, which compliance shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing and in accordance with paragraph (m);

(2) Installation and use of meters that do not comply with the accuracy of subparagraph (f)(1), provided that the manufacturer's guaranteed accuracy of the meters is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the meters were installed and operate according to the manufacturer's specifications and in accordance with paragraph (m); or

(3) Use of an alternative metering method approved pursuant to this section, provided that the accuracy of any such method is ±5.0% or better, and provided that a professional engineer licensed by the state of New Hampshire and in good standing certifies that the source implemented the alternative method as approved by the commission and certifies that the alternative method achieves the stated accuracy of ±5.0% or better.

(g) Small thermal sources shall measure useful thermal energy produced using one of the following methods:

(1) For any small thermal sources, the methods described in paragraphs (e) or (f);

(2) For small thermal sources using solar thermal technologies, the method described in paragraph (h);

(3) For small thermal sources using geothermal technologies, the method described in paragraph (i); or

(4) For small thermal sources using thermal biomass technologies, the method described in paragraph (j).

(h) Calculation of useful thermal energy produced by small thermal sources using solar technologies.

(1) "Q" means thermal energy generated, stated in Btu's.

(2) "R" means the Solar Rating and Certification Corporation (SRCC) OG100 rating on Mildly Cloudy C Conditions, stated in thousands of Btu's per day.

(3) "L" means the orientation and shading losses calculated based on solar models such as Solar Pathfinder, T-sol, Solmetric, or another model approved by the Commission, converted from a percentage to the equivalent number less than 1.

(4) "t" means the total operating run time of the circulating pump as metered, stated in hours.

(5) "h" means 11 hours per day to convert the SRCC OG100 rating to an hourly basis (conversion factor).

(6) To calculate Q, the useful thermal energy produced by small thermal sources using solar technologies, the source shall compute the product of R, t and the result of 1 minus L, and divide the result by the product of h and 1,000, as in the formula below:

$$Q = [R * t * (1 - L)] / (h * 1,000)$$

(i) Calculation of useful thermal energy produced by small thermal sources using geothermal technologies.

(1) "Q" means thermal energy generated, stated in Btu's.

(2) "HC" means the Air Conditioning, Heating and Refrigeration Institute (AHRI) certified heating capacity at part load, stated in Btu's per hour.

(3) "COP" means the AHRI Certified Coefficient of Performance.

(4) "t" means total operating run time of the pump when the entering water temperature is greater than the leaving water temperature, stated in hours.

(5) Small thermal sources using geothermal technologies may calculate Q, the useful thermal energy produced, by multiplying HC by the difference between COP and 1, multiplying the result by t, and dividing the result by COP, as in the formula below:

$$Q = [HC * (COP - 1) * t] / COP$$

(j) Calculation of useful thermal energy produced by small thermal sources using thermal biomass renewable energy technologies.

(1) "Q" means the thermal energy generated, stated in Btu's.

(2) "D" means the default pellet density, which shall be 0.0231 pounds per cubic inch.

(3) "R" means the auger revolutions per hour.

(4) "V" means auger feed volume, stated in cubic inches per auger revolution. Small thermal sources shall assume that V equals one of the following:

a. 5 cubic inches per revolution for augers with a 2" inside diameter;

b. 20 cubic inches per revolution for augers with a 3" inside diameter;

c. 50 cubic inches per revolution for augers with a 4" inside diameter;

d. 95 cubic inches per revolution for augers with a 5" inside diameter; or

e. 150 cubic inches per revolution for augers with a 6" inside diameter.

(5) "EC" means the default energy content of pellet fuel, which shall be 7870 Btu per pound.

(6) "ASE" means the default thermal efficiency expressed as a percentage based on the manufacturer's warranty of average seasonal thermal efficiency, or based on a default thermal efficiency of 65%.

(7) "t" means the total auger run time in hours as metered.

(8) The estimated amount of fuel burned (the product of D, R, V and t) shall be verified by the fuel purchase records and fuel inventory.

(9) Small thermal sources using thermal biomass renewable energy technologies with wood pellets as the fuel source may calculate Q, the useful thermal energy produced, by computing the product of D, R, V, EC, ASE and t, as in the formula below:

$$Q = (D * R * V * EC * ASE * t)$$

(k) Thermal sources using solar thermal technologies.

(1) "Q_g" means the heat generated in the collector loop, stated in Btu's.

(2) "dm/dt" means the mass flow of the collector working fluid measured near the inlet to the solar storage tank, stated in pounds per hour.

(3) "c_p" means the specific heat of the collector fluid, stated in Btu's per pound (mass), degrees Fahrenheit (BTU/lbm-°F).

(4) "Ti" means the collector loop inlet temperature measured near the outlet of the solar storage tank, stated in degrees Fahrenheit.

(5) "To" means the collector loop outlet temperature measured near the inlet to the solar storage tank, stated in degrees Fahrenheit.

(6) "t" means the frequency at which data readings are recorded, stated in hours.

(7) Meter sensors shall be installed on the collector loop as close to the water storage tank as practical and in accordance with the meter manufacturer's guidance.

(8) Thermal sources using solar thermal technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm/dt, c_p, the difference between To and Ti, and t, as stated in the formula below:

$$Q_g = (dm/dt)*c_p *(To - Ti) * t$$

(l) Thermal sources using geothermal technologies.

(1) "Q_g" means heat generated in the ground loop, stated in BTU's.

(2) "dm/dt" means mass flow measured near the outlet of the ground loop, stated in pounds per hour.

(3) "c_p" means specific heat of the working fluid, stated in BTU/lbm-°F.

(4) "t" means the frequency at which data readings are recorded, stated in hours.

(5) "Ti" means ground loop inlet temperature measured at the inlet to the ground loop, stated in degrees Fahrenheit.

(6) "To" means ground loop outlet temperature measured at the outlet from the ground loop, stated in degrees Fahrenheit.

(7) Bleed points, supplemental boilers and cooling towers shall be excluded from the calculation.

(8) Meter sensors shall be installed on the ground loop as close to the ground loop inlet and outlet as practical and in accordance with the manufacturer's recommendation.

(9) Thermal sources using geothermal technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm/dt, c_p, the difference between To and Ti, and t, as stated in the formula below:

$$Q_g = (dm/dt) * c_p * (To - Ti) * t$$

(m) Thermal sources using thermal biomass renewable energy technologies.

(1) "Q_g" means the thermal energy generated from biomass, stated in Btu.

(2) "dm_{out}/dt" means mass flow metered upstream of distribution and downstream of parasitic loads, stated in pounds per hour.

(3) "h_{out}" means the specific enthalpy at the metering point determined by temperature data and, for superheated steam, by pressure data, stated in Btu's per pound.

(4) "dm_{in}/dt" means mass flow of water into the feedwater or condensate pumps, stated in pounds per hour.

(5) "h_{in}" means the specific enthalpy at the metering point which will be a function of the enthalpy of incoming condensate and make-up water prior to the first condensate or feedwater pumps, stated in Btu's per pound.

(6) "t" means the frequency at which data readings are recorded, stated in hours.

(7) All metering systems shall measure boiler feedwater flow, pressure and temperature as close to the first feedwater pump inlet as possible, thereby excluding the deaerator.

(8) Metering for systems that produce hot water shall include sensors for temperature and hot water mass flow placed as close as possible to the boiler hot water distribution header inlet.

(9) Metering for systems that produce steam shall include sensors for temperature, pressure and steam flow placed as close as possible to the steam distribution header inlet and thereby prior to distribution to process loads.

(10) For saturated steam systems, pressure and temperature shall be measured to verify the absence of superheat at the measurement point.

(11) For superheated systems, both pressure and temperature measurements shall be required.

(12) Regardless of phase, the enthalpy under the measured conditions shall either be calculated using International Association for the Properties of Water and Steam (IAPWS) Industrial Formulation 1997 (IF97) formulas or taken from IAPWS or derivative steam tables.

(13) Thermal sources using thermal biomass renewable energy technologies shall calculate Q, the useful thermal energy produced, by calculating the product of dm_{out}/dt, (h_{out}), and t, and subtract from that number the product of dm_{in}/dt h_{in} and t, as stated in the formula below:

$$Q_g = [dm_{out}/dt * (h_{out}) * t] - [dm_{in}/dt * (h_{in}) * t]$$

Puc 2506.05 <u>Calculation of Certificates for Production of Useful Thermal Energy</u>

(a) Sources producing useful thermal energy, the independent monitor or the designated representative shall report to GIS the useful thermal energy produced and the amount of RECs calculated pursuant to this part, as verified by the source's independent monitor.

(b) Useful thermal energy shall be expressed and reported in megawatt-hours where each 3,412,000 Btu's of useful thermal energy is equivalent to one megawatt-hour.

(c) Small thermal sources shall receive certificates based on the useful thermal energy produced as metered pursuant to Puc 2506.04(e) or (f) and discounted, as applicable, by the discount for meter accuracy pursuant to paragraph (e) or as calculated pursuant to Puc 2506.04(h), (i), or (j).

(d) Large thermal sources shall receive certificates based on the useful thermal energy calculated pursuant to Puc 2506.04(e) or (f), discounted by the sum of the percentage discount for meter accuracy pursuant to paragraph (e) and the percentage discount for operating energy and thermal storage losses, or parasitic load, pursuant to paragraph (f).

(e) The discount factor for meter accuracy referenced in paragraphs (c) and (d) shall be one of the following:

(1) If the meters used to measure useful thermal energy output comply with the accuracy of the European Standard EN 1434 as provided in Puc 2506.04(e)(1) or the accuracy pursuant to Puc 2506.04(f)(1), there shall be no meter accuracy discount; or

(2) If the meters used to measure useful thermal energy output do not comply with the accuracy of the European Standard EN 1434 as provided in Puc 2506.04(e)(1) or the accuracy pursuant to Puc 2506.04(f)(1), the applicable meter discount shall be the manufacturer's guaranteed accuracy of the meters used or the accuracy of the alternative method approved pursuant to Puc 2506.06.

(f) The discount factor for large thermal sources for parasitic load referenced in paragraph (d) shall be one of the following:

(1) For sources using solar thermal technology, the discount factor shall be 3.0% of the useful thermal energy produced as measured pursuant to Puc 2506.04;

(2) For sources using geothermal technology, the discount factor shall be 3.6% of the useful thermal energy produced as measured pursuant to Puc 2506.04;

(3) For sources using thermal biomass renewable energy technology, the discount factor shall be 2.0% of the useful thermal energy produced as measured pursuant to Puc 2506.04; or

(4) The discount factor shall be the source's actual metering of the parasitic load.

Puc 2506.06 Request for Alternative Method for Measuring Thermal Energy

(a) A source shall not use an alternative metering method until that alternative method is approved by the commission.

(b) A source seeking approval of an alternative method shall submit an application to the commission that includes the following information:

(1) The name, mailing address, daytime telephone number, and e-mail address of the person requesting approval for the alternative method;

(2) The name and location of the source at which the alternative method will be implemented;

(3) A description of the metering method otherwise required by these rules and the reasons it cannot be used with the applicant's facility;

(4) A description of the proposed alternative method;

(5) Technical data and information demonstrating that the accuracy of the method otherwise required by these rules will be substantially achieved by the proposed alternative method (such data and information may include third party data such as product test results from independent test laboratories, performance data based on nationally recognized product test/certification programs, published resource data for use in calculations, and examples of the use of the method by other organizations for similar purposes); and

(6) Certification by a professional engineer licensed by the state of New Hampshire and in good standing of the meter accuracy rate that will be achieved by the alternative metering method and that the proposed alternative method is technologically sound.

(a) Electricity generation in megawatt-hours and useful thermal energy expressed in megawatt-hours shall be measured and verified in accordance with ISO-NE and GIS operating rules and this Part.

(c) The commission shall approve an alternative metering method that satisfies the requirements of paragraph (b).

Attachment 2-1

New Hampshire Department of Environmental Services Approval of Particulate Emissions Stack Test.

The State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES

Thomas S. Burack, Commissioner

April 28, 2014

Debra A. Howland
Executive Director and Secretary
New Hampshire Public Utilities Commission
21 South Fruit Street, Suite 10
Concord, NH 03301-2429

**Re: Recommended Certification as a Class I Thermal Renewable Energy Source
Littleton Regional Healthcare (LRH)
Littleton, NH**

Dear Ms. Howland:

The New Hampshire Department of Environmental Services (DES) was contacted by Charles Niebling of Innovative Natural Resource Solutions on behalf of Littleton Regional Healthcare (LRH) requesting certification of the wood-fired boilers located at LRH as a Class I thermal renewable energy source. DES recommends that the Public Utilities Commission (PUC) grant approval to LRH as a Class I thermal renewable energy source eligible to generate renewable energy certificates. A summary of the facility description, DES's review of particulate and NOx emission rates and monitoring requirements, and a recommendation for approval are presented below.

Facility Description

Facility Name: Littleton Regional Healthcare (LRH)
Facility Location: 600 Saint Johnsbury Road
Littleton, NH 03561
Gross Nameplate Capacity: 6.3 and 8.4 MMBtu/hr
Temporary (construction) Permit: TP-0127
Issue Date: May 13, 2013
Primary Fuel: Whole-tree wood chips and other low-grade clean wood fuels

Particulate Matter (PM) Emissions

By definition, "*Thermal biomass renewable energy technologies*", requires units rated between 3 and 30 MMBtu/hr gross heat input to meet a particulate matter (PM) emission rate limit of 0.10 pounds/million British thermal units (lb/MMBtu). Permit TP-0127 issued by DES contains pollution control equipment (electrostatic precipitator) operation and maintenance requirements (see Table 4, Item #7).

Emission Rate Confirmation

A PM emission test has been performed for LRH, and the test results have been reported in writing to DES. The emission test was performed for PM in accordance with the pre-test protocol reviewed by DES. The results of the emission test indicate the actual PM emission rate in lb/MMBtu meets the required 0.10 lb/MMBtu.

Nitrogen Oxides (NOx) Emissions

By definition, "*Thermal biomass renewable energy technologies*", requires units rated less than 100 MMBtu/hr gross heat input to meet best management practices (BMP) as established by DES for control of nitrogen oxides (NOx) emissions. DES herein establishes BMP as conducting boiler tune-ups annually and conducting combustion efficiency testing initially and annually demonstrating results equal to or greater than 99%.

BMP Confirmation

LRH measured actual carbon monoxide (CO) and carbon dioxide (CO_2) concentrations in the exhaust gas using a hand-held portable analyzer (or alternative method approved by DES) to determine combustion efficiency using the following equation:

$CE(\%) = 100 \times CO_2 / (CO_2 + CO)$

Where:

CE = combustion efficiency

CO_2 = % by volume of carbon dioxide in the flue gas, and

CO = % by volume of carbon monoxide in the flue gas.

The results of the initial test indicate that the combustion efficiency meets the required 99%. DES anticipates that LRH will be able to meet ongoing BMP annually.

Conclusion and Recommendation for Approval

DES believes that LRH currently meets, and annually will meet, the requirements to be certified as a Class I - New Biomass thermal renewable energy source. DES recommends that the PUC certify LRH as a Class I thermal renewable energy source eligible to generate thermal renewable energy certificates beginning the second calendar quarter 2014 (April 1, 2014), because LRH has demonstrated that the following conditions have been met:

1) LRH emits PM at an average rate less than or equal to 0.10 lb/MMBtu; and
2) LRH currently maintains CE equal to or greater than 99%.

If you have any questions, please contact me at joseph.fontaine@des.nh.gov or (603) 271-6794.

Sincerely

Joseph T. Fontaine
Trading Programs Manager
Air Resources Division

Attachment 3-1

Component Specification Sheets

1. Feedwater electromagnetic Flowmeter: Converter
2. Feedwater Electromagnetic Detector: Detector
3. Supply Steam Pressure Transmitter

66 Jackson Street | Littleton, NH 03561 | Ph 603.444 6578 | Fax 603 444 2364
www.yeatonassociates com

15. Specifications

15.1 Specifications

■ General Specifications

Measuring range: (measuring range by flow rate conversion)

Combined detector	Small/Middle meter size (1/2" to 18") CMAG-II-F/W & CMAG-RC-F/W
Measuring range	0-1.0ft/s to 0-32.8ft/s (0-0.3m/s to 0-10m/s) (A range of 0-0.3ft/s to 0-1.0ft/s (0-0.1m/s to 0-0.3m/s) can be dealt with by an option specified at order time)

Combined detector	Largel meter size (20" to 36") CMAG-* type
Measuring range	0-1.0ft/s to 0-32.8ft/s (0-0.3m/s to 0-10m/s)

Accuracy: (Accuracy when combined with the detector)

Combined detector: Small/Middle meter size (1/2" to 18") CMAG-II-F/W, CMAG-RC-F/W

Accuracy: ±0.25 % of Rate*

- * This pulse output error result is established under standard operating conditions at CSSC's flow calibration facility, (NIST Traceable).
- * Individual meter measurement error may vary up to ±0.3% of Rate at 1.64 ft/s (0.5m/s) or more and ±0.25% of rate ±0.039 inch/s (1mm/s) at 1.64 ft/s (0.5m/s) or less.
- * Current output: plus ± 8μA (0.05% of span.)
- * Refer to individual calibration data for each individual meter's measurement error.

Combined detector: Large meter size (20" to 24") CMAG-* type

Accuracy: ±0.25 % of Rate*

- * This pulse output error result is established under standard operating conditions at CSSC's flow calibration facility, (NIST Traceable).
- * Individual meter measurement error may vary up to ±0.3% of Rate at 3.28 ft/s (1.0m/s) or more and ±0.25% of Rate ±0.079 inch/s (2mm/s) at 3.28 ft/s (1.0m/s) or less.
- * Current output: plus ± 8μA (0.05% of span.)
- * Refer to individual calibration data for each individual meter's measurement error.

Combined detector: Large meter size (28" to 36") CMAG-* type

Accuracy: ±0.5 % of Rate*

- * This pulse output error result is established under standard operating conditions at CSSC's flow calibration facility, (NIST Traceable)..
- * Individual meter measurement error may vary up to ±0.5% of Rate at 3.28 ft/s (1.0m/s) or more and ±0.3% of Rate ±0.157inch/s (4mm/s) at 3.28 ft/s (1.0m/s) or less.
- * Current output: plus ± 8μA (0.05% of span.)
- * Refer to individual calibration data for each individual meter's measurement error.

(Note) Refer to individual specification sheet's accuracy when combined with another detector.

Conductivity: 3 μS/cm or more (Combined detector : CMAG-Fractional)
5 μS/cm or more (Combined detector : CMAG-II/RC & EMAG-II/RC)

Ambient temperature: -4 to 140 °F (-20 to +60℃)

Storage temperature: - 13 to 149°F (-25 to +65℃)

Power supply: 100 to 240Vac (allowable voltage range: 80 to 264Vac 50/60Hz)
24Vdc (allowable voltage range: 18 to 36Vdc) or
110Vdc (allowable voltage rangel:90 to 130Vdc)

Power consumption: Without communication function
15W (22VA) or less
When standard is used;
(10W(14VA) at 100Vac and Excitation current: 0.2A)
With communication function
17W (24VA) or less

■ Input

Input signal:
- Flow rate proportional signal from the detector
- Digital input signal
  - Signal type: 20 to 30Vdc voltage signal
  - Input resistance: About 2.7kΩ
  - Number of input points: 1

Digital input function: Select either of the following.

- Range switching input: Large/Small range switching of unidirectional double range, forward/reverse direction double range
- Counter control input: Internal totalization counter start/stop/reset control
- Output hold input: The current output and pulse output are kept to their preset values.
- Zero adjustment input: Start still water zero adjustment.

■ Output

Current output: 4 to 20mAdc (load resistance 750Ω or less)

Digital output 1:
Output type: Transistor open collector
Capacity: 30Vdc, Max 200mA
Number of output points: 1

Digital output 2: output
Output type: Semiconductor contact signal (no polarity)
Capacity: 150Vdc, Max. 150mA
150Vac (peak value), Max. 100mA
Number of output points : 1

Digital output function: Select one of the following:

- Totalization pulse output:

Pulse rate	Max. 10kHz(10000pps) ··· DO1 Max. 100Hz(100pps) ··· DO2
Pulse width	Can be set within a range of 0.3 to 500ms. However, must be 40% or less of the full-scale cycle. If the full scale 1000pps is exceeded, automatically set to 40% of the full-scale cycle.

- Multi-range switching output: In the case of fourfold range or forward/reverse double range, the digital output is used by two points.
- High and low alarm output
- High-high and low-low alarm output
- Empty alarm output
- Preset counter output
- Converter malfunction alarm output
- Multiple range high and low limit alarm output

Output display: Full-dot matrix 128 x 128-dot LCD (with back light)

■ **Communication signal**

Method (protocol): HART or PROFIBUS (option), Modbus (option)

Load resistance: 240 to 750Ω (HART)

Load capacity: 0.25 μF or less (HART)

■ **Structure**

IP67 and NEMA 4X

■ **Housing**

Aluminum alloy

■ **Coating**

Acrylic resin-baked coating, metallic-gray colored

■ **Cable connection port**

1/2-14NPT thread

Cable connections not provided.

■ **Surge arresters**

Surge arresters are installed in the power supply and current signal output circuit.

9. Specifications

The flowmeter specifications and the type specification code used when ordering the flowmeter are described in this chapter.

9.1Specifications

Meter size: 1/2, 1, 1 1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 18 inch
(15, 25, 40, 50, 80, 100, 150, 200, 250, 300, 350, 400,450 mm)

Measurement range in terms of flow velocity:
0 – 1.0 ft/s to 0 – 32.8 ft/s (0 – 0.3 m/s to 0 – 10 m/s).

0 – 0.3 ft/s to 0 – 1.0 ft/s (0–0.1 m/s to 0–0.3 m/s) range is available optionally.

System accuracy:

Accuracy: ±0.2 % of Rate*

* This pulse output error result is established under standard operating conditions at flow calibration facility, (NIST Traceable).
* Individual meter measurement error may vary up to ±0.5% of Rate at 1.64 ft/s (0.5m/s) or more and ±0.3% of rate ±0.039 inch/s (1mm/s) at 1.64 ft/s (0.5m/s)or less.
* Current output: plus ± 8μA (0.05% of span.)
* Refer to individual calibration data for each individual meter's measurement error.

Fluid conductivity: 5 μS/cm minimum

Fluid temperature: 14 to 176°F (–10 to +80 °C): EPDM rubber Lining detector
14 to 248°F (–10 to +120 °C): Teflon PFA Lining detector

Ambient temperature: – 4 to 140°F (–20 to +60 °C)

Fluid pressure: –15 psi or –1.0 bar (–0.1 MPa) to the nominal pressure of the connection flange.

Connection flange standard: See Table 9.2 Type Specification Code.

Principal materials

Case • • • • • • Carbon steel

Flange material • • • • • 1/2" to 8" (15mm to 200 mm):304 stainless steel
10" to 18" (250mm to 450mm): carbon steel

Lining • • • • • 1/2" to 2" (15 to 50 mm): Teflon PFA
3" to 16" (80 to 400mm): EPDM rubber (std.) & Teflon PFA (opt.)
18"(450mm): EPDM rubber

Electrodes • • • • 316L stainless steel (standard)

Grounding rings • • 316 stainless steel (standard)

See Table 9.2 Type Specification Code for optional materials and other related information.

Measuring tube material • • 304 stainless steel

Coating: Phthalic acid resin coating, pearl-gray colored (standard)

Structure: IP67 and NEMA 4X Watertight (Standard)

Separate

Option: IP 68 and NEMA 6P Submersible type

Specification of Submersible type

Structure: Separate type only (Only CMAG EPDM rubber lining is available.)

Range of underwater: within 5m

Coating: Black tar epoxy resin, thickness 0.5 mm

Executed evaluation test: It is confirmed that it leaves for four months every depth 5m, and moisture doesn't infiltrate internally.

Separate

Cable connection port: 3/4-14NPT male screw for both signal cable and exciting cable

Separate

Cable length: Allowable cable length between the converter and the detector varies with the electrical conductivity of fluid. See Figure 9.1

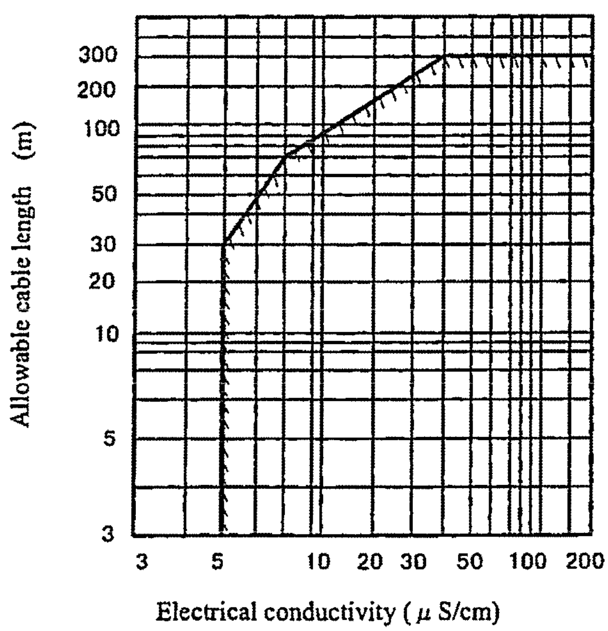


Figure 9.1 Electrical Conductivity vs. Cable Length

Flow and calibration velocity range:

It calibration by standard Range shown in the table below when Range is not specified.
It calibration when there is specification by flowing quantity Range in which the customer is specified. Is this specification Range flowing quantity of Figure 9.1. Please confirm becoming in the upper bound value from the flow velocity chart.

Meter size	Standard Flow rate	
(mm)	Volume (m^3/h)	Velocity (m/s)
15	2	3.144
25	6	3.395
32	10	3.454
40	15	3.316
50	25	3.537
65	40	3.348
80	60	3.316
100	100	3.537
150	200	3.144
200	300	2.653
250	600	3.395
300	900	3.537
350	1200	3.465
400	1600	3.537
450	2500	4.366

To select the meter size: See Figure 9.2 and find meter sizes within the velocity of 0.1 to 10 m/s for a specified full-scale (measuring range high limit) flow. Select one that has its full-scale velocity between 1 and 3 m/s.

Make sure the full-scale flow rate used for the final planning stage stays within 10 m/s in terms of flow velocity.

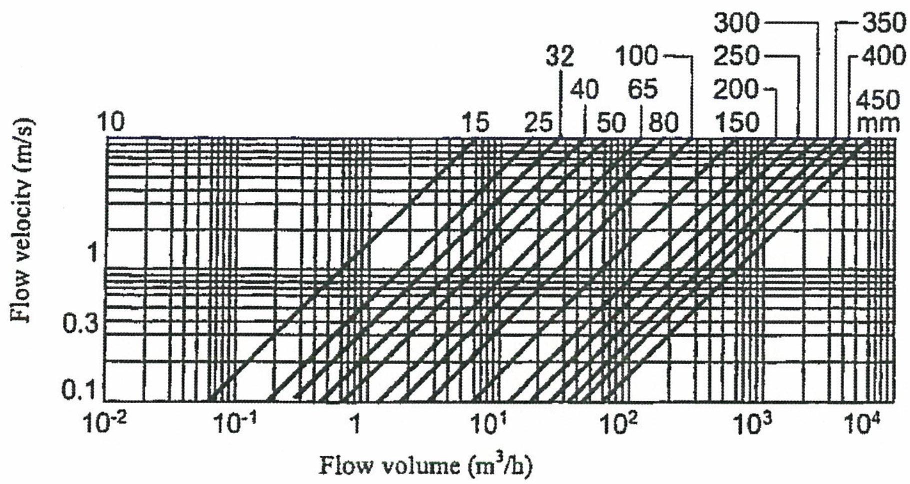


Figure 9.2 Flow velocity vs. flow volume

SI Unit

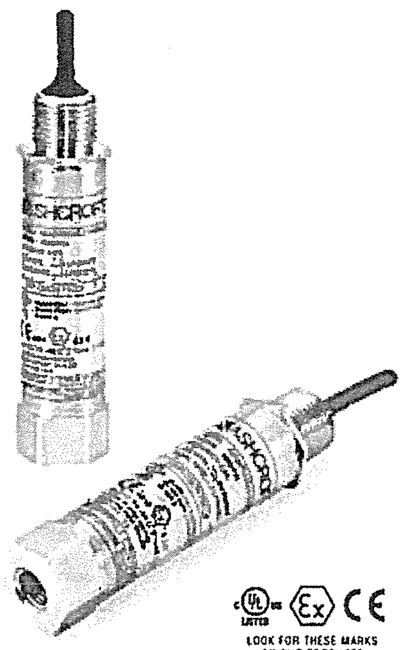
Flow volume / Meter size	Flow velocity range			
	0.1m/s	0.3m/s	1m/s	10m/s
15mm	0.0631m³/h	0.1908m³/h	0.6361m³/h	6.361m³/h
25mm	0.1767m³/h	0.5301m³/h	1.767m³/h	17.67m³/h
32mm	0.2895m³/h	0.8686m³/h	2.895m³/h	28.95m³/h
40mm	0.4523m³/h	1.357m³/h	4.523m³/h	45.23m³/h
50mm	0.7067m³/h	2.120m³/h	7.067m³/h	70.67m³/h
65mm	1.195m³/h	3.583m³/h	11.95m³/h	119.5m³/h
80mm	1.809m³/h	5.428m³/h	18.09m³/h	180.9m³/h
100mm	2.827m³/h	8.482m³/h	28.27m³/h	282.7m³/h
150mm	6.361m³/h	19.08m³/h	63.61m³/h	636.1m³/h
200mm	11.31m³/h	33.93m³/h	113.1m³/h	1131m³/h
250mm	17.67m³/h	53.01m³/h	176.7m³/h	1767m³/h
300mm	25.45m³/h	76.34m³/h	254.5m³/h	2545m³/h
350mm	34.64m³/h	103.9m³/h	346.4m³/h	3464m³/h
400mm	45.23m³/h	135.7m³/h	452.3m³/h	4523m³/h
450mm	57.25m³/h	171.7m³/h	572.5m³/h	5725m³/h

US Unit

Flow volume / Meter size	Flow velocity range				
	0.328ft/s	0.98ft/s	3ft/s	10ft/s	32.8ft/s
1/2 inch	0.2801 gal/min	0.8403 gal/min	2.561 gal/min	8.538 gal/min	28.01 gal/min
1 inch	0.7781 gal/min	2.334 gal/min	7.115 gal/min	23.72 gal/min	77.81 gal/min
1 1/2 inch	1.992 gal/min	5.975 gal/min	18.21 gal/min	60.71 gal/min	199.2 gal/min
2 inch	3.112 gal/min	9.337 gal/min	28.46 gal/min	94.86 gal/min	311.2 gal/min
3 inch	7.967 gal/min	23.90 gal/min	72.85 gal/min	242.8 gal/min	796.7 gal/min
4 inch	12.45 gal/min	37.35 gal/min	113.8 gal/min	379.4 gal/min	1,245 gal/min
6 inch	28.01 gal/min	84.03 gal/min	256.1 gal/min	853.8 gal/min	2,801 gal/min
8 inch	49.80 gal/min	149.4 gal/min	455.3 gal/min	1,518 gal/min	4,980 gal/min
10 inch	77.81 gal/min	233.4 gal/min	711.5 gal/min	2,372 gal/min	7,781 gal/min
12 inch	112.0 gal/min	336.1 gal/min	1,025 gal/min	3,415 gal/min	11,200 gal/min
14 inch	152.5 gal/min	457.5 gal/min	1,394 gal/min	4,648 gal/min	15,250 gal/min
16 inch	199.2 gal/min	597.5 gal/min	1,821 gal/min	6,071 gal/min	19,920 gal/min
18 inch	252.1 gal/min	756.3 gal/min	2,305 gal/min	7,684 gal/min	25,210 gal/min

ASHCROFT®

Model A2X Explosion/Flame Proof Pressure Transmitter



LOOK FOR THESE MARKS ON OUR PRODUCTS

APPLICATIONS:

Oil field equipment, upstream oil and gas production, natural gas compression and transfer control, alternative energy projects

FEATURES:

- *cUL and ATEX listed*
- *Choice of 0.25, 0.50 or 1.0% accuracy*
- *Pressure ranges from 5 psi through 10,000 psi*
- *CE mark*
- *316L SS wetted materials, 17-4 PH optional*
- *304 SS case*
- *Six output signals to choose from*
- *Optional absolute pressure ranges available*

The Ashcroft® A2X pressure transmitter is ideal for a broad spectrum of pressure sensing requirements requiring approvals for explosion/flame proof.

The Ashcroft® A2X is designed and manufactured to provide the user with accurate, reliable, and stable output data. This is accomplished through the use of an on board microprocessor, that is programmed during a unique digital compensation process, to provide extremely linear and precise performance over the entire specified pressure and temperature range.

PERFORMANCE SPECIFICATIONS

Reference temperature 70°F (21°C)

Accuracy, Three Classes (% Span):	±25	±0 5	±1.0

Includes non-linearity (Terminal Point Method), hysteresis, non-repeatability, zero offset and span setting errors

Best Fit Straight Line* (BFSL):	±.20	±.40	±.50

Includes non-linearity hysteresis, non-repeatability errors
*Add ±.05% for ranges above 5000 psi

Stability:
≤ ±0.25% Span/year @ reference conditions

Durability: Greater than 10 million cycles

ENVIRONMENTAL SPECIFICATIONS

Temperature Limits:

Storage:	−40 to +125°C	(−40 to 257°F)
Process:	−40 to +125°C	(−40 to 257°F)
Operating:	−40 to +125°C	(−40 to 257°F)
Compensated*:	−20 to +85°C	(−4 to 185°F)

*Consult factory for other options

Temperature Effects: −20 to +85°C (−4 to 185°F)
- 1.0% of Span for .25% Accuracy Class
- 2.0% of Span for .50% and 1.0% Accuracy Classes

Humidity Effects: No performance effects from 0 to 95% relative humidity, non-condensing
0-100% RH with "W" enclosure.

*Consult factory

FUNCTIONAL SPECIFICATIONS

Respone Time: <2ms

Pressure Ranges: Vacuum, gauge, compound and absolute pressure from 0-5 psi through 0-10,000. Equivalent ranges in bar available. See order guide section (reverse.)

Vibration Effect:

Shock:	100g Peak, 11ms
Random:	10g RMS, 20-2000Hz
Sweep:	50-2000Hz, 5g peak

Position Effect: ± 0.02% Typical

CE Mark (standard): EN 61326:1997 + A1, 1998 Annex A
Heavy Industrial Immunity (Annex A, Table A.1)
Light Industrial/Residential Emission (Table 4)

Overpressure (F.S.)*:	Proof	Burst
0#/vac. to 300 psi	1.5 x F.S.	min. 2 x F.S.
500-10,000 psi	1.2 x F.S.	1.5 x F.S.

*For higher overpressure ratings use XK8 option.
See page 2 for additional option.

ELECTRICAL SPECIFICATIONS

Output Signal:		Supply Voltage: (unregulated) Minimum	Maximum
0-5Vdc	(3 Wire)	12Vdc	36Vdc
0-10Vdc	(3 Wire)	14Vdc	36Vdc
1-5Vdc	(3 Wire)	10Vdc	36Vdc
1-6Vdc	(3 Wire)	10Vdc	36Vdc
4-20mA	(2 Wire)	12Vdc	36Vdc*

*30Vdc max for Intrinsically Safe installations

Power Requirements:
Supply Current: <5mA for voltage outputs

Electrical Termination:
1/2 NPT male conduit with flying leads or shielded cable

Circuit Protection: Reverse polarity and mis-wire proected
Insulation Resisance (Circuit to Case): 100Mohm @ 30Vdc

PHYSICAL SPECIFICATIONS

Case: Material 304SS

Wetted Materials: 316L SS diaphragm and presure port. optional 17-4PH SS diaphragm and 316L SS pressure port (see How to Order Section).

Ingress Protection Rating: IP65, NEMA 7,9
All units less than 500 psi include a small metal sintered filter at the top of the unit. This is necessary to equalize the internal pressure with atmospheric pressure but can be a point of moisture ingress.

HAZARDOUS AREA CERTIFICATIONS

Explosion Proof – cUL (USL/CNL): Specify A2X
Class I, Div. 1 & 2, Groups A, B, C and D
Class II, Div. 1 & 2, Groups E, F and G

Flame Proof – ATEX: Specify A2X
CE Ex II 2 G
Ex d IIC T4

NOTE: For 4-20mA units following approvals also apply:
Intrinsically Safe – FM/CSA:
Class I, Div. 1
Class I, Div. 2, Non-Incendive
Refer to Ashcroft drawing #825A022 for wiring and installation requirements.

NOTE:

Refer to Ashcroft Model A2 for Heavy Industrial, non-Hazardous rated configurations and Ashcroft Model A4 for Intrinsically Safe/non-Incendive applications

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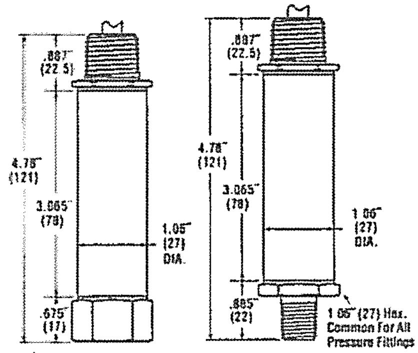
Tel: 203-385-0648 • Fax: 203-385-0408
email: info@ashcroft.com • www.ashcroft.com

ASHCROFT®

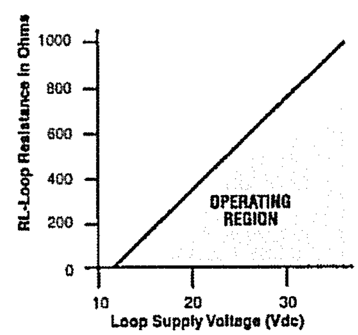
Model A2X Explosion/Flame Proof Pressure Transmitter

DIMENSIONS dimensions in ( ) are mm



EXPLOSION / FLAME PROOF ENCLOSURE

Load Limitations 4-20mA Output Only



VdcMIN = 12V + (0.022A* X (RL))

$R_L = R_S + R_W$

R_L = Loop Resistance (ohms)

R_S = Sense Resistance (ohms)

R_W = Wiring Resistance (ohms)

* (Includes a 10% safety factor)

XK8 OVERPRESSURE (F.S.)

	Proof	Burst
0 to 2000 psi	200%	800%
3000 to 5000 psi	150%	300%
7500 to 10 000 psi	120%	150%

NOTE:
Refer to Ashcroft Model A2 for Heavy Industrial, non-Hazardous rated configurations and Ashcroft Model A4 for Intrinsically Safe/non-Incendive applications.

(7)Available only with accuracy B & C.

How To Order

A2X – □ – □□□ – □□ – □□ – □□□□□□ – □ – X□□

Type Configuration
(A2X)

Accuracy / Temp. Effects
(A) 0.25%/≤1.0% (-20°C to +85°C)
(B) 0.50%/≤2.0% (-20°C to +85°C)
(C) 1.00%/≤2.0% (-20°C to +85°C)

Pressure Connection
(M01) ⅛ NPT-M
(M02) ¼ NPT-M
(F02) ¼ NPT-F
(MEX) 7/16-20 SAE-M
(F09) 9/16-18 (¼)-F (Aminco)
(M04) ½ NPT-M
(F04) ½ NPT-F
(MG4) G ½ M
(VM2) VCR inlet fitting ¼" VCR gland with 9/16-18 male nut
(VF2) VCR inlet fitting ¼" VCR gland with 9/16-18 female nut
(others available upon request)

Output Signal
(05) 0-5 Vdc
(10) 0-10 Vdc
(15) 1-5 Vdc
(16) 1-6 Vdc
(42) 4-20mA

Electrical Termination
½ NPT Male Conduit

Flying Leads
(C2) with 3' leads
(C5) with 10' leads

Shielded Cable
(C1) with 3' cable
(C6) with 15' cable
(C7) with 30' cable
(P7) with customer defined length

Pressure Range
(1.5#) 1.5 psi(5)(6)(7)
(5#) 5 psi(5)(6)
(10#) 10 psi(5)(6)
(15#) 15 psi(5)
(30#) 30 psi(5)
(50#) 50 psi
(60#) 60 psi
(75#) 75 psi
(100#) 100 psi
(150#) 150 psi
(200#) 200 psi
(300#) 300 psi
(500#) 500 psi
(750#) 750 psi
(1000#) 1000 psi
(1500#) 1500 psi
(2000#) 2000 psi
(3000#) 3000 psi
(5000#) 5000 psi
(7500#) 7500 psi
(10,000#) 10,000 psi(4)
(0# & vac.) 0 psi/Vac.(5)(6)
(15# & vac.) Vac./15 psi(5)(6)
(30# & vac.) Vac./30 psi(5)(6)
(45# & vac.) Vac./45 psi(6)
(60# & vac.) Vac./60 psi(6)

(4)17-4PH SS Sensor Required
(5)17-4PH SS Sensor Not Available
(6)Gauge pressure only
(7)Available only with accuracy B & C

Measurement Type
(G) Gauge Pressure Sensor
(A) Absolute Pressure Sensor

Optional X-Variations
(XCL) Non-standard(4) calibration
(XK8) 17-4PH SS Sensor Material
(X6B) Cleaned For Oxygen Service

NOTE: All A2X pressure transmitters include a 9 pt. NIST traceable calibration certificate

All specifications are subject to change without notice.
All sales subject to standard terms and conditions.

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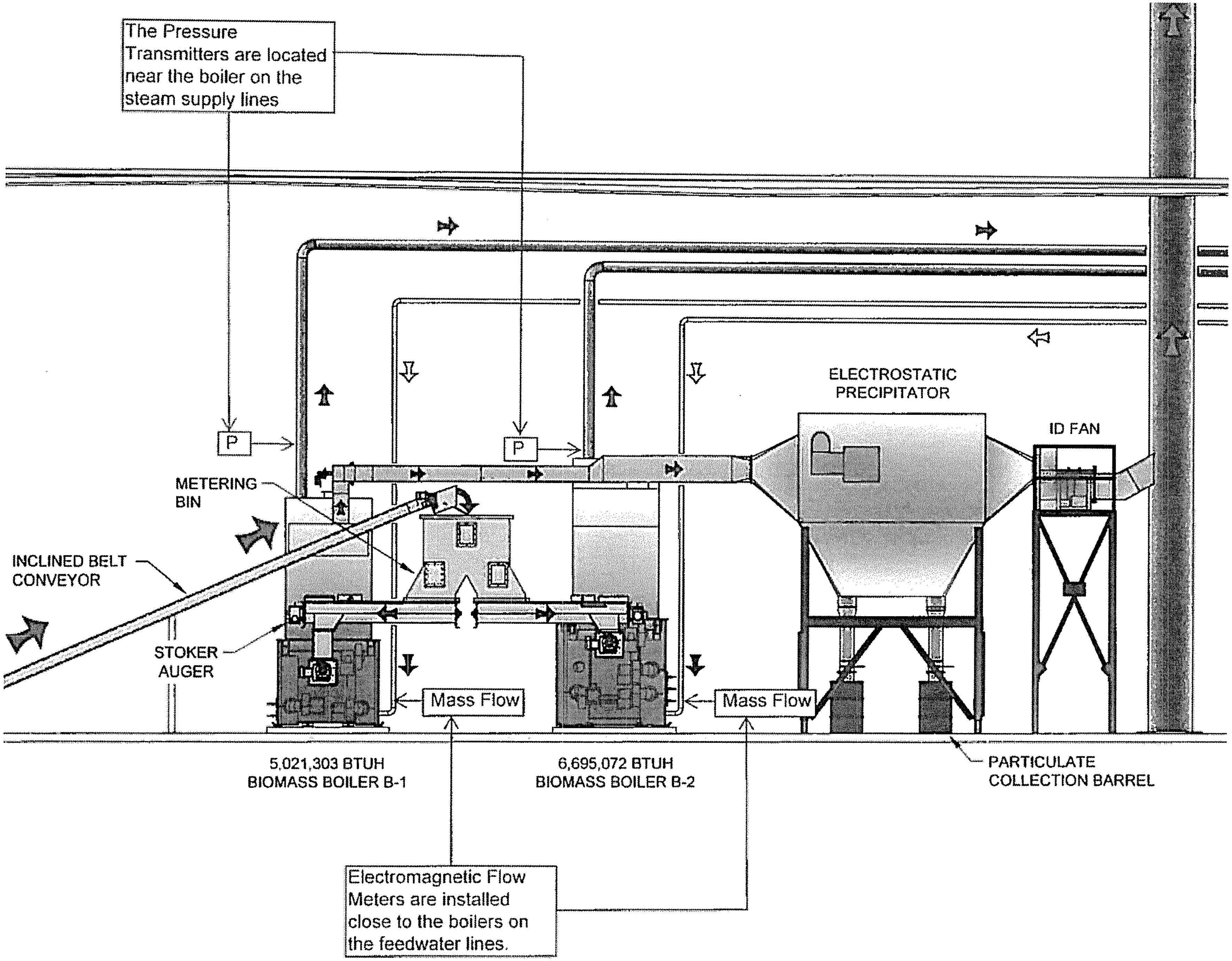
Attachment 3-2

Metering System Schematic


The Pressure Transmitters are located near the boiler on the steam supply lines
P
P
METERING BIN
INCLINED BELT CONVEYOR
STOKER AUGER
ELECTROSTATIC PRECIPITATOR
ID FAN
Mass Flow
Mass Flow
5,021,303 BTUH
BIOMASS BOILER B-1
6,695,072 BTUH
BIOMASS BOILER B-2
PARTICULATE COLLECTION BARREL
Electromagnetic Flow Meters are installed close to the boilers on the feedwater lines.

Attachment 3-3

Calibration Remarks

"Please summarize the manufacturer's recommended methods and frequency for metering system calibration and provide reference for source document (e.g. owners/operators manual):"

Electromagnetic Flow Meter:

Manufacturer does not recommend altering factory calibration settings. The unit is self-calibrating. This is fully addressed in the "Instruction Manual" which is apparently not available online. Please find Chapter 9 of the "Instruction Manual" below.

Pressure Transmitter:

The Ashcroft A2XB cannot be calibrated. The manufacturer recommends that the sensor be checked once per year against a known pressure. If there is measureable drift, then the sensor needs to be sent back to the factory and/or replaced.

Attachment 3-4

Interim Alternate Metering Method

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www.yeatonassociates.com

YEATON ASSOCIATES, INC.

Interim Alternate Metering Method – USEFUL THERMAL ENERGY

FACILITY: Littleton Regional Healthcare

LOCATION: Littleton, New Hampshire

RELEVANT RULING: Draft Puc 2505.02(e)(2)

❖ Overview

In compliance with Order no. 25,678 issued June 19, 2014, and pursuant with draft Puc 2505.02(e), this document provides a detailed explanation of the methodology used to measure and calculate thermal energy, in MWh's produced by the Littleton Regional Healthcare's biomass plant in any preceding period of operation.

❖ Useful Thermal Energy: Megawatt-hours Produced

Assumptions

- Mass flow rate of feedwater into the boiler ($\dot{m}_{in}$) is measured directly (meter accuracy ±0.2% of rating per manufacturer (NIST traceable)). Average daily values are shown in appendix table.

- Mass flow rate of steam out of the boiler ($\dot{m}_{out}$) is equal to $\dot{m}_{in}$. *Rationale:* There exist no ancillary steam usages or parasitic loads between the flow meter on the feed water line and the pressure gauge on the steam supply line.

- The average daily specific enthalpy of entering feedwater (h_{in}) is equal to that of saturated water at 240°F.

- The average daily specific enthalpy of the supply steam leaving the boilers (h_{out}) is equal to saturated steam at the daily recorded supply pressure. Average daily values are shown in appendix table. *Rationale:* These boiler models have no capability for superheated steam. The supply pressure is measured at the boiler collar.

- Assume a 2.0% loss in useful thermal energy due to parasitic loads, as required by draft PUC 2506.05(f).

Methodology

- Total Daily Thermal Energy = [($\dot{m}_{out}$) x (h_{out}) - ($\dot{m}_{in}$) x (h_{in})] x (0.98).

- Values for each day of the month are provided in the Appendix Table. Monthly totals are also shown.

Comparison with draft Puc 2506.04(m)

The methodology and assumptions used herein to estimate useful thermal energy generated by Littleton Regional Healthcare are actually closely aligned with guidance provided in the draft Chapter of the Public Utilities Commission 2506.04(m) Renewable Portfolio Standards. Notable exceptions are:

- ($\dot{m}_{out}$) is not measured close to the header. Therefore, minor parasitic loads (condensate traps) between the boiler and the header have not been explicitly accounted for.

- (h_{in}) is measured and recorded daily. The temperature is noted several times per week by the facility manager as he reads the thermostat measuring the steam temperature leaving the de-aerating tanks. He reports 240F as a maximum value, which we have therefore conservatively used (lower assumed feedwater temperatures would make the boilers appear to create even more thermal energy, for a given state of saturated steam supply.)

- The time interval is not 1-hour. Rather the steam plant performance record spreadsheet is manually populated by the facilities staff once per day.

- Both temperature and pressure in the supply steam are not measured – only pressure. As noted above, these boilers have no physical mechanism for producing superheated steam, and so pressure or temperature alone should suffice. Going forward we will comply with the Ruling, of course, which requires both pressure and temperature measurement.

Sample Calculation:

In the attached Appendix Tables, calculations to be submitted for the month of April are shown. The results are:

April 2014: 569.0 Megawatt-Hours

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APPENDIX:

Month:	April					
Boiler:	#1					
Day	Cumulative Total Feedwater (lbs)	Daily Net Feedwater (lbs)	Supply Steam Pressure (PSI Gauge)	Supply Steam Specific Enthalpy (Btu/lb)	Feedwater Specific Enthalpy @ 240°F (Btu/lb)	Daily Useful Thermal Energy (minus 2%) (Btu)
1	Boiler Off					
2	Boiler Off					
3	Boiler Off					
4	Boiler Off					
5	Boiler Off					
6	Boiler Off					
7	Boiler Off					
8	Boiler Off					
9	Boiler Off					
10	Boiler Off					
11	Boiler Off					
12	Boiler Off					
13	Boiler Off					
14	Boiler Off					
15	Boiler Off					
16	Boiler Off					
17	Boiler Off					
18	Boiler Off					
19	Boiler Off					
20	Boiler Off					
21	Boiler Off					
22	Boiler Off					
23	Boiler Off					
24	Boiler Off					
25	Boiler Off					
26	Boiler Off					
27	Boiler Off					
28	Boiler Off					
29	Boiler Off					
30	Boiler Off					
31	Boiler Off					

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Month:	April					
Boiler:	#2					
Day	Cumulative Total Feedwater (lbs)	Daily Net Feedwater (lbs)	Supply Steam Pressure (PSI Gauge)	Supply Steam Specific Enthalpy (Btu/lb)	Feedwater Specific Enthalpy @ 240°F (Btu/lb)	Daily Useful Thermal Energy (minus 2%) (Btu)
March 31	256,712.0					
April 1	341,141.0	84,429.0	87.0	1,188.6	208.6	81,083,129.4
2	71,961.0	71,961.0	80.0	1,187.1	208.6	69,003,446.1
3	137,200.0	65,239.0	83.0	1,187.8	208.6	62,602,470.2
4	223,483.0	86,283.0	86.0	1,188.4	208.6	82,846,745.0
5	270,564.0	47,081.0	83.0	1,187.8	208.6	45,178,296.7
6	333,591.0	63,027.0	81.0	1,187.4	208.6	60,455,158.1
7	405,113.0	71,522.0	86.0	1,188.4	208.6	68,673,607.7
8	471,068.0	65,955.0	82.0	1,187.6	208.6	63,276,607.0
9	527,344.0	56,276.0	82.0	1,187.6	208.6	53,990,665.4
10	597,914.0	70,570.0	84.0	1,188.0	208.6	67,731,858.1
11	670,634.0	72,720.0	84.0	1,188.0	208.6	69,795,390.7
12	741,440.0	70,806.0	84.0	1,188.0	208.6	67,958,366.8
13	805,960.0	64,520.0	86.0	1,188.4	208.6	61,950,465.2
14	860,416.0	54,456.0	85.0	1,188.2	208.6	52,276,594.6
15	913,463.0	53,047.0	86.0	1,188.4	208.6	50,934,382.0
16	975,140.0	61,677.0	84.0	1,188.0	208.6	59,196,511.4
17	1,053,526.0	78,386.0	83.0	1,187.8	208.6	75,218,155.2
18	1,132,423.0	78,897.0	81.0	1,187.4	208.6	75,677,576.4
19	1,206,985.0	74,562.0	84.0	1,188.0	208.6	71,563,310.2
20	1,277,127.0	70,142.0	83.0	1,187.8	208.6	67,307,323.3
21	1,369,489.0	92,362.0	71.0	1,185.4	208.6	88,412,102.1
22	1,430,169.0	60,680.0	79.0	1,187.1	208.6	58,183,115.1
23	1,487,843.0	57,674.0	71.0	1,185.4	208.6	55,207,548.3
24	1,532,851.0	45,008.0	85.0	1,188.2	208.6	43,206,716.8
25	1,607,201.0	74,350.0	84.0	1,188.0	208.6	71,359,836.3
26	1,684,563.0	77,362.0	84.0	1,188.0	208.6	74,250,701.5
27	1,740,945.0	56,382.0	84.0	1,188.0	208.6	54,114,462.6
28	1,817,892.0	76,947.0	80.0	1,187.1	208.6	73,784,524.5
29	1,866,579.0	48,687.0	85.0	1,188.2	208.6	46,738,478.1
30	1,939,128.0	72,549.0	83.0	1,187.8	208.6	69,617,048.2
Monthly Total (Btu)						**1,941,594,593.0**
Monthly Total (MWh)						**569.0**

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