NHEC Smart Meters vs. "Smart Meter Gateway Devices"

NHEC has recently received letters from a handful of members asserting that the smart meters which NHEC is installing throughout its distribution system are "smart meter gateway devices" which, under newly-enacted legislation, may not be installed without the written authorization of electric utility consumers. This assertion is patently and demonstrably wrong.

Smart Meter Background

1. Over the past several decades, as new technologies became available, gas, water and electric utilities, like most other businesses, have adopted digital technology for collecting, processing and storing business information, including the amount of utility commodities delivered to consumers' premises. Many utilities have long ago switched to digital meters. Others, like NHEC, have continued to rely primarily upon old analogue meters for the initial measurement of usage. These meters must still be visually inspected at periodic in-person meter-reading visits, but the analog information is now entered into hand-held digital recording devices at the meter location and these hand-held devices transmit the now-digital meter readings to the utility via the internet or other communications systems.

2. Over the past decade, various federal, state and industry initiatives have recognized the desirability of further automating utility meter services in order to improve utility efficiencies, system reliability, outage response time and to provide consumers with more sophisticated usage information and tools to help manage their resource consumption and utility bills.

3. As a result of these initiatives and developing technologies, a number of New Hampshire water, gas and electric utilities have deployed automated meters which operate

digitally and which will eliminate the need for in-person meter reading visits by automatically transmitting meter readings to the utilities via periodic wireless or wired transmissions.

4. Over the past ten years, NHEC has been engaged in the process of evaluating, planning, and now implementing a major upgrade of its communications, systems management, and metering infrastructure. NHEC refers to this effort as the Communications Systems Infrastructure and Advanced Metering Infrastructure Plan ("CSI/AMI Project").

5. During this same time, a number of major policy initiatives, including the Energy Independence and Security Act of 2007 and the American Recovery and Reinvestment Act of 2009, have encouraged utilities to deploy new technologies which are intended to make utility systems increasingly clean, efficient, reliable and safe, while offering the potential for lower overall consumer costs. These initiatives and related technologies are often referred to as the "Smart Grid." Utility systems upgrades of the type which NHEC has been developing as part of its CSI/AMI Project are considered essential to these Smart Grid initiatives.

6. In 2010, NHEC received a grant from the United States Department of Energy ("DOE") pursuant to the American Recovery and Reinvestment Act of 2009, in the amount of $15.9 million. The DOE grant covers approximately 45% of the projected $35 million cost of NHEC's CSI/AMI Project, all to the benefit of NHEC's membership.

7. An essential component of NHEC's CSI/AMI Project is the replacement of all old analog electric meters with meters which record electric usage in a digital format and are capable of periodically transmitting meter reading information back to NHEC by means of short-range wireless transmissions. These low-power, short-range transmissions are relayed from one meter to the next until they reach NHEC's backbone communication system. Once on NHEC's backbone communication system, the meter readings are communicated back to NHEC's

EnergyAxis metering information system via wireless and/or fiber optic transmissions. The information communicated back to NHEC is the same type of information that is collected by NHEC's old analog meters – whole house usage. This usage information is sent using a unique identifying number. There is no personal or confidential information transmitted. Even so, NHEC has elected to encrypt the whole house usage data being transmitted as an added precaution.

8. To date, NHEC has installed and is currently operating approximately 71,000 of these new meters. Approximately 12,000 old meters remain to be replaced.

What is a "Smart Meter"?

9. It is important to recognize that "smart meter" is a generic term which is both widely and very loosely applied to a wide variety of advanced meters which may share some common characteristics, but which also vary substantially, from one meter type to the next, in their function, design, properties and capabilities. In short, not all "smart meters" are the same.

10. Despite the wide array of devices which might fall under the "smart meter" umbrella, there are certain characteristics common to most "smart meters" which help to define that term and which serve to generally divide all "smart meters" into one of two distinct groups.

11. Although based upon differing technologies, most devices commonly referred to as "smart meters" have the ability to record electric usage in a digital format. They are capable of reading the total cumulative energy delivered without the necessity of an in-person visit to the meter site, and at intervals not limited to the traditional monthly basis. These meters can communicate their meter readings to the utility via wired or wireless transmissions or some combination thereof. These meters can also automatically alert the utility in the case of power

outages. Meters which share this basic set of capabilities could be characterized as "basic" or "standard" smart meters.

12. There is a second broad subset of smart meters which share a substantial set of additional capabilities. These "advanced" smart meters contain a second, separate communications device which is capable of communicating (through wireless transmitter/receivers which are sometimes referred to as a "Zigbee boards" or "smart meter gateway devices") with specially equipped appliances or electrical equipment located within consumers' premises and which allow the advanced smart meter to record and/or control electric usage associated with these "smart meter-enabled" devices. These smart meter-enabled devices have their own transmitter/receivers and may be separate plug-in controllers or may be built into appliances or other electric consumer devices. Under either scenario, communications with smart meter-enabled appliances or equipment inside consumers' premises can only be accomplished when an "advanced" smart meter is present.

"Smart Meter Gateway Devices" and NH RSA 374:62

13. NH RSA 374:62 was enacted by passage of Senate Bill 266 ("SB 266") in the spring of 2012. The bill was titled, "an act prohibiting electric utilities from installing and maintaining **smart meter gateway devices** without the residential or business owner's consent." (emphasis added). A complete copy of the bill, as enacted, is attached.

14. In summarizing the purpose and scope of SB 266 its prime legislative sponsor, Rep. Andrew Manuse testified that the bill was written with knowledge of NHEC's on-going smart meter deployment and that its requirements were not intended to apply to NHEC's smart meters, but rather to apply only to "gateway devices and load control devices that are optional add-ons to a "smart meter." In Rep. Manuse's words:

> To recap, and to be clear, with this bill WE ARE NOT allowing people to opt-out of "smart meters," per se, because the device itself does the same thing as a "dumb meter." Instead of a meter reader coming to your house, the electricity reading of the full house will be sent wirelessly to the company 7-10 times a day once a smart meter is installed. What the bill WILL DO is require people to opt-in to the installation of "load control devices," which enable a remote control of your heating or air conditioning systems, for instance, as well as the technology (called a "gateway board") that reads electrical use data for specific enabled appliances inside your home, such as your heater, air conditioner, refrigerator, and so on. (A. Manuse testimony before the Senate Energy Committee, February 9, 2012) (emphasis in original).

15. SB 266, as described by Rep. Manuse, created NH RSA 374:62 which requires that electric utilities obtain written consent from home and business owners prior to the installation of "smart meter gateway devices" as that term is specifically defined within the statute. As defined, "smart meter gateway devices" must be all of the following: 1) They must be electric utility meters, components thereof or ancillary devices thereto; 2) They must be located at an end-user's residence or business; and, 3) They must serve as communications gateways so as to communicate with, monitor or control electrical equipment within the end-users' home or business. The new NHEC meters, which are being widely deployed throughout NHEC's system, simply are not "smart meter gateway devices."

NHEC's "Smart Meter"

16. NHEC is currently deploying smart meters manufactured by Elster Solutions throughout NHEC's service territory. The specific meter model being installed for residential accounts, and which is the subject of the recent handful of member letters, is the Elster Solutions Type R2S. Elster Solutions offers certain optional versions of its Type R2S meters. Among the options available to utilities is that of purchasing Type R2S meters either with or without Zigbee boards. The Elster Solutions Type R2S meters which NHEC has purchased for general deployment throughout its system are those **without** Zigbee boards or any other smart meter gateway components. Accordingly, the new NHEC meters are "basic" or "standard" smart

meters. They are capable of recording the cumulative total of energy which passes through the meter (whole-house), on a kWh basis, in a digital format. They are programmed to read the total cumulative energy delivered on an hourly basis. They are programmed to transmit meter readings approximately ten times per day. These readings are wirelessly transmitted back to NHEC's EnergyAxis metering information system through its network of Elster Solutions Meters and NHEC's backbone communication infrastructure. These Elster Solutions Meters are not "advanced" smart meters. These meters, with their single 900 MHZ range transmitters, can only communicate with NHEC's EneryAxis metering information system.[1] They do not contain a second transmitter/receiver, smart meter gateway device, or any other device which would allow them to communicate with, monitor, or control any smart meter-enabled appliances or equipment which members may have within their premises.

17. As the accompanying affidavit of NHEC's Metering Supervisor, Douglas Bergholm, documents, NHEC's Standard Smart Meters do not perform the functions which would make them "smart meter gateway devices," as defined by NH RSA 374:62.

NHEC's "Advanced" Smart Meters

18. As Mr. Bergholm explains, NHEC has only purchased a limited number of "Zigbee-equiped" meters to support NHEC's voluntary time-of-use pricing pilot program. Because of the closed nature of the EnergyAxis metering and information system which Elster Solutions has provided, even these potentially "advanced" smart meters will only communicate with Zigbee-enabled devices which have been individually commissioned or "paired" with the specific NHEC Zigbee-equiped meter installed at the premises. In other words, even a pilot program participant with one of the few Zigbee-equiped smart meters and a NHEC-provided in-

[1] In certain system configurations, not utilized by NHEC, the 900 MHZ transmitters can also send whole-house usage data to EnergyAxis in-home displays deployed by the utility. NHEC is not deploying such displays on its system.

home display would only generate and view whole-house usage data. NHEC's Zigbee-equiped smart meter located at the pilot participant's premises will not communicate with any smart meter-enabled appliance or equipment which the participant may own unless the member requests that the equipment be commissioned, provides NHEC with that equipment's unique identifying information, and NHEC agrees to and performs the commissioning of that equipment with its EnergyAxis system. In this regard, NHEC's "advanced" smart meters are only potentially "smart meter gateway devices." In any event, they are only provided to members who have volunteered to have them and an in-home display as part of their participation in NHEC's pilot program.

Conclusion

The smart meters which NHEC is installing throughout its distribution system are not "smart meter gateway devices" subject to the requirements of NH RSA 374:62. That statute was never intended to apply to the type of "basic" or "standard" smart meter NHEC is deploying. More importantly, NHEC's Standard Smart Meters simply do not perform the functions required to make them "smart meter gateway devices."

CHAPTER 150
SB 266-FN – FINAL VERSION

03/21/12 1263s

2012 SESSION

12-2999
09/03

SENATE BILL ***266-FN***

AN ACT prohibiting electric utilities from installing and maintaining smart meter gateway devices without the residential or business property owner's consent.

SPONSORS: Sen. Forsythe, Dist 4; Sen. Barnes, Jr., Dist 17; Sen. Boutin, Dist 16; Sen. Bradley, Dist 3; Sen. Forrester, Dist 2; Sen. Gallus, Dist 1; Sen. Lambert, Dist 13; Sen. White, Dist 9; Rep. Manuse, Rock 5; Rep. Giuda, Merr 7; Rep. Kurk, Hills 7; Rep. Baldasaro, Rock 3; Rep. Comerford, Rock 9

COMMITTEE: Energy and Natural Resources

ANALYSIS

This bill prohibits electric utilities from installing and maintaining smart meter gateway devices without the residential or business property owner's consent.

. . . . . .

Explanation: Matter added to current law appears in ***bold italics.***
Matter removed from current law appears [~~in brackets and struckthrough.~~]
Matter which is either (a) all new or (b) repealed and reenacted appears in regular type.

CHAPTER 150
SB 266-FN – FINAL VERSION

03/21/12 1263s

12-2999
09/03

STATE OF NEW HAMPSHIRE

In the Year of Our Lord Two Thousand Twelve

AN ACT prohibiting electric utilities from installing and maintaining smart meter gateway devices without the residential or business property owner's consent.

Be it Enacted by the Senate and House of Representatives in General Court convened:

150:1 New Subdivision; Smart Meter Gateway Devices. Amend RSA 374 by inserting after section 61 the following new subdivision:

Smart Meter Gateway Devices

374:62 Property Owner's Consent Required for Smart Meter Gateway Devices.

I. In this subdivision:

(a) "Smart meter gateway device" means any electric utility meter, electric utility meter component, electric utility load control device, or device ancillary to the electric utility meter, which is located at an end-user's residence or business, and which serves as a communications gateway or portal to electrical appliances, electrical equipment, or electrical devices within the end-user's residence or business, or which otherwise communicates with, monitors, or controls such electrical appliances, electrical equipment, or electrical devices.

(b) "Electric utility" means any public utility, as defined in RSA 362:2, which is engaged in the sale or distribution of electricity ultimately sold to the public, any rural electric cooperative, without regard to whether a certificate of regulation or deregulation is on file with the public utilities commission, and any municipal electric system operating pursuant to RSA 38 within or outside its municipal boundaries.

II.(a) No electric utility that sells or provides electricity within the state of New Hampshire shall install a smart meter gateway device on or in a person's home or business without the written consent of the person or persons who own the home or business.

(b) An electric utility selling or providing electricity shall create a form that the person or persons who own the home or business must sign to opt-in to having a smart meter gateway device installed on or in his or her home or business. The form shall, in at least 12-point boldface type, state that:

(1) The opt-in is optional and one's service will not be affected if one elects not to opt-in; and

(2) The device is a "smart meter gateway device," and provide the definition in subparagraph I(a).

III. When an electric utility enrolls a homeowner or business owner for electrical service at his or her home or business, the electric utility shall disclose in writing whether a smart meter

gateway device has been installed, and shall remove, or allow to be removed, all smart meter gateway devices upon written request of the homeowner or business owner.

150:2 Effective Date. This act shall take effect upon its passage.

Approved: June 7, 2012
Effective Date: June 7, 2012

AFFIDAVIT OF DOUGLAS BERGHOLM

I, Douglas Bergholm, being duly sworn, do hereby depose and state as follows:

1. I am employed by New Hampshire Electric Cooperative, Inc. ("NHEC") as Metering Supervisor. I am a licensed master electrician and have a degree in Electrical Power and Control Technologies.

2. In the course of my employment at NHEC I have been closely involved on a first-hand basis in the development and implementation of NHEC's Communications System Infrastructure and Advance Metering Infrastructure Plan ("CSI/AMI Project"), which involves the replacement of all NHEC's analog electric meters with so-called smart meters.

3. As a result of my duties relating to the CSI/AMI Project, I am familiar with the specifications and uses of the new meters which NHEC is installing.

4. NHEC's new meters are manufactured by Elster Solutions, a leading national and international supplier of such equipment. Elster Solutions and its Elster family of companies make a wide variety of electric, gas and water meters for utility customers. One of the factors which favored the selection of Elster Solutions as NHEC's meter supplier was Elster Solutions' flexibility concerning the specific meter components or modules which NHEC could select for inclusion or exclusion in the meters which NHEC would purchase. More specifically, NHEC could purchase Elster Solutions meters with or without the factory installed Zigbee modules, which have the potential to provide the meters with gateway capabilities.

5. In the near term, NHEC's only planned need for the potentiality of gateway communications capabilities provided by the Zigbee module is limited to a small volunteer pilot program. Likewise, in the long term, NHEC will be providing programs and services which involve the gateway communications made possible by the Zigbee module only to those members who voluntarily choose such programs and services. Accordingly, NHEC chose to purchase nearly all its Elster Solutions meters without the Zigbee module ("NHEC's Standard Smart Meters"). NHEC did purchase approximately 1,000 Zigbee-equiped meters ("NHEC's Advanced Smart Meters") to support NHEC 's pilot program.

6. Because they lack a Zigbee module or other gateway communications enabling device, the Standard Smart Meters installed in NHEC's service territory can only transmit to and or receive data from NHEC's EnergyAxis utility information system. NHEC's Standard Smart Meters do not serve as communications gateways or portals to electrical appliances, equipment or devices within NHEC's members' premises. Nor do these meters communicate with, monitor, or control such appliances, equipment or devices.

7. I have read the definition of "Smart meter gateway device" in Senate Bill 266. As I have described, NHEC's Standard Smart Meters simply do not perform the functions listed in that definition.

8. In fact, because the EnergyAxis system which NHEC is using is a private network that communicates only to known and defined devices, which have been specifically, intentionally and individually paired or commissioned to the system using identifying information unique to each such device, even NHEC's Zigbee-equiped Advanced Smart Meters do not serve as smart meter gateway devices unless the Co-op member has

voluntarily participated in or facilitated the commissioning of each in-home device to which meter communications is desired.

9. I am not aware of any firmware or software which could provide NHEC's Standard Smart Meter with gateway communications, thereby transforming it into a Smart Meter Gateway Device. To my knowledge, Elster Solutions does not offer such products. In any event, no such firmware or software, if it exists, is installed in NHEC's Smart Meters.

10. While NHEC's Standard Smart Meter and NHEC's Advanced Smart Meter both bear the "elster TYPE R2S" name and are generally identical in appearance, they are distinguished from one another by markings on the faceplate. I have attached photographs of each type of meter. NHEC's Advanced Meter bears the label "Zigbee Meter." NHEC's Standard Smart Meter references the FCC identifier for the FCC - authorized 900 MHZ range transmitter used for communications between the meter and NHEC. NHEC's Advanced Smart Meter references both the 900 MHZ transmitter and the FCC identifier for the FCC-authorized 2400 MHZ range Zigbee transmitter.

11. Prior to signing this affidavit I consulted with representatives of Elster concerning the specifications and capabilities of NHEC's Elster Solution's meters.

Dated this 9 day of August, 2012.

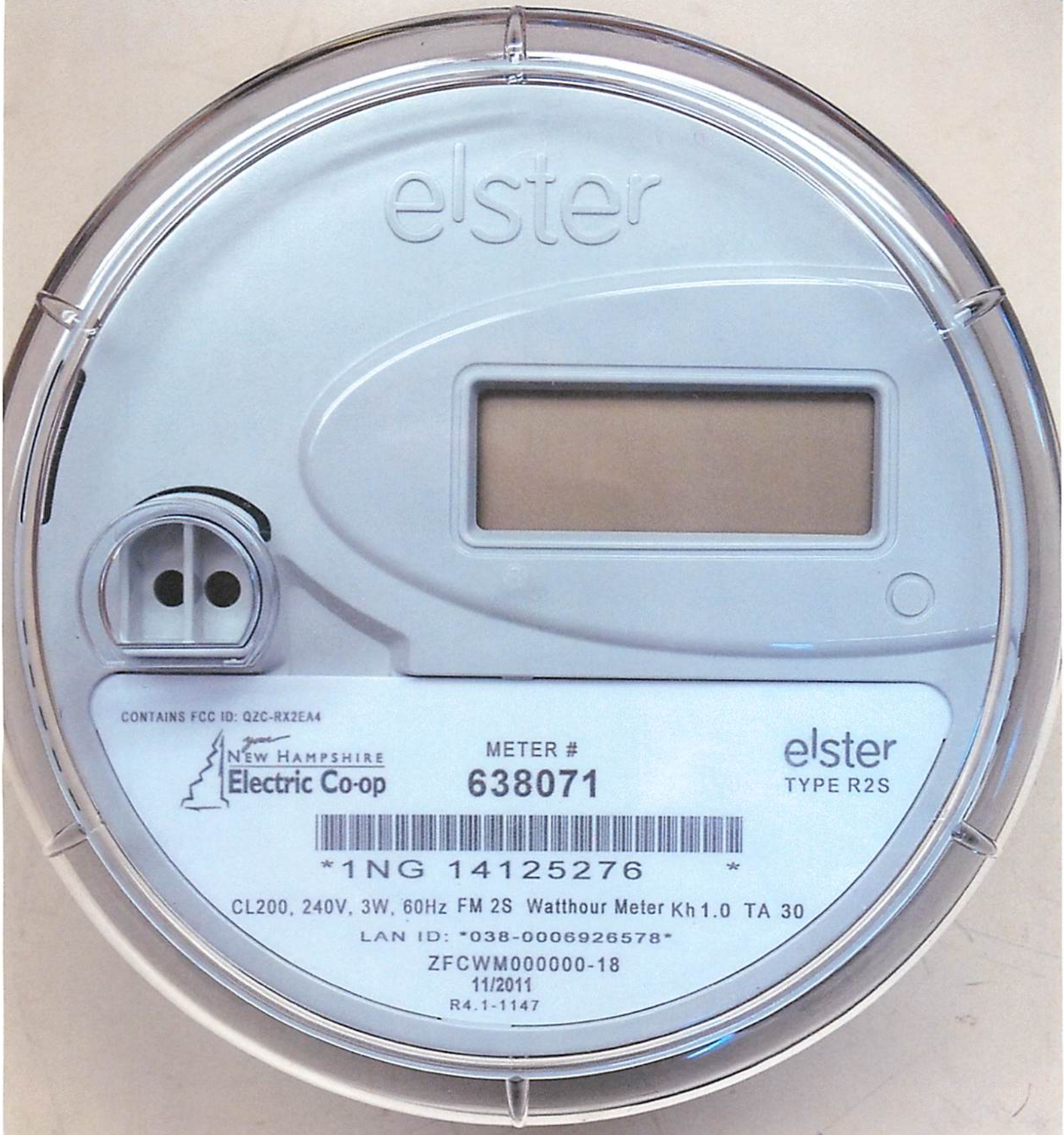
D. C. B.

Douglas Bergholm

STATE OF NEW HAMPSHIRE
COUNTY OF Grafton

Sworn to and subscribed before me this 9th day of August, 2012.

Sharon M. Yeaton
Notary Public/~~Justice of the Peace~~
My Commission Expires: 1/13/15


elster
CONTAINS FCC ID: QZC-RX2EA4
New Hampshire
Electric Co-op
METER #
638071
elster
TYPE R2S
*1NG 14125276 *
CL200, 240V, 3W, 60Hz FM 2S Watthour Meter Kh 1.0 TA 30
LAN ID: *038-0006926578*
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R4.1-1147


New Hampshire Electric Co-op
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CONTAINS FCC ID: G8JZGB1
New Hampshire Electric Co-op
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660525
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*1NG 14965695 *
CL200, 240V, 3W, 60Hz FM 2S Watthour Meter Kh 1.0 TA 30
LAN ID: *038-0007689573*
ZFCWM0B0000-19
04/2012
R4.1-1215

2 Product description

System overview

System architecture

The REX2 meter main circuit board contains the meter electronics. See Figure 2-1 for the single phase REX2 meter block diagram, and see Figure 2-2 for the Form 12S meter block diagram.

Figure 2-1. REX2 single phase meter block diagram

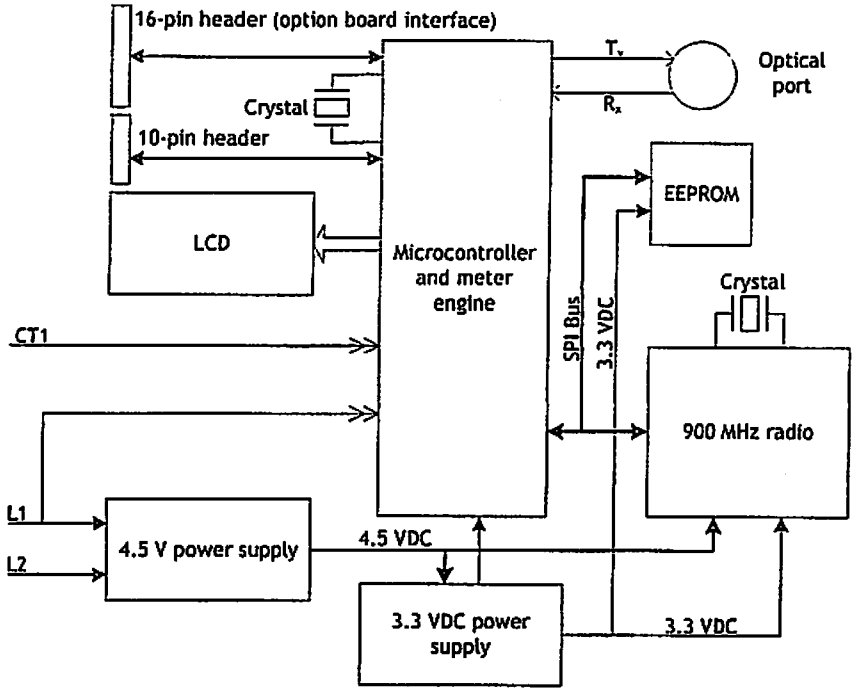
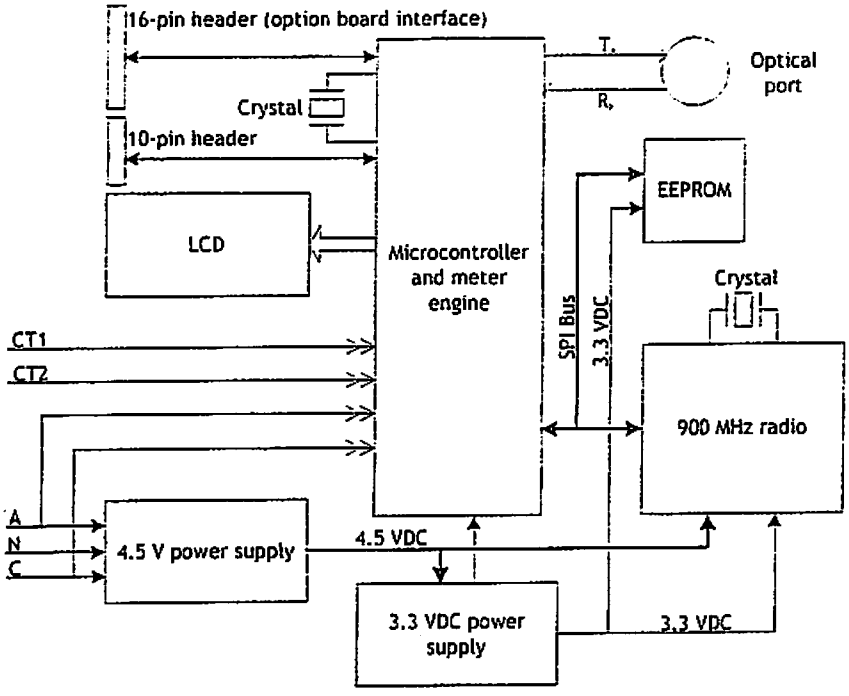


Figure 2-2. REX2 Form 12S meter block diagram



E Technical specifications

Absolute maximums

Voltage	144 VAC, 288 VAC, or 720 VAC (based on meter form)	
Surge voltage withstand	Test performed	Results
	ANSI C37.90.1 Oscillatory	2.5 kV, 2500 strikes
	Fast transient	5 kV, 2500 strikes
	ANSI 62.41	6 kV @ 1.2/50 µs, 10 strikes
	IEC 61000-4-4	4 kV, 2.5 kHz repetitive burst for 1 minute
	ANSI C12.16 dielectric	2.5 kV, 60 Hz for 1 minute
Current	Continuous at 100 % of the meter maximum current	
	Temporary (1 second) at 200 % of meter maximum current	

Operating ranges

Voltage	Nameplate voltage	Operating range	Switch control voltage range[1]
	120 V	96 V to 144 V	108 V to 144 V
	240 V	192 V to 288 V	216 V to 288 V
	600 V	480 V to 720 V	
Current	0 to Class ampere rating		
Frequency	Nominal 50 Hz or 60 Hz ± 5 %		
Temperature range	-40 °C to +85 °C inside meter cover		
Humidity range	0 % to 100 % noncondensing		

[1] The switch control voltage range is the voltage range required to change the state of the service control switch.

Operating characteristics

Typical burden	Less than 1.5 W
Current burden	0.1 milliohms typical at +25 °C
Accuracy	The REX2 meter meets ANSI C12.20 0.5 % accuracy class.

General performance characteristics

Starting current	
Forms 1S, 2S, and 12S	100 mA for Class 200; 160 mA for Class 320
Forms 3S and 4S	10 mA for Class 20
Startup delay	Less than 3 seconds from power application to pulse accumulation
Creep 0.000 A (no current)	No more than 1 pulse measured per quantity, conforming to ANSI C12.1 requirements.
Primary time base	Relative time is maintained by a crystal; real time is provided via the EnergyAxis network.

Service control switch specifications

Item	Description
Switch operations (mechanical)	50,000 minimum
Maximum switching current	200 A, minimum 15,000 operations
Maximum short-term current	10,000 A for 6 line cycles
Maximum continuous current	200 A
Maximum of two states	Fully open / fully closed
Contact resistance	0.25 milliohms maximum
Voltage isolation	4000 Vrms

TCB

GRANT OF EQUIPMENT AUTHORIZATION

TCB

Certification
Issued Under the Authority of the
Federal Communications Commission
By:

TUV Rheinland of North America, Inc.
Product Safety Division 762 Park Avenue
Youngsville, NC 27596

Date of Grant: 03/10/2010

Application Dated: 02/24/2010

Elster Solutions, LLC
208 S. Rogers Lane
Raleigh, NC 27610

Attention: John Holt , Principal Engineer

NOT TRANSFERABLE

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

FCC IDENTIFIER: QZC-RX2EA4
Name of Grantee: Elster Solutions, LLC
Equipment Class: Part 15 Spread Spectrum Transmitter
Notes: Spread Spectrum Modular Transmitter
Modular Type: Limited Single Modular

Grant Notes	FCC Rule Parts	Frequency Range (MHZ)	Output Watts	Frequency Tolerance	Emission Designator
	15C	902.8 - 927.6	0.25		323KG1D

Note 1: Limited Modular Approval: Power listed is conducted. This Module is approved only for installation in devices under control of the grantee and only for models indicated in this filing. Only antenna(s) documented in this filing may be used with this transmitter. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. OEM integrators and End-users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

TÜVRheinland®
Precisely Right.

RF Exposure Report

EUT Name: Rex2 Power Meters
EUT Model: RX2EA4, RX2EA4-I
FCC ID: QZC-RX2EA4 , QZC-RX2EA4I

FCC Title 47, Part 15.247(i), 1.1307(b), and 1.1310

Prepared for:

John Holt
Elster Solutions, LLC
208 South Rogers Lane
Raleigh, NC 27610
Tel: 919 250-5557
Fax: 919 250-5486

Prepared by:

TUV Rheinland of North America
762 Park Avenue
Youngsville, NC 27596
Tel: (919) 554-0901
Fax: (919) 556-2043
http://www.tuv.com/

Report/Issue Date: 9 February 2010
Report Number: Supplement to 30953899.001 - MPE

1 RF Exposure Measurement (Mobile Device) 15.247(i)

1.1 Test Methodology

In this document, we try to prove the safety of radiation harmfulness to the human body for our product. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The Gain of the antenna used in this product is measured in a Semi-Anechoic Chamber, and also the maximum total power input to the antenna is measured. Through the Friis transmission formula (see section 4.9.6) and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis transmission formula is a far field assumption, the calculated result of that is an over-prediction for near field power density. We will take that as the worst case to specify the safety range.

1.2 RF Exposure Limit

According to FCC 1.1310 table 1: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A)Limits For Occupational / Control Exposures				
300-1500	...	...	F/300	6
1500-100,000	...	...	5	6
(B)Limits For General Population / Uncontrolled Exposure				
300-1500	...	...	f/1500	6
1500-100,000	...	...	1.0	30

f = Frequency in MHz

1.3 EUT Operating condition

The software provided by Manufacturer enabled the EUT to transmit data at lowest, middle and highest channel individually.

1.4 Classification

The antenna of the product, under normal use condition, is at least 20cm away from the body of the user. Warning statement to the user for keeping at least 20cm or more separation distance with the antenna should be included in users manual. Therefore, this device is classified as a **Mobile Device.**

1.5 Test Results

1.5.1 Antenna Gain

The maximum Gain measured in Semi-Anechoic Chamber is 5.64 dBi or 3.66 (numeric).

1.5.2 Output Power into Antenna & RF Exposure value at distance 20cm:

Calculations for this report are based on highest power measurement and the highest gain of the antenna. Limit for MPE (from FCC part 1.1310 table 1) is f (MHz) / 1500 = 927.6 / 1500 = 0.62 mW/cm^2

Highest Pout is 250mW, highest antenna gain (in linear scale) is 3.27, R is 20cm, and f = 927.6 MHz

Pd = (250*3.66) / (1600π) = <u>0.182 mW/cm^2, which is 0.438 mW/cm^2 below to the limit</u>.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

1.6 Sample Calculation

The Friis transmission formula: Pd = (Pout*G) / (4*π*R^2)

Where;

Pd = power density in mW/cm2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
$\pi \approx 3.1416$
R = distance between observation point and center of the radiator in cm

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).

elster
Vital Connections

REX2™ meter
ANSI compliance certification

Certification and confirmation

REX2 meters have been tested and have been found to meet the requirements of the following standards and specifications

- ANSI C12.1-2001
- ANSI C12.20-2002
- California PUC D.98-12-080
- CISPR22
- ANSI C12.1-2007 (Draft 8)

The testing protocol required by ANSI C12.1 and California PUC D.98-12-080 concerning meter groups, failure criteria, and series of tests was followed during the testing program. This performance data were obtained from testing 37 REX2 meters. The required tests were supervised by Robert D. Rawls, Lab Engineer, and the results certified by Allan A. Dudash, Principal Engineer. Except as noted in the REX2 meter certification report, tests were performed at the Elster facility in Raleigh, North Carolina.

Elster hereby certifies that continuing quality assurance tests verify that the meter accuracy tests, represented by the records contained herein, are repeated on a periodic basis, sufficient to verify that standard performance of production meters is accurately represented by this data

Allan A Dudash
Test engineer

Robert D Rawls
Laboratory engineer

REX2™ meter

ANSI compliance test report

PB42-2019A

elster
Vital Connections

REX2 METER ANSI COMPLIANCE

Introduction

REX2 meters have been tested and have been found to meet the requirements of ANSI C12.1-2001, ANSI C12.20-2002, California PUC D.98-12-080, CISPR22, and ANSI C12.1-2007 (Draft 8). Extended reports exhibiting accuracy data, comments on the results, and raw data taken during the testing are available for inspection by interested parties (upon approval of the request).

All meters used in the certification tests were calibrated to normal as-shipped levels. All meter accuracy measurements were made with a WECO Test System using Radian standards. An appropriate piece of test equipment was used for each test, depending upon testing requirements and test equipment capabilities. All test equipment had valid calibration stickers. All testing was performed by qualified test personnel and overseen by a test engineer.

The testing began with the mechanical and enclosure requirements. These tests are not powered and therefore not dependent on firmware version. All ANSI enclosure tests were completed for this certification test. These enclosure tests include tests 9, 15, 20, 21, and 32 through 38. When the firmware was deemed stable, the remainder of the tests was completed with that firmware release.

ANSI C12.20 (2002) test reference

The REX2 meter is intended for all applications requiring, up to and including, ANSI Accuracy Class 0.5% meters. Therefore, the criteria used to evaluate the test results were those in ANSI C12.20 for Accuracy Class 0.5% meters. The test numbers used to reference the results are those given in ANSI C12.20-2002. Some of the tests in ANSI C12.20 refer to wiring diagrams in ANSI C12.1. In those cases, the meters were wired and tested as closely as possible to those diagrams. Some tests may have been run with a permitted alternate arrangement.

The testing protocol required by ANSI C12.1 and California Public Utilities Commission Document D.98-12-080, "Direct Access Meter Product Self-Certification Process," concerning meter groups, failure criteria, and series of tests was followed during this testing program. The series test requirement was run on a "Series Group," (see Table 1) and meets the test series requirement of both standards. ANSI C12.1-2007 (Draft 8) introduces more requirements concerning performance data, which is to be taken during testing and introduces an updated version of ANSI/IEEE C37.90.1. All of the requirements of ANSI C12.1-2007 (Draft 8) were followed during this testing.

Table 1 - Initial group meters used in testing

Meter style number	Serial number	Test ID	Form	Voltage
ZFCWJ000000	7693138	3138	2S	240
ZFCWJ000000	7693140	3140	2S	240
ZFCWJ000000	7693141	3141	2S	240
ZFCWJ000000	7694311	4311	2S	240
ZFCWJ000000	7694312	4312	2S	240
ZFCWJ000000	7694314	4314	2S	240

Summary of the tested meters

None of meters in the program were subjected to every test. To assist the reader, the following table shows which qualification groups were subjected to the ANSI C12.20 tests listed. Details of the individual tests, meters tested, and test results can be found in the validation project detail section. Meter 4314 had a firmware failure during Test 30, "Effect of operating temperature." It was taken as the one allowed failure and removed from further testing.

The meters used for testing were production meters, built and calibrated by manufacturing personnel on production equipment. The meters in this project were standard 240 VAC only meters and had no additional options. The meters sent for FCC certification are an exception; see Test 27 for details. The series group contained 6 meters (see Table 1). The remainder of the meters were used for miscellaneous testing. Tests, other than sequential tests, were assigned to meters within this group. See each individual test for coverage.

Table 2 - Additional meters used for testing

Meter style number	Serial number	Test ID	Form	Voltage
ZFCWJ000000	7672146	2146	2S	240
ZFCWJ000000	7672147	2147	2S	240
ZFCWJ000000	7672148	2148	2S	240
ZFCWJ000000	7672149	2149	2S	240
ZFCWJ000000	7672150	2150	2S	240
ZFCWJ000000	7672151	2151	2S	240
ZFCWJ000000	7672152	2152	2S	240
ZFCWJ000000	7672153	2153	2S	240
ZFCWJ000000	7672154	2154	2S	240
ZFCWJ000000	7672158	2158	2S	240
ZFCWJ000000	7672159	2159	2S	240
ZFCWJ000000	7672160	2160	2S	240
ZFCWJ000000	7672161	2161	2S	240
ZFCWJ000000	7672162	2162	2S	240
ZFCWJ000000	7672163	2163	2S	240
ZFCWJ000000	7672164	2164	2S	240
ZFCWJ000000	7672165	2165	2S	240

Table 1 Additional meters used in testing

Meter style number	Serial number	Test ID	Form	Voltage
ZFCWJ000000	7672166	2166	2S	240
ZFCWJ000000	7672167	2167	2S	240
ZFCWJ000000	7672168	2168	2S	240
ZFCWJ000000	7672169	2169	2S	240
ZFCWJ000000	7672170	2170	2S	240
ZFCWJ000000	7672171	2171	2S	240
ZFCWJ000000	7672172	2172	2S	240
ZFCWJ000000	7672173	2173	2S	240
ZFCWJ000000	7672174	2174	2S	240
ZFCWJ000000	7672175	2175	2S	240
ZFCWJ000000	7672176	2176	2S	240
ZFCWJ000000	7672177	2177	2S	240
ZFCWJ000000	7672178	2178	2S	240
ZFCWJ000000	7672179	2179	2S	240
ZFCWJ000000	7672180	2180	2S	240
ZFCWJ000000	7672181	2181	2S	240
ZFCWJ000000	7693135	3135	2S	240
ZFCWJ000000	7693136	3136	2S	240
ZFCWJ000000	7693137	3137	2S	240
ZFCWJ000000	7693139	3139	2S	240
ZFCWJ000000	7693142	3142	2S	240
ZFCWJ000000	7694316	4316	2S	240

Tests and summaries

Test 1: No load

The meters were tested to ANSI C12.20, section 5.5.2.1. Testing was done at 240 volts. The meter register display did not change and no pulses were gained or lost.

- Meters tested: 3136, 3137, and 3139
- Summary: All meters passed

Test 2: Starting load

The meters listed below were tested to ANSI C12.20, section 5.5.2.2. All current class 200 meters started and operated continuously at 0.100 amperes.

- Meters tested: 3136, 3137, 3139
- Summary: All meters passed

Test 3: Load performance

The meters listed below were tested to ANSI C12.20, section 5.5.2.3.

- Meters tested: 3136, 3137, 3139
- Summary: All meters passed the Accuracy Class 0.5 % criteria

Test 4: Effect of variation of power factor

Each meter form was tested to ANSI C12.20, section 5.5.2.4

- Meters tested: 3136, 3137, 3139
- Summary: All meters passed the Accuracy Class 0.5 % criteria

Test 5: Effect of variation of voltage

Meters were tested to ANSI C12.20, section 5.5.2.5. Test data is presented for full and light load currents.

- Meters tested: 3136, 3137, 3139
- Summary: All meters passed the Accuracy Class 0.5% criteria

Test 6: Effect of variation of frequency

Meters were tested to ANSI C12.20, section 5.5.2.6.

- Meters tested: 3136, 3137, 3139
- Summary: All meters passed the Accuracy Class 0.5 % criteria

Test 7: Equality of current circuits: multi-element meters

The meters were tested to ANSI C12.20, section 5.5.2.7.

- Summary: All meters passed the Accuracy Class 0.5% criteria

Test 8: Internal meter losses

The meters were tested to ANSI C12.20, section 5.5.2.8. Loss data in the voltage circuit was taken using a specially constructed and calibrated ALPHA meter with a WECO 1300 calibration station as a voltage source.

ANSI C12.1 calls for the losses in each voltage circuit of a meter not to exceed 5 watts or 20 VA. The power supply of the REX2 Meter is the main source of meter losses. The load of only the voltage sensing circuitry is 30 mw nominal at 240 volts.

- Meters tested: 2158, 2159, 2160
- Summary: All meters met loss requirements

Test 9: Temperature rise

Meters were tested to ANSI C12.20, section 5.5.2.9.

- Meters tested: 2161
- Summary: All meters passed

Test 10: Effect of register friction

The REX2 meter is a solid-state device. This test was omitted.

Test 11: Effect of internal heating

The meters were tested to ANSI C12.20, section 5.5.2.11. There were no anomalies or loss of data.

- Meters tested: 2158, 2159, 2160
- Summary: All meters passed

Test 12: Effect of tilt

The REX2 meter is a solid-state device. This test was omitted.

Test 13: Stability of performance

The meters were tested to ANSI C12.20, section 5.5.2.7 and ANSI C12.1, section 4.7.2.13. There were no anomalies, loss of data, and all meters met the accuracy requirement.

- Meters tested: 3136, 3137, 3139
- Summary: All meters passed

Test 14: Effect of polyphase loading

REX2 meters are single phase only. This test was omitted.

Test 15: Insulation test

All meters in the series group were tested to ANSI C12.20, section 5.5.3.2 and ANSI C12.1, section 4.7.3.1 for voltage withstand. The test was performed using an Associated Research, Inc. Model 7700 series Hipot tester. The meters had no disconnect links; therefore, internal breakdown could not be tested. Instead, the voltage was applied between the meter blades and foil around the meter cover.

There was no evidence of calibration shift, data loss or corruption, observed anomalies, arcing, or any physical damage. Leakage was less than 1 mA for all meters.

- Meters tested: Series group
- Summary: All meters passed

Test 16: Voltage interruption test (momentary power loss)

All series group meters were tested to ANSI C12.20, section 5.5.3.3, and ANSI C12.1, section 4.7.3.2, for voltage interruption. The meters were tested using a Power Science LTG-220 line transient generator.

There was no evidence of calibration shift, data loss or corruption, physical damage, or observed anomalies. Because of the nature of the test, the display is expected to flash on and off, and the power quality monitoring firmware is expected to display warnings of system voltage problems - which it does. All meters resumed normal operation when reference voltage was restored. There were no anomalies, loss of data, and no effect on accuracy.

- Meters tested: Series group
- Summary: All meters passed

Test 17: Effect of high voltage line surges

All series group meters were tested at the points required by ANSI C12.20, section 5.5.3.4, and ANSI C12.1, section 4.7.3.3. The meter voltages were wired in parallel and connected to the surge generator through a single coupler.

There was no evidence of calibration shift, data loss or corruption, physical damage, or observed anomalies.

- Meters tested: Series group
- Summary: All meters passed

Test 18: Effect of external magnetic field

The meters were tested to ANSI C12.20, section 5.5.3.5 and ANSI C12.1, section 4.7.3.4. There were no observed anomalies.

- Meters tested: 3135, 3140, 4311
- Summary: All meters passed

Test 19: Effect of variation of ambient temperature

The meters were test to ANSI C12.20, section 5.5.3.6 for the effect of ambient temperature. There were no observed anomalies.

- Meters tested: 3135, 3142, 4316
- Summary: All meters passed

Test 20: Effect of temperature overloads

Meters were tested to ANSI C12.20, Section 5.5.3.7.1 for the effects of temporary overloads at 7kA Peak. All the meters meet the 0.5% accuracy requirements. There were no observed anomalies or loss or corruption of data.

- Meters tested: 2152, 2153, 2154
- Summary: All meters passed

Meters were tested to ANSI C12.20, Section 5.5.3.7.2 for the effects of temporary overloads at 12kA RMS. All the meters meet the mechanical requirements.

- Meters tested: 2149, 2150, 2151
- Summary: All meters passed

Test 21: Effect of current surge in ground conductor

Meters were tested to ANSI C12.20, section 4.7.3.7 for the effect of current surge in the ground conductor. All the meters meet the 0.5% accuracy requirement. There were no observed anomalies or loss or corruption of data.

- Meters tested: 2146, 2147, 2148
- Summary: All meters passed

Test 22: Effect of superimposed signals

Test is no longer required.

Test 23: Effect of voltage variation: secondary time base

This test is not applicable to REX2 meters.

Test 24: Effect of variation of ambient temperature: secondary time base

This test is not applicable to REX2 meters.

Test 25 Electrical fast transient/burst test

All meters in the series group were tested according to ANSI C12.20, section 5.5.3.12 and ANSI C12.1, section 4.7.3.11, and the applicable wiring diagrams given in ANSI C12.1

There was no evidence of calibration shift, data loss or corruption, physical damage, or observed anomalies to any of the meters. No energy was accumulated.

- Meters tested: Series group
- Summary: All meters passed

Test 26: Effect of radio frequency interference (RFI)

Meters were tested in a GTEM in accordance with ANSI C12.20, section 5.5.3.13 and ANSI C12.1 section 4.7.3.12. All meters were tested in all orientations.

- Summary: All meters passed

Meters were tested at Elster for the Effects of Radio Frequency Interference. There was no indication of calibration shift, errors, data loss or corruption, or any observed anomalies. Any pulses accumulated on any meter were the equivalent of a partial disk rotation of an electromechanical meter.

- Meters tested: 3135, 3138, 3142, 4316

Test 27: Radio frequency conducted and radiated emission test

Meters were tested for conducted and radiated emissions by an independent testing agency in accordance with ANSI C12.20, section 5.5.3.14, ANSI C12.1 section 4.7.3.13, and FCC Part 15 for class B operation and CISPR-22. The meters were tested at 120 or 240 VAC depending upon meter form.

- Meters tested: 2942, 2946, 0332
- Summary: All meters met FCC Class B and CISPR-22 requirements

Test 28: Effect of electrostatic discharge (ESD)

All the meters in the series were tested according to ANSI C12.1 section 4.7.3.14 and IEC 61000-2-4. The meters were mounted in a standard socket sitting on a ground plane.

No meters accumulated any pulses. There was no evidence of calibration shift, data loss or corruption, physical damage, or observed anomalies.

- Meters tested: Series group
- Summary: All meters passed

Test 29: Effect of storage temperature

See Test 30.

Test 30: Effect of operating temperature

All the meters in the series group were tested according to the requirements of C12.1 sections 4.7.3.15 and 4.7.3.16 for the effect of operating/storage temperature (-40° C to +85° C) over a seven-day period.

- Meters tested: Series group

Meter 4314 suffered a firmware error which caused it to be withdrawn from this and all remaining testing. Energy accumulated by the remaining meters in the chamber compared to the meter outside was within expected limits. There was no evidence of data loss or corruption, physical damage, or observed anomalies.

- Summary: All meters passed

Test 31: Effect of relative humidity

The meters in the series group were tested according to the profile in ANSI C12.1 section 4.7.3.17. The meters were tested for 24 hours at 85° C and 95% RH with their covers in place. The meters were loaded at nominal Full Load amperes at 240 volts from an unregulated local utility source.

Meter 4314 suffered a firmware error during Test 30 and was not tested. Time and energy were within expected tolerances, and there was no loss or corruption of data or constants, and no observed anomalies. Post-test registration accuracy of all meters remained within calibration limits.

- Meters tested: Series group
- Summary: All meters passed

Test 32: Mechanical shock

There was no evidence of calibration shift, data loss or corruption, physical damage, or observed anomalies.

See the table after Test 38 for the evaluation by an independent testing agency.

- Meters tested: 2178, 2180, 2181
- Summary: All meters passed

Test 33: Transportation drop

This test was performed immediately after Test 35, Transportation vibration.

There was no evidence of calibration shift, data loss or corruption, physical damage, or observed anomalies.

- Meters tested: 2162, 2163, 2164, 2165
- Summary: All meters passed

Test 34: Mechanical vibration

There was no evidence of calibration shift, data loss or corruption, physical damage, or observed anomalies.

- Meters tested: 2178, 2180, 2181
- Summary: All meters passed

Test 35: Transportation vibration

The box was not inspected between Tests 35 and 33. See Test 33

- Meters tested: 2162, 2163, 2164, 2165
- Summary: All meters passed

Test 36: Weather simulation

There was no evidence of corrosion, leaks, fading, calibration shift, data loss or corruption, physical damage, or observed anomalies.

- Meters tested: 2166, 2172, 2173
- Summary: All meters passed

Test 37: Salt-spray test

There was no evidence of corrosion, calibration shift, data loss or corruption, physical damage, or observed anomalies.

- Meters tested: 2169, 2171, 2179
- Summary: All meters passed

Test 38: Rain tightness

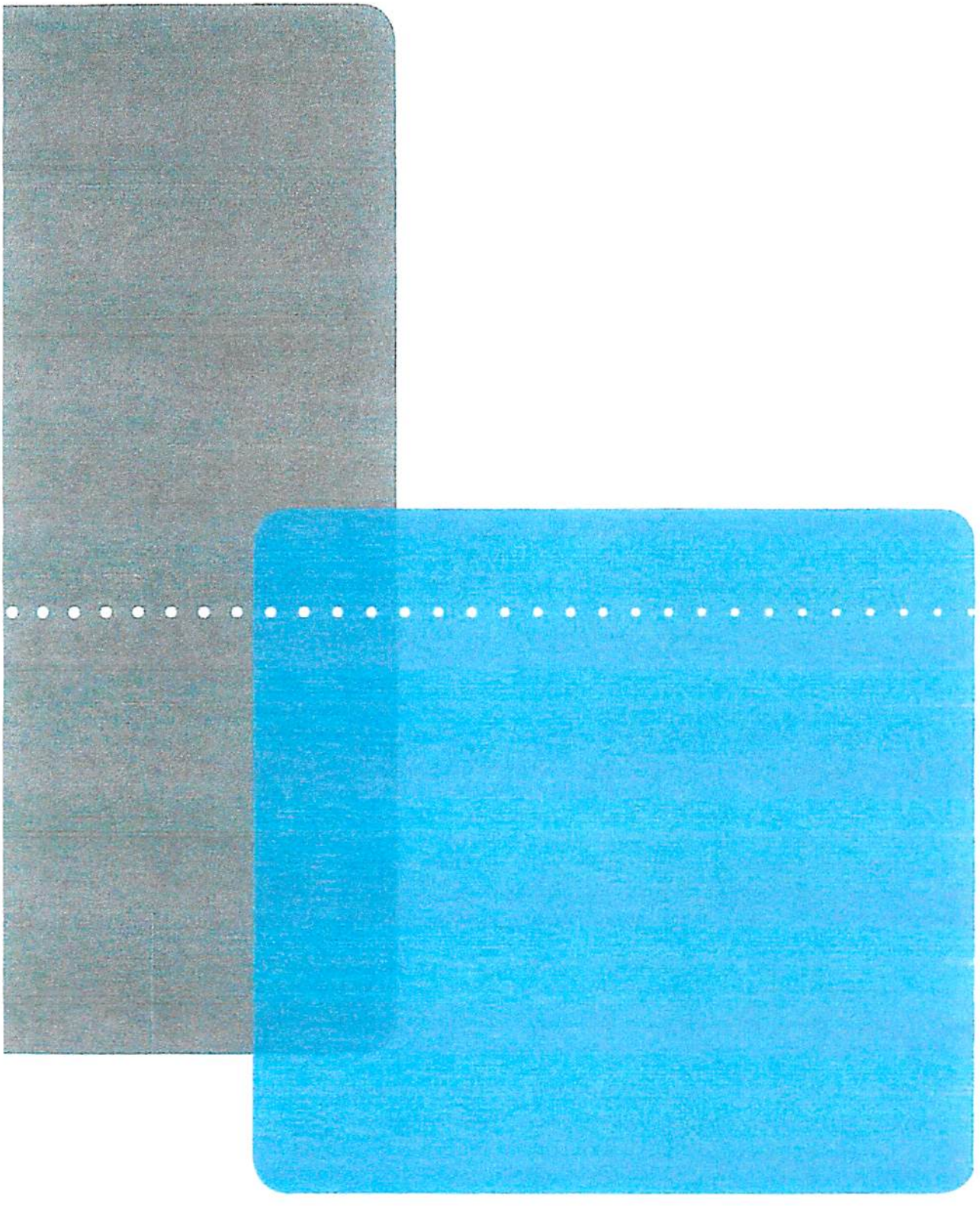
There was no evidence of leaks, calibration shift, data loss or corruption, physical damage, or observed anomalies.

- Meters tested: 2167, 2168, 2170
- Summary: All meters passed

The following summary was provided to Elster by the independent testing agency for these test services:

[illegible] Tests performed by [illegible] testing agency

Test number	Description of test	ANSI C12.1	Result
32	Mechanical Shock	4.7.3.18	Pass
33	Transportation Drop	4.7.3.19	Pass
34	Mechanical Vibration	4.7.3.20	Pass
35	Transportation Vibration	4.7.3.21	Pass
36	Weather Simulation	4.7.3.22	Pass
37	Salt-Spray	4.7.3.23	Pass
38	Raintightness	4.7.3.24	Pass



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