

- 1 **Q. [page 2-12, lines 4-5] Please provide details of the AMR program including costs and**
2 **the savings included in the revenue requirement calculation.**
3
4 A. Attachment A includes a copy of a report titled *2013 Metering Strategy* filed with
5 Newfoundland Power's 2013 Capital Budget Application, which includes analysis of the
6 cost benefits of Newfoundland Power's proposed use of AMR meters.

2013 Metering Strategy
Newfoundland Power 2013 Capital Budget Application

2013 Metering Strategy

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Table of Contents

	Page
1.0 Introduction.....	1
2.0 Background.....	1
2.1 Route Optimization.....	1
2.2 Safety Performance.....	2
2.3 Operating Costs.....	3
2.4 Capital Costs.....	3
3.0 Metering Landscape.....	4
3.1 AMR Technology.....	4
3.2 Changes to Measurement Canada Regulations.....	4
3.3 Ratemaking.....	5
4.0 AMR Cost Benefit Analysis.....	6
4.1 Economic Analysis.....	7
4.2 Sensitivity Analysis.....	8
5.0 Concluding.....	9
Appendix A: S-S-06 Specification	
Appendix B: Regression Line Analysis	
Appendix C: NPV Calculation	
Appendix D: Sensitivity Analysis	

1.0 Introduction

Metering is a core function of Newfoundland Power's ("the Company's") business. The Company provides electrical service to approximately 247,000 customers, the majority of which are supplied through an electricity meter that is read on a monthly basis.

Each year, the Company's capital budget provides for expenditures to purchase and install electrical demand and energy meters. Capital expenditures are driven by connecting new customers to the electrical system, federal regulations governing revenue meters, and improving safety and productivity.

The Company periodically reviews and updates its metering strategy to reflect the current state of metering (technology improvements, federal regulations, etc), in an effort to continually improve safety and operational efficiency at least cost to the customer. The purpose of this report is to identify the current and future direction of metering at Newfoundland Power.

2.0 Background

The Company last submitted its metering strategy to the Board of Commissioners of Public Utilities ("the Board") in its 2006 capital budget application. The strategy outlined four key metering objectives:

- Accuracy & Timeliness – the Company will continue to monitor and maintain existing meter reading accuracy and timeliness, and will continue to seek cost effective ways to improve the process through Automated Meter Reading ("AMR") technology or otherwise.¹
- Cost Management – the Company will manage metering costs by identifying and eliminating inefficiencies and by further use of AMR where the cost benefits clearly justify it.
- Worker Safety – the Company will continue to focus on the safety of its Meter Readers through existing programs. In addition to the targeted deployment of AMR devices in locations that pose safety risks, the Company will seek additional opportunities to deploy AMR technology in a cost-effective manner to enhance safety.
- Ratemaking – the Company will adjust its metering function as necessary to meet the requirements of changes in rates and rate structures as they arise.

These metering objectives have helped to achieve improved productivity and safety performance in meter reading since 2006.

2.1 Route Optimization

The primary means by which the Company manages the cost of the meter reading function is through Route Optimization. Route Optimization is the process of evaluating meter reading

¹ Automated Meter Reading ("AMR") technology enables a meter to be read remotely via a handheld receiver, eliminating the need for a meter reader to approach the meter for a visual read.

routes and making appropriate changes to ensure efficiency is achieved.² This evaluation requires taking a number of variables into consideration, such as the total reading time and driving time in the route, the total number of meters in the route along with the amount of AMR penetration, the length and location of adjacent routes, etc. For example, a route in a high growth area may become too large to be read in a single day, at which point some meters may be moved to an adjacent route, or some meters in the route may be converted to AMR to reduce the total read time. Another route may take less time to read as more and more meters get replaced with AMR meters. In this case meters may be added from an adjacent route, or in some situations two shorter routes can be merged into one route.

From 2007 through 2011, the Company connected 23,923 new customers. The meter reading requirements of these additional customers would have involved approximately 70 new meter reading routes. However, through the strategy of using route optimization and AMR technology for new customer connections, there has been no additional meter reading routes added due to customer growth.

2.2 Safety Performance

Safety performance associated with meter reading has improved since 2006. This is largely due to the continual improvement of the meter reader safety program. An important aspect of this program has been the use of AMR meters in locations that pose a safety hazard to meter readers. Such hazards may include unsafe terrain, deteriorated steps or walkways, and dogs.

Table 1 shows the number of lost time and medical aid incidents associated with the meter reading group over the past 5 years.

Table 1
Meter Reading Safety Performance

Year	2007	2008	2009	2010	2011
Lost Time Incidents	1	6	0	0	2
Medical Aid Incidents	4	1	0	3	1
Total	5	7	0	3	3

Meter Readers drive a total of approximately 1 million kilometres and take approximately 6 million steps per year to obtain meter readings. The use of AMR technology in general can reduce the total driving time required to read meters, eliminate the need for a meter reader to exit their vehicle, and reduce the total time spent walking on customers' property, all of which provides an opportunity for safer working conditions and reduced incidents.

² One meter reading "route" represents a volume of work that can be completed by one meter reader during a regular 8 hour day. On average, 345 meters can be read in one route. However, the number of actual meters in a route varies depending on factors such as:

- the density of meters in the route (urban routes typically have more meters than rural routes)
- percent of AMR meters in the route
- driving time to and from the route
- number of commercial customers in the route (high commercial routes typically have fewer meters than high residential routes)

2.3 Operating Costs

Operating costs for the Company's metering function are comprised of labour, vehicle and travel costs, and related administrative costs. Table 2 shows the total operating costs of the Company's metering function and the cost per customer for the years 2007 through 2011.

Table 2
Expenditure History and Unit Cost Projection

Year	2007	2008	2009	2010	2011
Operating Cost (000s)	\$3,191	\$3,365	\$3,318	\$3,225	\$3,198
Average Number of Customers	230,881	234,020	237,542	241,366	245,294
Operating Cost per Customer	\$13.82	\$14.38	\$13.97	\$13.36	\$13.04

As shown in Table 2, the total operating cost per customer for the Company's metering function has decreased since 2008, from \$14.38 in 2008 to \$13.04 in 2011. Although labour and fuel costs have increased over this period, the decrease in operating cost per customer is largely attributable to above average customer growth coupled with increased meter reading efficiency through the use of AMR technology for new customer connections and specific AMR projects.

2.4 Capital Costs

Table 3 shows the capital expenditures of the Company's metering function for 2007 through 2011, as outlined in the Company's 2012 Capital Budget Application.

Table 3
Expenditure History and Unit Cost Projection

Year	2007	2008	2009	2010	2011
<i>Quantity of New or Replacement Meters</i>					
New Connections	4,038	4,625	5,051	5,300	4,909
GROs/CSOs ³	3,546	13,691	14,188	10,284	13,671
Other ⁴	1,667	2,156	1,097	7,494	8,366
Total	9,251	20,472	20,336	23,078	26,946
<i>Meter Costs</i>					
Actual (000s)	\$1,154	\$1,474	\$ 1,962	\$ 1,872	\$ 1,763
Adjusted ⁵ (000s)	\$1,302	\$1,634	\$ 2,083	\$ 1,980	\$ 1,815

³ Government Removal Orders ("GROs") and Compliance Sampling Orders ("CSOs") are completed in accordance with Measurement Canada regulations under the *Electricity and Gas Inspection Act (Canada)*.

⁴ Meter requirements classified as "Other" include AMR meters installed for safety or winter accessibility purposes, meters replacements as part of specific AMR projects, or replacements for defective or broken meters.

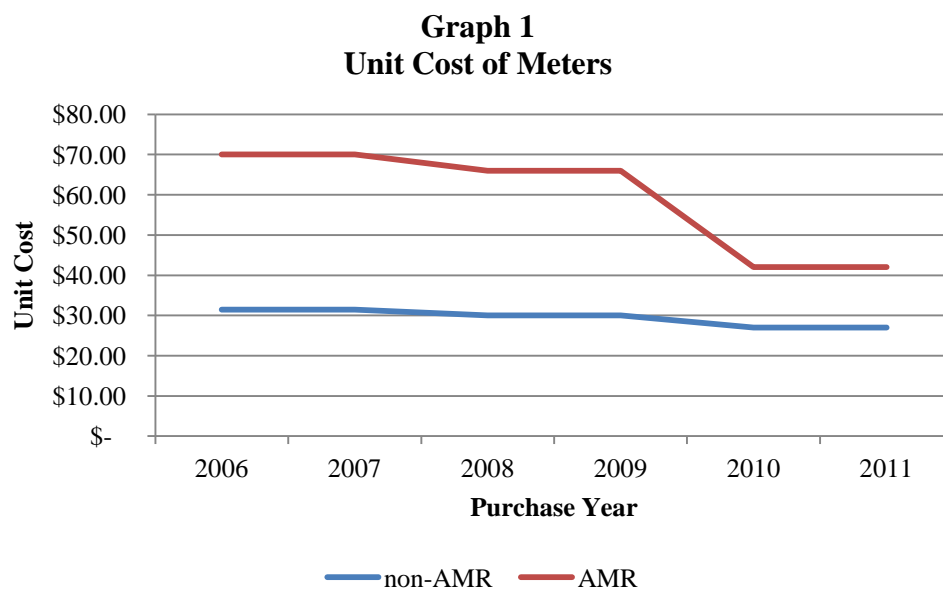
⁵ Cost in 2012 dollars.

Capital expenditures have been driven by purchasing meters to connect new customers to the electrical system, replacing expired meters as a requirement of federal government regulations, installing AMR meters to improve safety and productivity, and replacing defective or broken meters.

3.0 Metering Landscape

3.1 AMR Technology

The cost of AMR vs non-AMR meters has also decreased in recent years. Graph 1 below shows the changes in unit cost between AMR equipped meters and standard domestic non-AMR equipped meters since 2006.⁶



In 2006, a standard domestic non-AMR meter cost \$31.45, compared to an AMR meter cost of \$70.00, a difference of \$38.55. Today, the same non-AMR meter costs \$27.00, while the AMR version costs \$42.00, a difference of \$15.00.

3.2 Changes to Measurement Canada Regulations

In Canada electricity metering is regulated by Measurement Canada under the Weights and Measures Act. Newfoundland Power is responsible to ensure all federal regulations governing revenue meters are followed. Two important metering functions related to Measurement Canada compliance are Government Removal Orders (“GROs”) and Compliance Sampling Orders (“CSOs”). A GRO is an order to remove an electricity meter from service once it has reached its seal expiry date. A CSO is an order to remove a meter as part of a process to sample test a group of meters for measurement accuracy. The meters removed under CSOs are tested to determine if the expiry date for the group of meters will be extended and if so by how long.

⁶ The standard domestic meter accounts for 88% of all meters purchased by Newfoundland Power since 2006.

In 2011, Measurement Canada amended the legislation and applicable procedures and specifications regulating the sample testing of electricity meters.⁷ The changes in legislation have resulted in two significant changes in how the Company manages its meter inventory.

The first change is related to the length and number of extensions that can be granted to a group of meters tested under the CSO process. Under the previous specifications, the Company could sample test a group of meters indefinitely until the test results indicated the group was no longer operating accurately. Under the new procedures, the number of times a meter group can be tested is now finite, and the length of the seal extension is reduced with each round of testing.

The second change is related to the actual testing results of the sampled meters. These changes are statistical and complex in nature. However, the most significant change was made to the acceptable accuracy of a group of meters. Under the previous specifications, meters could receive a seal extension as long as the accuracy test showed the meters were within $\pm 3\%$ of specification. The new specifications allow for an accuracy of $\pm 2\%$ of specification. This reduction in the acceptable accuracy range will result in more groups of electromechanical meters failing the sample testing process and an increase in the number of meter replacements.

Measurement Canada required utilities to be fully compliant with the new regulations for electronic meters by January 2011, and for electromechanical meters by January 2014. In advance of the 2014 deadline for electromechanical meters, the Company has developed a transition strategy for compliance with the new legislation. The transition strategy includes a combination of sample testing electromechanical meters early under previous specifications, as well as the advance replacement of groups of electromechanical meters that are expected to fail testing in 2014 and beyond.

Table 4 below outlines the forecast number of meter replacements required from 2013 to 2017.⁸

Table 4
Required Meter Replacements – 2013 – 2017

	2013	2014	2015	2016	2017	Average ⁹
GRO/CSO Meter Replacements	20,255	19,271	17,631	18,287	13,732	17,835

3.3 Ratemaking

Metering requirements can be significantly influenced by ratemaking requirements. For example, demand management, alternative rates and energy conservation initiatives are typically

⁷ Measurement Canada changes include the implementation of a new sampling standard S-S-06, replacing the old standard LMB-EG-04. A copy of the S-S-06 Specification is included in Appendix A.

⁸ The number of meter replacements shown in Table 4 include the forecast GROs and CSOs for both electronic and electromechanical meters. The actual number of meter replacements will vary from forecast depending on compliance sampling test results for both electronic and electromechanical meters as each group of meters is tested.

⁹ The average number of GRO/CSO meter replacements from 2007 to 2011 was 11,076 per year.

supported with the collection of more detailed energy consumption and demand information than is provided by conventional metering systems.

Rate initiatives currently supported by the Company's metering function include (i) the Curtailable Service Option, which is supported by load recorder type meters that can verify the success of requested curtailments via telephone, (ii) the Company's metering program for its largest General Service customers (i.e. those with demands of 1,000 kVA and above), which uses load recorder type meters to obtain detailed load information and (iii) the Time of Day ("TOD") Rate Study which also uses load recorder type meters to obtain energy usage by time of day for use in customer billing.

The TOD Rate Study is a 2-year study involving 240 domestic customers and 4 large General Service customers. If TOD rates are determined to be a cost-effective rate option, changes will be required in the Company's metering function.¹⁰

4.0 AMR Cost Benefit Analysis

The Company currently uses AMR meters for (1) new customer connections, (2) to address safety and access concerns, and (3) specific projects involving route optimization. Based on current productivity improvements realized through the use of AMR meters, as well as the reduction in cost differential between AMR and non-AMR meters, an analysis was completed to determine if purchasing AMR meters for all meter replacements, particularly for GROs and CSOs, can further reduce the cost of meter reading.

Operating cost savings from purchasing AMR meters for all meter replacements would be achieved through increased meter reading productivity. As the penetration of AMR meters increases, so does the total number of meters that can be read per route, therefore reducing the total number of meter reading routes required.

¹⁰ To implement TOD rates to a broad range of customers would require smart meters to record consumption in intervals as determined by the rate parameters, a communications infrastructure and changes to the data collection and billing systems. The AMR meters being purchased under this strategy are not considered smart meters and will *not* be compatible with TOD rates.

4.1 Economic Analysis

Table 5 shows the forecast number of new customer connections for 2012 through 2017, an estimate of the number of GROs and CSOs to be completed during each year, as well as an estimate of the number of meter replacements required for safety, accessibility and route optimization.

Table 5
Customer and Meter Replacement Forecast

	2013	2014	2015	2016	2017
Metered Services ¹¹	243,561	246,665	249,784	252,956	255,987
Gross New Connections	4,657	4,554	4,586	4,659	4,524
GROs/CSOs ¹²	20,255	19,271	17,631	18,287	13,732
Other (Safety, Access, etc.) ¹³	4,156	4,156	4,156	4,156	4,156
Total	29,068	27,981	26,373	27,102	22,412
Incremental Capital Cost (000s)¹⁴	\$349	\$332	\$304	\$315	\$237
Total AMRs Installed ¹⁵	102,488	130,469	156,842	183,944	206,356
AMR Penetration ¹⁶	42.1%	52.9%	62.8%	72.7%	80.6%

¹¹ Forecast number of customer connections by year end, minus street and area lighting which are not metered services.

¹² The GRO/CSO forecast is based on changes to Measurement Canada legislation and following the Company's transition strategy as outlined in Table 4. This forecast will change as the result of actual compliance sampling results.

¹³ Forecast number for "Other" is based on a five-year historical average of meters installed for safety or winter accessibility, route optimization, or defective or broken meters.

¹⁴ The incremental capital cost is the total number of GRO/CSO meter replacements multiplied by the \$15 incremental cost of AMR meter versus non-AMR meters.

¹⁵ Total AMRs Installed is equivalent to the number of AMR meters in service at the end of the previous year plus the number of New Connections, GRO/CSOs and Other meters installed in the current year.

¹⁶ AMR Penetration is the Total AMRs Installed divided by the number of Metered Services.

Table 6 provides an estimate of the number of meter reading routes that will be required in each year based on the forecast penetration of AMR meters. The productivity improvements (meter reads per route) were determined using a regression line analysis based on current meter reading data. See Appendix B for details on the regression line analysis.

Table 6
Forecast Reduction in Meter Reading Routes¹⁷

	2012	2013	2014	2015	2016	2017
Metered Services	240,350	243,561	246,665	249,784	252,956	255,987
Meters Read per Route	371	411	458	507	562	611
Required # of Routes ¹⁸	648	592	539	493	450	419

AMR meter installations and associated route optimization would occur throughout the year shown, with forecast numbers achieved by year end. Operating savings would be fully realized in the year following the meter installations, and for each year for the 25 year life of the AMR meter. Table 7 provides an estimate of the potential operating cost savings in each year based on the forecast penetration of AMR meters.

Table 7
Meter Reading Operating Cost Reduction
(000s)

	2014	2015	2016	2017	2018
Compared to Previous Year	\$163	\$150	\$125	\$115	\$73
Cumulative	\$163	\$313	\$439	\$554	\$627

A net present value ("NPV") analysis was completed using the incremental capital costs to purchase only AMR meters and the corresponding reduction in operating costs. The results of the NPV show that purchasing only AMR meters provides a total benefit to the customer of \$5,828,011.¹⁹ See Appendix C for details on the NPV calculation.

4.2 Sensitivity Analysis

The economic analysis was based on average route sizes increasing as the percent of AMR meters on the route increases. The average route size was calculated using an equation relating route size to the percentage of AMR meters installed. This equation was developed using the regression line analysis from Appendix B.

¹⁷ Numbers shown are values forecast to be achieved by the end of each year.

¹⁸ Required # of Routes is equal to the number of Metered Services divided by the estimated Meters Read per Route.

¹⁹ Financial calculations also show that a positive benefit to the customer is achieved 3 years after an AMR meter is installed.

A sensitivity analysis was completed to determine the sensitivity of the NPV to the relationship between average route size and percent AMR (See Appendix D). This was done by selecting two additional equations, one that calculates a lower degree of productivity improvement as the percent AMR increases compared to the base case, and another that represents no productivity improvements from installing AMR meters. The results of this analysis are shown in Table 8.

Table 8
Sensitivity Analysis

	Calculated NPV
Base Case	\$5,828,011
25% of Base Case	\$2,232,886
No Productivity	-\$1,538,794

The sensitivity analysis shows that for the scenario where only 25% of the assumed productivity is achieved, the approach of purchasing only AMR meters still provides a benefit to the customer of \$2,232,886. If no productivity were achieved through AMR installation, the project would result in additional cost of \$1,538,794. Based on current results from the use of AMR in the Company's service territory, it is reasonable to assume that average route size can be increased through the deployment of AMR meters at an amount that provides an overall benefit to the customer.

5.0 Concluding

The metering function at Newfoundland Power continues to evolve as changes occur with federal regulations, technology and metering costs. As a result, the Company must re-evaluate and adjust its metering strategy to ensure that core objectives such as worker safety and meter accuracy are achieved in a manner that is least cost to the customer.

Based on the current review of metering at Newfoundland Power, the Company will:

- Continue with the objectives outlined in the 2006 Metering Strategy with respect to Accuracy & Timeliness, Cost Management, Worker Safety and Ratemaking.
- Implement the recommended transition strategy to comply with changes to Measurement Canada regulations.
- Proceed with purchasing only AMR meters for all meter replacements and new installations.
- Maintain its focus on route optimization in order to achieve productivity improvements through AMR and reduce costs.

Appendix A
S-S-06 Specification



Specifications

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 1 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

Sampling Plans for the Inspection of Isolated Lots of Meters in Service

1.0 Scope

This specification establishes the requirements that are applicable to in-service isolated lots of homogeneous electricity or gas meters, where a meter owner has chosen to utilize sampling inspection for the purposes of extending the reverification period of an in-service lot of meters. Where applicable, this specification may be utilized as an alternative to performing 100% meter reverification, upon expiry of a meter lot's initial or subsequent reverification period.

NOTE: Sampling plans, by design, contain inherent risks and limitations with regard to their usage and the conclusions they may or may not provide. Meter owners are therefore advised that, although conformity with the requirements of this specification may allow for the extension of a meter's reverification period, relying solely on the use of the sampling plans contained in this specification will not provide users with an assurance of compliance with the metering accuracy obligations prescribed under the [Electricity and Gas Inspection Act](#).

2.0 Authority

This specification is issued under the authority of section 19 of the [Electricity and Gas Inspection Regulations](#).

3.0 Normative References

3.1 ISO 2859-2:1985, *Sampling procedures for inspection by attributes – Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*. Table A - Single sampling plans indexed by limiting quality (LQ) (Procedure A).

3.2 [S-S-01](#), *Specifications for Random Sampling and Randomization*

3.3 Relevant Measurement Canada specification for the verification and reverification of the meter under test.

4.0 Administrative Requirements

Sampling inspection shall be carried out well in advance of the expiry of the reverification period of the meters so that in the case of non-conformity with the requirements, all meters forming part of the lot can be removed from service prior to the expiry of the reverification period.

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 2 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
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5.0 Sampling Inspection Requirements

5.1 Lot Formation

5.1.1 The lot shall be formed from meters that are homogeneous with respect to the requirements in Annex A.

5.1.2 At the discretion of a meter owner, larger lots may be reformed into multiple lots of smaller size.

5.2 Sample Selection

5.2.1 The sample shall be drawn at random, without replacement, from the lot listing, using authorized random sampling software that meets the requirements referenced in section 3.2. (Systematic sampling shall not be used).

5.2.2 The size of the sample shall be one obtained from the table in Annex C as per the sampling instructions provided by this specification. The sample representing the lot shall correspond to a value between n_{min} and n_{max} as identified in the table of Annex B.

5.2.3 Meter owners shall be responsible for assuring that the meters which are included in the sample meet the following criteria:

- (a) the identified meter is one which is currently installed in service;
- (b) the identified meter's metrological parameters have not been adjusted post installation;
- (c) the identified meter is homogeneous with regard to the criteria of A.1 of Annex A: and
- (d) the identified meter meets the total time on test criteria of A.2 of Annex A.

5.2.4 Where a sample meter does not qualify for inclusion as per the requirements of 5.2.3, meter owners shall not consider this meter as part of the sample group for performance testing purposes, and shall replace it with the sequentially subsequent meter on the preselected unsorted sample meter listing meeting the applicable criteria. The exclusion rationale for the subject meter(s) shall be reported as per the requirements of 5.3.4.

5.2.5 Where a meter, which has been removed from service, is not capable of having its performance assessed in accordance with the requirements of this document, the meter owner shall replace it with the sequentially subsequent meter on the preselected unsorted sample listing of meters available for testing. All meters and their associated test results shall be included unless compelling evidence for exclusion is identified and reported as per the requirements of 5.3.4.

5.2.6 Meters which have been excluded as sample meters as a result of not satisfying either 5.2.3 (a), 5.2.3 (b), 5.2.3 (c), 5.2.3 (d) or 5.2.5 shall not be returned to the parent lot.

5.2.7 Lots failing to meet the minimum sample size (n_{min}) criterion as a result of the total number of exclusions under 5.2.3, are not considered to be homogeneous and are not acceptable for seal extension. Where a lot is deemed to be nonhomogeneous, meter owners shall implement one of the following actions:

- (a) Re-form the lot on the basis of both the lot and sample homogeneity criteria contained in Annex A;
- (b) Assign a lower initial reverification period to the lot as per the requirements of section 5.7; or
- (c) Remove the lot from service.

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 3 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

5.3 Meter Sampling Records

5.3.1 For each lot assessed, a meter owner shall maintain records documenting:

- (a) a unique, owner-assigned lot number or record reference which includes an ordinal number indicating the lot's occurrence for assessment under this specification (including the current - i.e. 1st, 2nd, 3rd, etc.);
- (b) the homogeneity criteria details specified in A.1;
- (c) the utility number and manufacturer's serial number for each meter.

5.3.2 All meters identified by the owner as forming part of the lot, shall be listed in ascending order based on meter identification numbers or an inventory number generated by the associated informatics system.

5.3.3 The identification of each unsorted sample meter (n to n_{max}) selected from the lot, the sample meters tested, the quality characteristics examined, and the test results obtained, shall be documented.

5.3.4 All sample meters selected but not involved in the final calculations shall be accounted for by the meter owner and the reasons for exclusion shall be documented and, on request, made available for Measurement Canada review. Evidence of deliberate exclusion or improper accounting may disqualify the results of the sample's analysis.

5.4 Meter Inspection, Quality Characteristics, and Corrective Actions

5.4.1 Each sample meter shall be examined for conformance to all pertinent requirements as prescribed by reference 3.3.

5.4.2 Sample meters shall be inspected under identical conditions and within as short a time period as is practicable to achieve valid inspection results.

5.4.3 Each defective meter excluded from the final calculations shall be preserved for Measurement Canada review and shall be the subject of an investigation by the meter owner to determine the cause of the defect or defects. In the case of defective meters, a report shall be prepared and shall include the following information associated with this investigation:

- (a) details of the meter's make, model, Notice of Approval number, seal year, and identification numbers;
- (b) a description of the defect and its effect on the meter's operation, including performance test results where feasible;
- (c) a description of the steps taken to investigate the cause of the defect, including identification of the personnel both performing the investigation and providing information for its purpose;
- (d) an explanation of how the defect occurred, including where it occurred in the process;
- (e) an evaluation of the extent of the defect in the immediate situation as well as in situations likely to be similarly affected; and
- (f) details of the corrective and preventive action proposed or performed to address the cause and symptoms of the defect.

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 4 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
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5.4.4 In cases where a defective meter is encountered, the report required by clause 5.4.3 shall be provided to the local Measurement Canada representative for review prior to deciding upon the acceptability of the affected lot. Decisions regarding acceptability of the affected lot and the possible need for further investigation or corrective action shall not be made until Measurement Canada has evaluated the report and the statistical analysis of the data from the sample meters involved in the final calculations.

5.5 Acceptance Criteria

5.5.1 Individual Meters

5.5.1.1

Each meter in the sample can be considered acceptable if the following conditions are met:

- (a) the meter complies with all specified reverification performance requirements (reference 3.3);
- (b) the meter does not possess any defect which could affect its ability to meet specified requirements during its usage;
- (c) the meter has been obtained from a population whose seal year is still valid;
- (d) the meter has been received with a broken seal and an exclusion as per 5.3.4 cannot be justified.

5.5.1.2

To maintain overall homogeneity of the lot, sample meters, obtained from lots qualifying for an extension, which meet reverification requirements and which have been granted the same extension as the parent lot, shall, wherever possible, be returned to the parent lot and reinstalled following acceptance of the lot. Alternatively, these meters can be reverified.

5.5.1.3

Where sample meters require their seals to be broken in order to conduct meter performance testing, precautions should be taken to ensure the integrity of the results. If the lot is acceptable, the individual sample meters that are also acceptable shall be resealed with an additional identifier indicating the original seal year in the sealing assembly. Alternatively, these meters shall be reverified.

5.5.1.4

Sample meters that meet reverification requirements, yet have been obtained from lots not qualifying for an extension or sample meters not returned to the parent lot, shall be governed by Measurement Canada bulletins [E-26 Reverification Periods for Electricity Meters and Metering Installations](#) or [G-18 Reverification Periods for Gas Meters, Ancillary Devices and Metering Installations](#), with respect to the assigned reverification period.

5.5.2 Meter Lots

5.5.2.1

The sampling plan parameters of ISO 2859-2 (reference 3.1) as modified in Annex C of this document, shall be utilized for the inspection of isolated lots of meters in service.

5.5.2.2

The acceptability of the lot for the purposes of extending its reverification period, shall be established on the basis of the performance results of the sample with regard to the number of marginally conforming meters (C_1) and the number of nonconforming meters (C_2) evidenced, as defined in section 5.5.3.

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 5 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

5.5.2.3

Contractors are responsible for ensuring the performance quality of the in-service meter lots which they own. Where a seal extension period is available under this specification, contractors shall give consideration to their statutory obligation for keeping meters in good repair, when selecting the seal extension period to be applied from those which are available. Specifically, the conformance quality of an in-service lot of meters shall, in all cases, meet or exceed the declared limiting quality that is associated with level 5.

5.5.3 Meter Performance Test Limits

5.5.3.1

For all performance tests, required to be conducted as per the reverification specification applicable to the subject meter type or class, a Type 1 (C_1) marginally conforming meter is one whose performance error exceeds $\pm 2.0\%$ at any test point.

5.5.3.2

For all performance tests, required to be conducted as per the reverification specification applicable to the subject meter type or class, a Type 2 (C_2) nonconforming meter is one whose performance error exceeds $\pm 2.9\%$ at any test point.

5.5.3.3

For the purposes of section 5.5.2.2, a Type 2 (C_2) nonconforming meter is also counted as a Type 1 (C_1) marginally conforming meter.

5.5.4 Seal Extension Levels

5.5.4.1

Where a lot of meters is assessed against the requirements of this specification, the maximum seal extension level available for application to the lot, shall be established on the basis of satisfying the following criteria when applied to the n_{min} sample size as specified in a column of the applicable Annex C table:

Maximum Extension Level Criteria:

- (i) $c1 \leq Ac_{type\ 1}$
- (ii) $c2 \leq Ac_{type\ 2}$

5.5.4.2

Subject to the requirements of section 5.6, the maximum seal extension level that may be available for application to a lot, is the seal extension level associated with the limiting quality column of the applicable table in Annex C, C-1 or C-2 which satisfies the requirements of 5.5.4.1 for the established sample size n_{min} .

5.5.4.3

Where the maximum level of extension available to a lot of meters is determined to be level 4, the applicable seal extension period, as determined under Annex E, may be repeated without limitation on an ongoing basis where the applicable level 4 limiting quality criteria of Annex C, C-1 or C-2 and the Time on Test criteria of Annex E are met.

5.5.4.4

Subject to section 5.5.4.5, lots failing to meet at least level 4 criteria are not acceptable for extension. All meters in non-acceptable lots shall be removed from service.

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 6 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

5.5.4.5

Where a lot failing to meet level 4 criteria is capable of meeting the limiting quality criteria of level 5 (where available), the applicable level 4 extension period available as per Annex E, may be applied to the lot. However, upon expiry of this period, the lot cannot be re-sampled and must be removed from service.

5.5.4.6

Where a lot fails to meet at least level 4 criteria and this failure is as a result of not meeting the requirements of sec 5.5.4.1(ii), all sample meters identified as C_2 meters under section 5.5.3.2 shall be held in storage until Measurement Canada authorizes their further processing. Sample meters shall not be required to be held in storage (without just cause) after December 31st of the calendar year in which the sampling was conducted.

5.6 Use of Sampling Tables (Annex C, C-1, and C-2)

5.6.1 The value of n_{min} shall be established on the basis of the lot size and the maximum seal extension level being targeted. Once the n_{min} sample size has been determined, it is this value that shall be utilized for establishing the maximum seal extension level, where further movement within the table is limited to either the horizontal or a diagonal downward direction for the same n_{min} .

5.6.2 Notwithstanding the seal extension level available under the requirements of section 5.5.4.1, and subject to section 5.6.3, the maximum seal extension level that may be applied to the lot shall be established on the basis of the lot's ordinal sampling occurrence under this specification as specified in Annex D.

5.6.3 Where the maximum seal extension level available to the lot under Annex D is longer in duration than the previous seal extension period granted to the lot, the period applied shall not be greater than one level better than the previous extension level and this eligibility for the application of a longer period, is limited to a single occurrence within a meter lot's in-service life.

5.6.4 Where a lot population has never been assessed against the requirements of this specification, the seal extension period of reference for the purposes of 5.6.3, shall be the last extension period granted to the lot under the previously authorized compliance sampling program.

5.6.5 Where a lot population is re-formed under the requirements of 5.1.2 or 5.2.7, the maximum seal extension levels available to the re-formed lot shall be established in accordance with the requirements of 5.6.2, 5.6.3, and 5.6.4, as applicable to the parent lot before re-formation.

5.6.6 Where a lot's population size is 500 meters or less, a meter owner may, at their discretion, utilize the sampling plan as specified in Annex C-1. Where the sampling plan of Annex C-1 is utilized, the seal extension periods available under Annex E are reduced by 50% (rounded down to the nearest whole year).

5.6.7 Where a lot's population size is 60 meters or less, a meter owner may, at their discretion, utilize the sampling plan as specified in Annex C-2. Where the sampling plan of Annex C-2 is utilized, the only seal extension periods available under Annex E are those associated with a level 4 extension.

5.7 Seal Extension Periods (Annex E)

5.7.1 For meter lots still within their initial reverification period, the time on test (TT) requirements which need to be met or surpassed by each meter in the sample (as per the homogeneity requirements of A.2), shall be established on the basis of the meter's initial reverification period and the minimum period (in months) prescribed under Annex E.

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 7 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

5.7.2 For meter lots still within their initial reverification period, a sample meter's time on test (in months) is established from the date the sample meter is placed into service, to the date that it is removed from service (rounded down to the nearest whole month). For the purposes of this section and section 5.7.4, where months are established on the basis of day counts, one month is to be considered 31 days. Alternatively, months may be established on the basis of actual month days where this information is tracked on an ongoing basis relative to true months completed within a calendar period.

5.7.3 Subject to section 5.7.5, where a meter lot is no longer within its initial reverification period, the time on test (TT) requirements that need to be met or surpassed by each meter in the sample (as per the homogeneity requirements of A.2), shall be established on the basis of the previous seal extension period granted to the lot and the applicable subsequent extension percentage prescribed for the subject row as per Annex E.

5.7.4 For meter lots no longer within their initial reverification period, a sample meter's time on test (in months) is established from the date that the certificate was issued relative to the meter lot's last seal extension, to the date that the sample meter is removed from service (rounded down to the nearest whole month). Alternatively, a meter's time on test requirement is satisfied where it can be demonstrated that the sample meter has continuous uninterrupted service.

5.7.5 Meter lots that are sampled on an annual basis under this plan, are not subject to the time on test requirements of Annex E.

5.7.6 Where the time on test requirements for the 1st extension or subsequent extensions of a lot have not been met or where a sample is deemed non-homogeneous relative to the applicable time on test requirement, a lower initial reverification period (where the time on test requirements are satisfied) may be assigned to the lot.

5.7.7 Once a lower initial reverification period row has been assigned to a lot, further movement within the table is limited to either the horizontal, downward or diagonal downward directions (i.e. the initial reverification period reference cannot be increased on subsequent samplings of the lot).

5.8 Reverification Date Calculations

5.8.1 Subject to 5.8.2, where a seal period extension is granted under Annex E, the meters in the lot, less any nonconforming meters, shall be considered due for reverification on or before December 31 of the calendar year calculated as the sum of the year in which the first sample meter was removed from service and the extension period granted under Annex E (in years).

5.8.2 Where the first sample meter is removed from service in the calendar year which immediately precedes the meter lot's seal expiration year, the meters in the lot, less any nonconforming meters, shall be considered due for reverification on or before December 31 of the calendar year calculated as the sum of the lot's seal expiration year and the extension period granted under Annex E (in years).

5.8.3 Subject to 5.8.4, where a lot of meters fails to meet the requirements for an extension of its reverification period, the meters in the lot shall be considered due for reverification on the date established by the previous verification or reverification, as the case may be.

5.8.4 In the case of a lot of meters which fails to meet the requirements for an extension of its reverification period and the first sample meter was removed from service in a calendar year which preceded the meter lot's seal expiration year by more than one (1) calendar year, the meters in the lot shall be considered due for 100% reverification, on or before December 31st of the calendar year which postdates the year in which the first sample meter was removed from service.

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 8 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

Annex A (normative)

A.1 Lot Homogeneity Requirements

Where applicable, the meters in the lot shall be homogeneous with respect to the following characteristics:

Electricity Meters

- (a) type (transformer or self contained);
- (b) manufacturer and model, unless otherwise authorized in accordance with clause A.1.1;
- (c) voltage or voltage range;
- (d) maximum current range, unless otherwise authorized in accordance with clause A.1.1;
- (e) measurement functions (e.g. measured quantities, energy, demand), unless otherwise authorized in accordance with clause A.1.1;
- (f) firmware version, unless otherwise authorized in accordance with clause A.1.1;
- (g) frequency rating;
- (h) same model or type of telemetering device (if so equipped), unless otherwise authorized in accordance with clause A.1.1;
- (i) configuration / form (i.e. number of elements*, wye, delta or auto configuration);
- (j) status at time of last inspection (i.e. new, renewed, or reserviced);and
- (k) seal year (same seal year or two consecutive seal years, provided both are valid);

***With the exception that 1-element and 1.5-element meters may be mixed to form a lot.**

Natural Gas Meters

- (a) manufacturer and model, unless otherwise authorized in accordance with clause A.1.1.
- (b) same or similar capacity rating, unless otherwise authorized in accordance with clause A.1.1.
- (c) measurement functions (e.g. measured quantities, temperature/pressure conversion).
- (d) firmware version, unless otherwise authorized in accordance with clause A.1.1.
- (e) same model or type of telemetering device or auxiliary attachment (if so equipped), unless otherwise authorized in accordance with clause A.1.1.
- (f) status at time of last inspection (i.e. new, renewed, or reserviced).
- (g) seal year (same seal year or two consecutive seal years, provided both are valid).

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 9 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

A.1.1 Forming Lots with Mixed Meters

Where a lot includes meters which, for the purposes of lot homogeneity, are ones which possess a similar characteristic rather than a characteristic which can be readily identified as being the same, meter owners are responsible for maintaining documented records identifying the similarities which support the homogeneity conclusion (as concerns including these meters within the subject lot). For the purposes of compliance sampling, if an accredited organization wishes to combine, in one lot, various models or vintages of meters, and/or meters equipped with and without a telemetering device, the accredited organization shall submit a request to MC with accompanying documentation in support of their claim that these differing meters can be considered homogeneous.

A.2 Sample Homogeneity Requirements

The meters in a sample shall be homogeneous with respect to similar time in usage. For a sample meter to be considered homogeneous with regard to similar time in use, a meter shall have been in service for a time period that meets or exceeds the applicable time on test (TT) requirements of Annex E. Where n_{min} is not achieved with regard to this criteria, a meter owner may re-form the lot or reduce the seal period extensions available as per the requirements of section 5.7.




Annex B (normative)

Table of n_{min} to n_{max} Sample Sizes

Single Sampling	
n_{min}	n_{max}
30	37
42	52
44	55
65	81
80	100
125	156
200	250
315	394

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 10 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

Annex C - Single Sampling Plans Indexed by Quality Level (LQ)
(normative)

Lot Size		Limiting Quality (LQ)				
		3.15 (Level 1)	5.0 (Level 2)	8.0 (Level 3)	12.5 (Level 4)	20 (Level 5)
Up to 500	n_{min}	80	65			
	Ac _{type 1}	0	0			
	Ac _{type 2}	0	0			
501 to 1200	n_{min}	125	80	65	42	42
	Ac _{type 1}	1	1	1	2	4
	Ac _{type 2}	1	0	0	0	0
1201 to 3200	n_{min}	125	125	80	65	65
	Ac _{type 1}	1	3	3	4	8
	Ac _{type 2}	1	1	0	0	0
3201 to 10000	n_{min}	200	200	125	80	80
	Ac _{type 1}	3	5	5	5	10
	Ac _{type 2}	3	3	1	1	1
10001 to 35 000	n_{min}	315	315	200	125	125
	Ac _{type 1}	5	10	10	10	18
	Ac _{type 2}	5	5	3	3	3
	n_{min}	X		315	200	200
	Ac _{type 1}			18	18	32
	Ac _{type 2}			5	5	5

NOTE:

As per 5.5.3.1, Type 1 (C_1) > 2.0%

As per 5.5.3.2, Type 2 (C_2) > 2.9%

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 11 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

Annex C1 - Single Sampling Plans Indexed by Quality Level (LQ)
Small Lot Size Plan (with increased sampling frequency)
(normative)

Lot Size		Limiting Quality (LQ)			
		5.0 (*Level 1)	8.0 (*Level 2)	12.5 (*Level 3)	20 (*Level 4)
Up to 500	n_{min}	44	44	44	44
	$Ac_{type\ 1}$	0	1	2	4
	$Ac_{type\ 2}$	0	0	0	0

NOTE:

* Extension period as per section 5.6.6.

As per 5.5.3.1, Type 1 (C_1) > 2.0%

As per 5.5.3.2, Type 2 (C_2) > 2.9%

Annex C2 - Single Sampling Plans Indexed by Quality Level (LQ)
Very Small Lot Size Plan
(normative)

Lot Size		Limiting Quality (LQ) 5.0 (Nonconforming)
		Level 4
Up to 60	n_{min}	30
	$Ac_{type\ 1}$	0
	$Ac_{type\ 2}$	0

NOTE:

As per 5.5.3.1, Type 1 (C_1) > 2.0%

As per 5.5.3.2, Type 2 (C_2) > 2.9%

Category: STATISTICAL METHODS	Specification: S-S-06	Page: 12 of 12
Document(s): S-S-06 Implementation, Information Bulletin (2010-02-08)	Issue Date: 2010-06-21	Effective Date: 2011-01-01
	Supersedes: PS-S-04, LMB-EG-04	

Annex D - Available Extension Levels
(normative)

Ordinal Sampling Occurrence	Maximum Seal Period Extension Levels Available			
1st	Level 1	Level 2	Level 3	Level 4
2nd		Level 2	Level 3	Level 4
3rd			Level 3	Level 4
4th (and higher)				Level 4

Annex E - Time on Test (TT) Requirements and Maximum Seal Period Extensions
(normative)

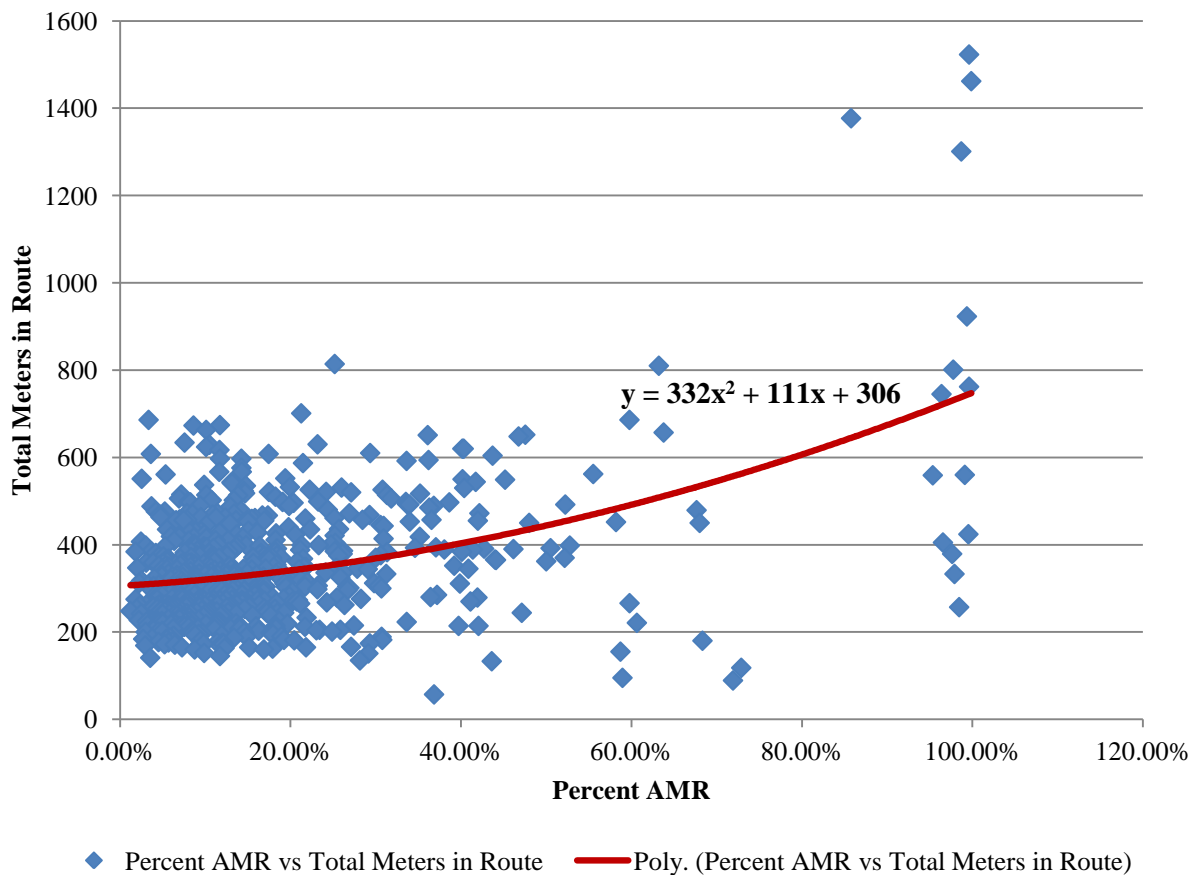
Initial Reverification Period (years)	1 st Extension (Months)	Subsequent Extensions*	Maximum Seal Period Extension (years)			
			Level 1	Level 2	Level 3	Level 4
12	115	75%	10	8	5	2
11	105	75%	9	7	5	2
10	84	70%	8	6	4	2
9	75	70%	7	5	3	2
8	67	70%	6	4	3	2
7	58	70%	5	4	2	1
6	50	70%	4	3	2	1
5	42	70%		3	2	1

*Subsequent extension TT based on indicated percentage multiplied by the previous extension (rounded up to the next whole month).

Alan E. Johnston
President

Appendix B
Regression Line Analysis

Regression Line Analysis



A Regression Line Analysis has been completed using current meter reading data to estimate the number of meters that can be read per route as the percent of AMR meters increases.

In the graph above, the total number of meters in each of the Company's 686 meter reading routes is plotted versus the percent of AMR meters in each route (a sample data set is shown in the table below). From this data, a 2nd order polynomial regression line is plotted and can be represented by the equation $y=332x^2+111x+306$, where x represents the percentage of AMR meters in the route and y represents the total meters that can be read in each route.

Although this equation represents current meter reading data at a specific point in time, it also provides a method for calculating the optimal average route size as a function of the percentage of AMR meters. For example, if 50% of the Company's meters were converted to AMR ($x = 0.50$), the estimated average route size can be calculated as follows:

$$y = 332x^2 + 111x + 306 = 332(0.5)^2 + 111(0.5) + 306 = \mathbf{445 \text{ meters}}$$

If 100% of meters were converted to AMR ($x = 1.00$), it is estimated that the average route size would be 749 meters.

$$y = 332x^2 + 111x + 306 = 332(1.00)^2 + 111(1.00) + 306 = \mathbf{749 \text{ meters}}$$

Currently, 20.76% of the Company's meters are AMR ($x = 0.2076$). The regression line equation calculates an optimal average route size of 343 meters (99.4% of the Company's actual average route size of 345 meters).

$$y = 332x^2 + 111x + 306 = 332(0.2076)^2 + 111(0.2076) + 306 = \mathbf{343 \text{ meters}}$$

Sample Data Set (Representing 32 of 686 Total Routes)

Route ID	Percent AMR	Total Meters in Route	Route ID	Percent AMR	Total Meters in Route
1-111	14.01%	207	2-111	17.10%	345
1-112	20.21%	292	2-112	14.29%	273
1-113	18.87%	371	2-113	99.35%	923
1-114	21.26%	701	2-114	8.71%	402
1-115	11.08%	361	2-115	11.44%	472
1-116	25.60%	375	2-116	24.75%	400
1-117	18.71%	326	2-117	55.52%	562
1-118	13.60%	456	2-118	52.24%	492
1-221	21.74%	460	2-119	10.50%	381
1-222	16.12%	428	2-221	9.83%	356
1-223	25.69%	436	2-222	15.01%	453
1-224	16.40%	378	2-223	10.72%	373
1-225	17.49%	366	2-224	35.20%	517
1-226	15.87%	315	2-226	11.81%	237
1-331	4.89%	327	2-227	18.40%	375
1-332	8.22%	304	2-331	10.18%	393

Appendix C
NPV Calculation

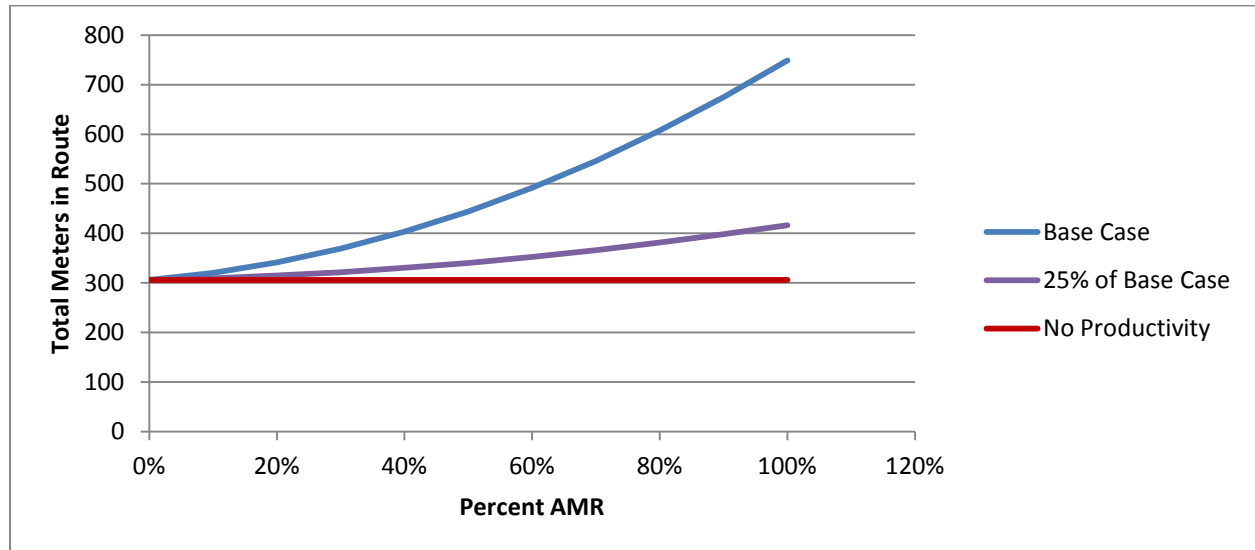
NPV Calculation

Average Incremental Cost of Capital: 7.4%
 CCA Rate: 8.00%

Year	Capital Expenditure	Capital Revenue Requirement	Operating Costs	Net Benefit	Present Worth
2013	\$356,980	\$38,637	\$0	-\$38,637	-\$35,975
2014	\$346,624	\$82,072	-\$170,205	\$88,133	\$76,406
2015	\$323,598	\$121,255	-\$333,273	\$212,018	\$171,143
2016	\$342,180	\$160,580	-\$475,802	\$315,223	\$236,919
2017	\$261,589	\$190,153	-\$611,687	\$421,534	\$294,993
2018	\$0	\$188,700	-\$704,680	\$515,980	\$336,208
2019	\$0	\$181,930	-\$717,013	\$535,083	\$324,632
2020	\$0	\$175,370	-\$729,533	\$554,163	\$313,042
2021	\$0	\$169,004	-\$741,892	\$572,888	\$301,322
2022	\$0	\$162,816	-\$754,900	\$592,083	\$289,961
2023	\$0	\$156,792	-\$768,138	\$611,345	\$278,766
2024	\$0	\$150,919	-\$781,715	\$630,796	\$267,816
2025	\$0	\$145,184	-\$795,545	\$650,361	\$257,098
2026	\$0	\$139,577	-\$809,701	\$670,124	\$246,658
2027	\$0	\$134,087	-\$824,276	\$690,189	\$236,539
2028	\$0	\$128,705	-\$838,827	\$710,121	\$226,602
2029	\$0	\$123,423	-\$854,065	\$730,643	\$217,086
2030	\$0	\$118,231	-\$869,602	\$751,370	\$207,863
2031	\$0	\$113,124	-\$885,379	\$772,255	\$198,920
2032	\$0	\$108,095	-\$901,428	\$793,333	\$190,270
2033	\$0	\$103,136	-\$917,776	\$814,640	\$181,918
2034	\$0	\$98,243	-\$934,337	\$836,094	\$173,845
2035	\$0	\$93,410	-\$951,008	\$857,598	\$166,030
2036	\$0	\$88,632	-\$967,976	\$879,344	\$158,510
2037	\$0	\$98,250	-\$985,248	\$886,998	\$148,873
2038	\$0	\$77,722	-\$1,002,827	\$925,105	\$144,570
2039	\$0	\$58,175	-\$754,925	\$696,750	\$101,382
2040	\$0	\$42,296	-\$519,796	\$477,499	\$64,692
2041	\$0	\$22,557	-\$317,514	\$294,957	\$37,208
2042	\$0	\$0	-\$125,260	\$125,260	\$14,712
Net Present Value					\$5,828,011

Appendix D
Sensitivity Analysis

Sensitivity Analysis



The 2nd order polynomial equation $y=332x^2+111x+306$, determined from the Regression Line Analysis in Appendix A, is shown as the 'Base Case' in the graph above. An additional equation, shown as the '25% of Base Case', was selected to represent a lower degree of productivity improvement as the percent AMR increases. The 'No Productivity' equation was also selected to represent a scenario where no productivity improvements are achieved through installing AMR.