nationalgrid

Introduction of Cutout Mounted Reclosers

To National Grid's

Electrical Distribution Network

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Acknowledgements:
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Reviewed by: [signature], Manager DAA Date: Feb, 2015
<<Name, Position, Organization>>

Approved by: [signature] DIRECTOR DIST PLAN Date: FEB 2015
<<Name, Position, Organization>>

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1. Executive Summary

The purpose of this paper is to safely and effectively introduce single phase cutout mounted reclosers to National Grid's Distribution Network	
Program Description:	Create a five year Capital Investment program for $ 3.0 M that will install 670 CMRs at targeted locations on National Grid's Overhead Distribution Network
Key goals of this Paper:	• Gain acceptance of a new device from stakeholder groups including executive management. • Justify a five year Capital Spending Program • Define a criteria for identifying appropriate CMR locations • Provide installation guidance for consistent application. • Plan for and manage end-of-line replacements
Stakeholders:	Network Strategy Asset Management Distribution Electric Operations Electric Materials and Standards Operations: Maintenance and Construction Overhead Lines I&M Compliance (Inspections Group) Network Strategy Standards, Polices and Codes T&D Work Methods Control Center Operations Electric Distribution Design HR L&D Electric, NE (Millbury Training Center) Investment Planning Project Management and Complex Project Group
Assumptions and Constraints:	Electric Operating Procedures #NG-EOP G014 'Clearance and Control Procedures' are adjusted to accommodate Non Reclose Assurance (NRA) procedures in New England. Electric Materials and Operations (Standards Group) has accepted CMRs as a standard item. Construction Standards and Work Method Bulletins are issued. Network Strategy Distribution Electric Operations, Field Engineering will be responsible for determining suitable locations. CMRs will be almost exclusively installed in radial overhead lines. Looped or main-line applications are considered exceptions and will require documentation on OMS (outage management system) circuit one line diagrams. Their operation (Open, Close, Auto and Non- reclose) will be directed by the System Operator. The O&M Compliance Group will incorporate CMRs in its inspections list in 2015. They will share the responsibility (along with OH lines) of managing device replacements.

2. Introduction

2.1 Purpose:

Safely and effectively introduce single phase cutout mounted reclosers to National Grid's Distribution Network.

2.2 Problem:

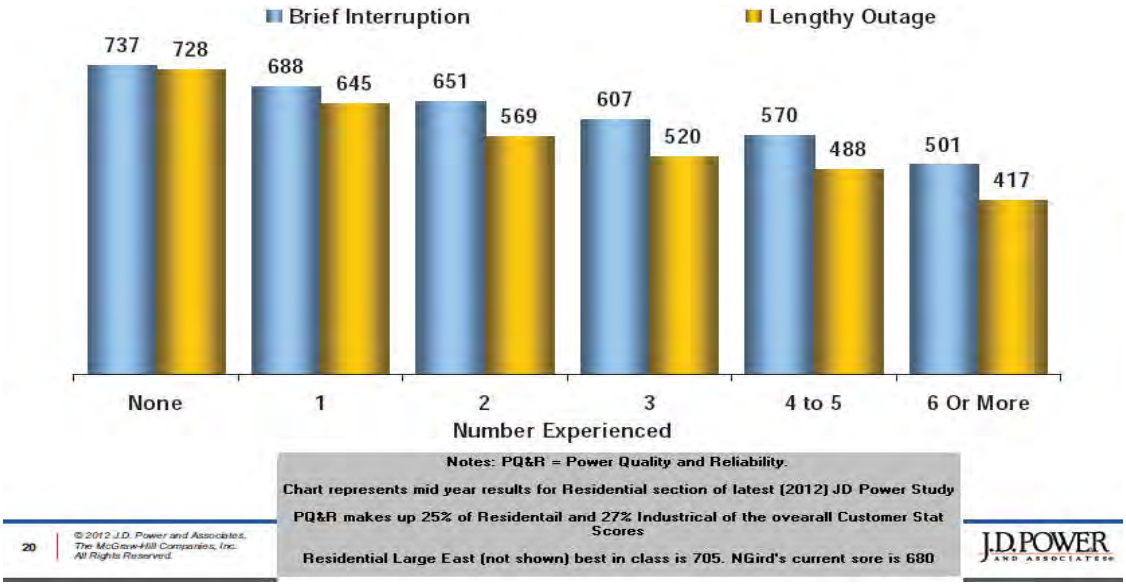
Outage statistics from IDS indicate that interruptions on fused line cutouts make a significant contribution to the annual reliability indices reported to our jurisdictions. Table 1 illustrates the average annual number of regulatory events, the Customer Interrupted (CI), and Customer Minutes Interrupted (CMI) that are related to line cutout interruptions

Table 1. Reliability Impact of Events on Fused Line Cutouts

Average Annual Reliability Impacts of Distribution OH Fused Cutouts '09 - '13 Regulatory Criteria, Major Storms Excluded							
Company	*Customers Served*	*Events*	*% of Annual Totals*	*Customers Interrupted*	*% of Annual Totals*	*Customer Minutes Interrupted*	*% of Annual Totals*
MECo	1,259,674	3,798	41%	190,275	16%	32,732,315	22%
TNECo	480,140	1,154	39%	58,650	14%	7,977,962	19%
NMPC	1,597,446	6,082	43%	372,073	24%	62,705,075	34%

In addition to improved system reliability, CMRs will improve service quality to the small group of customers who have experienced interruptions at a higher rate than our average customers. Candidate CMR locations were developed from the Frequently Blown Fuse list (Shown on Appendix A3). These line fuses have averaged at least one interruption in five consecutive years.

Table 2 JD Power, Power Quality and Reliability Report



Customer surveys done by JD Power and Associates indicate that customer satisfaction is directly related the number and length of interruptions experienced.[1] Table 2 (previous page) was extracted from a recent Power Quality and Reliability report. Based on a 1000 scale, higher numbers indicate greater customer satisfaction. Customer's that experience fewer and shorter duration interruptions are happier with their electric utility, than those that have experience more and longer duration interruptions.

3. Background & Scope

There are thousands of fused line cutouts installed on the Company's distribution networks. Table 3 lists the quantities by company and fuse size. Annually, approximately 7% of these line cutouts experience interruptions. Considering the current population, the introduction of CMRs must be targeted to parts of the network where the probability of preventing an outage is higher than a random location.

Table 3 - Number of fused cutouts on National Grid's Distribution System, November 2013

Line Cutout Population by Company					
Company	100 Amp	65 Amp	40 Amp	Other sizes	Totals
MECO	2,371	8,054	11,643	34,694	56,762
TNECo	997	2,937	3,978	13,180	21,092
NiMo	6,869	12,200	15,858	37,804	72,731

To insure the customer impact is consistent with other investments on the distribution network a location criterion was developed based on a cost per customer benefit ratio that is similar to National Grid's Distribution Recloser Program[2]. The customer benefit ratio considers outage frequency and the total number of customers interrupted at each potential line cutout location. It is expressed in terms of 'potential $ / CI saved'.

For the purpose of this program, line cutout locations with a cost benefit ratio of approximately $ 40 per benefiting customer are eligible for replacement with a CMR. Installation cost should be evaluated by Field Engineering based on the specific locations. However, Success Enterprise estimates have determined that the average installation cost of a CMR is $4,500 per phase.

Candidate locations were based on an IDS query developed by National Grid's Data Asset and Analytics group. The 'Frequently Blown Fuse' list used the following data and assumptions:

- Five years of event history at each Overhead line fuse location in National Grid's distribution network.
- The CMR will successfully reclose 75 % of the time

Potential $ / CI saved was calculated as:

[1] From JD Power PQ&R Chart from the 2012 Electric Residential Midpoint report.
[2] From National Grid Pole top recloser program data FY08 through FY12. The average annual spend per benefiting customer was calculated to be $41.

$ / CI saved = $4,500 / Total CI of the 5 yr test period *75 %

An example of the 'Frequently Blown Fuse' list is presented in Appendix A3.

Once locations are qualified based on $ /CI Saved, Network Strategy Field Engineers will review the causes of the interruptions to determine if a CMR is an appropriate tool to prevent future interruptions. Locations with high incidents of typically temporary faults (animal contacts, lightning, and unknowns) are considered better candidates than other locations with a history of typically permanent faults (deterioration, tree falls, and motor vehicle accidents).

Additionally, Network Strategy Field Engineers are encouraged to choose their own locations based on sound engineering judgment, especially if the device can be used to improve the performance of a regulatory worst performing feeder or mitigate a customer complaint.

A second criterion, based on the proximity of line cutouts from an active line barn was developed, but is not recommended to justify locations. Rather, it should be considered when prioritizing CMR work. That is, given an equal customer benefit from the frequency criterion, remotely located line cutouts should be given preference over those that are within close proximity to line barn. Details of the 'Driving Distance Criteria' are presented in Appendix A4.

3.1 Assumptions & Guidelines

Electric Operating Procedures #NG-EOP G014 'Clearance and Control Procedures' are adjusted to accommodate Non Reclose Assurance (NRA) procedures in New England.

Electric Materials and Operations (Standards Group) has accepted CMRs as a standard item. Construction Standards and Work Method Bulletins are issued.

Network Strategy Distribution Electric Operations, Field Engineering will be responsible for determining suitable locations.

The O&M Compliance (inspections) Group will incorporate CMRs in its inspections list. They will share the responsibility (along with the Operation's group) of managing device replacements.

An applications guide for the Network Strategy Engineer was written to insure consistent application of the device. See Appendix A5.

4. Problem Identification

4.1 Infrastructure Development

All of the devices installed on the distribution system will be in new condition. The device is self contained and does not require maintenance. It has a service soon indicator that displays when the vacuum interrupter reaches 10 % of it's remaining contact wear. When the 'service soon' target appears in the lower right corner of the LCD screen (shown above) the device should be replaced. End-of-life replacements will be

managed by the I&M Inspectors and the Operations group. Work Requests captured from the I&M inspections group will be assigned a Level 2 priority.

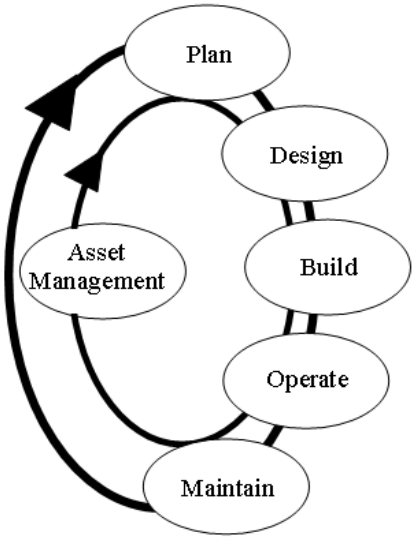
CMRs interruption rating is limited to 6.3 kA (symmetrical.) The available short circuit duty at each potential location will be reviewed by Network Strategy Field Engineering to insure the device is applied correctly.

4.2 Identification

CMRs will be almost exclusively installed in radial overhead lines. Looped or main-line applications are considered exceptions and will require documentation on OMS (outage management system) circuit one line diagrams. Their operation (Open, Close, Auto and Non-reclose) will be directed by the System Operator.

4.2.1 Asset Management and End-of-life Planning

The introduction of a new device to the distribution network requires consideration of the product's life cycle. Planning for each phase of the assets management cycle was done to ensure that CMRs are successfully integrated into the Company.



PLAN: The plan, described in this paper, was developed by a cross functional team with the input of stakeholders. Location criteria were designed such that cost per benefiting customers is consistent with the company's Pole-top Recloser Program, providing value to our customers and the Company.

DESIGN AND BUILD: Constructions Standards have been developed to ensure the physical installation of the devices is consistent with National Grid standards. A new GIS symbol and STORMS CU/MU units have been created to ensure work orders, inventories, and field locations are tracked and managed.

OPERATE: Changes to the Electric Operating Procedures # NG-EOP G014 'Clearance and Control Procedures' have been made which allow the System Operator and Operations Groups to establish protocols to effectively and safely operate the devices. In addition, stakeholder groups have been trained on the operation and maintenance of the device, including instruction at Annual Expert Training classes and company wide standards roll outs. National Grid's Electric Material Standards Group has issued Bulletin # 14-21 to documenting the device's features. See Appendix A6.

MAINTAIN: As described in Section 4.3 of this paper, device replacements will be managed through the I&M program and the Operations Groups. Steps have been taken to included CMRs in the company's proprietary Computa-pole PDA; an automated pick list that is used to manage the inspection program.

OBSOLESCENCE: National Grid has ordered six standard units from the manufacture. Limiting the number of skews will allow 'in-kind' replacements by the operations group without reengineering the installation. This becomes increasingly important as the program matures because there will be hundreds of active devices on the distribution network as the program matures.

4.2.2 System Impacts during Storm Emergencies

CMRs are not expected to be a tool that improves system performance during major storms because most faults caused by physical damage (fallen trees and broken poles) are typically permanent in nature. However, the device will not complicate restoration efforts because they can be replaced with a standard cutout door if damaged.

Some major events may cause extended outages to over head line protected by CMRs, rendering the self power device inoperable during the restoration effort. To overcome this issue, the manufacturer has installed an external power supply input that 'wakes up' the device with a 9 volt battery.

4.2.3 Protective Coordination and Operational Risks

All automatic reclosing relays present a risk of decreasing line sensitivity when attempting to clear electrical faults from the distribution network. That is, the initial fault current must remain high enough to trip the relay again after the device is reclosed. The remedy for loss of sensitivity is to ensure the initial line's fault current has high enough margin (approximately 120 % of minimum trip) to operate the device. To ensure the devices are correctly applied to the network, a protection review as described in EDP-DIV-11.0 'Setting for Distribution Feeder Overcurrent Protective Devices' will be done by National Grid Engineering.

4.3 Prioritization

4.3.1 Resource Considerations

The CMR is shipped from the manufacture with a standard cutout body. All ancillary equipment required to complete an installation are common material items. Installations are essentially a routine construction task and therefore, will not have a large impact on material resources.

4.3.2 Objectives and Benefits

National Grid Operations Groups, 'Operations Maintenance and Construction: Overhead Lines NY and NE', are expected to benefit by reducing non-fixed costs associated with responding to ad-hoc trouble calls. This includes a reduction in truck visits and labor costs associated with working unscheduled hours.

An attempt was made to calculate the number of truck visits that could potentially be avoided with targeted placements of CMRs. With the help of the Customer Reliability and Analytics, the population of line cutout locations with consecutive years of interruption events was analyzed. Of specific interest were locations with

multiple years of consecutive interruptions. The test group was developed from IDS event records (with regulatory criteria applied from 2009 through 2013) of line cutout interruptions from National Grid distribution network.

The population of line cutouts with two, three, four, and five consecutive years of at least one interruption are shown in the last column of Table 4. The study determined that as the number of consecutive years increased, the percentage of locations experiencing an interruption the following year also increased. That is, given the population of four year repeaters (339 locations); the probability of this group experiencing an event in year five is 54 %. A review of different five year data sets showed similar patterns. Therefore, targeting locations with a history of interruptions over consecutive years will likely yield more avoided interruptions resulting in fewer truck visits.

If all of the four year repeaters in Table 4 were replaced with CMRs, the estimated number of company wide truck visits avoided in year five is 136. That is,

Potential Avoid Truck Visits in Year 5 = 182 * 75% ≈ 136 Visits

Where 75% is the assumed success rate of a reclose attempt and 182 is the population of four year repeaters that experienced an outage in year five.

Table 4 . Line Cutouts Locations with Consecutive Years of Interruptions

Population of Line Cutouts with Interruptions in Consecutive Years All National Grid Distribution Companies 2009 through 2013 Reulatory Criteria Applied			
Consecutive Years with at Least One Event		Unique Event Locations	% of Population from Previous Year
Base Yr	2009	8,628	-
Two	2009 - 2010	2,049	24%
Three	2009 - 2011	785	38%
Four	2009 - 2012	339	43%
Five	2009 - 2013	182	54%

4.3.3 Costs

As presented at the September Tech Review, this paper proposes the development of a five year capital investment program that will install CMRs at targeted locations on National Grid's distribution network. The program proposes spending $3.0 M capital dollars over five consecutive budget years starting in FY16. Table 5 describes spending and unit quantities allocated by company and budget year.

Table 5. Proposed Program Spending by Company and Budget Year

Company	Proposed CMR Program Spending					
	FY16	FY17	FY18	FY19	FY20	Total Costs
NMPC	$ 153,000	$ 382,500	$ 382,500	$ 306,000	$ 306,000	$ 1,530,000
MECo	$ 112,500	$ 281,250	$ 281,250	$ 225,000	$ 225,000	$ 1,125,000
TNECo	$ 36,000	$ 90,000	$ 90,000	$ 72,000	$ 72,000	$ 360,000
	$ 301,500	$ 753,750	$ 753,750	$ 603,000	$ 603,000	$ 3,015,000

Company	Number of Proposed CMR Installations					
	FY16	FY17	FY18	FY19	FY20	Grand Totals
NMPC	34	85	85	68	68	340
MECo	25	63	63	50	50	250
TNECo	8	20	20	16	16	80
Yearly Totals	67	168	168	134	134	*670*

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5. Conclusions and Recommendations

This paper recommends a five year program that will install 670 cutout mounted recloses at targeted locations on National Grid's Electrical Distribution Network. The estimated capital cost of the project is $ 3.0 M. Spending will begin in FY16. Matt Wiltrout , from National Grids Project Management and Complex Construction team will manage the program. Capital spending by Power Plant Project number is illustrated in Table 6.

Table 6 Program Spending by Power Plant Project Number.

CMR Power Plant Project Spending by Year						
	FY16	FY17	FY18	FY19	FY20	Total Costs
MECo (C059664)	$ 112,500	$ 281,250	$ 281,250	$ 225,000	$ 225,000	$ 1,125,000
TNECo (C059663)	$ 36,000	$ 90,000	$ 90,000	$ 72,000	$ 72,000	$ 360,000
NY East (C053928)	$ 51,000	$ 127,000	$ 127,000	$ 102,000	$ 102,000	$ 509,000
NY Central (C059620)	$ 51,000	$ 127,000	$ 127,000	$ 102,000	$ 102,000	$ 509,000
NY West (C059607)	$ 51,000	$ 128,000	$ 128,000	$ 102,000	$ 102,000	$ 511,000
Yearly Spend	$ 301,500	$ 753,250	$ 753,250	$ 603,000	$ 603,000	$ 3,014,000

6. Factors Requiring Program Review

The initial program spend is intentionally conservative. This will allow the company to roll out the new devices to our Operations Group in a carefully staged manner, which was requested in our stakeholder meetings. The Program Manager (from National Grid's Project Management and Complex Construction' group) may change the spending forecast in FY17 based on the devices' acceptance and operating performance

7. Appendices

Companion documents to this paper are shown in Table 7.

Table 7. List of Appendices

Appendix Number	Page Number	Reference Name
A1	10 - 11	Definitions
A2	12	National Grid Overhead Construction Standards 12-330
A3	13	Sample of Frequently Blown Fuse List
A4	14 - 18	Duration Criterion Study
A5	19-22	Network Strategy Application Guide for the CMRs
A6	23	National Grid CMR Work Methods Bulletin #14—21

Appendix A1

Definitions[3]:

CI: Customer Interrupted. A total loss of electric power to one or more normally energized meters (Customer). CI is one of the basic factors needed to calculate common reliability indices including SAIFI and CAIDI.

CMI : Customer Minutes Interrupted. The period of time (in minutes) that a normally energized meter (customer) has lost electrical power. CMI is one of the basic factors needed to calculate common reliability indices including SAIDI and CAIDI.

Cutout Mounted Reclosers (CMR) – Single phase **c**utout **m**ounted **r**ecloser as described in the latest version of National Grid's Overhead Constructions Standards. See Appendix A2 the reclosing feature allows the device to clear transient faults from an over head primary distribution line. The device mounts into a 100 Amp cutout body.

Figure A1 - 1. Cutout Mounted Recloser S&C Trip Saver II

Customer: A metered electrical service point for which an active bill account is established.

Cutout, Fused Branch or Line Cutout: a combination of a fuse and a manual switch installed on an overhead primary distribution line. The fused line cutout isolates faulted sections of the circuit from the normal / healthy sections. It consists of two main parts. The cutout body which attaches to the pole or crossarm and the cutout door, a cylindrical tube that holds a fuse. The cutout door mounts into the cutout body and can be manually opened and closer with a Hot Stick / Load buster tool

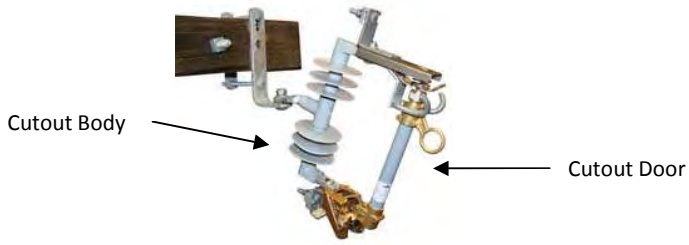


Figure A1 - 2 Typical Line Cutout

[3] Definitions denoted by * were reprinted from IEEE Guide for Electric Power Distribution Reliability Indices IEEE Std 1366- 2012

IDS: Interruption & Disturbance System. National Grid's sole source database for collecting event data for customer interruptions on the distribution and transmission network.

NYPSC: New York State Public Service Commission.

OH: Overhead primary distribution line.

Reclosing, Auto reclosing: the act of automatically closing an electrical device (circuit breaker, pole mounted recloser, or cutout mounted recloser) after it opened due to an electrical fault. Auto reclosing promotes service continuity by momentarily de-energizing the circuit which allows transient faults to clear themselves from the network.

Success Enterprise SE: National Grid's project estimating tool.

Stakeholders: A person, group or organization that has an interest in the purchase, installation, operation, or maintenance of Cutout Mounted Reclosers (CMR).

The Company: National Grid Electric Distribution Companies. Massachusetts Electric Company, MECo, Nantucket Electric, Niagara Mohawk Power Corp., NMPC, and The Narragansett Electric, TNECo.

Truck Visits (aka Trouble Calls): A response from a National Grid OH line crew to a location of reported trouble, typically at the request of the System Operator.

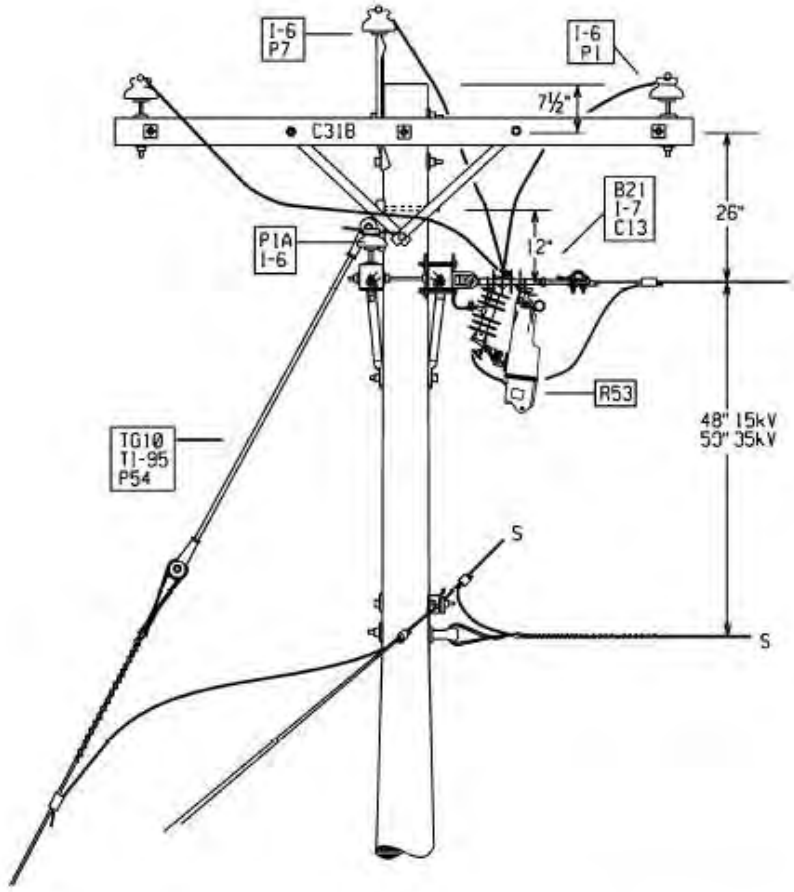
CAIDI*: The customer average duration index (CAIDI) represents the average time required to restore service.

SAIDI*: System Average Interruption Duration Index (SAIDI) indicates the total duration of interruption for the average customer during a predefined period of time. It is commonly measured in minutes or hours.

SAIFI* : System Average Interruption Frequency (SAIFI) indicates how often the average customer experiences a sustained interruption over a predefined period of time.

Appendix A2

National Grid Overhead Construction Standards



Supersedes all previous issues – New Standard

Notes:

1. Reclosers must be installed in a 100amp MacLean Power Systems Type XS fuse cutout mounting. (included with unit)
2. Install tag holder on pole - 8' up from ground level.
3. Provide sufficient clearance for operation, installation and removal of unit.
4. Install arrestors on **load side** of Recloser on same pole or adjacent poles within 300'. (Refer to Section 13.6.40A)
5. Location, application and setup of this device must be done under the direction of Electric Operations Engineering.

SINGLE PHASE VACUUM OPERATED CUTOUT MOUNTED RECLOSER– THREE PHASE TAP INSTALLATION			
ISSUE	PAGE NUMBER	OVERHEAD CONSTRUCTION STANDARD	nationalgrid
7/13	12-330		

Appendix A3 Sample of Frequently Blown Fuse list

NMPC Potential CMR Locations											
Company	Region	District	SUBSTATION	Line Cutout GIS_ID	District Code	UNIQUE_LOCATION	Number of Unique Events	BRANCH	Most likely Fuse Size(s)	Most likely # of line cutouts	$/CI Saved
01	Capital	Albany	SEMINOLE	725463867	30	30-33905: CF: ALBANY I-90	8	CF	80	1	4
01	Capital	Albany	VOORHEESVILLE	724684330	30	30-17852: IB: BETHLEHEM PARKING LOT	8	IB	65	1	8
01	Capital	Albany	GREENBUSH	724665004	30	30-07856: EA: EAST GREENBUSH HILLVIEW AVE	5	EA	65	1	10
01	Capital	Albany	EVERETT ROAD	724684963	30	30-42054: LB: COLONIE SCHUYLER HILLS RD	18	LB	80	1	12
01	Capital	Albany	UNIONVILLE	829242830	30	30-27651: S: NEW SCOTLAND WESTERN AVE	5	S	Unknown	1	12
01	Capital	Albany	BETHLEHEM	724607384	30	30-02158: HC: BETHLEHEM BAIN DR	5	HC	65	1	13
01	Capital	Albany	SEMINOLE	724676352	30	30-33905: CBB: ALBANY I-90	7	CBB	40	1	14
01	Capital	Albany	GREENBUSH	724658825	30	30-07851: FBL: EAST GREENBUSH MURIEL AVE	7	FBL	40	1	15
01	Capital	Albany	KRUMKILL RD	724651431	30	30-42152: EABAA: ALBANY MCCORMACK RD	5	EABAA	65	1	16
01	Capital	Albany	SAND CREEK	724542727	30	30-45251: DBB: COLONIE VLY RD	6	DBB	65	1	16
01	Capital	Albany	RENSSELAER	724666677	30	30-13254: CAAAAC: RENSSELAER RING ST	6	CAAAAC	65	1	16
01	Capital	Albany	KRUMKILL RD	724656579	30	30-42151: BAAAAABAC: ALBANY RUSSELL RD	7	BAAAAABAC	40	1	17
01	Capital	Albany	PINEBUSH	824347110	30	30-37154: L: GUILDERLAND VEEDER RD	5	L	65	1	20
01	Capital	Albany	KRUMKILL RD	724605158	30	30-42151: BAAAAAAAAAAB: BETHLEHEM WOODSCAPE RD	5	BAAAAAAAAAAB	65	1	20
01	Capital	Albany	BETHLEHEM	724655230	30	30-02155: CBA: BETHLEHEM	7	CBA	40	1	21
01	Capital	Albany	KRUMKILL RD	724824522	30	30-32751: BAAAAAAAAD: ALBANY ERIE ST	6	BAAAAAAAAD	40	1	23
01	Capital	Albany	GREENBUSH	1164480656	30	30-07852: EAAABAA: EAST GREENBUSH ELLIOT RD	9	EAAABAA	100	1	23
01	Capital	Albany	NASSAU	881331990	30	30-11340: FB: NASSAU US HWY 20	5	FB	50	2	26
01	Capital	Albany	HOAGS CORNERS	785527260	30	30-22145: AAAAA: NASSAU TSATSAWASSA LAKE RD	11	AAAAA	40	2	27
01	Capital	Albany	HOAGS CORNERS	724601441	30	30-22145: AAB: East Nassau	5	AAB	65	3	27
01	Capital	Albany	PINEBUSH	857156239	30	30-37153: JB: GUILDERLAND WESTERN AVE	7	JB	25	1	28
01	Capital	Albany	KRUMKILL RD	824349408	30	30-17852: LAAAAAA: BETHLEHEM CHARLES BLVD	6	LAAAAAA	65	2	28
01	Capital	Albany	MCKOWNVILLE	908566285	30	30-32751: BAAAAABAA: GUILDERLAND ARCADIA AVE	6	BAAAAABAA	65	1	28
01	Capital	Albany	GREENBUSH	803069562	30	30-07852: GACA: EAST GREENBUSH SNOOK ST	8	GACA	65	3	30
01	Capital	Albany	ALTAMONT	724582037	30	30-28356: EAAAAAB: GUILDERLAND LEESOME LN	7	EAAAAAB	40	1	33
01	Capital	Albany	WOLF ROAD	724604867	30	30-34453: HAD: COLONIE ROSEBUD LN	7	HAD	65	1	37
01	Capital	Albany	VOORHEESVILLE	824342551	30	30-17851: Z8: BERNE COLE HILL RD	6	Z8	25	3	38
01	Capital	Albany	DELMAR	724625933	30	30-27999: BA: BETHLEHEM KENWOOD AVE	6	BA	50	2	39
01	Capital	Albany	PINEBUSH	724652297	30	30-37156: CA: GUILDERLAND SEWARD ST	12	CA	100	3	39
01	Capital	Albany	NASSAU	725360811	30	30-11339: CAAB: SCHODACK BOYCE RD	6	CAAB	65	2	40
01	Capital	Albany	MENANDS	724625401	30	30-10156: DB: COLONIE CHERRY TREE RD	5	DB	100	2	41
01	Capital	Albany	MENANDS	724625475	30	30-10156: DD: COLONIE CHERRY TREE RD	9	DD	100	1	42
01	Capital	Albany	KRUMKILL RD	724673266	30	30-42151: BAAAAB: ALBANY HURON ST	7	BAAAAB	100	3	42
01	Capital	Albany	ALTAMONT	724581108	30	30-28356: JA: GUILDERLAND BOND RD	8	JA	65	1	47
01	Capital	Albany	UNIONVILLE	724607894	30	30-27652: LB: NEW SCOTLAND DELAWARE AVE	5	LB	80	2	47
01	Capital	Albany	VOORHEESVILLE	724625541	30	30-17851: FB: VOORHEESVILLE CROW RIDGE RD	14	FB	100	2	48
01	Capital	Albany	KRUMKILL RD	725469976	30	30-42151: HE: ALBANY NEW SCOTLAND AVE	5	HE	100	1	48
01	Capital	Albany	BETHLEHEM	699762820	30	30-02155: BAABABA: BETHLEHEM BENDER LN	5	BAABABA	80	3	51
01	Capital	Albany	DEKALB	724251642	30	29-98455: JA: RUSSELL HERMON-EDWARDS RD	5	JA	40	1	55
01	Capital	Albany	VOORHEESVILLE	824409094	30	30-17852: DAABA: NEW SCOTLAND NEW SCOTLAND RD	5	DAABA	65	3	55
01	Capital	Albany	UNIONVILLE	824347636	30	30-27652: BBA: NEW SCOTLAND ORCHARD HILL RD	7	BBA	65	1	57
01	Capital	Albany	SELKIRK	847099267	30	30-14951: CAAACA: BETHLEHEM	9	CAAACA	30	2	58
01	Capital	Albany	WOLF ROAD	724604857	30	30-34453: HAAA: COLONIE	6	HAAA	25	1	63
01	Capital	Albany	VOORHEESVILLE	927646259	30	30-17852: JAAAAAAAA: NEW SCOTLAND PAULEY LN	5	JAAAAAAAA	40	1	67
01	Capital	Albany	MCKOWNVILLE	908563474	30	30-32751: BAAAAC: GUILDERLAND I-87	9	BAAAAC	65	3	67
01	Capital	Albany	EVERETT ROAD	724616687	30	30-42054: HB: COLONIE CHERRY TREE RD	6	HB	65	1	67
01	Capital	Albany	MENANDS	724616773	30	30-10156: FB: COLONIE S LOUDON HEIG	8	FB	65	1	68
01	Capital	Albany	RENSSELAER	724659614	30	30-13254: CAAAAB: RENSSELAER BROADWAY	6	CAAAAB	100	3	68
01	Capital	Albany	SELKIRK	724603870	30	30-02156: KAAAAAAC: BETHLEHEM BEACON RD	5	KAAAAAAC	25	1	71
01	Capital	Albany	KARNER ROAD	918640123	30	30-31715: BAAA: COLONIE RED FOX DR	5	BAAA	25	1	86
01	Capital	Albany	VOORHEESVILLE	724580454	30	30-17851: XA: BERNE CHASE RD	5	XA	65	1	86
01	Capital	Albany	PINEBUSH	725313897	30	30-37153: FAAAAABA: GUILDERLAND CHERRY LN	5	FAAAAABA	25	2	89
01	Capital	Albany	NASSAU	770464265	30	30-11338: G: SCHODACK WOOD LN	6	G	40	2	91
01	Capital	Albany	EVERETT ROAD	724956787	30	30-42051: ZC: COLONIE MARLENE DR	5	ZC	Unknown	1	92
01	Capital	Albany	BETHLEHEM	724603860	30	30-02156: KAAAAAABD: BETHLEHEM WEMPLE RD	5	KAAAAAABD	50	1	109
01	Capital	Albany	PATROON	724676382	30	30-32351: OD: ALBANY WINTHROP AVE	5	OD	25	1	120
01	Capital	Albany	MENANDS	724753404	30	30-10157: JB: COLONIE GRENADA TER	7	JB	40	3	129
01	Capital	Hudson	BLUE STORES	792883911	33	33-30351: BAA: LIVINGSTON BUCKWHEAT BRIDGE RD	8	BAA	Unknown	3	3
01	Capital	Hudson	BLUE STORES	724779998	33	33-30353: R: LIVINGSTON DINGA RD	6	R	100	3	8
01	Capital	Hudson		1119398649	33	33-42753: HB: VALATIE KINDERHOOK ST	7	HB	40	1	11
01	Capital	Hudson	BLUE STORES	724768819	33	33-30351: KAAAA: CLERMONT US HWY 9	6	KAAAA	100	2	12
01	Capital	Hudson	BLUE STORES	804164798	33	33-30353: GAAAAAAAAA: TAGHKANIC COUNTY HWY 15	6	GAAAAAAAAA	65	2	14
01	Capital	Hudson	STUYVESANT	724745520	33	33-03552: BAB: STUYVESANT HUDSON AVE	9	BAB	40	1	18
01	Capital	Hudson	BLUE STORES	807277080	33	33-30351: P: CLERMONT COMMONS RD	7	P	25	1	31
01	Capital	Hudson	BLUE STORES	724700744	33	33-30351: BAAAAAA: LIVINGSTON LOYOLA RD	5	BAAAAAA	100	3	32
01	Capital	Hudson	VALKIN	929569434	33	33-42754: BAAAAAB: STUYVESANT CLOW LN	7	BAAAAAB	40	2	38
01	Capital	Hudson	RANDALL ROAD	724551126	33	32-46356: LAAB: CHARLTON CONSAUL RD	8	LAAB	80	1	39
01	Capital	Hudson	BLUE STORES	792884109	33	33-30351: BABAAAAAAAA: TAGHKANIC DEER HAVEN RD	5	BABAAAAAAAA	65	2	46
01	Capital	Hudson	BLUE STORES	724710557	33	33-30352: HAAB: CLERMONT RHINEBECK-HUDSON RD	6	HAAB	65	3	73
01	Capital	Hudson	HUDSON	824383019	33	33-08753: FA: HUDSON JOSLEN PL	5	FA	40	1	75
01	Capital	Hudson	BLUE STORES	895553866	33	33-30352: HAAAA: GERMANTOWN WOODS RD	7	HAAAA	40	2	90
01	Capital	Hudson	BLUE STORES	724771332	33	33-30352: HAABA: CLERMONT RHINEBECK-HUDSON RD	6	HAABA	65	2	118
01	Capital	Hudson	HUDSON	724753818	33	33-08751: GA: GREENPORT COUNTY HWY 29	5	GA	40	3	124

Appendix A4

Duration Criteria, The Driving Distance Study.

The use of CMRs at locations a good driving distance from an active line barn was studied to determine if they would improve the CAIDI performance of Niagara Mohawk's distribution network. Niagara Mohawk is subject to a negative revenue adjustment of $3M if system CAIDI exceeds 123 minutes. An additional $ 3M is at risk if CAIDI exceeds 129 minutes.

Moreover, the NYPCS has also set regional CAIDI performance targets. Currently, these are not subject to regulatory penalty. But results are reported to the NYPSC in the annual reliability report. CAIDI performance against the Company and Regional targets for the previous five years is shown in Table A4_1.

Drive time bands, segmented in 5 minute intervals, were plotted in the company's geographic information system software, ArcGIS. See Diagram AD 4 -1 on page 17 of this document. The inventory of line cutouts greater than or equal to a 60 minute drive from an active line barn were compiled. Out of the 41 active line barns, only 19 had inventory that fit this criteria. The complete inventory list is shown in Table A4_2.

Table A4_1. NMPC Company and Regional CAIDI Performance

Niagara Mohawk CAIDI Peformance by Compay and Regions*						
Company / Region	CAIDI Target	2013 mins	2012 mins	2011 mins	2010 mins	2009 mins
NiMO	***123***	***117.38***	***122.44***	***116.95***	***118.76***	***114.46***
Capital	120.0	120.39	106.67	105.69	116.85	129.21
Central	120.0	110.3	117.8	109.9	109.9	115.1
Frontier	105.0	104.5	104.4	108.7	97.1	94.4
Genesse	120.0	117.7	133.5	114.1	96.4	89.5
Mohawk Valley	150.0	115.6	123.2	132.0	110.2	98.3
Northeast	150.0	134.1	149.3	122.4	167.0	130.0
Northern	135.0	106.6	124.8	149.9	132.7	143.6
Southwest	105.0	121.0	107.2	108.6	76.7	83.8

*From 2013 NYPSC Reliability Report.

Legend
Failed to meet target
Within 1% of target

The Northeast and Northern regions had the greatest number of remotely located line cutouts, accounting for 62 % of the 1412 locations.

Table A4_2 Inventory of Line Cutout installations by Driving Distance

Number of pole locations in NiMO with fused cutouts > 60 minute drive from a line barn												
		Estimated Minimum Driving Distance in Minutes										
Region	Line Barn	60	65	70	75	80	85	90	95	100	105	Grand Total
Central	HINSDALE	70	16									86
Central	PULASKI	5	8	5	4							22
Frontier	NEWFANE	2				1						3
Genessee	ALBION	7	12		6	1	2	1	2	2		33
Genessee	BATAVIA	46	50	17	2							115
Mohawk Valley	OLD FORGE	15	2									17
Mohawk Valley	ROME	2										2
Mohawk Valley	UTICA	93	27	12	2	8						142
Northeast	GLOVERSVILLE	72	34									106
Northeast	NORTHVILLE	27	15	27	29							98
Northeast	TICONDEROGA	2										2
Northeast	WARRENSBURG	121	64	23	12		11	4				235
Northern	GOUVERNEUR	76	16	4	13	41	16					166
Northern	LOWVILLE	49	8	1	12	4	4				11	89
Northern	MALONE	15										15
Northern	POTSDAM	7										7
Northern	SARANAC	21	14	7	7	29	58					136
Northern	WATERTOWN	13	5	2	3							23
Southwest	FRANKLINVILLE	86	20	8	1							115
	Grand Total	729	291	106	91	84	91	5	2	2	11	1412

Once the locations were determined, the reliability history of the inventory list was gathered. From IDS recorders (2009 through 2013, with regulatory criteria applied), there were 352 interruption events. Of this, 286 (81 %) exceeded the 123 min regulatory target.

Next, an ideal distribution network was assumed. That is, all event locations were assumed to have a CMR and 75 % of the interruptions were successfully restored within one minute. The actual reliability performance was then compared to our ideal CMR network. The results are illustrated in Chart A4-3. As seen on the right axis, system CAIDI improved between 0.06 and 0.17 minutes. The total cost to build the ideal network is $ 6.4 M., which is the assumed cost to install 1412 CMRs at the remote line cutout locations

CAIDI performance at the Regional level was also reviewed. The results are shown in Table A4-4. The largest performance impact would have occurred in Mohawk Valley, where CAIDI improvement was 0.51 minutes in 2011. Again this assumes CMRs replaced fused cutouts at locations more than a 60 minute drive from an active line barn.

In spite of the overall CAIDI improvement, none of the company or regional results reported to the NYPSC would have improved enough to change a missed target.

In conclusion, replacing CMRs at remote line cutout locations will improve CAIDI. However, because these events have a small influence on the overall system CAIDI calculation, an investment based solely on distance is not recommended. Instead, the list of remotely located line cutouts should be used to prioritize qualifying locations. That is, given two location of equal reliability benefit, the Network Strategy Engineer should choose locations that are the furthest away from active line barns.

Chart A4-3 Comparison of System CAIDI performance with and without CMRs

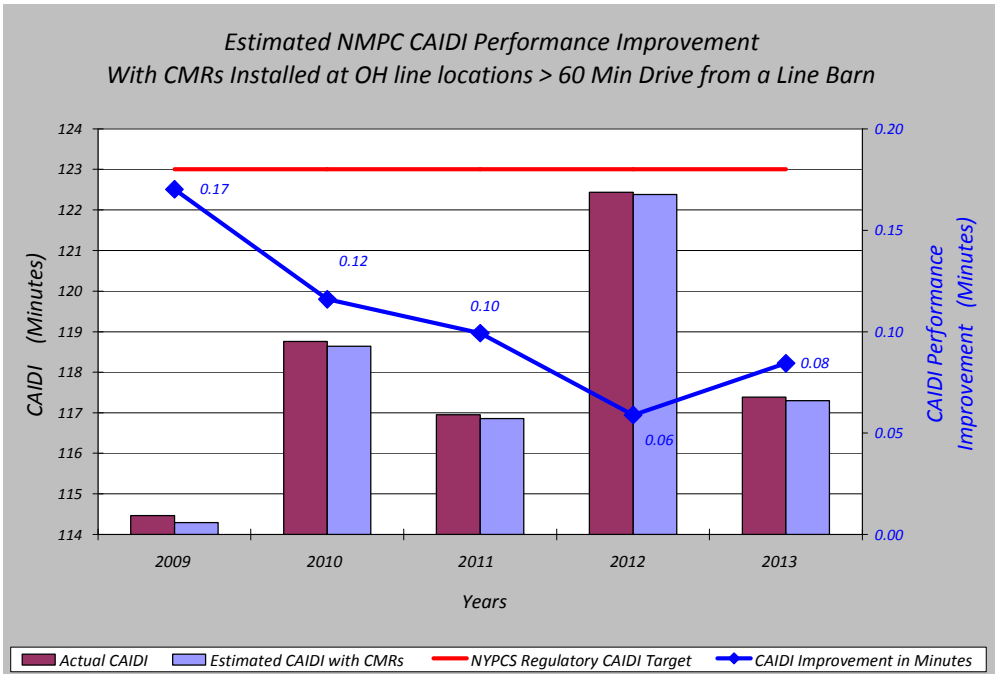
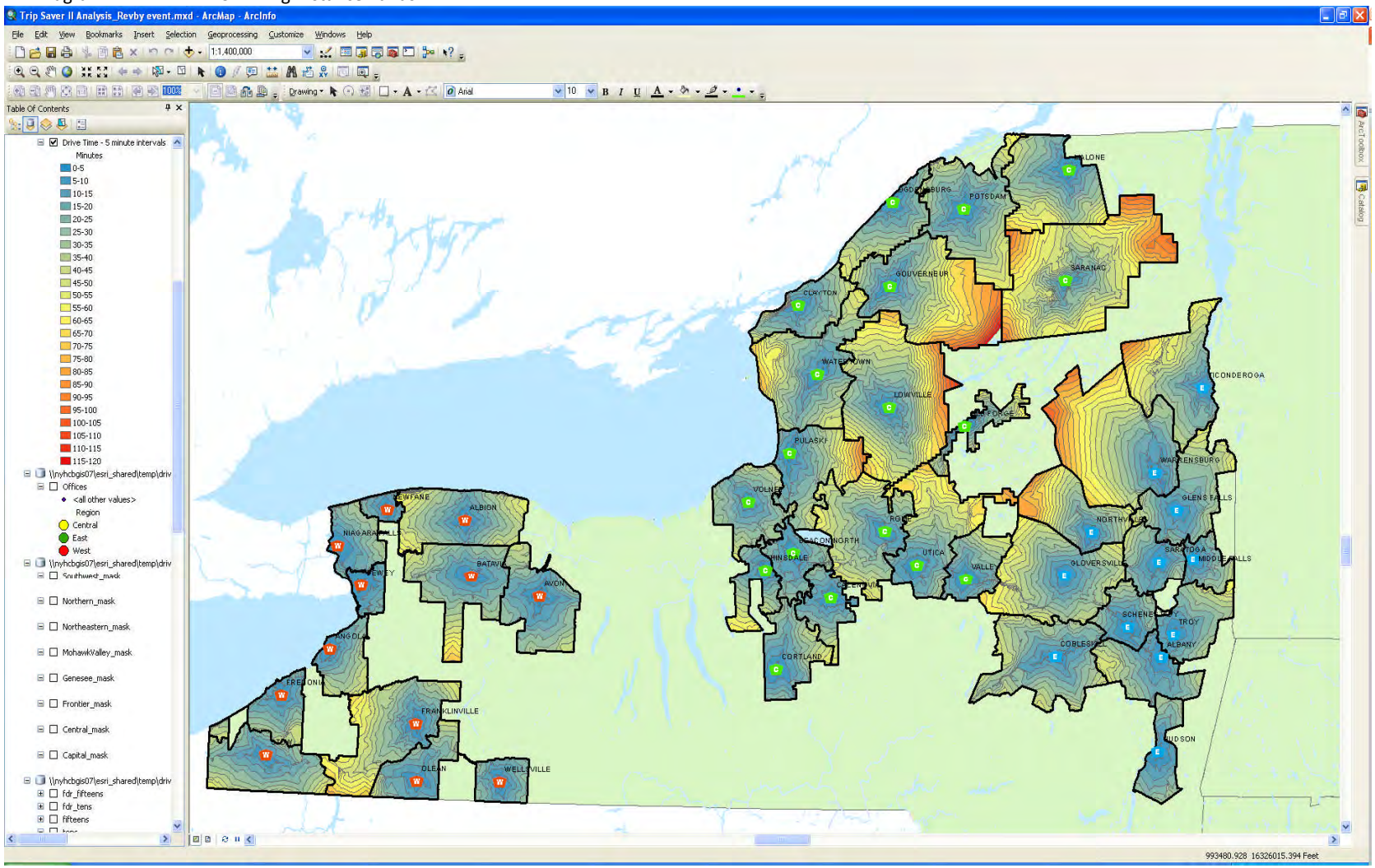


Table A4-4 Projected CAIDI Improvement if remotely located line cutouts were replaced with CMRs

Projected CAIDI improvement Replacement of Line Cutouts at Locations ≥ 60 Mintes with CMRs						
Company / Region	CAIDI Target	2009 mins	2010 mins	2011 mins	2012 mins	2013 mins
NiMO	***123***	0.17	0.12	0.10	0.06	0.08
Capital	120.0	0.00	0.00	0.00	0.00	0.00
Central	120.0	0.34	0.09	0.00	0.03	0.03
Frontier	105.0	0.00	0.00	0.00	0.00	0.00
Genesse	120.0	0.20	0.14	0.10	0.07	0.03
Mohawk Valley	150.0	0.08	0.25	0.51	0.14	0.15
Northeast	150.0	0.09	-0.05	0.02	0.00	0.09
Northern	135.0	0.31	0.03	0.17	0.26	0.10
Southwest	105.0	0.38	0.05	0.08	0.05	0.43

Diagram AD 4 – 1 NMPC Driving Distance Bands



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Appendix A5

Network Strategy Application Guide

Cutout Mounted Reclosers

S&C Trip Saver II

John Williams
Network Strategy, Field Engineering
October 28, 2013

Purpose:
The purpose of this application guide is to provide the Network Strategy Engineer with the required information to properly place the device in the distribution network.

Product Description:
Trip Saver II is a single phase drop out recloser that is mounted in a cutout body. The unit is self powered, contains a microprocessor control and a vacuum interrupter.

The microprocessor control has the ability to emulate common fuse, recloser, and over current curves. It can be programmed for 1 to 4 reclosing operations. Currently, all units purchased by National Grid will be set at the factory. The device has an LCD display that provides the status of the vacuum interrupter (open and closed) and the reclosing mode (Auto for enabled or NR for disabled). The display also indicates: load current, fault current value, number of operations, overload condition, and the unit's remaining life. The Trip Saver II does not have communication capabilities.

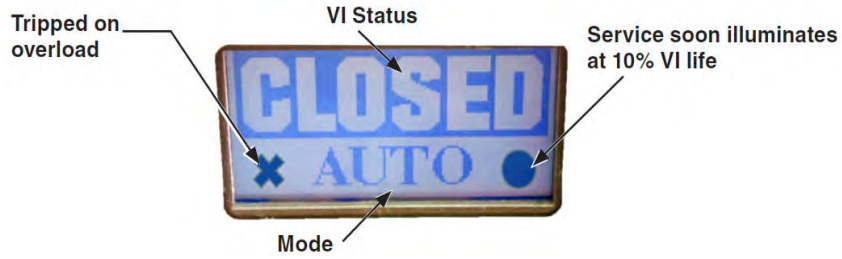

Figure 1 – Trip Saver II LCD Display

Basic Operating Features:
Cutout mounted dropout recloser operation is described in S&C bulletin 461-32, August 2012, and Product specifications bulletin 461-33. Also see http://www.youtube.com/watch?v=SWPq-pojrY for a short video description.

National Grid Standards:
Cutout mounted drop out reclosers are now accepted as National Grid Standard equipment. Please refer to the latest standards book for an illustration of pole construction types. Physical installation is described in a new 'Work Methods' bulletin that was issued in November of 2013.

National Grid will order six unique units. Their characteristics are shown in table 1.

The devices will share a common GIS symbol: CR STORMS CUs / MUs have been developed.

Table 1. National Grid Standard Units

Ngrid Device Number		Voltage class	Amps		TCC curves			Reclosing		
Generic Name	Standards Number	KV	Max Cont.	Max Interrupting rating Symetrical	1 st Curve	2nd Curve	Minimum Pick 2nd curve	Reclose Attemps	Time Delay	Reset time
NY - 1	R53F	15	100 A	6.3 kA	S&C 103	100 K	221.4 A	1	5 sec	15 sec
NY - 2	R53E	15	100 A	6.3 kA	S&C 103	65 K	137.6 A	1	5 sec	15 sec
NY - 3	R53D	15	100 A	6.3 kA	S&C 103	40 K	81.7 A	1	5 sec	15 sec
NE - 1	R53C	15	100 A	6.3 kA	100 K	100 K	221.4 A	1	5 sec	15 sec
NE - 2	R53B	15	100 A	6.3 kA	65 K	65 K	137.6 A	1	5 sec	15 sec
NE - 3	R53A	15	100 A	6.3 kA	40 K	40 K	81.7 A	1	5 sec	15 sec

Notes: Sectionalizer option is not used.

Please note the difference between devices purchased for NY and NE.
Trip Saver IIs purchased for NY will use a fuse save protection scheme. That is, the first Time-Current Characteristic (TCC) curve for NY devices will be set to a very fast curve (S&C's emulation of a Cooper # 103). The fuse saving scheme is designed to allow the reclosing device a chance to clear temporary faults before smaller downstream devices (typically fuses) permanently open.

It is important that only devices programmed for NE be used in NE.
Devices designed for use in NE will not use a fuse saving scheme. Both TCC curves will be set the same. This will insure all devices in the distribution circuit coordinate.

A fuse saving scheme is not recommended for use in NE because Non Reclose Assurance (NRA) rules are more effectively managed if the protective devices on the distribution circuit fully coordinate. By avoiding an instantaneous / fuse save scheme, a NE line crew can accurately determine if NRA tags are required at their work location without direction from the system operator.

Things to consider when placing Trip Saver IIs on the distribution system:
Trip Saver II's are intended to be installed on radial side taps only. Locations where lines can be tied or looped are to be avoided.

Why? Recent changes to EOP GO14 Clearance and Control procedures allow Trip Saver II to be operated under 'Personal Red Tag' rules. In order to conform to these rules, Trip Saver IIs have to be installed on radial side taps.

Exceptions: if there is a unique design application that calls for Trip Saver II to be installed on a circuit main line the device will need to be displayed on the EMS one lines with a unique switch number. Its operation will be directed by the System Operator.

Trip Saver II's interrupting rating is limited to 6.3 kA (symmetrical).

A minimum of 3 amps of line current is needed to insure the vacuum interrupter operates properly.

The maximum line current the device can continuously serve is limited to 100 amps, however, S&C does indicate the equipment hardware has an overload capability of 125 %.

Coordination Studies:
When placing a Trip Saver II, please review the settings on the distribution circuit breaker and any other reclosers. In New England, remove any instantaneous settings that miscoordination with the Trip Saver IIs.

Why ? Full coordination is required for the protection of the line worker and to insure NRA procedures are valid.

Please insure that the available fault-current at the proposed device location does not exceed 6,300 amps.

Trip Saver II has an inrush restraint feature which measures 2nd harmonics current to distinguish fault current from inrush current. This feature makes the device less susceptible to false tripping due to inrush current.

The minimum operate time of the Trip Saver II is one cycle. This is the time it takes for the vacuum interrupter to open.

Please refer to District Engineering EDP- DIV 11.0 for details on maintaining the proper coordinating time intervals (C.T.I) between protective devices. In NE, the coordinating time interval between the Trip Saver II and the upstream microprocessor controlled relay should be a minimum of 0.1 sec with 0.2 sec being used if possiable. In NY, the desired C.T.I between devices is also 0.2 sec.

Although not yet programmable by the user, the microprocessor control has many common fuse and recloser curves. The devices control emulates those TCC curves to a fairly high degree of accuracy[4]. However, S&C's representation of some curves from older devices (such as hydraulic reclosers) may have higher tolerance for inaccuracies. Please refer to S&C Trip Saver II Outdoor Distribution (15 kV and 25 kV) Time-current Character curve Bulletin located on the department share drive for a comparison of S&C's emulations and other manufacturer curves.

All S&C Trips Saver II curves can be found in the Aspen One Liner device library and the CYME TCC equipment library.

Life expectancy:
The number of successful operations in a Trip Saver II is directly related to the cumulative fault current interrupted. At maximum fault current, 6300 amps, the device's vacuum Interrupter will operate approximately 12 times. For locations with lower fault currents, up to 60 operations can be expected. When the vacuum interrupter's useful life is reduced to 10%, a circle will illuminate on the bottom right of the LCD screen. See Figure 1.

[4] 'If the recloser control manufacture uses an equation to generate the TCC, then there is no significant difference between the published curve and S&C's emulation.' From E.L Flowers email, Jerry Houghton October 25, 2013

Appendix 6 National Grid Work Methods Bulletin

Bulletin

nationalgrid

Issued by Standards #14-21

Safety
Standards
Work Methods

S&C Tripsaver II Single Phase Cutout Mounted Dropout Recloser

New England
SAP Item ID # 9387110, STD Item R53A – 40K
SAP Item ID # 9387111, STD Item R53B – 65K
SAP Item ID # 9387112, STD Item R53C – 100K
New York
SAP Item ID # 9387288, STD Item R53D – 40K
SAP Item ID # 9387287, STD Item R53E – 65K
SAP Item ID # 9387286, STD Item R53F – 100K

The S&C Tripsaver II is a single phase, cutout mounted recloser with an electronically controlled vacuum fault interrupter. The unit is self-powered (no battery) and requiring a minimum of 3 amps of line current to remain powered. It is has a maximum 100 amp continuous rating with a 5 amp minimum pickup. It is available in 40K, 65K, and 100K configurations (identified by a label on unit).

It is suited for up to 15 kV on lateral circuits that frequently experience momentary fault interruptions or remote areas requiring significant travel to address an outage. **All installations require a protection review by Network Strategy Engineering.**

The Tripsaver II has been added to the Overhead Standards and replaces the original Tripsaver which was piloted in 2009 in Rhode Island and Syracuse, NY. It is an updated version of the original Tripsaver with improved features and capabilities.

The Tripsaver II clears temporary faults preventing extended outages. The open interval between tripping operations is five seconds. Units are preprogrammed at the factory for one reclose operation. New York units are programmed for an initial fast trip " fuse save" feature.
Permanent fault present – Operating Sequence:

1) Open (internal Contacts for 5 secs)
2) Close (internal contacts)
3) Open (internal contacts if fault is still present)
4) Recloser drops open similar to a fused cutout.
5) Internal contacts reset in 2 secs after dropping out (unit must drop open by at least 25 degrees or the contacts will not reset).

Unit can be manually closed with a hot stick once the fault is cleared.

NG-EOP G014 Clearance and Control has been revised to include language specific to the Tripsaver II. The Tripsaver II can be treated as a fused radial distribution tap utilizing PRT & NRA tagging as defined in NG- EOP G014. The device can be operated, reclosing disabled or enabled by the person in charge of the work without the direction or permission of the System Operator. The switching and tagging to accomplish these actions shall be documented on the Field Clearance and Control Form (6.5.2). (Refer to NG-EOP G014 for specifics). This switch will not have a switch number and will not appear on the System Operator's EMS screen.

09/19/14 DFA