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# **Voltage Reduction Test**

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**Issue 1.0**

**REPORT**

*This document summarizes and analyzes the results of the Voltage Reduction Test carried out on July 15, 2010*

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## Document Change History

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## Related Documents

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MDP_RUL_0002	Market Rules for the Ontario Electricity Market, Chapter 5: Power System Reliability
MDP_PRO_0040	Market Manual 7: System Operations; Part 7.1 – System Operating Procedures
IMP_PRO_0035	Market Manual 7: System Operations; Part 7.3 – Outage Management
IMP_POL_0002	Market Manual 7: System Operations; Part 7.4 – IESO-Controlled Grid Operating Policies
IMO_SCO_Voltage Reduction-S	Load Reduction through Supply Voltage Reduction

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<b>Reference (Section and Paragraph)</b>	<b>Description of Change</b>
	First release.

# 1. Overview

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System voltage reduction tests were performed on July 15, 2010. A 3% voltage reduction test was implemented from 09:00 to 10:00 EST and a 5% voltage reduction test implemented from 13:00 to 14:00 EST.

Voltage reduction is achieved by the operation of a low tension step-down transformer under-load tap changing equipment at attended and/or supervisory controlled transformer stations. The facilities used for voltage reduction are facilities directly connected to the ICG that can reduce the low voltage side of the step-down transformers by either 3% or 5%. These facilities may be under the control of either a transmitter or a distributor with directly connected load facilities of an aggregated rating exceeding 20 MVA and with the capability to regulate distribution voltages under load.

We<sup>1</sup> sometimes use voltage reduction as a component of operating reserve. The values currently used for this purpose are:

- 1.5% demand reduction for a 3% voltage reduction; and
- 2.6% demand reduction for a 5% voltage reduction.

We normally conduct voltage reduction tests approximately every 18 months as per Market Manual 7.1: System Operating Procedures. The most recent previous test was conducted on January 22, 2009. These periodic voltage reduction exercises are conducted to:

1. Identify customer equipment problems so that corrective action may be taken;
2. Verify the demand reduction attainable and adjust demand reduction as necessary; and
3. Keep all involved staff familiar with procedures so that voltage reductions as a control action remain effective.

If there has been an actual voltage reduction event in the last 18 months that delivered similar information to a planned test, the normally scheduled test may be postponed or cancelled. For example, on June 12, 2007 emergency actions were required because a 500kV circuit was removed from service. From 12:43 to 13:29 EST, a 5% voltage reduction was instituted for all areas of the province except the Niagara region. Given the scope of this voltage reduction, the planned Voltage Reduction Test for July 17, 2007 was cancelled.

We initiated both the 3% voltage reduction test and the 5% voltage reduction test at the start of an hour. For the hours of the test, a demand reduction was anticipated and included in the day-ahead demand forecast. The rationale for this decision was that forecasting demand is an attempt to estimate expected demand based on the knowledge at hand. As these were planned tests, it was decided to carry that methodology forward and accurately reflect the expected reduction in the demand forecast.

During an actual voltage reduction event, IESO Control Room staff are instructed to re-introduce the MW reduction into the market schedule to prevent counter-intuitive price signals. As this was a

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<sup>1</sup> “We”, “us” and “our” refer to the *IESO*.

planned test and the demand forecast for the day was reflective of the expected demand during the voltage reduction event, we did not re-introduce the MW reduction back into the market schedule and allow the market price to decrease as forecast.

This year, the hours selected for this test were chosen to mimic the most recent voltage reduction test. As such, the 3% voltage reduction test was scheduled from 9:00 EST to 10:00 EST and the 5% voltage reduction test was schedule from 13:00 EST to 14:EST.

In order to determine the MW reduction, we compared the telemetered values of demand before the start of the reduction with the values of demand observed immediately after the test.

**- End of Section -**

## 2. Load Participation

### 2.1 Exclusions Prior to the Test

Exclusions<sup>2</sup> are normally communicated to us in advance through the outage management process. Participants requesting exclusions are required to provide rationale for their exclusion request, as well as actions that would prepare them to participate in the next test. Furthermore, they are also required to confirm their ability to participate in a real event.

The total amount of MW excluded from this year's test was slightly higher than the amount excluded from the previous test in 2009. A comparison of the exclusion quantities is included in Table 1.

For the 2010 test, a large portion of those utilities with health care customers indicated that they were working towards a solution.

Customer	2009		2010		Typical Reasons for Exclusion
	Load ( 3% test )	Load ( 5% test )	Load ( 3% test )	Load ( 5% test )	
Health Care	75 MW	125 MW	95 MW	165 MW	Patient safety, no funding for upgrades to equipment
Industrial	344 MW	380 MW	402 MW	546 MW	Loss of production, damage to equipment, employee safety
<b>Total</b>	<b>419 MW</b>	<b>505 MW</b>	<b>497 MW</b>	<b>711 MW</b>	

**Table 1: Exclusions - Loads Excluded Prior to the Voltage Reduction Test**

<sup>2</sup> See Appendix 1 for a definition of 'exclusion'.

## 2.2 Observations During the Voltage Reduction Test

Table 2 identifies any problems, comments or complaints we received during the tests from documentation submitted by the participants after the test.

Customer	Station Name	Problems/Comments/Complaints
Healthcare	Overbrook Busses	Customer did not receive a response to exemption request
Healthcare	Lorne Park B/J Buses	Load was switched after problems with the 3% voltage reduction test
Industrial	Fernbrook Pumping Plant	Requested exclusion during tests
Industrial	Napanee B Bus	Tap change required resulting in low voltage
Industrial	Morrisburg J/Q Buses	Requested exemption from 5% voltage reduction test due to customer protection complaint
Industrial	Crowland Q/Y Buses	Customer reports equipment damage concerns
Industrial	Red Lake B/Y Buses	Customer reported equipment trip at the end of the 5% voltage reduction test

**Table 2: Observations During Voltage Reduction Test**

**- End of Section -**

## 3. Results

### 3.1 IESO Results

#### 3.1.1 3% Voltage Reduction Test

The 3% voltage reduction test was conducted from 09:00 to 10:00 EST. To calculate the demand reduction, the demand immediately prior to the implementation of the test was compared to the demand at the point at which the demand reduction appeared to be complete. Similarly the demand immediately prior to the restoration of voltage was compared to the demand at the point at which the test appeared to be complete.

The observed demand reduction at the beginning of the test was 211 MW or 1.02% and the demand increase was 410MW or 1.76% when the voltage was restored. The average change in demand for the 3% voltage reduction test was a change of 1.46% of primary demand.

The demand reduction observed was lower than is normally expected from a 3% voltage reduction. Using the data shown below, demand appears to have been trending upward throughout the test. Only an additional 100 MW of change in demand at the start or end of the voltage reduction test would have equated to the expected 1.5% demand reduction.

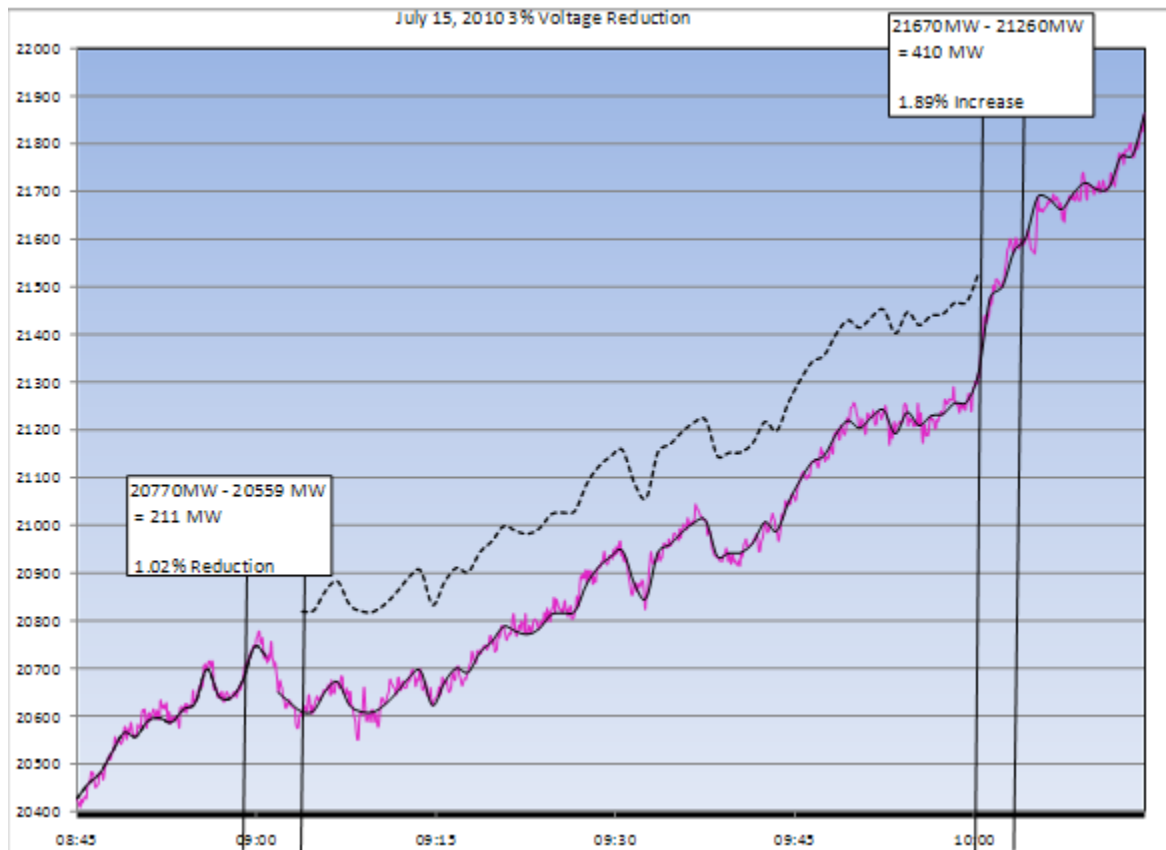
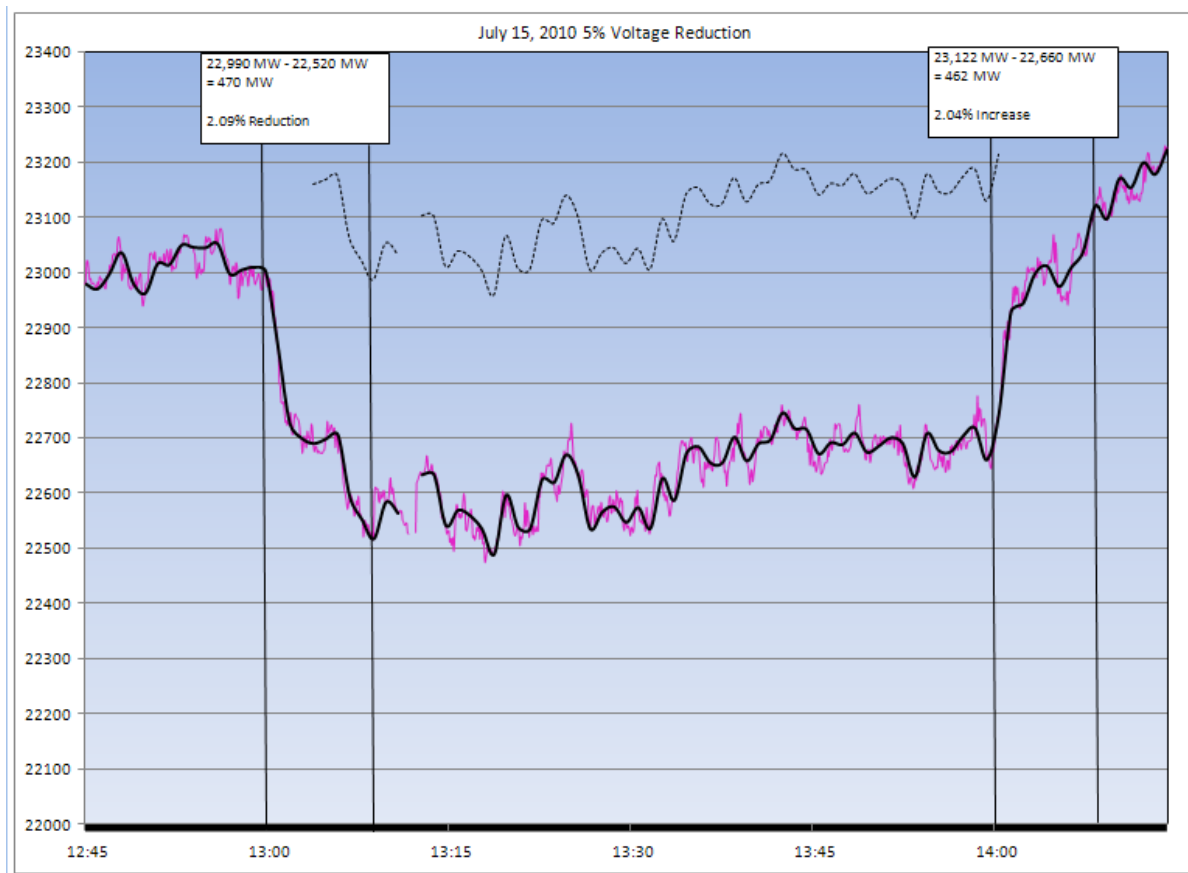


Figure 1: IESO Primary Demand Graph for 3% Voltage Reduction Test

### 3.1.2 5% Voltage Reduction Test

The 5% voltage reduction test was conducted from 13:00 to 14:00. The impact of the voltage reduction test on Ontario demand was measured using the same methodology as the 3% voltage reduction test. The observed demand reduction at the beginning of the test was 470MW or 2.09% when voltage was reduced. The observed demand increase was 462MW or 2.04% when the voltage was restored. The average result of the 5% voltage reduction test was a change of 2.07% of primary demand.

The demand reduction observed was lower than is normally expected from a 5% voltage reduction. Using the data shown below, demand appears to have begun to trend slightly upward as the test was being implemented. An additional 130 MW of change in demand at the start or end of the voltage reduction test would have equated to the expected 2.6% demand reduction.



**Figure 2: IESO Primary Demand Graph for 5% Voltage Reduction Test**

- End of Section -

## 4. Conclusions and Recommendations

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We use voltage reductions as a component of operating reserve at times and as an emergency control action. The values used for this purpose are a reduction in demand of 1.5% for a 3% voltage reduction and 2.6% reduction in demand for a 5% voltage reduction. The July 15, 2010 IESO voltage reduction test yielded an approximate demand reduction of 1.46% and 2.07% for the 3% and 5% voltage reduction tests respectively.

The scheduled times for the 5% voltage reduction test was chosen during a time of relatively flat demand while the 3% voltage reduction test was chosen during a time of heavy load pick up. This load pick up made it difficult to assess the impact of the voltage reductions. In 2009, the 3% and 5% voltage tests were performed during a relatively flat demand period which allowed for a clearer indication of the resulting demand decrease for the voltage reduction and demand increase for the voltage restoration. It is recommended that future tests also be scheduled during times when demand is expected to remain relatively flat.

As in the previous voltage reduction test in 2009, the IESO compared telemetered values of primary demand just before the start of the voltage reduction and immediately after the voltage was restored. This appears to be a more accurate way to assess the demand reduction than a comparison with a best similar day demand forecast profile (as used in tests prior to 2009). However with this method, determining the precise moment in which the voltage reduction begins and the voltage restoration ends can be difficult. Although this creates a margin for error, it was deemed negligible.

There were numerous instances of tap changer lock outs, many of which were on bottom tap, during both of the voltage reduction tests. In order to mitigate these instances, it is recommended that the IESO ensure the voltage profile allows for full range of operation of the tap changers to prevent tap changer lock out.

The results from these voltage reduction tests differed from the values that had been used to estimate the expected demand reduction during an actual voltage reduction. We will, however, continue to use 1.5% of demand for a 3% voltage reduction and 2.6% of demand for a 5% voltage reduction as we believe the following reasons altered the expected results:

- the hours used for testing were during times of load pick up
- the limited reduction potential as a result of tap changer lock out on bottom tap

We will continue to evaluate the appropriateness of the voltage reduction amount during future tests or in the event of an actual voltage reduction.

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# Appendix A: Definitions

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**Exclusion** – Denotes a facility that is not required to participate in the voltage reduction test.

Exclusions may be granted by the IESO either prior to the test through the outage process or during the test when the following criteria are met:

- Safety of employees or the public
- Injury to the environment
- Damage to equipment
- Loss of production<sup>3</sup>

**Voltage Reduction Test** – A test whereby distribution voltages are reduced in order to determine the effect on Ontario demand

These tests are conducted every 18 months to provide a benchmark for the load relief associated with both a 3% and 5% reduction in voltage.

- End of Section -

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<sup>3</sup> Exclusions for loss of production will only be granted for testing purposes. For real voltage reduction events, this is not a valid reason for exclusion.



## Appendix B: Load Exclusions Prior to the Test

Exempted Customers				
Customer Name	Station/ Transformer	Load ( 3% test )	Load ( 5% test )	Mitigation Plans
Industrial	Nebo TS	61.2	75	Temporary exclusion due to recent problems with equipment. Should be repaired for next test.
Industrial	Beach TS; Y2 bus	39.7	42.2	The customer having problems with air blower supply cables (loss of these blowers causes restart problems). They are replacing these cables. Should be available for future test.
Health Care	Elgin TS	22.1	22.4	Building new towers to their existing facility and do not have new equipment for voltage reduction.
Health Care	Glendale TS	8.4	9.5	Hospital integration to be completed late 2011.
Industrial	Glendale TS	19	20.1	Loss of production concerns. Work with customer to come up with a mitigation plan.
Health Care	Overbrooke TS	64.8	71	The customer is concerned about damage to sensitive diagnostic equipment (MRI and CT Scanner) and interruption in urgent patient care. Hydro Ottawa is working with the customer to develop a mitigation plan.
Industrial	Fergus TS	79.5	86.5	The customer has equipment and loss of production concerns. Continuing to work with LDC to come up with a mitigation plan.
Industrial	Wilson TS	113.4	118.7	The customer is concerned about equipment, loss of production, strike issues and safety. Continuing to work on a mitigation plan.
Industrial	Havelock TS	27.5	29.5	The customer is concerned about equipment, loss of production and safety. Continuing to work on a mitigation plan.
Industrial	Wallace TS	15.7	16.4	The customer is concerned about equipment, loss of production, and safety issues. Continuing to work to see if situation can be mitigated. The customer will continue to monitor and upgrade where necessary.
Industrial	P21R/P22R	8.3	8.3	Not a participant – manufacturing sector directly fed off of 230kV
Industrial	H24C/H26C	31.3	35.4	Not a participant – manufacturing sector directly fed off of 230kV
Industrial	B8W	5.6	6.6	Not a participant – manufacturing sector directly fed off of 230kV
Industrial	Dymond TS	n/a	32.1	Feeder upgrades have been completed by Hydro One. Customer participated in 3 % test but excluded from 5 % test. Will evaluate situation before next test.

Industrial	Meaford TS	n/a	17.6	Feeder upgrades have been completed by Hydro One. Customer participated in 3 % test but excluded from 5 % test. Will evaluate situation before next test
Health Care	Kent TS;Wallaceburg TS	n/a	62.4	System Control Operator requested exemption to be extended. Will follow up with email.
Industrial	St.Andrews TS	n/a	57.6	The customer installed new equipment. In discussion with customer to alleviate concerns regarding 5 % test.
<b>TOTAL LOAD EXCLUDED</b>		<b>496.5</b>	<b>711.3</b>	

**- End of Section -**

## References

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<b>Document Name</b>	<b>Document ID</b>
Market Manual 7: System Operations; Part 7.1 - System Operating Procedures	MDP_PRO_0040
Market Manual 7: System Operations; Part 7.4 - IMO-Controlled Grid Operating Policies	IMP_POL_0002
Voltage Reduction Test (January 22, 2009)	IESO_REP_0565

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