



Voltage Reduction Test

July 20, 2004

Issue 1.0

This document summarizes and analyzes the results of the Voltage Reduction Tests carried out on July 20, 2004.

REPORT

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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 - IMO-Controlled Grid Operating Policies
IMO_SCO_Voltage Reduction-S	Load Reduction through Supply Voltage Reduction

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Table of Changes

Reference (Section and Paragraph)	Description of Change

1. Overview

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

Voltage reduction tests are normally conducted every 18 months as per Market Manual 7.1: System Operating Procedures. These periodic voltage reduction exercises are conducted to:

- 1 Identify customer equipment problems so that corrective action may be taken,
- 2 Verify the load reduction attainable,
- 3 Measure the effectiveness of each exercise, and
- 4 Keep all involved staff familiar with procedures.

Voltage reduction is used by the IMO as a component of operating reserve. The values currently used for this purpose are 1.7% for a 3% voltage reduction and 2.8% for a 5% voltage reduction. NPCC Criteria Document A-06 requires that operating reserve be sustainable for a minimum of one hour.

System voltage reduction tests were performed on July 20, 2004. A 3% voltage reduction test was implemented from 10:30 to 11:30 and a 5% voltage reduction test implemented from 18:30 to 19:30.

– End of Section –

2. Exclusions

2.1 Exclusions

Some facilities did not participate in the voltage reduction tests. Exclusions are normally communicated to the IMO in advance through the integrated outage management process (IOMS) or during the test where problems are encountered.

2.2 Load Participation

The table below shows the comparison between the Ontario Demand and the load that participated in the tests.

Table 1: Load Participation

	3% Test	5% Test
Load Excluded prior to the test	135 MW	358 MW
Load Excluded during the test	198 MW	147 MW
Load that did not participate in the test	4,294 MW	3,782 MW
Load that participated in the test*	15,949 MW	15,784 MW
Ontario Demand at the time of the test	20,576 MW	20,071 MW

*Loads that did not participate partially/fully in the tests include the following:

- stations at which the tapchanger reached bottom tap before achieving the required voltage reduction
- stations where the aggregated loads are less than 20 MVA which are not required to participate in the voltage reduction tests
- connected wholesale customers who are not required to participate in the voltage reduction tests

– End of Section –

3. Demand Curves

When forecasting the demand for the voltage reduction test day, July 20, 2004, a best similar day of July 13, 2004 was chosen. Figure 1 below shows the actual demand curve for the test date as well as for the best similar day. Comparing these curves provides a graphic representation of what the demand would have been without the voltage reduction test in effect.

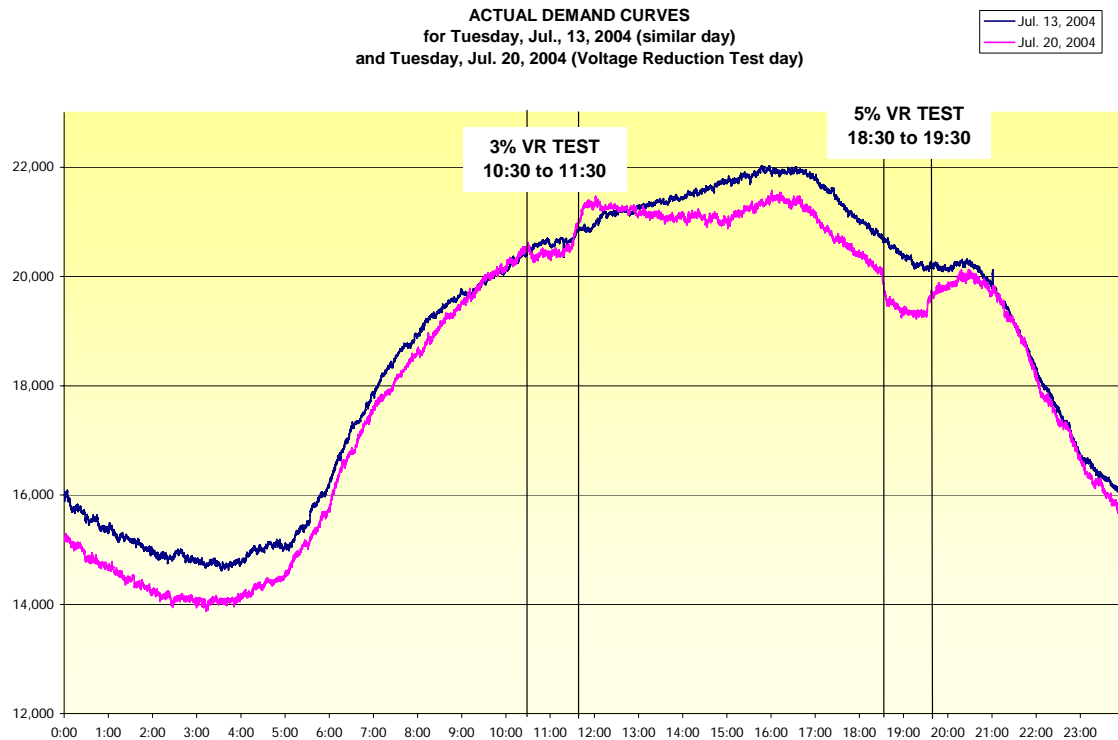


Figure 1: Actual Demand Curves for July 13, 2004 and July 20, 2004

The 3% voltage reduction test was conducted from 10:30 EST to 11:30 EST and the 5% test from 18:30 EST to 19:30 EST. The primary demand values used for the above graphs are averaged values over 3 second intervals.

– End of Section –

4. Results

4.1 IMO Results

4.1.1 3% Voltage Reduction Test

The 3% voltage reduction test was conducted from 10:30 to 11:30. To calculate the impact of the voltage reduction test on Ontario demand, the similar day demand curve was projected over the actual demand curve taking the load trend into consideration, as if no voltage reduction were in effect. This resulted in an estimated load reduction of 298 MW when the voltage was reduced and a load increase of 284 MW when the voltage was restored.

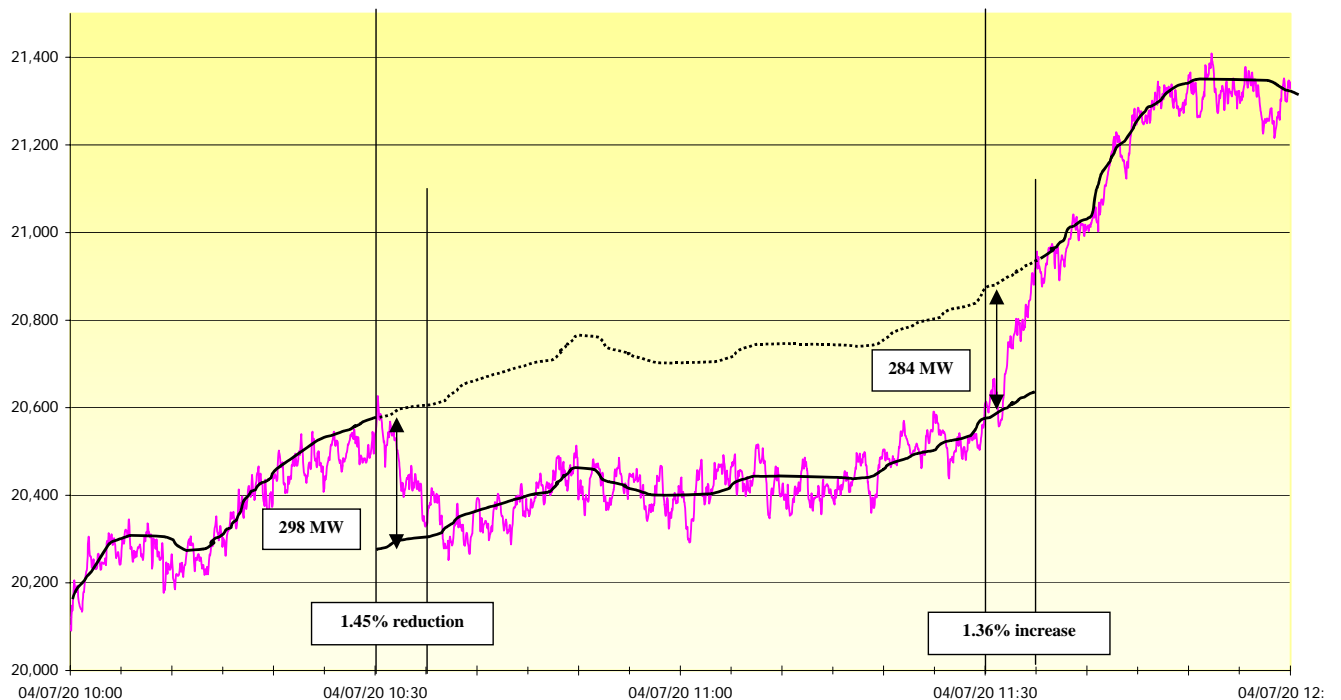


Figure 2: IMO Primary Demand Chart for 3% Voltage Reduction Test

4.1.2 5% Voltage Reduction Test

The 5% voltage reduction test was conducted from 17:30 to 18:30. To calculate the impact of the voltage reduction test on Ontario demand, the similar day demand curve was projected over the actual demand curve taking the load trend into consideration, as if no voltage reduction were in effect. This resulted in a calculated load reduction of 511 MW when the voltage was reduced and a load increase of 505 MW when the voltage was restored.

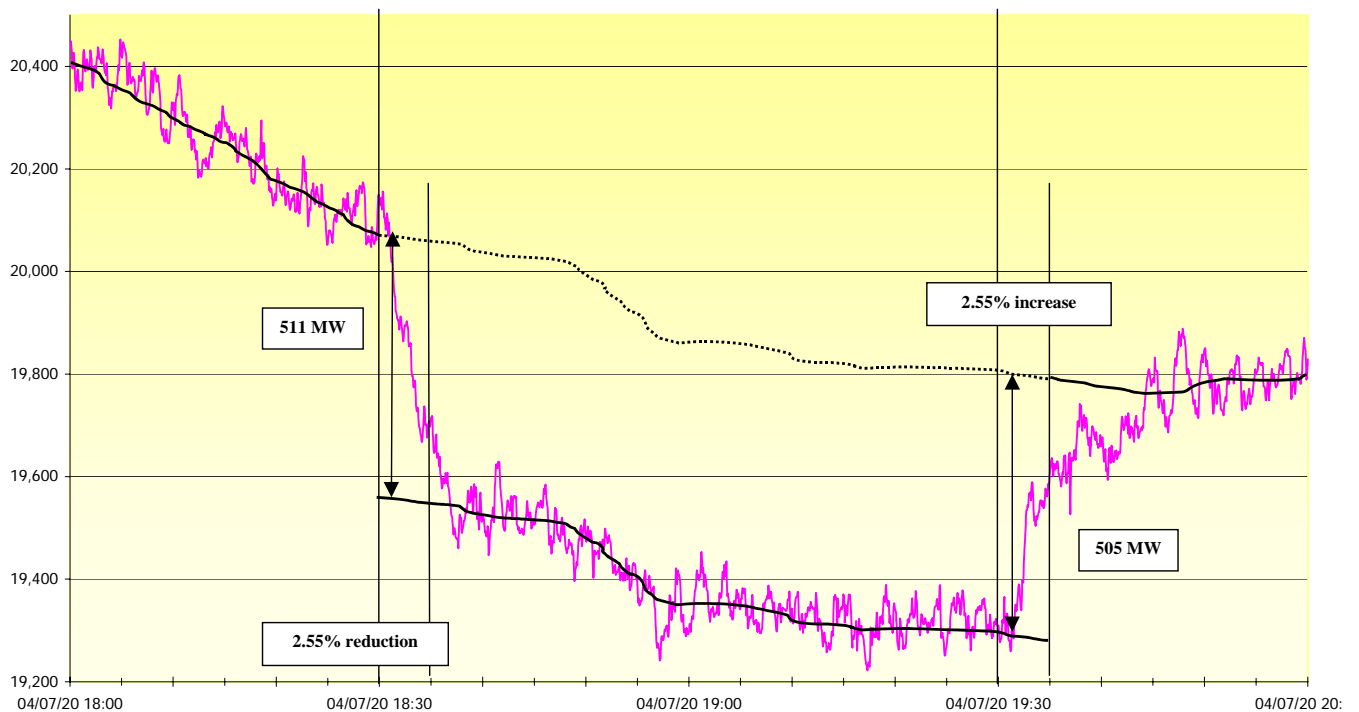


Figure 3: IMO Primary Demand Chart for 5% Voltage Reduction Test

4.2 Participant Results

The participant results for the 3% voltage reduction test showed a reduction of 68 MW and a restoration of 540 MW.

The participant results for the 5% voltage reduction test showed a reduction of 580 MW and a restoration of 388 MW.

The Ontario demand at the time of the tests was significantly higher than the load participating in the tests. This is a result of load not required to participate in voltage reduction tests and exclusions prior to the tests and during the tests.

4.3 Comparison of IMO and Participant Results

4.3.1 3% Voltage Reduction Test

The IMO results showed a reduction of 298 MW and a restoration of 284 MW, while the participant results were 68 MW and 540 MW respectively.

The differences in the results are very significant. The primary demand was trending high at the start of the 3% test and was trending even higher towards the end of the test. The demand-on-the-increase masked the reduction achieved by Market Participants at the start of the test while it inflated the relief at the end of the test.

An average of the IMO results for the 3% voltage reduction test shows a load relief of 291 MW or 1.40%.

4.3.2 5% Voltage Reduction Test

The IMO results showed a reduction of 511 MW and a restoration of 505 MW, while the participant results were 580 MW and 388 MW respectively.

The primary demand was trending low at the start of the 5% test and was trending low to flat towards the end of the test. The decreasing demand inflated the reduction achieved by Market Participants at the start of the test while it masked the relief at the end of the test.

An average of the IMO results for the 5% voltage reduction test shows a load relief of 508 MW or 2.55%.

Table 2: Comparison of IMO results with the Participants' results

	IMO Results		Participant Results	
	MW	%	MW	%
3% Reduction	298	1.45%	68	0.43%
3% Restoration	284	1.36%	540	3.26%
3% Average	291	1.40%	304	1.85%
5% Reduction	511	2.55%	580	3.68%
5% Restoration	505	2.55%	388	2.52%
5% Average	508	2.55%	484	3.10%

Note: The percentages calculated are based on the Ontario demand.

- Percent reduction = load reduced as a percentage of the Ontario demand prior to the reduction
- Percent restored = load restored as a percentage of Ontario demand after the restoration

4.4 Comparison of the IMO Tests Results with the Benchmark

Table 3: Comparison of the IMO test results with the benchmark

	July 17, 2001		January 23, 2003		July 20, 2004		Benchmark
	Ontario Demand	%	Ontario Demand	%	Ontario Demand	%	%
3% Test	19,164	1.7%	23,040	1.63%	20,576	1.40%	1.5%
5% Test	18 709	3.1%	24,440	2.59%	20,071	2.55%	2.6%

Note: The benchmark shown is the historical value of load relief resulting from the last two voltage reduction tests. The methodology used to derive the load relief from the last two tests was to transpose the (similar day load) forecast demand curve over the actual demand curve. This resulted in lower values.

The load relief achieved from the 2001 test was not taken into consideration for calculating the average for benchmark value because it was an instantaneous value unsustainable over an hour.

– End of Section –

5. Issues/Recommendations

Table 4: Recommendations and Action Items

No.	Issue	Recommendation	Action Item for:
1	Control Room ran into communication problems when preparing for the voltage reduction test. The contact information for some <i>market participants</i> was not correct.	<p><i>Market participants</i> are required by Market Rule Appendix 2.2 section 1.1.9.2 to notify the IMO any change in their telephone number or access code. Failure to do so leaves the IMO unable to contact the <i>market participants</i> when necessary.</p> <p>Amend the SCO: Monthly Testing to include all the voltage reduction <i>market participants</i>' system control facilities in Appendix A.</p>	<p><i>Market participants</i></p> <p><i>The IMO</i></p>
2	There was confusion regarding the customer notification process.	Amend Market Manual 7.1 (System Operating Procedures) to clarify the role of <i>Transmitters and Distributors</i> in notifying their connected customers of planned voltage reduction tests.	<i>The IMO</i>
3	Amendments to Market Manual 7.1 (System Operating Procedures) as recommended by Voltage Reduction Test January 13, 2003 report.	Amend Market Manual after inputs from stakeholdering.	<i>The IMO</i>

4	<p>There are discrepancies in the test results between <i>market participants</i> and the IMO. These differences in readings could be attributed to load trending light/heavy during the tests and the timing of the <i>market participants</i> test readings. The load is seen to stabilize 5 minutes into the test and 5 minutes after the end of the test.</p>	<p>Schedule one of the times selected for the next voltage reduction test to be during a flat load period to see whether there is a convergence in <i>market participants</i> and the IMO readings.</p> <p>Take readings right at the beginning of the test (10:30am) and 5 minutes into the reduction (10:35am), and again right at restoration (11:30am) and 5 (11:35am) minutes into the restoration.</p>	<p><i>The IMO</i></p> <p>Voltage reduction <i>Market participants</i></p>
5	<p>New benchmark values for load relief achievable are:</p> <ul style="list-style-type: none"> • 1.5% for 3% voltage reduction • 2.6% for 5% voltage reduction 	<p>Amend the IMO_SCO_Voltage Reduction-S reflecting new benchmark values.</p> <p>Implement the necessary changes to the operating procedures, programs and displays.</p>	<p><i>The IMO</i></p>

– End of Section –

6. Conclusions

Voltage reduction is used by the IMO as a component of operating reserve and as an emergency control action. The values currently used for this purpose are a reduction in demand of 1.7% for a 3% voltage reduction and 2.8% for a 5% voltage reduction.

Experience from the last 3 years of voltage reduction tests shows the sustainable load relief could be lower although higher instantaneous values were realized on the outset. The values from the last 2 years could be averaged to 1.5% for a 3% voltage reduction and 2.6% for a 5% voltage reduction.

It is, therefore, recommended that the IMO's existing load reduction values be changed to 1.5% for a 3% voltage reduction and 2.6% for a 5% voltage reduction.

– End of Section –

Appendix A: Definitions

Exclusion:

Used to denote a facility that is not required to participate in the voltage reduction test. Exclusions may be granted by the IMO 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 production¹

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 –

¹ 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: Notification Letter

June 11, 2004

**Voltage Reduction Test –
Tuesday, July 20, 2004 (alternate date July 22nd)**

This letter is to inform you that a system voltage reduction test is scheduled for Tuesday, July 20, 2004 in accordance with Market Manual 7.1, section 4.8.1, System Operating Procedures. The purpose of the test is:

1. To establish and record the load reduction resulting from a system voltage reduction of 3% and 5%.
2. To locate operational or customer problems which should be resolved.

The test will consist of two voltage reduction exercises:

1. A 3% exercise, from 10:30 EST to 11:30 EST.
2. A 5% exercise, from 18:30 EST to 19:30 EST.

The responsibilities of market participants and the procedures to be followed in carrying out the voltage reduction test are outlined in Market Manual 7.1 System Operating Procedures. All stations that are unattended without supervisory control, and/or with a peak load of less than 20 MVA during the week of the test, should be excluded.

On the test date, the IMO will initiate the commencement and termination of voltage reduction tests, consistent with the planned schedule. All involved market participants will be contacted via telephone to request the commencement of voltage reduction, at the planned percentage level. For all stations involved in the test, megawatt readings are required for each scheduled exercise. While it is desirable that all readings and changes occur as close to the schedules time as possible, it is important that the voltage changes occur at approximately the same time at all stations. It is suggested that the readings be taken in the 3 or 4 minutes before the reduction and immediately following the reduction, and again 3 or 4 minutes before restoration and immediately following restoration. A reading sheet template for use in recording the test results is attached.

The IMO will be responsible for data collation and will conduct a study and analysis of the voltage reduction procedures and results. Please forward all test results, reading sheets and records of customer complaints via email to: mark.wilson@theIMO.com or if this is not possible to the address below:

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Independent Electricity Market Operator

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Toronto, Ontario

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Each market participant is responsible for customer notification and handling of customer complaints, both during and after the test. Any such complaint, and a brief explanation of the corrective action planned, should be recorded and submitted with the readings. All exclusions should be kept to a minimum in order to maintain the validity of the test results. A list of exclusions for stations qualifying for the test should be included with the readings, along with reasons and the megawatt load involved.

The Market Rules (Chapter 5, Sections 3.4.1.5 and 3.7.1.5) specify the following criteria for use by the IMO, transmitters and distributors in granting approvals to exclusion requests while voltage reduction is in progress:

- Safety of the employees or the public, or
- Undue injury to the environment, or
- Damage to equipment.

In addition, for the purposes of voltage reduction tests, exclusions may be granted where loss of production occurs.

All advance requests for exclusion from voltage reduction tests will be made by transmitters or distributors to the IMO through the outage management process no later than 10:00 a.m. EST 3 business days in advance of the voltage reduction test. The IMO will approve or reject exclusion requests based on the criteria above within 2 business days of the scheduled test.

Market Participants participating in the test are:

Cambridge And North Dumfries Hydro Inc.	Canadian Niagara Power Inc.
Enwin Powerlines Ltd.	Hydro One Brampton Networks Inc.
Hydro One Networks Inc.	Hydro Ottawa
Hydro Vaughan Distribution Inc.	Kitchener-Wilmot Hydro Inc.
Markham Hydro Distribution Inc.	Richmond Hill Hydro Inc.
Toronto Hydro-Electric System Limited	Waterloo North Hydro Inc.

The voltage reduction test is subject to postponement to July 22, 04 if system conditions are unfavorable. It may be rescheduled at a later date with as much advance notice as possible if both dates, July 20 & 22, are not suitable. The exercises are subject to cancellation if a voltage reduction is applied for system purposes prior to the test date.

Below is the link to the report on last year's voltage reduction test and the results:

http://www.theimo.com/imoweb/pubs/ircp/IMO_REP_0205_Public.pdf

Yours truly,

P. Doran
Manager
Market Facilitation
Market Operations & Forecasts

– End of Section –

References

Document Name	Document ID

– End of Document –