

**Transmission Operator  
Reliability Readiness Audit Report**

**Hydro One Networks Inc.**

**June 26–29, 2006**

**Barrie, Ontario, Canada**



North American Electric Reliability Council

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## **Introduction and Audit Process**

The North American Electric Reliability Council (NERC) Reliability Readiness Audit and Improvement Program is one of the commitments of NERC and the industry following the blackout of August 14, 2003, to strengthen the reliability of the North American bulk power system. The program conducts independent audits of balancing authorities, transmission operators, reliability coordinators, and other key entities that support the reliable operation of the bulk power system to assess their preparedness to meet their assigned reliability responsibilities. The audits identify strengths and areas for improvement in an effort to promote excellence in operations among these organizations. The document [\*NERC Readiness Audit Procedure\*](#) describes and defines the process used for reliability readiness audits. This document and other documents related to the program are available at <http://www.nerc.com/~rap/>.

The reliability readiness audit teams, each led by a NERC staff member and a regional co-leader, include industry volunteers with considerable expertise selected to provide representation from other interconnections, other regions, and neighboring operating entities. The teams also typically include representatives from the Federal Energy Regulatory Commission (FERC) staff.

The public version of the reliability readiness audit report contains the majority of the audit team's findings. Any discussion of findings pertaining to critical energy infrastructure will be contained in Appendix 1, a confidential appendix to the report that is sent privately to the organization audited and is not included in the public version of the report.

The audit team for the Hydro One Networks Inc. (HONI) audit met on-site with HONI representatives on June 26–29, 2006. This report reflects the views and recommendations of the audit team regarding the readiness of HONI to meet its responsibilities as a transmission operator.

### **Audit Team**

|                        |   |
|------------------------|---|
| Darrell Piatt*         | NERC  |
| Gerry Mosier*          | Northeast Power Coordinating Council (NPCC)       |
| Chad Bush              | Michigan Electric Transmission Company (METC)     |
| Richard (Rusty) Dawson | Electric Reliability Council of Texas (ERCOT)     |
| Aleksandar Mitreski    | Independent System Operator – New England (ISONE) |
| Patrick Doyle          | Hydro Quebec Transmission (HQT)                   |
| Jason Hickman**        | Northeast Power Coordinating Council (NPCC)       |

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\*\*Observer

## **Organization Profile**

HONI is one of four subsidiaries of Hydro One Incorporated. Hydro One Incorporated is owned by the government of the Province of Ontario, Canada, and serves as a holding company for HONI, Hydro One Brampton, Hydro One Remotes, and Hydro One Telecom. HONI is the largest subsidiary company and is involved with planning, construction, operations, and maintenance of the electric transmission system and distribution network. HONI owns and operates 97% of the electric transmission system in the Province of Ontario, Canada. HONI's peak load of 26,160 MW occurred on July 13, 2005.

HONI's transmission system serves a 640,000 square km area using 3,800 km of 500 kV lines, 5 km of 345 kV lines, 13,800 km of 230 kV lines, and 10,800 km of 115 kV lines. The lines include 26 interconnections with other Canadian provinces and United States electric utility companies. These interconnected entities include Hydro Québec, Manitoba Hydro, Minnesota Power and Light, New York Power Authority, Niagara Mohawk (National Grid), and the International Transmission Company in the state of Michigan.

HONI does not own generation, but delivers the generation interconnected to its system to large industrial customers, remote communities, retail customers, and local distribution companies. The fuel mix of the 30,000 MW of generation in the HONI footprint is 21% coal, 26% hydro, 37% nuclear, and 16% gas. Ontario Power Generation owns and operates 75% of this generation, and the remaining 25% is owned and operated by Bruce Power and other energy providers. The Ontario Energy Board is the overall regulating authority for the electric market in the Province of Ontario.

HONI is registered with NERC as a transmission owner, a transmission operator, a transmission planner, load serving entity, and a distribution provider. HONI is also a member of NPCC and maintains membership on a number of committees, task forces, and working groups.

## **Executive Summary**

The audit team found no significant operational problems and concluded that HONI has adequate facilities, processes, plans, procedures, tools, and trained personnel to perform the transmission operator functions necessary to maintain the reliable operation of the bulk power system. The audit team identified a number of positive observations and potential examples of excellence. It also offers five recommendations that, if implemented, will greatly enhance HONI's readiness to operate reliably and maintain the reliability of the bulk power system. The findings are listed in order of importance.

## **Potential Examples of Excellence**

The audit team identified the following potential examples of excellence in its reliability readiness audit:

1. *See discussion in Appendix 1*
2. *See discussion in Appendix 1*

## **Positive Observations**

The audit team noted the following positive observations during the reliability readiness audit process:

1. HONI has a strong commitment to 100% NERC certification at the reliability level for all controllers. (Section 4)
2. HONI elevates safety to a level of critical importance in all elements of its operations.
3. HONI effectively utilizes the dispatcher training simulator to enhance controller training. (Section 5)
4. HONI uses its intranet site to enhance training resource availability and use. (Section 5)
5. HONI has a well-integrated network management system (NMS) that provides easy access to all required tools and associated documents. (Section 10)
6. *See discussion in Appendix 1.*
7. HONI has a carefully designed and fully equipped backup control center with adequate levels of security, redundancy, and operability. (Section 9)
8. HONI's impressive audit preparation increased the audit team's ability to review all of the essential reliability-related operations.

## **Recommendations**

The audit team recommends that HONI take the following actions to address issues discovered during the audit process:

1. Develop and implement the following changes and enhancements to the training program: (Section 5)
  - a. Develop and implement a programmatic training curriculum for senior controllers using a systematic approach.

- b. Require the HONI trainers to obtain the NERC-certified training provider status and provide continuing education hours to support the controller re-certification process.
  - c. *See discussion in Appendix 1.*
  - d. Provide annual training opportunities for each controller to travel to and operate from the backup control center.
  - e. Increase the availability of reliability coordinator system-controller documents to the HONI controllers as appropriate.
2. Maintain the current HONI controller NERC-certification process as a high-priority project to meet the expected 2006 completion date. (Section 4)
  3. Review and revise the interconnection agreements that predate NERC standards and/or the current provincial *Transmission System Code*. (Section 1)
  4. Complete the document management system upgrade to effectively manage the periodic review, expiration, and revision of policies and procedures. (Section 6)
  5. Review and revise the backup control center implementation plan to consider transportation requirements for all expected scenarios. (Section 9)

## **Discussion**

The reliability readiness audit team examined the following key areas during the audit. The detailed discussion that follows provides the foundation for the recommendations, positive observations, and potential examples of excellence that the team identified. The report uses the generic term “system operator” to refer to all on-shift operating personnel responsible for executing the functions necessary to operate reliably and maintain the reliable operation of the bulk power system. This term will be used for the discussions unless additional specificity is required, such as the *balancing* system operator, or *transmission* system operator. This report refers to those personnel as controllers or transmission controllers.

### **1. Agreements**

*The balancing authority must have agreements that establish its authority as a balancing authority. The balancing authority/transmission operator must have agreements that establish the reliability coordinator for its footprint.*

HONI operates in the NPCC region and is registered with NERC as a transmission operator and a planning authority. Certification of HONI in these registered areas will be accomplished by the region as the NERC functional model is fully implemented.

The balancing authority and reliability coordinator functions for HONI are performed by the Independent Electricity System Operator (IESO). The scope of the balancing authority and reliability coordinator services that are provided to HONI are clearly defined in an agreement dated December 12, 2005 and titled *Amended and Restated Operating Agreement between Hydro One Networks, Inc. and the Independent Electricity System Operator*. The agreement was reviewed by the audit team.

HONI has interconnection agreements with its interconnected electric utilities, the generators connected to the HONI system, and the load serving entities that are served from its system. The team noted that the interconnection agreements related to nuclear generating units covered each required area of operations in great detail. For prospective new transmission, generation, or load serving interconnections, HONI has pro-forma agreements that comply with NERC standards and the provincial *Transmission System Code*.

A review of the HONI's interconnection agreements indicated that the latest revision of several agreements predate the publishing of the NERC standards. The team recommends that the agreements that predate the NERC standards or the current provincial *Transmission System Code* be reviewed and revised to reflect the current operating requirements.

## **2. Operator Authority**

*The balancing authority/transmission operator is responsible for establishing and authorizing the system operator position that will have the on-shift responsibility for the safe and reliable operation of its portion of the bulk power system in cooperation with neighboring operating entities and the reliability coordinator.*

The HONI controllers have a clear letter of authority signed by senior management that empowers them to operate the interconnected transmission system in a reliable and safe manner. This authority includes the shedding of firm load, if necessary, to ensure system reliability. The authority of the HONI transmission operators is also stated clearly in their job descriptions.

The HONI transmission system controllers are very clear as to their authority and confident in their ability to reliably and safely operate the transmission system. In the questionnaires completed for this audit, HONI's interconnected neighbors indicated that they are confident of the HONI controllers' ability and authority to operate the transmission system in a reliable and safe manner.

## **3. Delegation of Authority**

*Any functions that have been delegated must be clearly documented. The documentation must recognize that the balancing authority/transmission operator that is delegating the function continues to be responsible for that function.*

IESO, the reliability coordinator and the balancing authority for the HONI footprint, has not delegated any of its functions to HONI, the transmission owner/operator, nor has HONI delegated any of the transmission owner/operator functions to another entity. The team noted that there are some overlapping tasks that are being performed by both IESO and HONI; however, this does not constitute delegation of authority. The team believes this overlapping of tasks provides a second look at some of the critical operational elements of transmission system reliability.

#### **4. Staff Certification**

*Balancing system operators and transmission system operators must be NERC-certified operators. The balancing authority/transmission operator must have sufficient NERC-certified operator staff for continuous coverage of the system operator positions.*

HONI has embarked on an aggressive program to have all of its operations managers, supervisors, and controllers NERC-certified at the reliability level. At present nine operating managers and nine controllers are NERC-certified. The goal is to have all 73 controllers NERC-certified at the reliability level by the end of the calendar year 2006.

The team commends HONI for its commitment to 100% certification of the transmission system controllers, operational managers, and supervisors. Regarding this commitment, the team recommends that HONI maintain this goal as a high-priority corporate initiative.

#### **5. Training**

*The system operators must be adequately and effectively trained to perform their roles and responsibilities. The balancing authority/transmission operator must have documents that outline the training plans for the system operators. The balancing authority/transmission operator must have training records and individual staff training records available for review.*

HONI has a formal training program with a structured curriculum, designated training resources, and an automated tracking program to facilitate the management of the training program. Also the training program includes the use of a dispatcher training simulator to significantly enhance the quality of the training.

The initial training program for an entry level controller consists of five levels, classified as controller trainee one through controller trainee five. The formal training portion is divided into four six-month segments that provide 240 training hours per year for three years. This training time is continuous as the controller trainees are on a supernumerary shift schedule and do not participate in the regular shift schedule. Methods of instruction include on-the-job training, self study, formal classroom instruction, and practical exercises using checklists. Trainees are evaluated by supervisor and trainer assessments, written tests, simulator performance checklists, and work assignments.

After controllers have successfully completed the three-year training program, they enter as a controller level one. Upon successful performance in this classification for one year, they are promoted until they reach the controller level five, which is the top level of the controller classification. The training curriculum for this advanced career path includes refresher training on the core operational topics and safety, advanced operational topics, additional simulator training, and additional topics such as leadership and supervisory skills. The training delivery and evaluation methods are the same as those used in the initial training program.

- The HONI controller five receives 240 training hours per year, consisting of 85 hours of standard operational training, 35 hours of emergency operations training, and 120 hours of advanced operational training, leadership, and supervisory skills. The training

curriculum for the level five controllers is repetitive and lacks the structure of a systematic approach to curriculum development. In the opinion of the team, this approach does not support the life-long learning process for the senior level controller. The team recommends that HONI develop and implement a programmatic training curriculum for senior controllers using a systematic approach.

The emergency operations training consists of annual voltage reduction and load-shedding drills, including mock emergency drills with the reliability coordinator and interconnected generator owners and operators. Additionally, HONI runs blackstart drills, load restoration exercises, and other contingency response exercises. The dispatcher training simulator is an effective part of the training program, especially in the area of emergency operations training; HONI has 160 system simulations designed and installed on the simulator. The team commends HONI for its creative utilization of this tool.

HONI has just recently completed a new backup control center for its transmission system. The controllers have been to and operated from this facility. The team recommends that the annual training schedule provide to each controller the opportunity to travel to and operate from the backup control center.

The HONI transmission-controller training staff uses the performance-based systematic approach to training methodology for training development, delivery, and evaluation. These trainers are not NERC-certified training providers. The team recommends that the HONI training staff attend NERC's train-the-trainer courses and become NERC-approved training providers who can develop and provide the necessary continuing education units to support the NERC operator recertification training requirements.

## **6. Operating Policies and Operating Procedures**

*The balancing authority/transmission operator must have an established procedure to ensure that system operators and operations staff are aware of any changes to NERC, regional, and/or local policies or procedures prior to taking over control of a shift position.*

*The balancing authority/transmission operator must have shift change procedures for updating incoming shift personnel on the current status of the system.*

HONI has a substantial body of operating policies and procedures to support the reliable operation of its transmission system. These policies are readily available to operating personnel, and the controllers are knowledgeable of the content.

The Ontario Grid Control Center (OGCC), which is the main control center, uses an automated document management system, which was implemented in 2001, that provides real-time access to instructions, documents, diagrams, policies, agreements, standards, and other operating documents. This system, known as Networks One Documentation System (NODS), has a wide array of capabilities, including automated new or revised document notification, one-hour publishing, cross-functional document search and retrieval, linkages to asset databases, and portal functionality to corporate or external documents such as reliability coordinator documents.

While the NODS tool is fairly comprehensive, it does have some limitations. This tool will not automatically notify a document owner of life-cycle requirements such as revision or expiration dates. The notification process does not have a verification process to ensure full integration of the document into the operating environment. To meet these and other functional requirements, HONI is replacing NODS with the Hydro One Document System (HODS).

The new system keeps the functionality of NODS as well as providing administrator (gatekeeper) and content (owner) functions to incorporate document life-cycle maintenance activities. HODS also incorporates a feature that provides for notification verification when a new or revised document is published. Additionally, this tool has an alert function associated with the publishing of action requirements or informational bulletins. This tool was demonstrated for the audit team, and the team recommends that HONI implement the HODS system to take advantage of the increased functionality it provides.

The HONI controllers have mentioned that they would like to have increased access to the reliability coordinator system-controller documents. Since the tool that provides such access is available, the team recommends that HONI review and implement this request as appropriate, depending upon issues with the electric utility business unit segregation.

HONI has a controller shift change process that is clearly documented and carefully followed. The shift change process provides for the communication of the big picture information. Since the HONI transmission system has four geographic sectors, the process then moves to the sector specific information for the sector in which the controller will be working.

## **7. Planning**

*The balancing authority/transmission operator and its supporting planning organizations must have a process for day-ahead planning, and for longer-term planning, such as week-ahead, seasonal, and year-ahead, for the operation and outage scheduling of transmission facilities and generation and reactive resources.*

*The balancing authority/transmission operator and its supporting planning organizations must have agreements with its reliability coordinator to ensure that day-ahead and longer-term plans for the operation and outage scheduling of transmission facilities, and generation and reactive resources, will not jeopardize the reliability of the bulk power system.*

The HONI system planning and design group works with the Ontario Power Authority (OPA) as an entity that is the planning authority for the province. The OPA is also responsible for developing the integrated power system plan. HONI works with the OPA, the IESO, generator owners/operators, and other market participants to develop long-term solutions to the electric system needs for the Province of Ontario. If the HONI solution is identified as the solution of choice, HONI applies to the IESO for a system impact statement based on the assessment of the associated transmission studies. After the system impact statement is obtained, HONI seeks regulatory approval pursuant to initiating the construction of the project.

HONI works with the IESO and the NPCC task force on system studies to build the annual regional base case for transmission system studies. The base case data includes the assignment

of the loads to the respective buses and are furnished to IESO. The IESO then combines these data with the data of the other market participants and forwards to NPCC. HONI rates the transmission system elements according to established industry criteria, manufacturer's ratings, and the provincial *Transmission System Code*. The facility owners determine and provide the facility ratings to be used, and these cannot be changed by the reliability coordinator.

The transmission system studies are created using Siemens Power Technologies Inc. power system simulator for engineering (PTI-PSS/E) load flow program. These studies use a one- to five-year planning horizon. In accordance with the HONI-IESO operating agreement, the IESO performs the peak seasonal studies and the import/export capability studies. These studies are closely coordinated with HONI, and the results are communicated to the OGCC.

The HONI transmission development group performs various sensitivity studies of the transmission system using P-V and Q-V analysis, in n-1 and n-2 environments, to determine voltage adequacy and the system's reactive needs. If system needs are identified, the proposed project goes to the IESO for a system impact assessment so that regulatory approval can be obtained and the project scheduled for construction.

The operating planning group at HONI participates in the summer and winter seasonal assessment and outage planning support. In addition, the group performs the mid-term, short-term, and day-at-hand planning necessary to support the HONI transmission system operations. The outage coordination process and the associated planning will be discussed in the next section of this report.

## **8. Outage Coordination and Communication**

*Planned outages of transmission facilities and generating units must be coordinated with the reliability coordinator to ensure that conflicting outages do not jeopardize the reliability of the bulk power system.*

*Information relative to forced outages of transmission facilities and generating units that may jeopardize the reliability of the bulk power system must be shared with affected balancing authorities, transmission operators, and the reliability coordinator as expeditiously as possible.*

The outage coordination process is clearly defined and responsibilities are assigned in chapter seven of the *Market Manual* for the operation of the electric power system in the Province of Ontario. As part of the critical continuous outage plan, HONI gathers customer outage data and its own outage schedule for a period of time from twelve months to five years for all the critical work planned in that time frame. HONI places all the outage data into its network outage management system, a system that has a computer interface with the reliability coordinator's integrated outage management system. This allows HONI to submit outage requests via a Web-based tool and receive time stamped responses in the same manner. The reliability coordinator provides advanced approval of the outage two business days prior to the requested outage and final approval the day of the requested outage, no later than one hour prior to the outage start time.

The outage coordination process involves a proactive communication process between all of the market participants. HONI conducts meetings with the generation owners and operators that are connected to its system to discuss the proposed outage schedules. HONI exchanges by e-mail with these entities the current outage summary. In addition HONI holds quarterly continuous rolling outage plans meetings to review the outage plans for the upcoming quarter. These outage plans are posted to the reliability coordinator's Web site, where neighboring balancing authorities and reliability coordinators can access them.

The long-term outage planning process requires that outages scheduled for longer than four hours be submitted to the reliability coordinator at least thirty-three days in advance. Outages that are scheduled to be continuous and longer than five days must be submitted to the reliability coordinator at least three months in advance. Mid-term outage planning is defined as those outages between the thirty-three day advanced notice and the day-ahead outage planning. Short-term outages are those planned inside a three-day time frame. HONI holds a Monday morning production meeting and a "weekend edition" meeting, which occurs on Friday afternoon, to review the impact of currently planned outages based on the current system conditions. The studies to support the outage coordination process are performed by the reliability coordinator; however, the HONI operating planning department also runs outage studies to assist in the outage coordination process.

## **9. Plans for the Loss of Control Facilities**

*The balancing authority/transmission operator must have a workable plan to continue to perform the balancing authority/transmission operator functions that are required to maintain a reliable bulk power system following the sudden catastrophic loss of its primary control facility, or the partial or full failure of its computer facilities or monitoring tools at the primary control facility.*

HONI has a well-documented plan for evacuation of the OGCC and transfer of transmission-system control to its backup control center. The plan for transition to the backup control center includes the utilization of an interim control facility, near the OGCC, from which a level five controller can control all four sectors of the transmission system, begin the start-up of the backup control center, and maintain communications while other operating personnel are en route to the backup control center.

The backup control center is a secure facility that has fully redundant operational and communication capabilities. It is equipped with six monitors per console, versus the eight monitors per console in the OGCC, which accommodates four controllers per sector and two managers. Support personnel are located in a separate room at the backup control center to ensure the continuity of operations from this location. Electronic access to control documents and the operating policies and procedures is available at the backup control center.

HONI initiated a full test of the interim and the backup control center by transferring control of the transmission system to these facilities, along with the communications, and actually operating the transmission from these facilities. During the visit to the backup control facilities by the audit team a number of the functions of the control and communications were demonstrated to the team, but a full transfer was not accomplished due to time constraints.

One specific concern the team had was the plan's assumption that the controllers would use personal transportation to get to the backup control center. Personal transportation may be impeded by severe winter weather. Therefore, the team recommends that HONI review and revise the backup control center implementation plan to consider transportation options for all possible weather scenarios.

The team commends HONI for the planning, construction, and implementation of a carefully designed and fully equipped backup control center with good levels of security, redundancy, and operability.

## **10. Tools**

*The balancing authority/transmission operator must have adequate analysis tools to perform the balancing authority/transmission operator functions. Such tools include state estimation, precontingency and postcontingency analyses capabilities (thermal, stability, and voltage), mapboard (static, dynamic, hardwired, or projected), eTagging program, weather service, interchange scheduling system, outage scheduling system, trending tools, and a voice recording system.*

HONI has the necessary tools to help ensure reliable transmission-system operations. These tools include a well-integrated NMS that provides easy access to the full compliment of operating tools.

The operating tool functionality includes comprehensive alarm capabilities, full control capabilities, multi-functional supervisory control and data acquisition (SCADA) displays, breaker duty cycle, rotational load shedding, SCADA topology (full connectivity network model) and SCADA reconstruction (review of past events). The mapboard in the primary control center is fully dynamic and utilizes diagonal screens lit by rear projectors. These screens can also project direct video feeds from satellite receivers for news and weather.

Additional tools include a state estimator, dynamic thermal limit calculator, real-time contingency analysis tool, a training simulator, intuitive access to operating documents, control room information system, and key operating points. Also included is a real-time short-circuit tool and an alarm subsystem known as Application Watchdog which monitors the power system applications and alarm processor.

## **11. Load Shedding Plans**

*The balancing authority/transmission operator must establish plans for automatic load shedding for underfrequency or undervoltage conditions, coordinate load shedding plans with other interconnected entities, implement load shedding in steps to minimize further uncontrolled events, and have plans for operator-controlled manual load shedding to mitigate violations of system operating limits (SOL) or interconnection reliability operating limits (IROL).*

HONI has a manual load-shedding program that is implemented by use of a rotational load-shedding scheme. This scheme is implemented using a single screen on the NMS to select area,

amount of load, sequence, and duration of the load shedding actions. This manual load shedding program does not overlap with the underfrequency load-shedding program (UFLS).

HONI has a two-step UFLS that complies with NPCC requirements by establishing the required amount of load shedding for each step. The UFLS program information for each station and the UFLS relay information are available on the NMS screen by selecting the station information in the control room information system.

Load-shedding activities are coordinated with the reliability coordinator, local distribution companies, load serving entities, and the generator operators. If necessary HONI can perform additional load reduction by a three or five percent voltage reduction as directed by the reliability coordinator. The voltage reduction schemes are used in local areas and are not incorporated system-wide like the rotational load-shedding scheme.

## **12. Real-Time Monitoring**

### **a. System Visibility**

*The balancing authority/transmission operator must monitor operating data and status in real time for its area and adjacent areas as necessary to maintain situational awareness of its system.*

HONI has the capability to monitor a wide array of information to help manage its transmission assets, including flows, equipment condition, element loading, generator output, tie lines, and the terminal breaker status in some neighboring systems. Each controller station for the four operating sectors has eight screens that provide well-organized system data.

### **b. Alarms**

*The balancing authority/transmission operator must have effective and reliable alarming capability. This should be supported in the energy management system (EMS) and/or supervisory control and data acquisition (SCADA) system by alarm priority.*

HONI has standardized alarms by device, meaning that each alarm type has its own specific tone. Anytime a breaker, transformer, line protection, line segment, or other transmission system element alarm is triggered, its specific tone will sound in the control room and/or the backup control center.

The alarms are divided into eight priority levels (buckets) using sound and color elements. During a large contingency, a controller can group the alarms by priority, a specified area or manage them individually. HONI monitors the thermal and voltage limit violations through its real-time network. The NMS uses the state estimated values to compute a dynamic thermal limit based on the element preload and current temperature and wind speed parameters. An additional functionality of the NMS is ready access to a one-line diagram of the alarmed element and intuitive, drill-down access to detailed information.

A “watchdog” application monitors the health of the alarm system. The application monitors the alarm processor and the power system applications, including the state estimator, the thermal limit calculator, the contingency analysis tool, and the short-circuit applications. This system monitors all critical systems such as the contingency analysis, thermal limit calculator, and the voice system. An around-the-clock shift control engineer (SCE) position is responsible for monitoring the watchdog application as well as other key areas of operational support.

**c. Frequency**

*The balancing authority/transmission operator must monitor frequency, direct actions to resolve significant frequency errors, and correct real-time trends that indicate potentially developing problems. Frequency monitoring points should be of sufficient number and from several locations with sufficient area coverage to allow the balancing authority/transmission operator to effectively monitor the balancing authority/transmission operator footprint to determine possible islands.*

The frequency of the HONI transmission system is monitored from a minimum of fifty frequency monitoring points that take into account any possible islanding in the HONI footprint. These frequency points are monitored on a world-view NMS work station screen. Any frequency deviation outside defined limits triggers an alarm to prompt for controller intervention. If additional frequency monitoring is required, it can be performed using the programmable synchro-check relays that take frequency monitoring to a level well in excess of the fifty points minimum.

The NMS electronically archives system frequencies that can be used for trending or research.

**d. Voltage/Reactive Reserve**

*The balancing authority/transmission operator must monitor voltage levels and take appropriate actions to support the bulk power system voltage if real-time trends indicate potentially developing problems. Voltage measuring points must be of sufficient number and from several locations and voltage levels to allow the balancing authority/transmission operator to effectively monitor the voltage profile of its footprint.*

*The balancing authority/transmission operator must ensure that reactive reserves are available and properly located to satisfy the most severe single contingency.*

HONI operates within voltage parameters defined by the *Ontario Market Rules*. The rules specify the nominal, maximum continuous, and minimum continuous transmission voltage ranges. There are system control orders that provide the voltage operating levels and ranges of deviation in the northern and northwestern portions of the HONI transmission system footprint. The HONI voltage operating ranges are coordinated with its synchronously connected neighbors.

HONI works with the reliability coordinator to ensure that adequate reactive resources are in place, maintained, and available to be placed in-service to support the system voltage and reactive requirements. Since the *Ontario Market Rules* do not allow HONI to deal directly with the generators, the reliability coordinator monitors the system's voltage and reactive requirements and directs HONI to place the static reactive resources in-service as needed. Some of the capacitor, reactor, or condenser switching schemes deployed in the HONI transmission footprint are automatically deployed, but many static reactive resources are manually switched.

The reliability coordinator tracks the availability of automatic voltage regulators (AVR) on the generating units and specifies the operating limits if an AVR is in the manual mode or malfunctions. HONI has access to the AVR data and performs operating studies modeling the AVR characteristics. Additionally, the power system stabilizers (PSS) are modeled in the HONI operating studies, and procedures are in place that require HONI to be notified if a PSS is removed from service or the gain on a PSS unit is changed.

**e. Critical Facilities**

*Monitoring of facilities that are critical to the reliability of the bulk power system is a joint responsibility of the balancing authority, transmission operator, and the reliability coordinator.*

*An established process must determine which facilities are critical to the reliability of the bulk power system. Real-time operating information (data and status) and operating limits for these critical facilities must be provided to the balancing authority, transmission operator, and the reliability coordinator.*

The studies that identify the critical facilities for the HONI transmission system are performed by the reliability coordinator and coordinated with HONI. There are sixty-two security control orders that list all the SOL, IROL, and the associated remedial actions monitored by the reliability coordinator. These limits include interface limits, stability limits, equipment limits, voltage limits, thermal limits, and other critical operating parameters. This methodology conforms to the NPCC Document A-3, *Emergency Operations Criteria*.

**f. Transmission System Congestion**

*The transmission operator must monitor transmission flowgates and be prepared to take actions to alleviate congestion in conjunction with, and as directed by, its reliability coordinator.*

This task is performed by the reliability coordinator. The HONI controllers respond to the directions of the reliability coordinator.

**g. Load Generation Balance**

*The balancing authority must monitor the balance of load, generation, and net scheduled interchange in its balancing area. The balancing authority must take actions to mitigate unacceptable load, generation, and net scheduled interchange imbalance.*

N/A — HONI is not a balancing authority. This function is performed by the reliability coordinator.

**h. Contingency Reserves**

*The balancing authority must monitor the required reserves and the actual operating reserves in real time, and take action to restore acceptable reserve levels when reserve shortages are identified.*

N/A — HONI is not a balancing authority. This function is performed by the reliability coordinator.

**i. Special Protection Systems**

*The balancing authority/transmission operator and the reliability coordinator must be aware of the operational condition of special protection systems that may have an effect on the operation of the bulk power system.*

HONI has a number of special protection systems (SPS) on its transmission system. HONI prepares a facility description document that includes the technical parameters of the installation and operational description of each scheme. The transmission controller arms the scheme, and the reliability coordinator is updated manually or automatically via the inter-control center protocol data link regarding any change in status or other change in the operational parameters.

The NMS provides a good visual display of all the SPS on the HONI transmission system. It also provides the status of the SPS and an appropriate alarm for an abnormal status.

**13. System Restoration**

*The transmission operator must have a documented system-restoration plan that is consistent with NERC Reliability Standard EOP-005-0 — System Restoration Plans. This restoration plan must be provided to its reliability coordinator.*

*The transmission operator must be prepared to restore its transmission area following a partial or total collapse of the system and coordinate system restoration with its neighboring transmission operators and with the reliability coordinators.*

The *Ontario Power System Restoration Plan* defines the roles and responsibilities of all restoration plan participants for events such as blackstart, islanding, and load restoration. The plan's strategy calls for the building of several secure and sustainable islands in the Province of Ontario. At the discretion and direction of the reliability coordinator, the process of

synchronizing these islands begins and is continued until the entire system is synchronized with the interconnection and all loads are restored.

The role of HONI is to provide the cranking paths for bringing the generation back on-line and, at the direction of the reliability coordinator, restore load so as to stabilize the frequency of the island and any associated generation. There are line energization tests that are scheduled to coincide with the blackstart testing of the generators.

The OGCC controllers and other restoration plan participants attend coordinated system restoration plan workshops and exercises, which include table top simulations and dispatcher training simulator drills. HONI provides controllers with additional in-house area specific restoration training as part of the annual emergency operations training.

#### **14. Capacity and Energy Emergency Plan**

*Each balancing authority must have a capacity and energy emergency plan that address the applicable requirements of NERC Reliability Standards EOP-001-0 — Emergency Operations Planning and EOP-002-0 — Capacity and Energy Emergencies.*

The reliability coordinator owns and maintains the capacity and energy emergency plan. HONI fulfills the assigned elements as directed by the reliability coordinator. Additionally, HONI helps coordinate understanding of the scope and nature of the plan with its interconnected neighbors.

#### **15. Equipment Maintenance and Testing**

*Transmission and generator owners must ensure that maintenance of transmission lines, substation equipment, transmission protective systems, and generator relays is carried out according to company, regional, and/or NERC requirements.*

HONI has detailed equipment maintenance and testing procedures for all classes of equipment used on its transmission system. These procedures comply with the NPCC Document A-4, *Maintenance Criteria for Bulk Power System Protection*. The equipment maintenance and testing program is managed using an automated management tool that tracks schedules, provides work order management, monitors completion dates, and tracks other related information. The 2005 relay maintenance and testing program was completed on schedule, and the 2006 program is currently on schedule.

Outage requests for relay or other equipment maintenance activities by HONI maintenance personnel are submitted and managed using the network outage management system. HONI uses a review process known as a natural occurring event analysis (NOEA). For 2005 there were 1,279 NOEAs, of which forty-five were classified as relay misoperations (a relay misoperation is defined by NPCC Guideline B-21). Due to the redundant protection schemes utilized on the HONI system, most of these misoperations did not result in the tripping of the transmission element.

HONI uses time synchronized digital fault recorders, sequence of events recorders, power system dynamic recorders, and phasor measurement recorders. These devices are maintained according

to established procedures, and the maintenance is on schedule. Additionally the maintenance and testing program for the SPSs is well defined and on schedule.

## **16. Vegetation Management**

*The transmission operator must have a documented vegetation-management program.*

The HONI vegetation-management program is well documented and carefully managed. The program effectively incorporates danger-tree removal, brush removal, herbicide application, and inspection and planning to ensure that the transmission system reliability is not compromised by vegetation on or off the rights-of-way.

Mid-cycle patrols and vegetation-management practices are employed to ensure rights-of-way pose no threat to system reliability.

The vegetation-management program is administered by a planner in the asset management division, and the maintenance activities are completed by the forestry division. The 2006 vegetation-management program is currently on schedule. HONI had six vegetation-related incidents in 2005, all of which were caused by trees off the right-of-way. Four of these occurred under storm conditions, three were not on tie lines, and one occurred when a danger tree was being removed. These conditions impact the reportability of these vegetation-related events.

HONI assigns a unique identifier to each transmission line in the province and is presently converting its vegetation-management data to an electronic format to increase the effectiveness of program management. The electronic format conversion should be completed before the end of 2006.

## **17. Nuclear Power Plant Requirements**

*Transmission operators must support nuclear power plants in meeting regulatory requirements that allow the plant operators to maintain voltages within design limits and adequate off-site power sources in both normal and abnormal operating conditions (n-1 and system restoration).*

The HONI transmission system footprint has three nuclear power plants. These are Darlington, Pickering, and Bruce generating stations of which the latter two have two generating units. These comprise a total of 11,400 MW of generating capacity. HONI has detailed connection agreements with each plant that are unit specific. These agreements specify that HONI will supply any nuclear power plant load at a plant after a unit trip. This goes beyond site power and specifies specific capacity requirements for each plant. The reliability coordinator is responsible for contingency monitoring and restoration management, but HONI will supply the required load under any and all conditions. The reliability coordinator is responsible for ensuring that the critical bus voltages both pre- and post-contingency are maintained within the required operating limits for all possible planning contingencies and applicable criteria.

HONI owns facilities within the nuclear power plant switchyards, and routinely communicates, via commercial or satellite phone systems, with plant operators during both normal and

contingency conditions. The transmission operating environment necessary to ensure system reliability at the nuclear power plants is well documented and carefully managed.

## **APPENDIX 1: Critical Energy Infrastructure**

The following discussion is presented under private letter to the audited organization only and will not be included within the public version of the report.

## **APPENDIX 2: Audit Participants**

The following discussion is presented under private letter to the audited organization only and will not be included within the public version of the report.

### **APPENDIX 3: Documents Reviewed**

The following discussion is presented under private letter to the audited organization only and will not be included within the public version of the report.