

# **FirstEnergy Verification Team**

## **Report on the Implementation of Recommendations from the FirstEnergy Readiness Audit of February 26–27, 2004**

**June 22–23, 2005**



North American Electric Reliability Council

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## INTRODUCTION

On February 26 and 27, 2004, the North American Electric Reliability Council (NERC) conducted a readiness audit of the FirstEnergy (FE) control area. The readiness audit team that conducted the audit identified a total of forty-four recommendations, which are contained in the FE audit report, *NERC Control Area Readiness Audit for FirstEnergy — February 26–27, 2004*.<sup>1</sup>

This report addresses recommendations 27–33, which FE was to implement before the summer of 2005. Recommendations 1–26 were to be implemented prior to the summer of 2004 and are the subject of another report. Recommendations 34–44 were directed at entities other than FE.

NERC established the FE Verification Team (FEVT) to independently verify that FE had implemented the policies, procedures, and actions contained in recommendations 27–33 in the FE readiness audit report. The FEVT consisted of five subject-matter experts and two NERC representatives. It met on site with FE representatives on June 22–23, 2005, and conducted its verification through questionnaires, conference calls and discussion with FE staff, review of training and procedural documentation, viewing energy management system (EMS) displays, and interviews with management and transmission operators. The verification team also observed a thorough demonstration of the dispatcher training simulator (DTS) and a portion of a drill whereby the East Central Area Reliability Coordination Agreement (ECAR) portion of the FE system was transferred to and operated from the backup control center.

This report provides independent verification of the status of the implementation of the recommended policies, procedures, and actions contained in the FE readiness audit report that were to be completed before the summer of 2005.

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<sup>1</sup> The FE readiness audit report is available at [ftp://www.nerc.com/pub/sys/all\\_updl/rap/audits/FE\\_Final\\_Audit\\_Report.pdf](ftp://www.nerc.com/pub/sys/all_updl/rap/audits/FE_Final_Audit_Report.pdf), or <http://www.nerc.com/~rap/audits.html>.

## **EXECUTIVE SUMMARY**

The readiness audit team that conducted the February 2004 FE audit recommended that FE implement seven recommendations prior to the summer of 2005. The FEVT concluded that FE implemented five of the seven recommendations. To meet the intent of the remaining two recommendations, FE has embarked on multiple year projects. The FEVT finds no fault with FE's multiple year approach. The team recommends that NERC check the progress on these two items prior to the summer of 2006 and include a full verification check as a component of the next FE readiness audit scheduled for 2007.

The FEVT found FE to be very cooperative in the verification effort. FE personnel were knowledgeable about and responsive to the FEVT requests. The FEVT had full access to all requested documents and arrangements were made to observe requested activities. The FEVT commends FE for its openness and responsiveness to its requests.

The FEVT also observed a strong common commitment to reliability between operating, planning, and other support functions exhibited through the real-time support and on-call capabilities that FE has developed. These include rotating engineering staff between operations and planning to enhance individual skill sets.

As a result of the implementation of the readiness audit recommendations, the FEVT identified two positive points:

- A significant amount of unit reactive power capability testing has led to a substantial improvement in the accuracy of system models.
- FE has integrated and is using a DTS as part of its operator training program. FE demonstrated the use of the DTS in a training exercise. The FEVT was impressed by the depth and completeness of the developed scenarios, the interest and involvement of the trainees, and the positive and challenging environment maintained by the trainer.

## **STATUS OF RECOMMENDATIONS CONTAINED IN NERC CONTROL AREA READINESS AUDIT FOR FIRSTENERGY — FEBRUARY 26–27, 2004**

Recommendation 27 FE relies on independent power producers (IPP) to comply with the requirements in its interconnection agreements to ensure that FE meets ECAR and NERC testing for generator real and reactive power capabilities, unit ramp rate and dynamic response, modeling parameters, automatic voltage regulator status, and data submittal requirements. However, an explicit compliance verification program has not been developed. FE monitors its own generation and has a program in place to gather this information. The audit team recommends that FE establish policies and procedures to ensure that all generators within its control area provide all necessary information to comply with NERC *Planning Standard II.B. — Generator Equipment*, including generator testing.

### **OBSERVATION:**

FE Normal Operating Procedure No. 78 contains the policy and procedures to ensure that all generators within the FE control area comply with proposed *Reliability Standards MOD-023-1–MOD-027-1* (formerly NERC Planning Standard IIB). FE's procedures include sending an annual questionnaire to each generator owner requesting it to verify and update specific generator data as necessary, provide dates of when equipment was last tested, and provide test data results for the generator testing. Test requirements, including the frequency that tests are to be conducted, are based on *ECAR Document 4*.

The program was initiated in 2004 and the initial FE questionnaire included a request for all the aforementioned data and dates of tests. The questionnaire required responses to include dates of tests and/or validation of steady state data. Dates of tests and/or validation of data specifically required for dynamic simulation databases were optional. FE stated that the 2006 and subsequent questionnaires will require responses to include the dates of tests and/or validation of the dynamics data.

Reports from the generator owners containing the above-mentioned data were made available to the verification team.

**STATUS:** Completed.

Recommendation 28 FE has a formal testing program that provides for the complete testing of all FE-owned fossil generators in accordance with NERC planning standards. Under the current schedule, FE will complete the reactive capability verification of its coal-fired generators, located near Lake Erie, before the summer 2004 operating season and submit the results to the control area operator. FE's nuclear plants will submit their reactive capability, based on operating data and/or calculations, in accordance

with ECAR requirements. The audit team recommends that FE complete testing of all FE-owned generators in a timely manner and that FE require and monitor testing of IPP-owned generators.

**OBSERVATION:**

All viable generating units in FE's ECAR footprint have undergone a reactive test. Due to system conditions, FE has not been able to operate some of its units at maximum reactive power as specified by the manufacturer. On some generators, they experienced high voltage conditions at the generator terminals when they attempted to run the units at maximum reactive power output. In some instances, the tests were rerun when the system conditions were more favorable. In the instances where the units were never able to reach maximum reactive power output due to system conditions, power flow simulations were performed to determine if the maximum reactive power output could be expected to be obtained under more favorable system conditions.

*ECAR Document 4* specifies that the system voltages should not be affected by lead/lag testing. Therefore, the reactive lag tests were run on high system load conditions and the reactive lead tests on light system load conditions. Reactive power limits are set based on the capability test and are reported to the generator owners. For nuclear units, FE uses reactive capability limits based on historical analysis.

**Positive point:** A significant amount of reactive capability testing has been performed on generators interconnected to FE's transmission system. Physical capability testing gives confidence to plant operators about the true capabilities of the generators. FE holds a conference call every Monday morning with the generation owners/operators during which the condition of the units is discussed. Tuesday through Friday morning conference calls are held to discuss updates to generator unit conditions.

FE has made significant improvements to its system models as a result of the reactive testing that was conducted.

**STATUS:** Completed.

Recommendation 29 FE indicated that it updates generator model information when test information shows a difference between the original characteristics and actual performance. FE reported that it does not use disturbance-monitoring equipment to update models. The audit team suggested FE review this practice and use actual disturbance information to update its models.

**OBSERVATION:**

There have been no recent events on FE's system that would merit a postmortem dynamic simulation study. FE stated, however, that if an appropriate event occurred and was adequately captured, it would consider performing a postmortem study for model validation. FE has recently installed six digital fault recorders (DFR) with dynamic data recorder (DDR) capability and plans to install an additional ten in 2006.

FE has undertaken other model-validation efforts. It uses DFR data to verify short-circuit impedances and relay operations. It also uses supervisory control and data acquisition (SCADA) data from the peak hour of the season to validate load power factor through direct load measurements. Where several substations are supplied from the same transmission line and there is no individual substation metering, the power factor is determined by the metered flows on each end of the line and the aggregated load supplied by the line.

FE is participating in the Eastern Interconnection Phasor Project (EIPP). DFRs with phasor measurement units (PMUs) capability have been purchased and are presently being installed at two locations. Fourteen potential additional locations have been identified. FE expects captured data from the PMUs will be used to validate dynamic models.

FE's position is that the best way to benchmark generator model data is to undertake actual generator testing using a program like the one used by the Western Electricity Coordinating Council (WECC). FE has said that it is working to develop and implement such a program, and has scheduled a vendor to make a presentation to FE transmission and generation personnel to discuss the procedures, benefits, and costs of on-site generator testing.

**STATUS:** Not complete.

Recommendation 30 FE performs transient stability analysis related to new generation interconnections and has supported regional transient stability and dynamic investigations. The audit team recommends that FE perform a transient stability analysis at least on an annual basis, to evaluate the effects of multiple contingency outages and the potential for transient stability problems.

**OBSERVATION:**

A consultant has completed a system-wide stability study for FE that considered fault-induced single and multiple contingencies. A variety of load levels and transfer patterns were evaluated. For the single Category B contingencies, the consultant considered fault-induced outages of all 345-kV lines and all 345/138-kV transformers. As discussed below, selected Category C and D contingencies were also evaluated. Category C contingencies, as described in *Reliability Standard TPL-003-0*, are “event(s) resulting in the loss of two or more multiple elements” – cascading outages are not acceptable. The type of Category C contingencies evaluated in the study were single-line-to-ground fault scenarios, with delayed clearing due to a stuck breaker or protection system failure. A Category D contingency, as described in *Reliability Standard TPL-004-0*, is an “extreme event resulting in two or more (multiple) elements removed or cascading out of service.” The type of Category D contingencies evaluated in the study were three phase-to-ground fault scenarios, with delayed clearing due to a stuck breaker or protection system failure.

The consultant initially evaluated Category D scenarios. A few of the Category D scenarios resulted in units tripping but in no case did the tripping lead to cascading outages. The Category D scenarios that resulted in generator unit tripping were rerun by degrading the three-phase fault to a single-phase fault (i.e., decrease the severity of the contingency to a Category C event). Results of this analysis indicated no unit tripping concerns for any of the single Category B or Category C contingency events.

FE stated that it intends to perform dynamic simulations, on an annual basis, to assess the robustness of its under-voltage load shedding (UVLS), which inherently involves category C- and/or D-type scenarios.

The study indicated the FE system encounters thermal or voltage limits prior to angular stability limits. FE is performing dynamic voltage stability analyses annually and is evaluating the need to perform additional annual stability studies.

**STATUS:** Complete.

Recommendation 31      The audit team recommends that FE evaluate the use of a formal job task analysis (or use a similar tool) to identify tasks for each position in the System Control Center (SCC). This will target specific needs and the benefit of the training provided.

**OBSERVATION:**

FE used an internal audit team to perform a job task analysis (JTA) on the east and west transmission positions. Operator interviews have been completed. The results have been verified by management and are being incorporated into the JTA. FE has stated that the JTA will incorporate additional input from the supervisors and will be evaluated for future expansion.

The FE Operations Training Department has reviewed the JTA and identified no critical gaps in the training program. Enhancements to the existing training program, however, have been implemented.

**STATUS:** Complete.

Recommendation 32      FE should research the personnel resource requirements for operating a DTS, looking particularly at the time and skills needed to run scenarios on the DTS. The audit team is concerned that FE may be underestimating the resources required to support this very important function.

**OBSERVATION:**

FE has developed a DTS at two separate locations, one in ECAR and the other in the Mid-Atlantic Area Council (MAAC). The DTS training sessions are designed so that operators work through scenarios as a team similar to actual operation. The DTS has dedicated trainers at both locations and the capability exists for mutual support. The DTS was operational in June 2004 with the first ECAR class presented in the fall.

The DTS is in a series between the program development system (PDS) and the EMS. The EMS architecture requires that the DTS model be updated prior to the EMS being updated. Two full-time trainers are supported by as many as seven applications staff to accomplish these tasks.

**Positive point:** FE demonstrated the use of the DTS in a training exercise. All phases of the demonstration were impressive, including the depth and completeness of the developed scenarios, the interest and involvement of the trainees, and the positive and challenging environment maintained by the trainer.

**STATUS:** Complete.

Recommendation 33      The team recommends that the backup control center be functionally independent from the primary control center and that it not rely on the continued functionality of any computer or communications facilities located at the primary control center.

**OBSERVATION:**

The FE backup control center became operational in mid-April 2005 and a full-scale drill, whereby the ECAR portion of the FE control area was being operated from the backup site, was in effect during the FEVT site visit. The FEVT observed a portion of the drill inside the backup facility. The backup control center has the same real-time capabilities as the primary control center including the necessary support infrastructure. The FE backup control center is a viable option for many emergency scenarios.

The transition from the primary to the backup control center is governed by procedures and working relationships with the generation company and the Midwest Independent Transmission System Operator (MISO).

Further details relating to the backup control center have been redacted from the public version of this report due to critical infrastructure security concerns.

**STATUS:** Not complete.