Exelon Generation.

10CFR50.59(d)(2)
10CFR72.48(d)(2)

LG-14-149
November 5, 2014

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Limerick Generating Station, Units 1 and 2
Facility Operating License Nos. NPF-39 and NPF-85
NRC Docket Nos. 50-352, 50-353 and 07200065

Subject: 10CFR50.59 and 10CFR72.48 Evaluation 24-Month Summary Report for the Period July 1, 2012 through June 30, 2014

Attached is the 24-Month 10CFR50.59 and 10CFR72.48 Evaluation Summary Report for Limerick Units 1 and 2 for the period of July 1, 2012 through June 30, 2014, forwarded pursuant to 10CFR50.59(d)(2) and 10CFR72.48(d)(2). The report includes brief descriptions of any changes, tests and experiments, including a summary of the evaluation of each. Four plant changes were approved and/or implemented using 10CFR50.59 Evaluations during this 24-month period. There were no plant changes implemented using 10CFR72.48 Evaluations during this 24-month period. The summaries of these changes are included in this report.

There are no regulatory commitments contained in this letter.

If you have any questions, please contact Robert B. Dickinson at (610) 718-3400.

Respectfully,

Original signed by

Thomas J. Dougherty
Vice President – Limerick Generating Station
Exelon Generation Company, LLC

Attachment: Limerick Generating Station 10CFR50.59 and 10CFR72.48 Evaluation 24-Month Summary Report, July 1, 2012 through June 30, 2014

cc: Administrator Region I, US NRC
Director, Division of Spent Fuel Storage and Transportation, US NRC
Project Manager, NRR, US NRC
USNRC Senior Resident Inspector, LGS

Limerick Generating Station

10 CFR 50.59 Evaluation and 10 CFR 72.48 Evaluation

24-Month Summary Report

2014

Note: This report summarizes 10 CFR 50.59 and 10CFR72.48 Evaluations that were approved between July 1, 2012 and June 30, 2014.

Evaluation #1

Evaluation number:	LG2012E003 Rev.0
50.59 Reviewer approval date:	11/27/12
PORC number:	12-045
PORC approval date:	1/14/13
Implementing document:	ECR 12-00450 Rev.0
Evaluator:	Andy M. Olson
Reviewer:	Robert C. Potter

	Unit 1	Unit 2	Units 1 & 2	Common
Unit applicability:	[x]	[ ]	[ ]	[ ]
Complete on:	[x]	[ ]	[ ]	[ ]

Title:

Limerick Unit 1 Cycle 15 Cycle Management

Description of Activity:

This 10CFR50.59 review addresses the acceptability of the following items implemented under the Limerick Unit 1 Cycle Management Fuel Change Package (FCP) ECR LG 12-00450:

- COLR Limerick 1, Rev. 10, Core Operating Limits Report for Limerick Generating Station Unit 1 Reload 14 Cycle 15
- 3DM Databank LGS 1, Rev. 6, Limerick 1 3D MONICORE Databank
- Safety analyses of the Loss of Stator Cooling (LOSC) event, including UFSAR Chapter 15 updates, Design Basis Document (DBD) L-T-12 updates, and 3 General Electric-Hitachi (GEH) reports:
  - 0000-0150-6369-R0, Evaluation of Loss of Stator Water Cooling at Limerick Generating Station
  - 0000-0150-6369-R1, Evaluation of Loss of Stator Water Cooling at Limerick Generating Station
  - 0000-0151-7357-R0, Evaluation of Loss of Stator Water Cooling for Limerick Generating Station Unit 1 Cycle 13, Unit 1 Cycle 14, and Unit 2 Cycle 11

This 50.59 review is primarily applicable to Unit 1. However, the safety analyses, UFSAR updates and DBD updates are applicable to both units and were reviewed accordingly.

The UFSAR and DBD L-T-12, DESIGN BASIS ACCIDENTS, TRANSIENTS, AND EVENTS, have been updated to add and describe the loss of stator cooling (LOSC) as a pressurization event. The LOSC event was previously considered to be bounded by other pressurization events. Thus, it was not analyzed for Limerick Unit 1 Cycle 15. The Limerick Unit 1 Cycle 15 Core Operating Limits Report (COLR) has been updated, based on GEH analyses documented in three GEH reports, to reflect higher (more restrictive) operating limit minimum critical power ratio (OLMCPR) limits under some conditions due to the previously unanalyzed LOSC pressurization event. The 3D MONICORE (3DM) databank has been updated to reflect these same changes to OLMCPR values.

50.59 Screening LG2012S066 Rev. 0 addresses the use of a new version of the ODYNM10A software for transient analyses. 50.59 Screening LG2012S010 Rev. 1 addresses the use of a new version of the PANAC11A/P software for core design and licensing calculations and includes changes to Rev. 0 of the 50.59 Screening to address a revised description of PANAC11A/P changes provided by global nuclear fuels (GNF). These two software changes were determined to not require prior NRC approval as the changes to the software are within the constraints and limitations of the NRC approved methodology. No other changes to software or methodologies are associated with this Limerick Unit 1 Cycle 15 Cycle Management engineering change request (ECR).

Reason for Activity:

The UFSAR Chapter 15 and DBD changes and GEH LOSC analyses are necessary because the LOSC pressurization event has been identified as bounding under some operating conditions and was not previously an analyzed pressurization event. The COLR and 3DM databank changes in FCP ECR LG 12-00450 are necessary to allow the implementation of updated OLMCPR values associated with the LOSC pressurization event.

Effect of Activity:

The UFSAR and DBD changes ensure all potentially limiting events are documented and evaluated. The GEH reports document the results of safety analyses performed on the LOSC event and ensure that all events are analyzed appropriately. The proposed COLR and 3DM databank changes in FCP ECR LG 12-00450 ensure that the plant is configured and operated in accordance with the Cycle 15 licensing basis, Limerick Technical Specifications and the Limerick UFSAR. All proposed changes do not change any design functions and do not impact the control or operation of equipment.

Summary of Conclusion for the Activity’s 50.59 Review:

FCP ECR LG 12-00450 identifies several changes to the plant configuration and licensing basis to be made during Limerick Unit 1 Cycle 15. All changes reviewed under the 50.59 support or evaluate the LOSC pressurization event and its associated impacts. The COLR revision and supporting GEH analyses were generated based on results from NRC reviewed and approved methodologies. All GEH analyses were performed within the constraints of the GEH quality assurance program as reviewed and approved by the Exelon Corporation. The 3DM databank update implements the limits calculated and documented in the COLR. Thus, the 50.59 Screening determined that the COLR and 3DM databank changes associated with Limerick Unit 1 Cycle 15 FCP ECR LG 12-00450 do not require a 50.59 Evaluation and may be implemented without obtaining prior NRC approval.

The UFSAR and DBD updates and analyses performed for the LOSC pressurization event constitute a change to a plant SSC that adversely affects a UFSAR described design function. Thus, the UFSAR and DBD updates and safety analyses performed to evaluate the LOSC pressurization event for Limerick were determined to require a 50.59 Evaluation. There are no changes to any SSC associated with the UFSAR or DBD updates or the LOSC analyses. The LOSC event is an expected plant transient event as described in SIL 581, but it has not previously been explicitly analyzed. All analyses were performed using NRC approved methodologies and are consistent with the existing plant configuration and performance characteristics. The UFSAR and DBD were updated to include the LOSC event based on these analyses. Updated fuel thermal operating limits, implemented via the COLR, will ensure that the reactor fuel and reactor vessel coolant pressure boundary will operate within their design limits. Thus, the 50.59 Evaluation concluded that the LOSC pressurization event analyses and associated UFSAR and DBD updates may be implemented without obtaining prior NRC approval.

Evaluation #2

Evaluation number:	LG2013E001 Rev.0
50.59 Reviewer approval date:	3/18/13
PORC number:	13-008
PORC approval date:	3/22/13
Implementing document:	ECR 12-00019 Rev.0 Unit 1 ECR 12-00024 Rev.0 Unit 2
Evaluator:	Ken Collier
Reviewer:	Joseph R. Basak

	Unit 1	Unit 2	Units 1 & 2	Common
Unit applicability:	[ ]	[ ]	[x]	[ ]
Complete on:	[x]	[ ]	[ ]	[ ]

Title:

Electro-Hydraulic Control (EHC) System Upgrades

Description of Activity:

The proposed activity is a configuration change for each unit that implements an upgrade to the Pressure Regulator and Turbine-Generator Control System described in UFSAR Section 7.7.1.5. This upgrade will replace the GE Mark I analog Turbine Control System (referred to as the EHC system) with a Westinghouse digital Turbine Control and Protection System (referred to as the DEHC System). The DEHC system utilizes an Ovation Based Distributed Control System that includes a Turbine Control System (TCS) and an Emergency Trip System (ETS), each consisting of redundant controllers, power supplies, I/O and testable dump assemblies. The DEHC System TCS performs the reactor pressure control, turbine speed and load control, system test functions and provides backup overspeed protection. The DEHC System ETS performs the primary turbine overspeed protection and all other turbine protection related functions.

The DEHC System TCS and DEHC System ETS controllers will be installed in the existing EHC System cabinet in the Auxiliary Equipment Room (AER). The DEHC System Infrastructure network and communication controllers will be installed in the AER in the location of an abandoned Process Computer Cabinet which will be removed. Separate Remote I/O cabinets for the DEHC System TCS and DEHC System ETS will be installed in the Turbine Building Lube Oil Room. Each of these network “drops” will be powered from redundant 120 VAC UPS backed power supplies for improved system reliability.

The existing EHC system controls (switches, pushbuttons and indicators and EHC system panel inserts) in the control room will be replaced with redundant operator workstations, each powered from an independent power supply. These workstations provide the human machine interface (HMI) with the DEHC System. The operator workstations will communicate with the DEHC System controllers over a redundant communication network. All of the existing turbine and pressure control functions will be available on both operator workstations and provide the operator controls for the DEHC system during normal startup, power generation, and shutdown conditions. The operator workstations will include process and diagnostic alarming, monitoring of turbine process conditions, valve testing capabilities, trending and sequence of events recording capability as part of the HMI graphics. Since the control system programming is resident on the TCS and ETS controllers, the operator workstations are nonessential components, i.e., the turbine will continue to operate if one or both of the workstations fail. Two (2) new hard-wired manual turbine trip pushbuttons will be installed on the control room bench board and at the front standard to provide the operator with the ability to manually trip the turbine independent of the digital control system.

The existing turbine mechanical and electrical hydraulic trip components in the turbine front standard will be replaced with redundant Testable Dump Manifolds (TDM), one actuated by the DEHC System TCS and the other by the DEHC System ETS. Each TDM includes three separate trip solenoid valves that will block the supply to and vent the Emergency Trip System (ETS) hydraulic header upon de-energization of at least two of the trip solenoid valves. The result is a redundant two-out-of-three electrical trip mechanism. The new front standard design ensures that the turbine can be electrically tripped with the presence of a single component failure and allows individual online testing of each TDM.

The proposed upgrade will replace the functionally diverse mechanical and electrical overspeed trip functions with electrically diverse overspeed trip functions performed by the DEHC System. The DEHC System ETS will include a Woodward Diverse Turbine Overspeed Protection System (DTOPS) as a replacement for the EHC System Mechanical Overspeed Trip. The DTOPS operates on a different operating platform with different hardware than the backup overspeed trip system performed by the Ovation TCS controllers. The primary and backup overspeed trip function will have separate and independent speed inputs and will actuate separate and independent testable dump manifolds. As such, the primary overspeed trip function performed by the ETS – DTOPS is electrically diverse and independent from the backup overspeed trip function performed by the TCS.

All of the Non-Safety related position/test switches associated with the Main Stop Valves, Control Valves, Bypass Valves, Intermediate Stop Valves and Intercept Valves, that are used to provide interlock, position indication, and alarm functions for all the stated turbine valves will be removed by this upgrade. Their functions will be replaced using the existing LVDTs and system software logic. The limit switches and pressure switches that provide Reactor Protection System trip inputs for Turbine Stop Valve Closure and Turbine Control Valve Fast Closure are not affected by this design change.

The DEHC System will maintain the same turbine protection and perform the same turbine runback functions on Loss of Stator Water Cooling or Power Load Unbalance (PLU) as the EHC System.

The DEHC System will perform the same turbine and pressure control functions as performed by the EHC System but will add the ability to perform automatic reactor cooldown and provide test compensation logic during Control Valve testing to minimize fluctuations in reactor pressure. Throttle pressure control logic will include a proportional only control block, lead/lag network and two series notch filters, which is the configuration of the existing EHC system. The throttle control pressure regulation will be the same as the EHC System. The initial DEHC system tuning values account for the digital cycle delay times and are equivalent to a "curve fit" of the existing EHC system performance. System performance will be verified during power ascension.

The proposed upgrade to the Pressure Regulator and Turbine-Generator Control System includes the following:

- Removal of the EHC cabinet 1(2)0-C663 internals and installation of the Westinghouse Ovation System digital electronics in the existing cabinets.

Removal of the following Turbine Front standard components:

- Mechanical Overspeed Trip Device Linkage
- Mechanical Shutoff Valve
- Oil Reset Solenoid Valve
- Oil Reset SOV Position Valve
- Oil Trip Solenoid Valve
- Oil Reset SOV Position Switch
- Turbine-Generator Mech. Trip Switch
- Relay Trip Valve
- Mechanical Trip Solenoid Valve
- Mech. Trip Pilot Valve, Shut-off Valve, & Trip Valve
- Mechanical Lockout Solenoid Valve
- Trip Pilot Valve and Relay Trip Valve
- Secondary Valve
- Electrical Trip Solenoid Valve
- Electrical Lockout Solenoid Valve

- Removal of the existing EHC speed sensors and installation of four new active and four new passive speed sensors at the Front Standard. Installation of one new speed sensor mounting bracket and the modification of the existing bracket.
- Disconnection and removal of the Permanent Magnet Generator from the EHC system

- Removal of EHC system controls and/or indicators and test pushbuttons from the Main Control Room (MCR) Turbine Console 1(2)0-C653 (trapezoidal) and Turbine Vertical Board 1(2)0-C670, which are replaced by Human Machine Interface (HMI) displays
- Removal of analog indicators for LP Turbine Extraction Steam pressure, Condenser Vacuum pressure, and LP Turbine Inlet pressure and the Control and Bypass Valve Position recorder from the Main Control Room (MCR) Turbine Console 1(2)0-C653, which are replaced by HMI displays.
- Installation of manual trip pushbuttons on the MCR 1(2)0-C653 consoles.
- Installation of manual trip pushbuttons at the Front Standard.
- Replacement of the primary turbine overspeed trip device (mechanical) with the ETS Woodward DTOPS and a dedicated ETS Testable Dump Manifold (TDM). The DTOPS modules will be installed in the Remote I/O (RIO) cabinet in the Lube Oil Room and the TDM will be installed at the front standard. The primary overspeed trip setpoint is maintained at 110% of rated turbine speed.
- Replacement of the backup overspeed trip device (electrical) with the Ovation TCS and a dedicated TCS TDM. The TCS processors will be installed in the EHC System cabinet in the AER and the TDM will be installed at the front standard in parallel with the DTOPS TDM. The backup overspeed trip setpoint is being conservatively changed from 112% to 111% of rated turbine speeds.
- The new DEHC system will perform the same turbine runback functions as the existing system on Loss of Stator Water Cooling or Power Load Unbalance (PLU).
- Installation of new Infrastructure cabinets in the Auxiliary Equipment Room (AER) in place of abandoned Process Computer cabinets. The infrastructure cabinet will contain controllers associated with the Operator and Engineering Work Stations but not the DEHC System controllers (TCS and ETS). The infrastructure cabinets will be powered from redundant 120 VAC UPS sources
- Installation of new Turbine Control System (TCS) and Emergency Trip System (ETS) Remote Input / Output (RIO) cabinets in the Lube Oil Rooms. The RIO cabinets will be powered from redundant 120 VAC UPS sources.
- Removal of all non-safety related limit switches and test switches associated with the Main Stop Valves (MSV), Control Valves (CV), Intermediate Valves (IV), Intermediate Stop Valves (ISV) and Bypass Valves (BPV).
- Implement DEHC interface to Plant Process Computer (PPC) via Data Link and hardwire connections.
- Modify the following MCR Annunciation Windows related to EHC:
    - 105 Main Turbine windows A3(3), B2(7), B3(8), E1(21), I1(41) and I2(42)
    - 106 Main Steam windows D5(20), E5(25), F5(30), G5(35) and H5(40)

- Incorporation of a new Control valve test compensation logic scheme to minimize Reactor and Main Steam Line pressure changes during valve testing.
- Incorporation of a new Operational features that provides an automatic cool-down function allowing the operator to manually select the cool-down rate.

The proposed activity also includes site acceptance, installation, modification, and operability testing. A Site Acceptance Test will be performed prior to installation, during which functional testing will be performed. A Modification Test will be performed after installation but prior to unit startup to complete calibrations and functional testing of the DEHC system. The Operability or Power Ascension Test will include performance verifications during unit operation as well as control system tuning.

The proposed activity includes changes to operating and maintenance procedures (new and revised) that incorporate differences in the control system specifics, i.e.; hard control stations replaced by soft control graphical interfaces. The procedure changes will not alter the overall functions of the Pressure Regulation and Turbine-Generator System as described in the UFSAR.

The proposed activity includes a UFSAR change that revises the control system description but does not change the functional requirements in the UFSAR. Unit differences in the UFSAR description will occur when the first unit is installed and will be removed with the installation of the second unit.

The proposed activity will require a change to the description of the overspeed trip system in Technical Requirements Manual Section 3/4.3.8 for Unit 1 and Unit 2. The change will revise the name of the overspeed trip systems but will not change the surveillance requirements.

Reason for Activity:

The existing EHC system, which has little redundancy and fault tolerance, is obsolete and no longer supported by the manufacturer. The EHC system has been a significant contributor to turbine trips and plant transients in the past, as well as requiring extensive setup and maintenance in calibration and testing each refueling outage. The implementation of a digital EHC system will provide redundant control elements in the new control system, and are configured to allow operation with a single failure along with facilitating on-line replacement of a failed component. This will effectively eliminate many of the numerous single failure points that are part of the existing EHC system. The DEHC system has continuous self-diagnostics that will issue an alarm if a problem has been detected. The benefits will be reduced maintenance cost, increased unit availability, increased unit reliability, and reduced operating cost.

Effect of Activity:

The turbine-generator control functions (speed control, load control, flow control, valve control, or load limit, and turbine protection) are the same for the DEHC system as they were for the EHC system. Valve positions will be measured by the existing Linear Variable Differential Transformers (LVDT) instead of the existing limit switches. The DEHC system function of controlling Reactor pressure will be functionally the same as the existing EHC system. The operational requirements associated with Reactor pressure, turbine speed, trip setpoints, load limits, generator runback, maximum combined flow limit, valve stroke times and Bypass Valve response times remain the same for the DEHC System as the existing EHC System.

The proposed activity does not affect any Nuclear Safety Related (NSR) components. This modification has no interface with any safety systems; nor does it adversely affect the function of any safety related or non-safety related systems and components. There is no impact on the design bases, or safety analysis as described in the LGS UFSAR due to the proposed activity. There is no impact on how the turbine operating parameters are controlled even though the operator interface with the turbine controls changes (i.e., HMI software controls vs. hardware controls).

The failure modes of the DEHC System, including software failure modes, are equivalent to or bounded by the failure effects of the existing EHC System. These failures include any single valve failing open, closed or as-is; all valves failing open, closed or as-is; a turbine trip; a turbine trip without bypass capability; pressure regulation failing open, closed or as-is; and a turbine trip failure on demand. These failure modes have been previously addressed in the UFSAR.

The effect of the proposed change on the design functions is that the logic for these functions will now be accomplished within the DEHC system software as opposed to the relays and transistor/amplifier logic of the EHC system. The reliability of the DEHC system is improved through the use of a redundant design for critical functions. The guidance provided in TR-102348 Revision 1 “Guideline on Licensing Digital Upgrades” is utilized to address issues of Software Dependability, Human-System Interface, Failure Modes and Effects, and Electromagnetic Compatibility.

The turbine characteristics specified in the OPL-3 for the current fuel cycle were evaluated for potential impact on transient and accident analyses by Westinghouse document WNA-AR-00305-GLIM, which concluded that the inputs in the current cycle analyses are bounding for the DEHC system and no changes are necessary due to the turbine control system upgrade.

The position switches and pressure switches that provide Reactor Protection System trip inputs for Turbine Stop Valve Closure and Turbine Control Valve Fast Closure are not affected by this design change.

The proposed UFSAR and TRM changes for Unit 1 and Unit 2 will revise the control system description, but do not change the functional or surveillance requirements of the turbine and steam bypass pressure control system.

Summary of Conclusion for the Activity's 50.59 Review:

The following changes associated with the proposed activity were judged to fundamentally alter the existing means of performing or controlling design functions and are reviewed in the 50.59 Evaluation:

- Analog to digital control since the digital controls contain different failure modes than the existing analog system.
- Conversion from hard controls to soft controls as it involves more than minimal differences in the Human Machine Interface
- Change from functionally diverse turbine trip mechanisms to redundant electrically diverse trip mechanisms.

The 50.59 Evaluation has determined that the proposed activity does not result in operation of equipment outside the design functions as currently described in the UFSAR. The turbine and steam bypass pressure control system will perform the same functions within the same operational limits with the DEHC system as previously required for the EHC system. The malfunctions and accidents currently analyzed in the UFSAR for the EHC system are bounding for the DEHC system. In addition, the proposed change does NOT create the possibility for an accident or malfunction of equipment important to safety of a different type than previously analyzed in the UFSAR. With increased redundancy and improved reliability, the DEHC system will NOT increase the frequency of accidents previously evaluated in the UFSAR and will NOT increase the likelihood of a malfunction of equipment important to safety. There are no new system interfaces created by the proposed control system upgrade and no physical changes to the steam path, turbine-generator or steam bypass system. The design does not alter or affect any ECCS system or barrier credited in mitigating the consequences of an accident. As such, the proposed activity does NOT increase the consequences of an accident or malfunction of equipment important to safety as previously analyzed in the UFSAR and will NOT result in a design basis limit for a fission product barrier being altered or exceeded.

The 50.59 Screening has determined that the equipment / hardware changes, operating / maintenance procedure changes and modification / operability testing being implemented in conjunction with the proposed activity do not affect or alter the performance requirements or design function of the turbine and steam bypass pressure control system, Reactor Protection System, Turbine Generator or any other SSC as described in the UFSAR. These changes have no adverse effect on how any UFSAR described design function is performed or controlled, and no adverse impact on plant procedures or system operating parameters. There are no changes to any UFSAR described evaluation methodology or the use of an alternative methodology in establishing the design basis or safety analyses. The proposed activity does not involve a test or experiment that would operate any SSC outside of its UFSAR described design function. A change to the TRM description of the overspeed trip system will be required but no changes to the Technical Specifications or Operating License are required.

Based on the results of this review, the proposed activity can be implemented without prior NRC review and approval.

Evaluation #3

Evaluation number:	LG2013E002 Rev.0			
50.59 Reviewer approval date:	3/6/13			
PORC number:	13-006			
PORC approval date:	3/20/13			
Implementing document:	ECR 12-00035 Rev.0			
Evaluator:	Andy M. Olson			
Reviewer:	Robert C. Potter			

	Unit 1	Unit 2	Units 1&2	Common
Unit applicability:	[ ]	[ ]	[x]	[ ]
Complete on:	[ ]	[ ]	[x]	[ ]

Title:

Application of TRACG04P Version 4.2.69.0 for OPRM Setpoint Determination at Limerick

Description of Activity:

This activity addresses the use of the General Electric Hitachi (GEH) advanced, multi-purpose NSSS thermal-hydraulic transient code TRACG04P, Version 4.2.69.0, for the purpose of determining the Oscillation Power Range Monitor (OPRM) setpoints for Limerick Generating Station. OPRM setpoints are determined for each operating cycle as part of the standard reload licensing process performed in accordance with General Electric's Standard Application for Reactor Fuel (GESTAR II) methodology. The cycle specific OPRM setpoints are presented in the Core Operating Limits Report (COLR). Version 4.2.69.0 of TRACG04P is an upgraded version of the NRC approved TRACG02A program originally developed and licensed to determine OPRM setpoints. Version 4.2.69.0 of TRACG04P has not been generically approved by the NRC for OPRM setpoint determination. OPRM system trip functions are described in the UFSAR and the evaluation of OPRM period based detection algorithm (PBDA) setpoints is performed as part of the Limerick cycle specific safety analysis process. NEDO-32465-A is cited in Technical Specification 3.3.1.1 by reference. Therefore, use of TRACG04P Version 4.2.69.0 constitutes a change in methodology requiring evaluation in accordance with 10CFR 50.59.

The TRACG02A version of the TRACG thermal-hydraulic code was approved by the NRC and used in the preparation of NEDO-32465-A during the original design and licensing of the GE OPRM system. In 2006 the TRACG code was upgraded to TRACG04 to support coupling with an improved kinetics model resulting from GE's transition to the PANAC11 version of the 3-dimensional core simulator program PANACEA. In 2009 GE implemented a PC-based version of the TRACG04 program, TRACG04P, Version 4.2.57.11. In 2010 GE implemented an updated version of the TRACG04P program, Version 4.2.60.3. These earlier software upgrades were evaluated under 10CFR 50.59, as documented in 50.59 Evaluations LG2007E002, LG2009E001 and LG2011E001, respectively. This 50.59 Evaluation has been prepared to support upgrading TRACG04P to Version 4.2.69.0. Version 4.2.69.0 implements fixes to several programming deficiencies. This 50.59 evaluation necessarily addresses all software changes implemented subsequent to the version of the program reviewed and approved by the NRC, TRACG02A.

Due to similarities between the Limerick Unit 1 and Unit 2 design/licensing bases, this change is applicable to both LGS units.

Reason for Activity:

The TRACG04P code has recently been revised by the vendor, GE-Hitachi (GEH), to address a number of programming issues identified since its initial release. The use of TRACG04P version 4.2.69.0 for Limerick DIVOM analysis when determining OPRM stability setpoints constitutes a change in methodology. The upgraded version of the code was developed under the GEH NRC-approved Quality Assurance Program. However, since TRACG04P Version 4.2.69.0 has not been reviewed and approved by NRC for Delta CPR Over Initial MCPR Verses Oscillation Magnitude (DIVOM) analysis, and GEH is not a license holder, the change needs to be evaluated under 10CFR 50.59 by Exelon.

Effect of Activity:

The method of determining OPRM setpoints is described in the Limerick Generation Station Technical Specification BASES 2.2.1.2, which states;

> "There are four "sets" of OPRM related setpoints or adjustment parameters: a) OPRM trip auto-enable setpoints for APRM Simulated Thermal Power (30%) and recirculation drive flow (60%); b) period based detection algorithm (PBDA) confirmation count and amplitude setpoints; c) period based detection algorithm tuning parameters; and d) growth rate algorithm (GRA) and amplitude based algorithm (ABA) setpoints.
>
> The first set, the OPRM auto-enable region setpoints, are treated as nominal setpoints with no additional margins added. The settings, 30% APRM Simulated Thermal Power and 60% recirculation drive flow, are defined (limit values) in a note to Table 2.2.1-1. The second set, the OPRM PBDA trip setpoints, are documented in the COLR. There are no allowable values for these setpoints. The third set, the OPRM PBDA “tuning” parameters, are established or adjusted in accordance with and controlled by station procedures. The fourth set, the GRA and

ABA setpoints are established as nominal values only, and controlled by station procedures. "

The TRACG thermal-hydraulic code supports the determination of the second set of setpoints, period based detection algorithm (PBDA) trip setpoints.

The TRACG thermal-hydraulic code is used to develop a conservative relationship between the change in fuel bundle critical power ratio (CPR) and the hot bundle oscillation magnitude. This conservative relationship is used to determine the Delta CPR Over Initial MCPR Verses Oscillation Magnitude (DIVOM) curve. The DIVOM curve, in conjunction with the initial maximum critical power ratio (IMCPR) and the hot bundle oscillation magnitude, is used by Global Nuclear Fuels (GNF) to determine the OPRM PBDA setpoints.

The algorithms used to detect thermal-hydraulic instability related neutron flux oscillations, described in Technical Specification BASES 2.2.1.2, are not impacted by this activity. TRACG04P is only used in the setpoint determination.

The slope of the DIVOM curve represents the thermal-hydraulic responsiveness of the fuel to a given oscillation magnitude. Thus, a steeper slope is more conservative than a flatter slope (NEDO-32465-A). Benchmarking of the NRC-approved TRACG02A code and the TRACG04P Version 4.2.69.0 code has determined that the DIVOM slope developed using TRACG04P generates a slightly more conservative (steeper) DIVOM slope. Therefore, TRACG04P Version 4.2.69.0 can be applied for Limerick DIVOM analysis when determining OPRM stability setpoints without prior NRC approval.

Summary of Conclusion for the Activity’s 50.59 Review:

The use of TRACG04P version 4.2.69.0 for Limerick DIVOM analysis when determining OPRM stability setpoints constitutes a change in methodology that is addressed by the 50.59 Review.

GEH benchmarking analyses confirm that TRACG04P produces DIVOM curves that are slightly conservative (more limiting) than those produced by TRACG02A. Therefore, the use of TRACG04P Version 4.2.69.0 does not constitute a departure from a method of evaluation described in the UFSAR and TRACG04P can be used to support the determination of cycle specific OPRM setpoints without prior NRC approval.

The version of TRACG is below the level of detail discussed in the UFSAR and Technical Specifications, therefore a change to the UFSAR and Technical Specification BASES is not necessary. Due to the similarities between the Limerick Unit 1 and Unit 2 design/licensing bases, this change is applicable to both units. The 50.59 Review is being processed as part of the Limerick Unit 2 Cycle 13 Reload Fuel Change Package, ECR LG 12-00035.

Evaluation #4

Evaluation number:	LG2011E003 Rev.0
50.59 Reviewer approval date:	7/11/11
PORC number:	11-022
PORC approval date:	7/13/11
Implementing document:	ECR 10-00247 Rev.0 Unit 1 ECR 10-00287 Rev.0 Unit 2
Evaluator:	Ken Collier
Reviewer:	Mark Gift

	Unit 1	Unit 2	Units 1 & 2	Common
Unit applicability:	[ ]	[ ]	[x]	[ ]
Complete on:	[ ]	[ ]	[x]	[ ]

Title:

Reactor Recirculation M/G Set Replacement with ASD Units

Description of Activity:

Note:
This modification was reported complete on Unit 1 in the 2012 24-Month 10CFR50.59 Evaluation Summary Report and is being updated in this report to reflect implementation on Unit 2 in 2013.

This activity will install Adjustable Speed Drives (ASDs) to replace the existing Reactor Recirculation motor-generator (M/G) Sets at Limerick Generating Station, Units 1 and 2. The main components of the M/G Set being replaced are a drive motor, oil fluid drive coupling with scoop tube and positioner, generator, and oil cooling heat exchangers and pumps. The ASDs main components are a multiple winding step-down transformer, AC-DC-variable AC power converters, water cooling system with heat exchangers, and dual control and protective microprocessor systems with independent back-up protection relays. The ASD is a solid state static 3 phase inverter which converts the 60 Hz input line frequency to a variable output frequency to control the Reactor Recirculation Motor speed in the same manner as the existing M/G Set.

New Main Control Room (MCR) analog controls & indications will be installed on Recirculation Control panel 1(2)0-C602 and Reactor Control panel 1(2)0-C603 to interface with the ASD digital control system to provide and monitor command signals to control recirculation pump speed. A new Human-Machine-Interface (HMI) touch screen panel will be installed for each ASD on MCR panel 1(2)-C626 to echo the indications at the HMI touch screen mounted locally on each ASD drive panel. The locally mounted HMI screen provides indication & control of

ASD parameters whereas the MCR HMI screen provides ASD parameter status indication only.

The existing 13.2kV feeder breaker for the M/G Sets will be reused as input for each ASD. ASD output voltage, frequency, current and volts/hertz ratio will match that currently specified for the Recirc pump motor. New digital protective relays suitable for the ASD transformer load will replace the existing analog M/G Set drive motor protective relays. New digital protective relays, configured in a 2-out-of-3 logic, will replace the existing analog relays for differential over-current protection of the recirc pump motor. New over-frequency relays, also configured in a 2-out-of-3 logic to trip the 13.2kV breaker, will provide back-up over-speed protection for the Recirc pump motor.

Each ASD will have a new closed loop demineralized cooling water system with heat exchangers cooled by the Service Water system. Each unit will have three 100% capacity heat exchangers, one serving each ASD with one swing heat exchanger in reserve. All three heat exchangers will be located in the same area as the existing M-G set lube oil coolers. The third swing heat exchanger allows replacement of a fouled heat exchanger while on-line, which is an improvement over the one existing lube oil cooler for each M/G Set. The closed loop cooling water system cools the ASD transformer, power cells, and panel internals using internal ASD pumps.

Reason for Activity:

Operation of the Reactor Recirculation System is critical to power production. The existing M/G Set equipment and controls are obsolete and have experienced numerous failures and spurious operation resulting in unexpected speed changes. This results in reduced unit output, unexpected reactivity changes or a plant trip. The existing Reactor Recirculation M/G Sets are original equipment. The vintage of this equipment necessitates heavy reliance on large rotating electrical and hydraulic energy conversion components and their associated moving parts, and requires a significant maintenance effort with each refueling cycle. The performance of these components has been degrading with age, and the cost of maintaining the system to achieve expected reliable performance is increasing. Additionally, some of the major components are in need of replacement/refurbishment but are obsolete and no longer supported by the Original Equipment Manufacturer (OEM), GE.

The ASD uses solid state power conversion and highly reliable state-of-the-art digital control systems to produce the frequency and voltage applied to the pump motor. This precise control results in a finer and more stable control of the Recirc pump motor speed, and thus recirculation flow. Reactor Recirc pump will be more precise, controllable, stable, and reliable due to the fully redundant microprocessor based electronic control systems versus the existing obsolete and unreliable single failure vulnerable electro-mechanical control system.

Replacing the M/G Set and fluid coupling eliminates the variability, spurious fluctuations, and instability experienced with the present antiquated analog control and fluid coupling technology. Additionally, the elimination of the fluid coupling and the associated oil support system also removes a significant maintenance effort to maintain and replace the fluid coupling and lubrication oil required for the M/G Set operation.

The ASDs are much more efficient than the existing M/G sets, and they use less power than the M/G sets. The increase in efficiency by use of the ASDs means that station loads during operation will decrease, thus providing more Megawatts to the grid. Increasing the reliability of the Recirc speed control system results in more stable, reliable plant output which ultimately results in increased grid stability.

Effect of Activity:

The Reactor Recirculation system is a non-safety-related system that is necessary for power production. The function of the Reactor Recirculation system to control reactor power level during normal power production operations is not affected by this modification.

Startup of the ASD is slightly different than startup of an M/G Set due to the changes in method of control and different types of startup permissives present in the control circuits. The ability to produce manual Reactor Recirc Pump runbacks has been added to aid Operations in system control when other plant conditions require it. The licensing basis is not otherwise affected by the changes to the Reactor Recirc system due to these control changes.

Protective actions such as reactor scram are provided by other systems external to the Reactor Recirculation system, are safety-related, and completely independent of the Reactor Recirculation Control System. There is no change to the Reactor Protection System and Engineered Safety Feature Actuation System. Thus, for any Reactor Recirculation System transient or accident, the Reactor Protection System and Engineered Safety Features Actuation System will provide exactly the same response as before the proposed activity.

Safety-Related Requirements

All equipment and circuits affected by this activity are non-safety-related, and not subject to environmental qualification (EQ).

Licensing Impacts

The UFSAR must be revised to document the changes made by this project. The affected UFSAR sections are:

Chapter 1, Table 1.3-8, Significant Design Changes from PSAR to FSAR
Chapter 1, Table 1.10-1, Acronyms Used in UFSAR
Chapter 3, Section 3.8.4.1.8, Turbine Enclosure
Chapter 5, Table 5.2-3, Reactor Coolant Pressure Boundary Materials
Chapter 5, Section 5.4.1, Reactor Recirculation Pumps
Chapter 5, Table 5.4-1, Reactor Recirculation System Design Characteristics
Chapter 7, Section 7.1.1, Identification of Safety-Related Systems
Chapter 7, Section 7.7, Control Systems not Required for Safety
Chapter 8, Section 8.1, Electrical Power - Regulatory Guides & IEEE Standards
Chapter 8, Section 8.6, Electrical Power - Onsite Power Systems
Appendix 9A, Fire Protection Evaluation Report
Chapter 9, Section 9.4, HVAC Systems
Chapter 9, Section 9.5, Other Auxiliary Systems
Chapter 15, Section 15.3, Decrease in Reactor Coolant System Flow Rate
Chapter 15, Section 15.9, Plant Nuclear Safety Operational Analysis

The revised Fire Protection Review is being reviewed separately per LS-AA-128.
The Technical Specifications, LCO’s and Bases, were reviewed and no impacts were identified.
The Technical Requirements Manual Section was reviewed and no impacts were identified.

Summary of Conclusion for the Activity’s 50.59 Review:

A 50.59 Screening reviewed the installation of the ASD as the replacement power drive for the M/G Set to the recirculation pump motor. The following changes associated with the proposed activity were determined to be potentially adverse since each was judged to fundamentally alter the existing means of performing or controlling design functions as described in the UFSAR:

- Change from analog to digital control system with failure modes different than the existing analog system
- Changes in acceleration capability and pump coast down time due to the ASD using direct frequency control and without any inherent inertia.
- Change in the Human-System-Interface (HSI) for recirc pump manual speed control from a continuously variable analog system to an incremental discrete step digital system.

A 50.59 Evaluation is required because of the need to consider the changes in the method of controlling the Reactor Recirculation pump with the use of digital interfaces with the digital ASD control and ultimately the control and monitoring of core flow. The use of an ASD using electronic frequency conversion changes the pump response time on ASD feeder breaker trip, and introduces the potential for higher frequency and faster acceleration than presently possible with the M/G Set. However, for the transients and accidents analyzed in the Evaluation, it is the ATWS/RPT breaker that trips the recirc pump motor and not the input breaker trip. Therefore, the faster coast down time with input breaker trip is not a factor in this analysis. Also, the internal ASD limits are backed-up by independent over-frequency trip relays to protect the motor from inadvertent overspeeding. Thus, these conditions have been analyzed and determined to be not adverse.

An FMEA/PRA performed on the ASD digital hardware concluded that failure with the ASD has less probability than with the present analog system. The ASD has multiple redundancies built into the power and control systems resulting in a very reliable system. A System Integrity Review (SIR) was prepared to document the acceptability of the ASD for recirc control. The SIR concluded that the ASD is reliable and of sufficient quality such that the design minimizes challenges to safety systems and is acceptable for this application. Software used by the ASD was found to be of high quality and common cause software failures were determined to be bounded by existing transient analysis.

The change in HSI was determined not to result in an increased probability of operator error which could lead to an unexpected speed excursion. The ASD HSI preserves the functionality of the present recirc control system while providing additional safeguards not present in the existing HSI to prevent inadvertent operator actions. New functionality was introduced, manually initiated runbacks, to increase operator response to transients while removing operator burden. The manual runback pushbuttons have guards in place to prevent inadvertent operator initiation. The redundancy and self-check software built into the HSI Input/Output modules provides further assurance against spurious system manipulations. Thus, the ASD HSI was found to not result in an increase in the frequency of occurrence of an accident nor does it increase the likelihood of occurrence of a malfunction of an SSC important to safety previously evaluated in the UFSAR.

Probability Risk Assessment (PRA) model applicability review was completed. IR #965797, assignment 51 has been assigned to ensure that Limerick Design / System Engineer review is performed prior to next PRA update, to ensure that the PRA modeling of the Reactor Recirculation System remains consistent with the as-built plant.

The affected sections of the UFSAR are outlined in the effects section above. UFSAR Change Request Number 2011-001 is processing these changes for Unit 1.

No increases in transients, accidents, malfunctions, consequences, or increased probabilities of likelihood of an accident or malfunction have been identified as adverse in the 50.59 review process. There are no Technical Specification or Operating License changes required in this activity. Based on the 50.59 Evaluation identified below, in conjunction with the Fire Protection Review acceptability, the activity may be implemented per plant procedures without obtaining a License Amendment.