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August 15, 2003

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Dresden Nuclear Power Station, Units 2 and 3
Facility Operating License Nos. DPR-19 and DPR-25
NRC Docket Nos. 50-237 and 50-249

Quad Cities Nuclear Power Station, Units 1 and 2
Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

Subject: Update to Information Supporting the License Amendment Request to Permit Uprated Power Operation at Dresden Nuclear Power Station and Quad Cities Nuclear Power Station

References:

(1) Letter from Keith R. Jury (Exelon Generation Company, LLC) to U. S. NRC, "Commitments for Resolution of Steam Dryer Degradation Issue," dated June 27, 2003

(2) Letter from Keith R. Jury (Exelon Generation Company, LLC) to U. S. NRC, "Schedule for Completing Committed Actions Regarding Resolution of Steam Dryer Degradation Issue," dated July 10, 2003

(3) Letter from K. A. Ainger (Exelon Generation Company, LLC) to U. S. NRC, "Additional Mechanical Information Supporting the License Amendment Request to Permit Uprated Power Operation at Dresden Nuclear Power Station and Quad Cities Nuclear Power Station," dated August 13, 2001

In References 1 and 2, Exelon Generation Company (EGC), LLC, committed to evaluate the degradation of the Quad Cities Nuclear Power Station (QCNPS), Unit 2 steam dryer and, if necessary, submit supplemental information to the NRC regarding previous licensing correspondence in support of the extended power uprate (EPU) performed for QCNPS, Units 1 and 2, and Dresden Nuclear Power Station (DNPS), Units 2 and 3. The supplemental information was to be provided by August 15, 2003.

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EGC and General Electric (GE) Company have evaluated the information previously provided to the NRC in support of the EPU license amendment request and have determined that the information provided in the responses to Questions 3B and 7 in Reference 3 requires updating. Attachment A to this letter provides updated information for responses 3B and 7 in Reference 3. Revised information is indicated by revision bars.

Attachment A contains proprietary information. GE, as the owner of the proprietary information, has executed the affidavit enclosed in Attachment B, which identifies that the enclosed proprietary information has been handled and classified as proprietary, is customarily held in confidence, and has been withheld from public disclosure. The proprietary information was provided to EGC in a GE transmittal that is referenced by the affidavit. The proprietary information has been faithfully reproduced in Attachment A such that the affidavit remains applicable. GE has requested that the enclosed proprietary information be withheld from public disclosure in accordance with the provisions of 10 CFR 2.790, "Public inspections, exemptions, requests for withholding," and 10 CFR 9.17, "Agency records exempt from public disclosure." Attachment B also provides a non-proprietary version of Attachment A.

Should you have any questions related to this letter, please contact Mr. Allan R. Haeger at (630) 657-2807.

Respectfully,

Patrick R. Simpson

Patrick R. Simpson
Manager – Licensing
Mid-West Regional Operating Group

Attachments:

Attachment A: Updated Responses to DNPS and QCNPS EPU RAIs 3B & 7 (Proprietary version)
Attachment B: Affidavit for Withholding Portions of Attachment A from Public Disclosure
Updated Responses to DNPS and QCNPS EPU RAIs 3B & 7 (Non-proprietary version)

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Dresden Nuclear Power Station
NRC Senior Resident Inspector – Quad Cities Nuclear Power Station
Office of Nuclear Facility Safety – Illinois Department of Nuclear Safety

Attachment B

Affidavit for Withholding Portions of Attachment A from Public Disclosure
Updated Responses to DNPS and QCNPS EPU RAIs 3B & 7 (Non-proprietary version)

General Electric Company

AFFIDAVIT

I, George B. Stramback, state as follows:

(1) I am Manager, Regulatory Services, General Electric Company ("GE") and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 1 to GE letter DJB03005, Daryle Bouchie (GE) to Pat Simpson (Exelon), *Updated Responses to DNPS and QCNPS EPU RAI 3B and 7, August 14, 2003*. The proprietary information in Enclosure 1, *Updated Responses to DNPS and QCNPS EPU RAIs 3B & 7, August 14, 2003 (GE Proprietary Information)*, is delineated by a double underline inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation[3] refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner, GE relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.790(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by General Electric's competitors without license from General Electric constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future General Electric customer-funded development plans and programs, resulting in potential products to General Electric;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a., and (4)b, above.

(5) To address 10 CFR 2.790 (b) (4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GE, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GE, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within GE is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GE are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed results and conclusions of failure modes and effects analyses of the Steam Dryer which encompass and take into account analyses and repairs utilizing inspection techniques, testing, analytical models and methods, including computer codes, which GE has developed. The development of these models and computer codes was achieved at a significant cost to GE, on the order of a few hundred thousand dollars.

The development of the evaluation process along with the interpretation and application of the inspection and analytical results is derived from the extensive experience database that constitutes a major GE asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GE.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GE would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 15th day of August 2003.

George B. Stramback
George B. Stramback
General Electric Company

<u>Question</u>

3. *In Section 3.3.5, you evaluated the effects of the EPU on the potential for flow-induced vibration of the reactor internal components due to the increase in steam produced (>20%) in the core, the increase in the core pressure drop, and the increase in the recirculation pump speed. You indicated that the evaluation was based on the vibration data for the reactor internal components recorded during the startup testing of DNPS and QCNPS plants and on operating experience from similar plants. The expected vibration levels under EPU conditions were estimated by extrapolating the vibration data recorded during startup testing at the DNPS and QCNPS units.*

3A. Discuss whether and how the recorded vibration data can be applicable for your calculation of the flow induced vibration stress level after the steam separators and dryers hardware modifications that are required for the EPU.

3B. Provide a sample evaluation for the most critical components (i.e., steam dryers and steam separators) and the basis for using the operating experience of similar plants.

3C. Discuss the potential for flow-induced vibration of the reactor internal components due to various mechanisms, including, in particular, the fluid-elastic instability in the steam separators and dryers at the proposed power level. If the details of the analysis and the results are documented in a report, submit the report for staff review.

3D. Provide a discussion on the potential for excessive vibrations, high noise levels, and the instrument lines leakage that might be caused by the increased recirculation pump speed or flow for the proposed power uprate, as described in the NRC Information Notice 95-16.

<u>Response</u>

3A. There is no recorded vibration data for the steam dryer. It is a non-safety related component and it was not instrumented during startup. By analysis it was shown that the dryer natural frequencies do not change significantly with the addition of the hardware modification. Hence the modifications will have negligible effect on the dryer response. There were no modifications to the steam separator due to EPU.

3B. Steam Dryer and Steam Separator Evaluations

Steam Dryer

The steam dryer has no safety function. The sole function of the steam dryer is to remove moisture from the steam in order to minimize erosion of the piping and turbine and to improve the turbine efficiency. The Boiling Water Reactor Vessel Internals Project (BWRVIP) document BWRVIP-06, which was endorsed by the NRC, also states that the dryer is non-safety related and failure of a dryer component may cause an operability concern but has no safety impact. Hence the dryer was not instrumented during startup testing and no measured vibration data is available for the prototype plant.

The design criteria for the steam dryer is that the structural integrity of the dryer is maintained when subjected to a steam line break occurring beyond the main steam isolation valves. Since the dome pressure is not changed under EPU conditions, steam dryer structural integrity evaluations performed for a steam line break for the current rated thermal power is applicable to EPU conditions.

The operational histories of steam dryers in the Quad Cities 2 and other plants were also studied to see if there were any flow induced vibration related problems in the dryer. In plants other than the Quad Cities 2 plant, drain channel cracks and outer bank hood damage were found due to high cycle fatigue from flow induced vibration effects. Actually, the outer bank hood damage was due to the combined effects of the turbine stop valve (TSV) closure and high cycle fatigue from flow induced vibration. Some other dryer component high cycle fatigue failures, such as tie bars, lifting rods and hood support brackets, may have been due to vibration effects during OLTP operation. Drain channel cracking has also occurred even during normal OLTP operation and is usually repaired after detection. The outer bank hoods adjacent to the steam outlet nozzles at DNPS and QCNPS are four times thicker than at the plant where the damage occurred, while the TSV closure time is identical. Hence it is expected that the outer bank hood can withstand the transient. While instances of drain channel cracking and hood cracking have occurred at operating plants, it is an operational issue only, relating to proper drying of the steam before it leaves the dryer. No structural integrity problems have been observed with these cracks. The dryers are visually inspected during removal in each refueling outage and any observed cracking can be repaired.

In June 2002, QCNPS Unit 2 experienced a significant increase in steam moisture content while operating at EPU conditions. Measurements indicated that the moisture content had increased by a factor of 10 (from 0.03 to a value of 0.27%). When the moisture content increased to approximately 0.7%, the power level was reduced to approximately 97% of OLTP. QCNPS decided to shut down the plant on July 12, 2002, to inspect the steam dryer. Inspection of the steam dryer revealed that a ¼-inch stainless steel cover plate measuring approximately 120" x 15" had failed near the main steamline "A" and "B" nozzles.

In May 2003, QCNPS Unit 2 experienced another significant increase in steam moisture content while operating at EPU conditions. Inspection of the steam dryer in June 2003 lead to the conclusion that the increase in steam moisture content was due to significant through-wall cracking, deformation, and failure of the outer bank hood on the 90° side of the dryer. In addition, the outer bank hood on the 270° side was cracked and several internal braces and tie bars had failed.

The cause of the dryer failure in 2002 is postulated to be high cycle fatigue resulting from high frequency acoustic loading and augmented by low frequency pressure loading. For the 2003 cracks the cause is postulated to be high cycle fatigue resulting from low frequency pressure loading. The cracks in the hoods and braces are most likely to have been initiated during steady-state power operation. The cracks continued to grow until the transient pressure loads from the stuck open relief valve and subsequent manual relief valve openings enlarged the cracks through-wall, leading to the increased steam moisture content. The previous cover plate failure in 2002 may have subjected the dryer structure on the 90° side to significant additional loading.

To evaluate the above postulate, detailed finite element models of the whole dryer in various stages of degradation were created. These finite element models were subjected to pressure loads derived from reactor test data as well as computational fluid dynamics (CFD) results. The pressure drop across the outer hood is composed of two parts - the overall dryer pressure drop, and a pressure drop caused by the high local velocities between the dryer outer hood and the reactor vessel. The velocity is high in this region because of the relatively small area through which the steam flows as it approaches the MSL nozzles. During power uprate, [[

]]The dynamic pressure load response is about twice the static response.

Using the above pressures, the maximum dynamic stresses for the un-reinforced dryer at the crack initiation points are calculated. The crack initiation point is at a gusset plate weld near the top of the outer hoods. Prior to the modifications in 2003, the maximum dynamic stresses for the un-reinforced dryer at the crack initiation points are [[ ]]. For the reinforced dryer, the maximum stresses are less than [[ ]]at the gusset plate reinforcements. Since the stresses for the reinforced dryer are less than the GE allowable stress criteria of 10,000 psi, it is concluded that the reinforced dryer can operate at EPU conditions without exciting the dryer components above their established vibration criteria limits.

Steam Separator

The steam separator is also not a safety-related component. The steam separators at QCNPS and DNPS are of the fixed axial flow type. The steam separators have no moving parts and are made of stainless steel. In each separator, the steam-water mixture rising through the standpipe impinges on vanes, which give the mixture a spin to establish a vortex to allow the centrifugal forces to separate the water from the steam. The steam leaves the separator at the top and passes into the wet steam plenum below the dryer. The separated water exits from the lower end of each stage of the separator and enters the pool that surrounds the standpipes to join the downcomer annulus flow.

The Quad Cities shroud head and steam separator assembly uses 219 GE Model 65M axial flow steam separators. Each steam separator is mounted on a 6-inch schedule 40 standpipe. The array of standpipes and steam separators are braced laterally. The 65M separator has an inner barrel [[ ]]), a middle tube with skirt ([[ ]]) and an outer tube ([[ ]]). At the top of the separator is the pre-dryer tube ([[ ]]). From the bottom of the skirt to the top of the pre-dryer is about [[ ]]in height.

Flow induced vibration (FIV) loads acting on separators can be broadly classified into two types: FIV loads on the separators themselves and the FIV loads generated by the swirling motion of the steam/water flow which act on the shroud head and shroud. These two effects are briefly discussed below.

Steam Separator Vibration

The FIV effects of the QCNPS and DNPS steam separators (Model 65M) were evaluated based on FIV tests on the BWR/6 separators (Model AS2B). Because the GE Model 65M steam separators at QCNPS and DNPS were judged to be structurally very robust, no vibration tests were performed on them. Only thermal hydraulic tests were completed during the steam separator development tests. With the introduction of a smaller diameter and more flexible BWR/6 steam separators (Model AS2B), extensive vibration tests were conducted. The AS2B separator has an inner barrel ([[ ]]), and an outer tube with skirt ([[ ]]). From the bottom of the skirt to the top of the separator is about [[ ]]in height. The results of the BWR/6 separator FIV testing has shown that the expected maximum flow induced vibration stress is around [[ ]]which is under GE allowable stress of 10,000 psi.

In order to use the BWR/6 separator vibration test data to calculate the flow induced vibration response of the Model 65M separator, the structural dynamic characteristics of the 65M separator are established first and then they are compared with those of the Model AS2B separator. Structurally both steam separators are composed of a number of concentric cylinders with ring segments and radial struts. Finite element models using SAP4G07V beam element are developed for both separators. The finite element model predicted the first two natural frequencies are [[ ]]for the Model 65M separator, and [[ ]]for the Model AS2B separator. It is seen that first natural frequency of Model 65M separator is about two times higher then that of the Model AS2B separator. The finite element model predicted AS2B separator first model natural frequency of [[ ]]is in very good agreement with the test measured first model frequency of [[ ]].

It is assumed that the turbulence flow-induced forcing function established from the Model AS2B separator test condition is also applicable to the Model 65M separator. The magnitude of the forcing function is then adjusted according to the dynamic pressure head (ρU^2). It is noted that the steam/water velocity, U, inside the 65M separator is about [[ ]]of that inside the tested AS2B separator. The steam/water density, ρ, inside the 65M separator is about [[ ]]of that inside the AS2B separator. The analytically calculated peak stress response of the Model 65M separator is about [[ ]], much less than the conservative GE allowable stress of 10,000 psi. Thus, it can be concluded that the QC2 Model 65M separator FIV performance is acceptable at EPU conditions.

Steam Separator Effects on Shroud Head and Shroud Vibration

The swirling motion given to the steam/water mixture causes twisting loads to act on the shroud through the shroud head. In the same way, the vibratory loads from the steam separator also act on the shroud through the shroud head. Since the shroud is a safety related component, the separator/shroud structure was tested at various power conditions up to the rated power during plant startup. [[

]]

[[

{3}]]

3D. The vibration issue associated with increased containment noise and vibration levels due to increased recirculation pump speed was investigated and reported in GE SIL No. 600. The conclusion of this investigation was that the increased noise and vibration levels associated with higher recirculation pump speeds were a direct result of a residual heat removal (RHR) testable check valve not being properly seated. Testing demonstrated that the containment noise and RHR vibration levels were greatly attenuated when the RHR testable check valve was properly seated.

The containment noise and vibration associated with the RHR testable check valve, at increased pump speeds and flow rates, was determined by testing to have no detrimental effect on plant equipment, including the reactor recirculation system (RRS) piping, RHR piping, the recirculation pumps and motors, and the containment structure.

<u>Question</u>

7. In Section 3.3.6, you stated that EPU conditions result in an increase in saturated steam generated in the reactor core. For constant core flow, this in turn results in an increase in the separator inlet quality and dryer face velocity and a decrease in the water level inside the dryer skirt, all of which affect the steam separator-dryer performance. The results of the evaluation demonstrate that the steam separator-dryer performance remains acceptable up to some portion of extended power prior to any substantive hardware modification. To reduce the moisture content, hardware modifications are required. These modifications will be completed before EPU implementation.

Confirm whether and how your evaluation in Section 3.3.4 for the structural integrity of steam separators and dryers will be affected by the required hardware modifications due to the proposed EPU at DNPS and QCNPS.

<u>Response</u>

<u>Introduction</u>

Evaluation for the DNPS and QCNPS EPU have concluded that the steam separator/dryer configurations for these plants are operating near their capabilities at pre-EPU conditions, and that higher main steam moisture content can be expected at EPU. A dryer modification will be implemented in order to limit the moisture in the main steam line to be no worse than current conditions; however, the design goal is less than or equal to 0.2% at EPU conditions. [[

]]

Code and Safety Design Basis
The steam dryer is a non-safety component. The dryer is required to maintain structural integrity during design basis events (i.e., not generate loose parts that can prevent safety components from fulfilling their safety function during the event). The design basis for the dryer includes the normal operating condition as well as the faulted Main Steam Line Break (MSLB) pressure loading condition, including weight and seismic loads. However, the original design basis analysis for the dryer addressed primarily the MSLB pressure differential loading as the limiting case, based on the criteria of total structural collapse or loose parts. The dryer is not an ASME code component. While the ASME Section III code was utilized for the normal condition, the faulted condition was evaluated based on plastic collapse criteria. Bounding differential pressure values were established for the critical components required to maintain structural integrity without gross collapse. The pressure differential across the dryer for the DNPS and QCNPS MSLB event at EPU conditions was bounded by the pressure differential based on plastic collapse criteria established in the design basis analysis for the critical components. Therefore, the dryer was deemed qualified for the EPU.

Subsequently, the DNPS and QCNPS steam dryers were modified to include perforated inserts in the dryer outlet plenum. As part of this modification, detailed finite element stress analysis of the dryer assembly was performed and qualified to the applicable ASME code stress limits. Even though the steam dryer is not an ASME Code component, the steam dryer and the modification evaluations used the allowable stress limits from ASME Code Section III, Subsection NG, 1989 Edition for design qualification, for Normal/Upset and Faulted conditions.

Structural Evaluation
Structural analyses for the perforated insert modification were performed using ANSYS56D finite element computer code. Stress analyses with conservative load estimates showed that the perforated inserts, dryer structures, and the dryer support/RPV interface remain within the ASME Code stress limits for all service conditions. ANSYS56D is the computer program ANSYS Revision 5.6, which has been developed and is maintained by ANSYS, Inc. ANSYS56D is a large-scale general purpose finite element computer program. The code is a "Level - 2" GENE Quality Assurance program under controlled condition.

By analysis it was shown that the dryer natural frequencies do not change significantly with the addition of the perforated insert modification. Therefore, the modifications will have negligible effect on the dryer dynamic response.

Structural evaluations were performed for the dryer, dryer modification (perforated inserts), and dryer support brackets for gravity, EPU pressures, seismic loads, and steam line breaks loads. For the faulted condition, the original design basis analysis considered the MSLB pressure loads and seismic loads separately. However, for the analysis of the modified dryer, these loads were combined. The EPU pressures used in the analyses were the following values calculated for the modified dryer.

Service Levels	[[	
Normal		
Upset		
Faulted		]]

Maximum stresses calculated for the dryer structures are compared with the ASME Code stress limits in the following table.

Service Level	Stress Category	[[	Stress Allowable Ksi
Normal & Upset:			
	Pm		14.440
	Pm+Pb		21.660
Faulted:			
	Pm		34.656
	Pm+Pb	]]	51.984

Flow Induced Vibration (FIV) effects are discussed as part of the response to RAI #3B.

<u>Recent Quad Cities Unit 2 Dryer Failures:</u>

The RAI #3B response was updated to include discussions on the FIV effects and the newly postulated failure mechanisms/root cause of the recent failures occurred in June 2002 and May 2003 in the Quad Cities Unit 2 Dryer. A discussion of the dryer modifications as a result of the failures is also included in the RAI #3B response.