US-APWRRAIsPEm Resource

From: Ward, William
Sent: Thursday, November 05, 2015 7:06 PM
To: 'us-apwr-rai@mhi.co.jp'; US-APWRRAIsPEm Resource
Cc: Ryan Sprengel; Otto, Ngola; Zimmerman, Jacob
Subject: US-APWR Design Certification Application RAI 1096-8266 (8.2 Offsite Power System)
Attachments: US-APWR DC RAI 1096 EEB 8266.pdf

MHI,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, KHNP requests, and we grant, 60 days to respond to this RAI. We will adjust the schedule accordingly.

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

William R. Ward, P.E.
Senior Project Manager
U.S. Nuclear Regulatory Commission
m/s T6-D38M
Washington, DC, 20555-0001
NRO/DNRL/Licensing Branch 2
ofc T6-D31
ofc (301) 415-7038

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Created By: William.Ward@nrc.gov

Recipients:
"Ryan Sprengel" <ryan_sprengel@mnes-us.com>
Tracking Status: None
"Otto, Ngola" <Ngola.Otto@nrc.gov>
Tracking Status: None
"Zimmerman, Jacob" <Jacob.Zimmerman@nrc.gov>
Tracking Status: None
"'us-apwr-rai@mhi.co.jp'" <us-apwr-rai@mhi.co.jp>
Tracking Status: None
"US-APWRRAIsPEm Resource" <US-APWRRAIsPEm.Resource@nrc.gov>
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REQUEST FOR ADDITIONAL INFORMATION 1096-8266

Issue Date: 11/05/2015
Application Title: US-APWR Design Certification - Docket Number 52-021
Operating Company: Mitsubishi Heavy Industries
Docket No. 52-021
Review Section: 08.02 - Offsite Power System
Application Section: SRP 8.02, BTP 8-9

QUESTION
08.02-18

In Request for Additional Information (RAI) response dated December 18, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13360A164), Mitsubishi Heavy Industries, LTD, the applicant, discussed its response to RAI 1017-7058, Question 08.02-17 concerning Bulletin 2012-01, “Design Vulnerability in Electric Power system,” (ADAMS ML12074A115) related to the recent operating experience that involved the loss of one of the three phases of the offsite power circuit (single-phase open circuit condition) at Byron Station.

The applicant stated in part the following:

That the electrical protective devices will detect undervoltage (UV) conditions such as loss of voltage or degraded voltage conditions. However, the electrical protective devices are not designed to detect an open phase condition or an open phase condition with a high impedance ground fault condition.

A qualitative assessment during a heavy loading condition of the reserve auxiliary transformers (RATs), which normally supply the Class 1 E buses, shows that an open phase condition [OPC] or an open phase condition with a high impedance ground fault on an offsite power circuit may possibly be detected by UV protection using two-out-of-three logic.

The qualitative assessment, during a heavy loading condition, of the unit auxiliary transformers (UATs), which alternatively supply the Class 1E buses in a back-feeding condition from the grid, shows that an open phase condition or an open phase condition with a high impedance ground fault, on an offsite power circuit, may possibly be detected.

Based on the assessment for the current US-APWR design, design improvement is incorporated by following the "Open Phase Condition Initiative" document which is issued by NEI to address the issues raised by NRC Bulletin 2012-01.

MHI will change the protection scheme design of the offsite power circuits by adding dedicated detection device(s) for open phase condition on the high voltage side of the RATs and main transformer (MT) so that the detection device(s) can:

1. Detect an open phase condition on the high voltage side of the transformers, with or without grounding.

2. An alarm is initiated in the MCR for open phase conditions and the offsite power circuit supplying the Class 1E buses is isolated and automatically transferred to another offsite source or to a Class 1E GTG, upon detection of the open phase condition in all plant operating conditions.

3. This design change also includes detection of a two phase open condition, with or without grounding.

4. The type of detection device(s) will be identified considering site specific offsite power system configuration in the site-specific detailed design phase, consistent with the industry schedule described in the NEI "Open Phase Condition Initiative".

5. Surveillance requirements such as channel calibration, channel check, setpoint verification, etc. are required to ensure the protection. Surveillance requirements will be provided when with detection device(s) have been determined. Therefore, an additional COL Item will be added to the DCD to address these surveillance requirements.

The following detection and mitigation strategies are discussed in the guidance found in Branch Technical Position (BTP) 8-9, “Open Phase Conditions in Electric Power System,” (ADAMS ML15057A085):

a. The OPC should be automatically detected and alarmed in the main control room under all operating electrical system configurations and plant loading conditions. The detection circuits should be sensitive enough to identify OPCs under all operating electrical system configurations and plant loading conditions for which the offsite power supplies are required to be operable in accordance with plant technical specifications (TSs) for safe shutdown.

   The detection circuit should minimize spurious indications for an operable offsite power source in the range of voltage perturbations such as switching surges, transformer inrush currents, load or generation variations, lightning strikes, etc., normally expected in the transmission system. If the plant auxiliaries are supplied from the main generator and the offsite power circuit to the ESF bus is configured as a standby power source, then any failure (i.e., OPC) should be alarmed in the main control room for operators to take corrective action within a reasonable time. In such cases, the consequences of not immediately isolating the degraded power source should be evaluated to demonstrate that any subsequent design bases conditions that rely on offsite power circuit(s) for safe shutdown do not create plant transients or abnormal operating conditions. Also, the remaining power source(s) can be connected to the ESF buses within the time assumed in the accident analysis.

b. If offsite power circuit(s) is (are) functionally degraded due to OPCs, and safe shutdown capability is not assured, then the ESF buses should be designed to be transferred automatically to the alternate reliable offsite power source or onsite standby power system within the time assumed in the accident analysis and without actuating any protective devices, given a concurrent design basis event.

c. The design of protection features for OPCs should address the following:

i. Power quality issues caused by OPCs such as unbalanced voltages and currents, sequence voltages and currents, phase angle shifts, and harmonic distortion that could affect redundant ESF buses. The ESF loads should not be subjected to power quality conditions specified in industry standards such as Institute of Electrical and Electronic Engineers (IEEE) Standard (Std) 308-2001, "Criteria for Class 1E Power Systems for Nuclear Power Generating Stations," Section 4.5, "Power Quality," with respect to the design and operation of electrical systems as indicated in Regulatory Guide (RG) 1.32 "Criteria for Power Systems for Nuclear Plants."

ii. Protection scheme should comply with applicable requirements including single failure criteria for ESF systems as specified in 10 CFR Part 50, Appendix A, GDC17, and 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3), which require compliance with IEEE Std 279-1971 "Criteria for Protection Systems for Nuclear Power Generating Stations" or IEEE Std 603-1991, "Standard Criteria for Safety Systems for Nuclear Power Generating Stations." RG 1.153, "Criteria for Power, Instrumentation, and Control Portions of Safety Systems," provides additional guidance on this topic.

If protective features are provided in a non-Class 1E system only, a failure of the non-Class 1E scheme should not preclude the onsite electrical power system from performing its safety function given a single failure in the onsite power system.

iii. Protection scheme design should minimize misoperation, maloperation, and spurious actuation of an operable off-site power source. Additionally, the protective scheme should not separate the operable off-site power source in the range of voltage perturbations such as switching surges, load or generation variations etc., normally expected in the transmission system.

iv. The unbalanced voltage/current conditions for ESF components expected during various operating and loading conditions should not exceed motor manufacturer's recommendations. The International Electrotechnical Commission (IEC) Standard IEC 60034-26, National Electrical Manufacturers Association (NEMA) Standard (MG 1) Parts 14.36 and 20.24, and IEEE Std C37.96-2012 (Guide for AC Motor Protection), Section 5.7.2.6, "Unbalanced Protection and Phase Failures," may be used for general guidance.

Technical Specification Surveillance Requirements and Limiting Conditions of Operation for equipment used for mitigation of OPCs should be identified and implemented consistent with the operability requirements specified in the plant TSs and in accordance with 10 CFR 50.36(c)(2) and 10 CFR 50.36(c)(3). RG 1.93 "Availability of Electric Power Sources," provides additional guidance on this topic.

REQUEST FOR ADDITIONAL INFORMATION 1096-8266

The staff has determined that the applicant in response to RAI 1017-7058, Question 08.02-17, did not completely address detection and mitigation strategies as described in BTP 8-9 including DCD descriptions. Therefore, the staff requests that the applicant address the following in response to this RAI:

a. Include a description in the DCD which explains how the US-APWR design meets the guidance in BTP 8-9.

b. Describe the design features that would be provided in the event that offsite power circuit(s) is (are) functionally degraded due to open-phase conditions, and safe shutdown capability is not assured, then the safety-related buses should be designed to be transferred automatically to the alternate reliable offsite power source or onsite standby power system within the time assumed in the accident analysis and without actuating any protective devices, given a concurrent design basis event.

c. Provide an ITAAC that demonstrates and verifies the following, including setpoints:

    i. Monitoring/detecting/alarming in the control room in the event of the OPCs,

    ii. Automatically separates the Class 1E safety-related buses from the offsite power source and transfers safety-related loads to the unaffected offsite power source or the emergency diesel generators.

d. Provide Technical Specifications in accordance with accordance with 10 CFR 50.36(c)(2) and 10 CFR 50.36(c)(3).