Enclosure 2
Timeline and Milestones Information in Support of the
Assessment Plan for Generic Issue on High Energy Arc Faults Involving Aluminum

Milestone 1: Plan Required Future Testing.

Task 1a: The staff will develop a schedule for HEAF testing.

Target: Complete

A. Perform a phenomena identification and ranking table (PIRT) exercise to determine influencing parameters.

The PIRT exercise was performed via a facilitated expert elicitation process. The staff documented the results in NUREG-2218, "An International Phenomena Identification and Ranking Table (PIRT) Expert Elicitation Exercise for High Energy Arcing Faults (HEAFs)," issued January 2018.

B. Perform a systematic and thorough review of Phase 1 test results to determine state of knowledge and additional research needs.

The staff has reviewed Phase 1 test results and incorporated lessons learned in future testing.

C. Develop a test plan based on the results of the PIRT and a review of initial test results.

The staff developed a plan for phase II large- and small-scale testing:

- Small-scale tests will be conducted at Sandia National Laboratories (SNL): These tests are designed to enable a better understanding of particle dispersion phenomena resulting from HEAF fire-induced failure modes. More specifically, this investigation will characterize particle properties and morphology for HEAF models. Information gained from the small-scale testing will be used for modeling purposes.

- Large-scale testing will be conducted at the KEMA test facility. The objectives of this study are to:

  (1) quantitatively characterize the thermal conditions, pressure conditions, and deposits on nearby surfaces created by HEAFs occurring in electrical enclosures and bus ducts, and

  (2) provide qualitative illustrations of the impact of HEAFs on typical switchgear room targets such as electrical cable and nearby equipment.

  HEAFs in cabinets containing aluminum bus bars are of particular interest because they may produce more severe effects than HEAFs in cabinets containing copper bus bars. The Generic Issues Review Panel (GIRP) may use the HEAF experimental data, combined with target damage criteria, to determine the adequacy of existing HEAF zones of influence

(ZOIs) in Appendix M to NUREG/CR-6850, Electric Power Research Institute (EPRI) 1011989, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities, Volume 2: Detailed Methodology," issued September 2005, for electrical cabinets with aluminum bus bars and bus ducts containing aluminum.

- The staff has contract with SNL to develop modeling to estimate the additional energy release from the interaction of aluminum during a HEAF event.

D. In April 2018, the NRC conducted a 2-day public workshop inviting members of the public, licensees, test facilities, EPRI, and the Nuclear Energy Institute (NEI). The NRC received comments to help finalize large and small test plans. The NRC staff is putting together a NUREG/CP capturing details of discussions.

The staff established dates for large- and small-scale testing:

- Small-scale test date - Testing took place in June and July of 2018. The staff expects a completed report from SNL by the end of September.

- Large-scale test date—Beginning September 10, 2018, the NRC will conduct 1 week of preliminary scope testing. Additional testing will be conducted in 2019 with support from the international community (32 tests are predicted, and will be informed by the four preliminary tests performed in September 2018).

- The staff has a contract with SNL to develop a conceptual model explaining the phenomena based on the small scale test results. Work is scheduled to begin in late 2018, and a model is expected in 2019. The final report is expected in 2019.

Milestone 2: Complete large- and small-scale testing necessary for the NRC staff to complete the evaluation of a HEAF involving aluminum components.

Target: 2020

Task 2a: In cooperation with the international community, the staff will perform the large- and small-scale testing necessary to establish new regulatory guidance on HEAF mitigation.

A. The staff expects to have completed small-scale testing and preliminary large-scale testing in 2018, in sufficient time to obtain necessary experimental data to establish the scope of the bulk of large-scale testing in 2020.

B. The first round of large-scale testing will focus on aluminum components present in the area where the HEAF occurs.

C. The staff expects the bulk of large-scale testing to occur in 2019 and possibly to continue into 2021. A total of 32 full-scale tests are anticipated in 2019, following the four pilot tests in 2018.

Milestone 3: Perform Pilot Plant Sensitivity Studies.

Target: Spring 2021- pilot plant studies performed
Spring/Summer 2021 - report summarizing results completed

Task 3a: In preparation for industry pilot studies, the staff needs to identify suitable sites for the studies to assess the risk of having aluminum in the areas where HEAFs are evaluated to possibly occur.

Target: Spring of 2019 - staff to prepare list of plants for studies.

A. The NRC put out a request for volunteer plants at the workshop in April 2018.

B. The staff is requesting a meeting with EPRI/NEI to discuss industry's participation in the pilot plant studies. The GIRP chairman will initiate correspondence with EPRI/NEI.

C. The staff will request industry initiate the process to identify pilot plants for evaluations by fall 2020. The target is three to four plants in order to gain sufficient information on impact due to various configurations.

a. Through working group interaction and the public meetings it was indicated that no pilot plants will participate until the modeling and ZOI approach to be used by the GIRP has been established by the EPRI/NRC working group.

Task 3b: In preparation for industry studies, the staff will develop a "ZOI for Pilot Plant Studies" using an NRC/EPRI workshop under the Office of Nuclear Regulatory Research memorandum of understanding:

Target: Spring 2021

1) The NRC staff expects to use a joint industry EPRI/NRC working group process to make an informed judgment on the aluminum ZOI.

a. Additional tests have been identified to inform the ZOI development through the EPRI/NRC working group and public comment period.
   1. Generator decrement curve testing (1-2 Tests)
      a. Discussed at the Public Workshop on April 18, 2018 (ML18108A210)
      b. Discussed at the Public Meeting on January 23, 2019 (ML19046A388)

   2. Confirmatory testing related to the electrical enclosure power configuration (i.e. Supply side vs. Load Side) (1-2 Tests)

a. Discussed at the Public Meeting on March 20, 2019 (ML19108A420)

2) By the end of July or early August 2018, the staff will discuss with EPRI industry's participation in developing this ZOI.

3) The profile for "ZOI for Pilot Plant Studies" should include an assessment of the travel of conductive aluminum byproducts and their impact on surrounding electrical equipment.

Task 3c: Selected plants will perform plant sensitivity studies to assess the increase in risk from a HEAF in areas with aluminum.

Target: **Spring 2021**—NRC along with industry will complete and issue findings.

A. Plants will perform sensitivity studies using "ZOI for pilot plants."

B. Staff will determine risk impact and issue results.

(Note: If this zone of influence elicitation process is not successful, then the NRC staff and contracted subject matter experts will perform the evaluation, using insights from operating experience and recent test results.)

Milestone 4: Determine HEAF fault characteristics

Task 4a: Determine electrical fault characteristics which correspond to including HEAF events into bin 16 of NUREG-2169, "Nuclear Power Plant Fire Ignition Frequency and Non-Suppression Probability Estimation Using the Updated Fire Events Database"

Task 4a is complete. The results are sufficient to complete the GI assessment, but work will continue as necessary to develop new guidance.

Task 4b: Use an NRC/EPRI MOU HEAF research effort to make an informed judgment on how arcing fault events are counted towards HEAF frequency. This effort will aim to consolidate current HEAF frequency guidance and refine the classification of HEAF "binning".

The frequency of HEAF events should relate to the modeling and treatment of HEAF events from operating history. This joint effort should determine electrical fault characteristics which correspond with including HEAF events into bin 16 of NUREG-2169, EPRI 3002002936, "Nuclear Power Plant Fire Ignition Frequency and Non-Suppression Probability Estimation Using the Updated Fire Events Database: United States Fire Event Experience Through 2009," issued January 2015.

Task 4b is half complete. However, all the frequency work does not need to be fully complete for GI assessment.

The HEAF suppression frequently answered question (FAQ) 17-0013 was completed on March 20, 2018.

The frequency work is continuing and will be needed for developing new generic communication. The frequency refinement effort will proceed in parallel with the GI assessment under the existing EPRI/NRC MOU and will be incorporated into the final results as appropriate. The results from EPRI are expected late summer 2019.

Milestone 5: Complete a risk/safety determination.

Target: Mid 2021

Task 5a Staff will perform a confirmatory review of the information gathered during the pilot plant study including risk insights.

Milestone 6: Complete Assessment report.

Target: Mid 2021

Task 6a: Determine whether the GI should proceed to the next stage, ROI.

A. The GIRP will determine whether the issue should proceed to the next stage, ROI, based upon information obtained from testing, surveys, and industry pilot plant studies.

B. The GIRP will complete its assessment report to include the following:

- technical analysis
- risk/safety determination
- regulatory analysis (Schedule and extent of analysis TBD)

Task 6b: If the decision to proceed to ROI stage is approved by management, then the staff will form a transition team to transfer the issue to the appropriate regulatory office. The transition team will assist in a smooth transition of the GI to the regulatory office. The team may help develop a proposal for new regulatory guidance for HEAFs involving aluminum.

Milestone 7: Develop new generic communications on HEAFs involving aluminum.

Target: During 2020

Task 7a: The staff will determine the extent of condition of having aluminum in electrical components in areas subject to potential HEAFs.

A. The staff will assess the extent of condition of having aluminum in areas susceptible to a HEAF and identify any other generic implications for nuclear power plants.

B. Using information from the industry survey and pilot plant studies, the staff will determine the extent to which aluminum components are used in areas where HEAFs are postulated to occur, assess the impact, and recommend whether further generic communications are necessary.

C. The staff will inform management on possibly issuing a new generic communication or updating existing ones to communicate the potential increase in damage for HEAF events involving aluminum components and will potentially gather more information.

Task 7b: Develop and issue any necessary short-term corrective actions or generic communication.

A. Assess the existing risk-informed/performance-based (RI/PB) fire protection program regulation and guidance to determine whether any necessary short-term corrective actions are appropriate to ensure adequate safety in the event a HEAF occurs in areas where aluminum components are present.

B. Upon completion of large-scale HEAF testing, the staff will form a team of experts to assess the testing results to recommend if any changes are necessary to the ZOI. As appropriate, the staff will use either a working group, as was done for cabinet heat release rates, or an expert elicitation, as was done for the hot short probabilities.

C. The staff will inform management on whether to issue a new or updating existing generic communications to communicate the potential increase in damage for HEAF events involving aluminum components and potentially gather more information.