Revised Response to PRA Issue List Regarding APR1400 FSAR Section 19.1

Issue # PRA-53 (AI 19-53)

It is unclear why some reactor trip sequences do not appear to include the consequential LOOP event. Also, it is unclear from the information in the DCD, how the consequential LOOP was modeled for LOCA and other events that may actuate the ESF.

Response - (Rev.1)

Consequential LOOP is evaluated for all modeled initiating events in the APR1400 full power internal events PRA.

Consequential LOOP is modeled as a top event in the “transient” event trees (e.g., general transients, loss of condenser vacuum, loss of DC bus A or B, loss of feedwater, etc.) Consequential LOOP is modeled in these transient event trees as a transfer to the "GRID-LOOP" event tree for these events since the LOOP event tree is more indicative of the accident sequence progression. That is, the accident sequence success (and failure) paths are the same for these transient events and consequential LOOP events (i.e., successful mitigation requires either successful secondary cooling, or successful feed and bleed with subsequent long-term heat removal) and by transferring to the GRID-LOOP event tree, allows for subsequent consideration of SBO events. Subsequent failure of all four DGs can transfer from the GRID-LOOP event tree to the GRID-SBO event tree which considers the use of the alternate AC (AAC), and the possibility of offsite power recovery. Transfer to the GRID-LOOP event tree is determined as a result of the evaluation of fault tree gate GNP-GRID which is a small sub-tree which selects the appropriate basic event for the likelihood of consequential LOOP given the initiating event. Failure of fault tree GNP-GRID results in transfer to the GRID-LOOP event tree. Success of fault tree GNP-GRID results in the evaluation of remainder of the event tree for the original initiating event.

For the other events including SGTR and LOCAs, LSSB’s, etc. the accident sequence progression is significantly different than it is for GRID-LOOP, and this sequence information would be lost if there were a transfer to the GRID-LOOP tree. Hence, the conditional loss of offsite power is modeled within the fault trees supporting the event tree top events for these initiators (fault tree gate GNP-GRID). GNP-GRID, which incorporates the probability of consequential LOOP given a reactor trip, directly fails offsite power in the AC power fault trees by failing power to the UATs and SATs. Note that by not transferring to the GRID-LOOP event tree, there is no subsequent transfer to the GRID-SBO event tree if all four DGs fail, and therefore, neither the AAC nor the possibility of offsite power recovery is considered (e.g., SLOCA with subsequent SBO is considered a non-recoverable core damage sequence). This may be conservative, but generally, the small IEFs associated with these type initiators coupled with the likelihood of a conditional LOOP and the low probability of failing all four DGs makes these cutsets non-risk significant.

However, upon discussion with the NRC, further review of fault tree GNP-GRID was performed, and it was determined that the appropriate conditional loss of offsite power basic event was not always being chosen. The APR1400 PRA model assumed that there were separate two conditions leading to a conditional LOOP event; LOCAs, and non-LOCAs. Review of industry data (e.g., NUREG/CR-6538, etc.) identify two cases as well, but the cases are reactor trips

without a coincident ESF actuation signal, and reactor trips with a coincident ESF actuation signal. Since there are non-LOCA events which result in the generation of an ESF signal (e.g., some large steam line breaks, etc.), it was determined that the APR1400 PRA model is using the incorrect consequential LOOP probabilities for non-LOCA initiators which generate an ESF signal.

This issue will be fixed in the next PRA update to ensure that all modeled initiators which result in ESF signal generation use the consequential LOOP probability associated with events which cause result in ESF signal generation, and only those initiators which do not generate an ESF signal will use the consequential LOOP probability associated with events which do not result in ESF signal generation. Current industry guidance will be reviewed to determine the appropriate values for these two consequential LOOP probabilities.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is impact on the DCD, thus PRA model (specifically the logic under fault tree gate GNPGRID) will be revised to ensure that the appropriate consequential LOOP probabilities are being applied to each initiating event modeled in the APR1400 Full Power Internal Events PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

The Data Analysis Notebook (APR1400-K-P-NR-013104-P) will be updated as appropriate during the next PRA update to include the any changes to the consequential LOOP basic events, and to update the reference for the data source, if necessary. The Auxiliary Power System Notebook (APR1400-K-P-NR-013211-P) will be revised during the next PRA update to correct the consequential grid failure sub-tree (GNP-GRID) to ensure that all modeled initiating events use the appropriate consequential LOOP probability as defined in the Data Analysis Notebook.