**TRN Resource: Combining Solutions into Solution Sets for Risk Reduction**

Due to the multiplicative nature of the risk calculations employed in the Risk Assessment Excel workbook, the risk reduction associated with a combination of two solutions is likely to differ from the sum of the risk reduction provided by each solution individually. This characteristic may create the temptation to analyze every potential solution and combination of solutions to address risk associated with a given critical load, which may be both infeasible and not particularly valuable. This worksheet provides guidance to avoid this problematic situation, by suggesting reasonable methods to limit and/or combine the analyzed solutions.

## Avoid Combining Mutually Exclusive Solutions into Solution Sets

When developing solution sets, take care to avoid combining multiple solutions where the implementation of one solution would make the others unnecessary into solution sets. For example, developing or improving a redundant system with automated start-up is an alternative to doing the same for a system with manual start-up with procedures and training. There is no need to analyze those two competing solutions together.

## Create Solution Sets That Holistically Address Vulnerability

The vulnerability portion of the Technical Resilience Navigator (TRN) Risk Assessment Excel workbook documents resilience gaps in several categories: redundancy, design basis, reliability, and start-up configuration. In the Risk Assessment Excel workbook, these are presented as vulnerability questions. Shortfalls in any of these categories should be considered a gap. But, if there are gaps in multiple categories, remedying any one individually does not provide substantial risk reduction.

Only by improving or providing a redundant system that is fully functional, with “yes” answers in every category of the vulnerability questions seen in **Tab 4** of the Risk Assessment Excel workbook (with start-up either automated or manual with up-to-date procedures and training), can major risk reductions be attained.

While solutions may be developed to address each of the individual gaps associated with the various vulnerability categories, consider combining those solutions into a solution set that provides a fully functional redundant system. Rather than investigate each individual risk-reducing solution, and every possible combination of those solutions, this allows a much smaller number of combinations to be analyzed.

### An Example of Combining Vulnerability Reducing Solutions

Assume you are looking at a risk scenario from the Risk Assessment Excel workbook that addresses vulnerability by answering the vulnerability questions in **Tab 4** of the Risk Assessment Excel workbook. In this example, assume that there was a primary redundant system, but it was not designed for a specific hazard or threat, had no reliability measures, did not have automatic start-up, and did not have any written procedures for manual start-up. Potential solutions could include:

* Redesigning the primary backup system to withstand the realized hazard or threat from the risk scenario
* Adding a preventive maintenance plan, with written schedules and procedures and documentation of performance and testing, alongside onsite parts sufficient for the duration of the realized hazard or threat
* Adding automatic start-up configuration
* Adding written procedures for manual start-up with regular training.
* Adding a secondary redundant service.

Due to the multiplicative nature of risk, the chances of any of these individual solutions having a major impact on the risk reduction to the site is low; however, combining them into a solution set may result in lower site risk. Keeping in mind the guidance above, we know that:

* Solutions C and D are mutually exclusive and contradictory solutions to the same vulnerability issue. Putting them together in the same solution set would not result in any additional risk reduction. Therefore, any solution sets developed should not include both of them.
* Combining Solutions A, B, and D or Solutions A, B, and C would address vulnerabilities to the primary redundancy system. These could be considered solution sets that would have a greater impact on risk reduction than individual solutions.
* Solutions A, B, and D or Solutions A, B, and C could be modified to be more comprehensive by including Solution E so that all vulnerabilities from the redundant systems (first and second) are addressed.
  + Keep in mind that it would be more logical to include a second redundant system that addresses key vulnerabilities (i.e., is designed against dual-impact hazards, has reliability measures, and is able to start up if called upon).

## Accelerated Mission Restoration

Solutions may also reduce consequence of the loss of an asset by accelerating mission restoration without the use of the critical load. Consider if any solutions that accelerate mission restoration can be applied site-wide, across multiple critical loads, or if the cost and scope of the individual solution is such that it needs to be considered individually for each critical load in the prioritization process.

For example, if a mutual-aid agreement could reduce the mission restoration time across the entire site, it would make more sense for that solution to be carried forward rather than analyzing a separate mutual-aid agreement for each critical load.