

cables, commonly referred to as "inter-cable shorting." Inter-cable shorting is less likely than intra-cable shorting. At this time, the following configurations should be considered:

- For any individual multiconductor cable (thermoset or thermoplastic), any and all potential spurious actuations that may result from intra-cable shorting, including any possible combination of conductors within the cable, may be postulated to occur concurrently regardless of number. However, as a practical matter, the number of combinations of potential hot shorts increases rapidly with the number of conductors within a given cable. For example, a multiconductor cable with three conductors (3C) has 3 possible combinations of two (including desired combinations), while a five conductor cable (5C) has 10 possible combinations of two (including desired combinations), and a seven conductor cable (7C) has 21 possible combinations of two (including desired combinations). To facilitate an inspection that considers most of the risk presented by postulated hot shorts within a multiconductor cable, inspectors should consider only a few (three or four) of the most critical postulated combinations.

- For any thermoplastic cable, any and all potential spurious actuations that may result from intra-cable and inter-cable shorting with other thermoplastic cables, including any possible combination of conductors within or between the cables, may be postulated to occur concurrently regardless of number.

- For cases involving the potential failure of more than one multiconductor cable, a maximum of two concurrent spurious actuations should be assumed. For cases where more than two concurrent spurious actuations can occur as the result of intra-cable shorting within a single multiconductor cable they should be considered. The consideration of more than two concurrent spurious operations in more than two cables will be deferred pending additional research.

- Inspectors will consider the potential spurious operation of a direct current (DC) circuit given failures of the associated control cables even if the spurious operation requires two concurrent hot shorts of the proper polarity (e.g., plus-to-plus and minus-to-minus) provided the required source and target conductors are each located within the same multiconductor cable.

- The consideration of thermoset cable inter-cable shorts will be deferred pending additional research.

D. Instrumentation Circuits. Required instrumentation circuits are beyond the scope of this associated circuits guidance and must meet the same requirements as required power and control circuits. There is one case where an instrument circuit could potentially be considered as an associated circuit. If a fire-induced failure of an instrument circuit could interfere with the post-fire safe-shutdown capability, but not have a direct effect on systems and equipment needed to achieve and maintain hot shutdown, then the instrument circuit may be treated as an associated circuit and handled accordingly.

3. *Likelihood of Undesired Consequences.* The inspectors must assess the potential consequence of the associated circuit failure. The inspector should review the specific NPP process and instrumentation diagrams (P&IDs)¹ for flow diversions, loss of coolant, or other scenarios that could significantly impair the NPP's ability to achieve and maintain hot shutdown.² For the specific area under evaluation, the inspector may wish to consider components that could prevent operation or cause maloperation as the components of interest. When considering the potential consequence of such failures, the inspector should also consider the time at which the prevented operation or maloperation occurs. Failures that impede hot shutdown within the first hour of the fire tend to be most risk-significant in a first-order evaluation. Consideration of cold shutdown circuits will be deferred pending additional research.

Items To Be Deferred at This Time, Pending Additional Research

The following items are either considered of relatively low risk significance and/or are being deferred pending additional research:

- Inter-cable shorting for thermoset cables is considered to be substantially less likely than intra-cable shorting. Hence, the inspection of potential spurious operation issues involving inter-cable shorting for thermoset cables is being deferred pending additional research.

- Inter-cable shorting between thermoplastic and thermoset cables is considered less likely than intra-cable shorting of either cable type or inter-cable shorting of thermoplastic cables. The inspection of spurious actuation issues involving inter-cable shorting

¹ For NPPs that do not use P&IDs, the inspector will have to gather the same information from flow diagrams and cable routing/logic diagrams.

² Hot shutdown is defined in the NPP technical specifications.

between thermoplastic and thermoset cables is therefore being deferred pending additional research.

- Pending further research, inspectors will not consider configurations involving three or more concurrent spurious operations involving more than three cables.

- Recent testing strongly suggests that a control power transformer (CPT) in a control circuit can substantially reduce the likelihood of spurious operation. The power output of the CPT relative to the power demands of the controlled device(s) appears critical. Pending additional research, inspectors may defer the consideration of multiple (i.e., two or more) concurrent spurious operations due to control cable failures if they can verify that the power to each impacted control circuit is supplied via a CPT with a power capacity of no more than 150% of the power required to supply the control circuit in its normal modes of operation (e.g., required to power one actuating device and any circuit monitoring or indication features).

- Recent testing strongly suggests that fire-induced hot shorts will likely self-mitigate (e.g., short to ground) after some limited period of time. Available data remains sparse, but there are no known reports of a fire-induced hot short that lasted more than 20 minutes. This is of particular importance to devices such as air-operated valves (AOVs) or pressure-operated relief valves (PORVs) which return to their de-energized position upon mitigation of a hot short cable failure. Pending further research, inspectors should defer the consideration of such faults if they can verify that a spurious operation of up to 20 minutes duration will not compromise the ability of the plant to achieve hot shutdown.

Items Not To Be Considered at This Time in Inspections

The following items are considered of very low likelihood and/or low risk, and will not be considered in the risk-informed inspection process:

- Open circuit (or loss of conductor continuity) conductor failures will not be considered as an initial mode of cable failure. Note that cable shorting (e.g., a short to ground) may result in an open circuit fault due to the tripping of circuit protection features.

- Inter-cable short circuits involving the conductors of an armored cable will not be considered. Such failures are considered virtually impossible unless the short involves the cable's grounded armoring.

- Inter-cable short circuits involving the conductors of one cable within a