



Transitioning From Appendix R to NFPA 805: Risk Assessment Pathway

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TRANSITIONING FROM APPENDIX R TO NFPA 805: RISK ASSESSMENT PATHWAY

Illustrative method for NFPA 805
transition (Section 4.2.4.2) via
manual suppression example



Appendix R



- 10 CFR Part 50, Appendix R, Paragraph III.G.2
 - Except as provided for in paragraph G.3 ..., one of the following means of ensuring that one of the redundant trains is free of fire damage shall be provided [non-inerted containment]
 - Separation ... by a fire barrier having a 3-hour rating
 - Separation ... by a horizontal distance of more than 20 feet with no intervening combustible or fire hazards ... [with] fire detectors and an automatic fire suppression system
 - Enclosure ... in a fire barrier having a 1-hour rating ... [with] fire detectors and an automatic fire suppression system



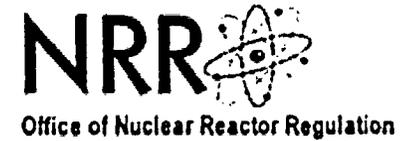
Appendix R (continued)



- 10 CFR Part 50, Appendix R, Paragraph III.G.3
 - Alternative or dedicated shutdown capability ... in the area ... under consideration should be provided
 - Where the protection of systems whose function is required for hot shutdown does not satisfy the requirement of paragraph G.2 of this section; or
 - Where redundant trains of systems required for hot shutdown located in the same fire area may be subject to damage from fire suppression activities or from the rupture or inadvertent operation of fire suppression systems
 - In addition, fire detection and a fixed fire suppression system shall be installed



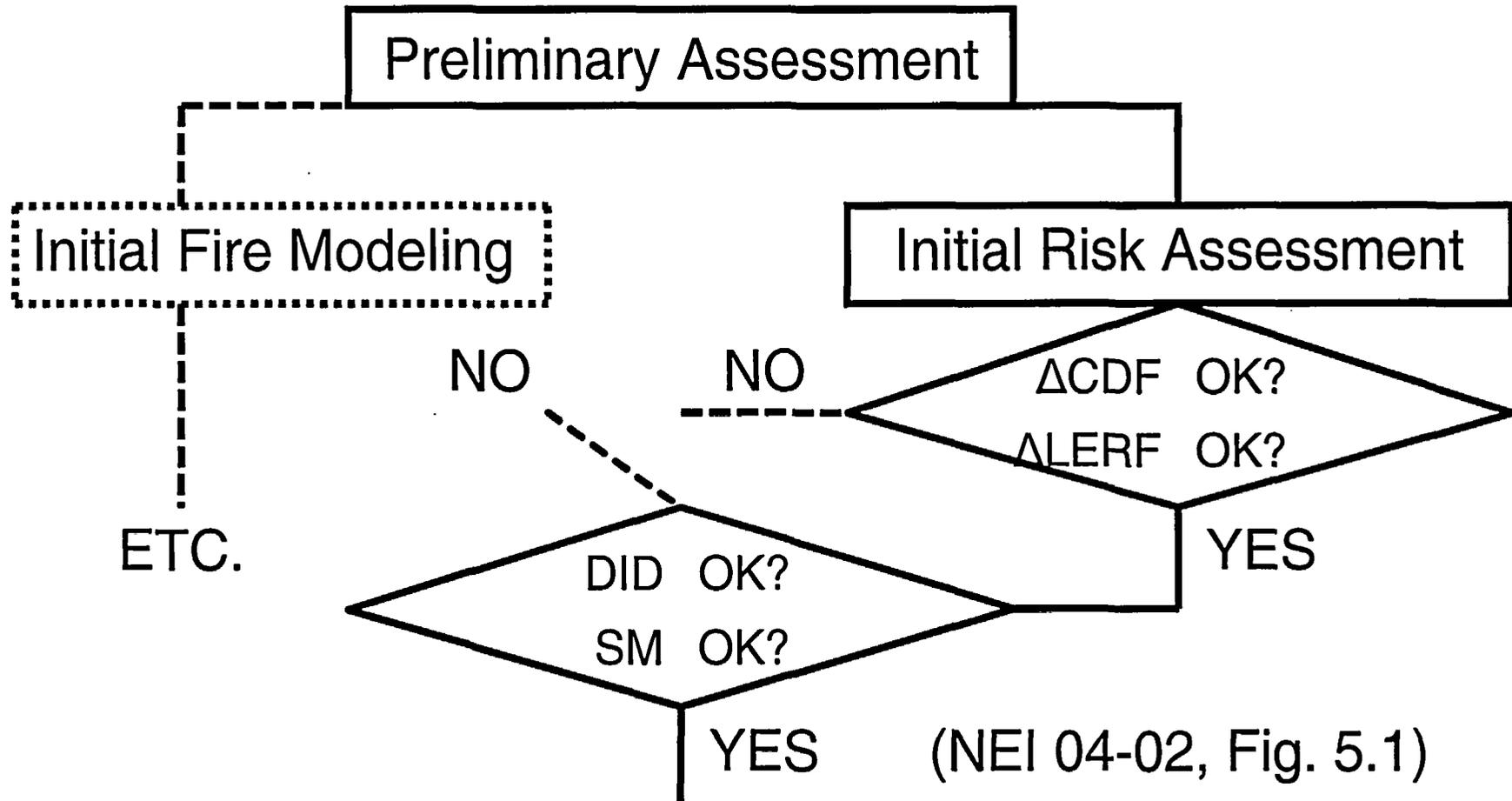
Cable Spreading Room



- Appendix R licensee has cable spreading room (CSR) protected by non-compliant fixed gaseous suppression system
 - Cables for numerous redundant trains are present
 - Compensatory measures temporarily in place
- Compliance alternatives
 - “Deterministic” – upgrade current or install new suppression system (expensive), or file exemption
 - “Risk-informed, performance-based” – NFPA 805



Change Evaluation Process



Done – Document Analysis



Appendix R → NFPA 805



- Preliminary assessment via initial fire modeling or initial risk assessment
- “An example approach for acceptance criteria for changes in risk from a plant change can be found in Regulatory Guide [RG] 1.174” (NFPA 805)
 - RG 1.174 and NFPA 805 also require that adequate defense-in-depth (DID) and sufficient safety margin (SM) be maintained



Initial Risk Assessment NRR

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- Fire frequency, CSR (λ) = 0.003/yr
- Probability of non-suppression (P_{NS})
 - System maloperates (0.05) + suppressing agent is ineffective (0.05) ≈ 0.1
- Probability of cable failures (P_{CF}) = 0.1
- Conditional core damage probability (CCDP) = 0.1 (alternative shutdown)
 - All of above are “mean” values



Risk Assessment (Cont.)



- Δ Core damage frequency (CDF)
 - $\lambda * P_{NS} * P_{CF} * CCDF = 3E-6/yr$ (“mean”)
 - “Mean” ΔCDF does not satisfy RG 1.174 quantitatively (i.e., $< 1E-6/yr$)
 - Alternatives
 - Upgrade current or install new suppression system
 - Satisfy “deterministic” requirements (Appendix R, III.G.3)
 - Credit highly reliable automatic detection and manual suppression by plant fire brigade
 - Re-evaluate ΔCDF



Risk Assessment (Cont.)



- Credit highly reliable automatic detection and manual suppression by plant fire brigade
 - Probability of non-suppression, manual (P_{NS}) = 0.01
- From before
 - Fire frequency, CSR (λ) = 0.003/yr
 - Probability of cable failures (P_{CF}) = 0.1
 - Conditional core damage probability (CCDP) = 0.1 (alternative shutdown)
- “Mean” Δ CDF now = $3E-7$ /yr
 - Satisfies RG 1.174 quantitatively (i.e., $< 1E-6$ /yr)



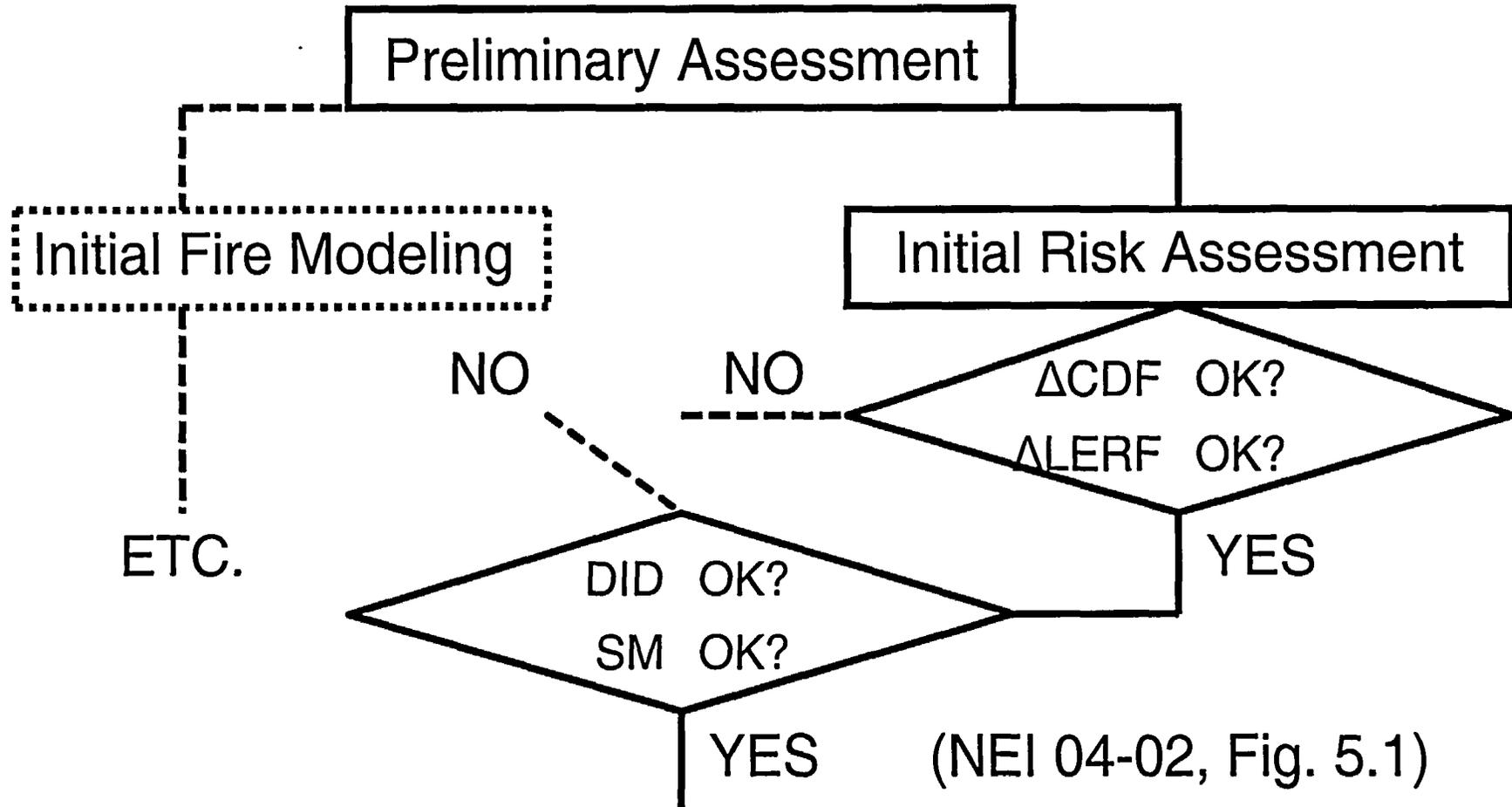
Risk Assessment (Cont.)



- RG 1.174 also requires that adequate DID and sufficient SM be maintained
 - Typically, this is evaluated qualitatively
 - Nonetheless, a quantitative estimate on the upper bound Δ CDF can suggest whether additional DID or SM is needed



Change Evaluation Process



(NEI 04-02, Fig. 5.1)

Done - Document Analysis



Risk Assessment

(Continued)



- Assume λ , P_{NS} , P_{CF} and CCDFP are lognormal variables with large error factors (EFs) of 10 each \rightarrow total compound EF on Δ CDF $<$ $\exp\{(4[\ln 10]^2)^{0.5}\} \approx 100$, implying an upper bound $\approx 6E-7/\text{yr}$ (i.e., $100 * \underline{\text{median}}$, not mean [$\neq 100 * 3E-7/\text{yr}$])
 - Even this upper bound satisfies the RG 1.174 criterion of $1E-6/\text{yr}$, suggesting adequate DID and SM
 - RG 1.174 Δ LERF requirements follow parallel thought process (omitted in example)



Summary



- Example for manual suppression under Appendix R, Paragraph III.G.3, chosen to illustrate transition to NFPA 805 via Change Evaluation Process pathway for initial risk assessment
 - RG 1.174 quantitative (Δ CDF [and Δ LERF]) and qualitative (DID and SM, with quantitative representation) criteria are satisfied