



SAFE – The Post-Fire Reactor Safety Solution

Ensure plant safety using deterministic, performance-based, or a combination of both safe shutdown analysis strategies.

The Genesis® System Assurance and Fire Protection Engineering (SAFE) module automates plant-system failure analysis by evaluating a model of plant systems, equipment, and cable support relationships. This model is success path based. SAFE maintains this success path model including equipment and cable location and resolution data.

SAFE is developed to automate the regulatory compliance analysis required by:

- 10 CFR 50 Appendix R
- NFPA 805 Performance-Based analysis
- Fire PRA, NUREG/CR-6850
- Non-Power Operations
- Multiple Spurious Operations, RG 1.189

SAFE supports fire PRA models using dedicated reporting of individual fire events that report direct fire failures. These reports can directly input PRA software such as CAFTA® or WinNUPRA®. The PRA code calculates the CCDP/CLERP for the fire, given the set of unavailable equipment.

System Features

Analysis Model

Define success paths for performance goals, systems, equipment and cables:

- **Systems supporting performance goals**
- **Equipment supporting plant systems**
- **Equipment supporting equipment**
- **Cables supporting equipment**
- **Systems supporting equipment**

Automated Analysis

Identify the failed cables and equipment in the evaluation area and determine the effects of those failures by propagating the failures through the success paths defined in the analysis model.

Analysis Change Process

Track and manage the revision of the analysis model using the Analysis Change Process (ACP). Perform a what-if analysis by placing portions of the analysis model into a revised design state.

Get automated status updates based on electronic signatures for preparer, reviewer and approver. Electronic history files are automatically created and viewable from within SAFE.

Analysis Results

Displaying the analysis model by success path in SAFE's hierarchical tree-view allows you to view the post-fire status of all components and their support success paths. To distinguish between failed and unaffected components within the analysis tree, failed components are displayed in red text. The analyst uses this information to develop and assign resolutions to system, equipment, or cable failures, thereby crediting their performance. When this analysis is re-run, these resolutions prevent failure of the resolved items. SAFE provides an analysis review form, so you can evaluate

the contribution of a resolution to the analysis. SAFE displays resolved components in blue text.

What-If Analysis

Postulate changes and evaluate the results without affecting the database analysis of record, thereby maintaining data integrity during the evaluation. The what-if scenario feature allows you to postulate a particular set of equipment and cables to be considered as failed by the analysis.

Analysis Reporting

SAFE includes analysis summary and failure report generation functions for many types of reports including:

- *Success path*
- *Logic diagrams*
- *Equipment and cable data sheet*
- *System logic*
- *Equipment and cable resolution by fire area*
- *Manual actions resolution*

The screenshot shows the GENESIS SOLUTION SUITE - SAFE-PB: BFNP interface. The main window displays a hierarchical tree view of analysis results. The tree starts with 'GOALS, ALL: Systems, ALL: Equip-Equip, ALL: Equip-Cables, ALL: Equip-Systems, ALL: Locations, 02:01: ACP M...' and branches down through various components. Some components are highlighted in red text, indicating they are failed, while others are in blue text, indicating they are resolved. The tree view includes sub-panels for 'System Success Path: 1 - ALL', 'Equipment Success Path: 1ALL', and 'Cable Success Path: 1ALL'. A legend at the bottom of the window explains the symbols and text colors used in the analysis results.

Symbol	Description	Text Color	Component Type
Red lightning bolt	Unavailable due to direct damage or logical failure	Red Text	Failed equipments, cables, systems, and performance goals
Blue checkmark	A Resolution is applied to this component	Blue Text	Resolved equipment, cables, and systems
Green star	Required for Hot Shutdown	Black Text	Available equipment, cable, system, or performance goal (without resolution)
Yellow exclamation mark	Important to Safe Shutdown	Black Text	Available equipment, cable, system, or performance goal (without resolution)
Green checkmark	Required for Hot Shutdown and Resolved	Blue Text	Resolved equipment, cables, and systems
Red lightning bolt	Required for Hot Shutdown and Unavailable	Red Text	Failed equipments, cables, systems, and performance goals
Yellow exclamation mark	Important to Safe Shutdown and Resolved	Black Text	Available equipment, cable, system, or performance goal (without resolution)
Yellow exclamation mark	Important to Safe Shutdown and Unavailable	Black Text	Available equipment, cable, system, or performance goal (without resolution)
Red lightning bolt	Required for Hot Shutdown and Unavailable	Red Text	Failed equipments, cables, systems, and performance goals
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Yellow exclamation mark	Important to Safe Shutdown and Unavailable	Black Text	Available equipment, cable, system, or performance goal (without resolution)

SAFE Analysis Results

The analysis summary report provides you with a detailed presentation of the area being analyzed. This report provides that post-fire status of all modeled performance goals, systems, equipment and cables.

The analysis summary report includes a detailed analysis of causes for each failed performance goal, system, equipment, and cable. Failure presentation details support components associated with equipment failure, such as electrical equipment failure and/or cable failures.

NEI 00-01 / Regulatory Guide 1.189

Extend the deterministic analysis to include the potential for multiple, simultaneous and spurious actuations by associating the affected system to a RIS performance goal (method). SAFE's analysis engine, using the existing deterministic cable logic, provides the results of a fire as a result of multiple shorts.

NFPA 805 Performance-Based Analysis

SAFE enables you to refine the deterministic analysis model by evaluating fire model scenarios for a given compartment. The Appendix R analysis and the 805 analysis models share the appropriate data.

Non-power Operational Mode Analysis

SAFE includes Non-Power Operational (NPO) mode assessments. The assessment includes an analysis of a different or additional set of systems and components and time dependencies; during non-power operations and full power operations, as well as an evaluation of Key Safety Functions (KSF) for High Risk Evaluations (HRE) as mandated by NUMARC 91-06.

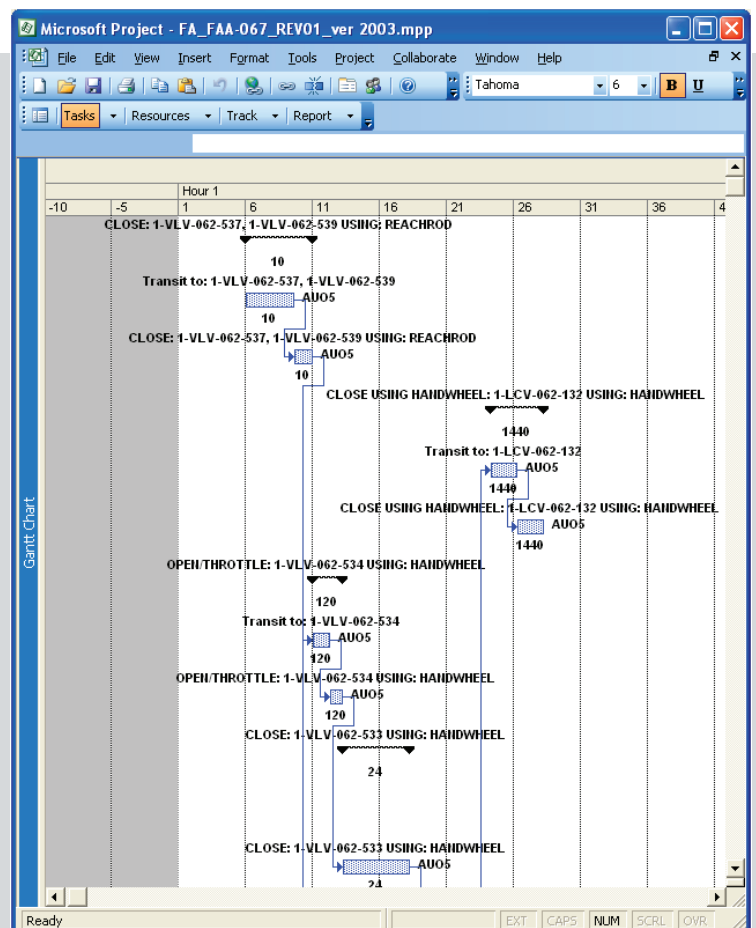
NPO positional requirements, which may differ from the Appendix R analysis, are defined. The analyst performs a separate non-power operational mode analysis using NPO specific resolutions.

Manual Operator Actions/Timelines

SAFE documents the basis of the manual actions feasibility and reliability analysis in accordance with NUREG-1852. Functionality to generate manual operator action timelines is also included. SAFE interfaces with Microsoft® Project to produce a manual actions timeline by operator.

Combustible Loading

SAFE calculates combustible loads of cables, and fixed and transient combustibles by fire area and fire zone. A transient combustible material permit controls which transient combustibles are allowed within a fire zone location. Based on the permit's status, SAFE automatically adds or removes transient combustibles to or from a fire zone and



updates the fire zone's combustibles loading calculations. The fire protection combustibles loading feature also calculates fire severity. SAFE fire area records track fire zone specific data for suppression, detection and exemptions.

Analysis Archival and Archive Manager

SAFE analyses are maintained online to support evaluation of design changes. The analysis archival tool electronically stores the analysis of record, allowing online comparison of the what-if analysis to the analysis of record. You can retrieve a previously archived analysis and compare it visually or electronically, with new results to evaluate the impact of proposed design changes.

The archive management tool provides the ability to generate analysis summary reports for archived analysis files. The archive management tool includes features to help track the progress of archiving SAFE analyses. The analysis of record is updated and re-archived.

NFPA 805 Performance-Based Transition

For plants transitioning to NFPA 805, the entire plant is partitioned into fire compartments.

SAFE supports a fire compartment characterization for the entire plant. This compartmentalization includes calculating the barrier failure probabilities, evaluating barrier openings and penetrations, and identifying the presence of automatic suppression/detection in support of multi-compartment scenario analysis.

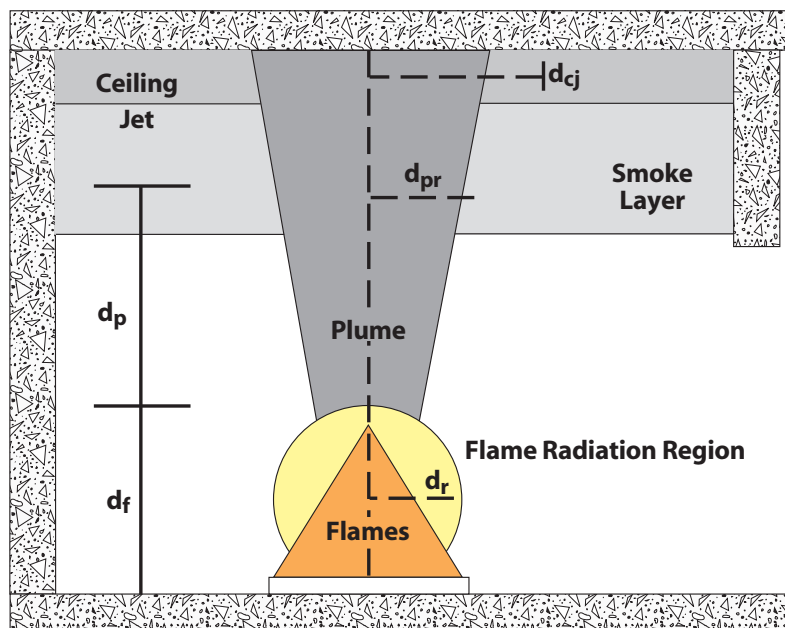
In support of the risk change evaluations in RG 1.174, fire ignition frequencies are automatically calculated for each fire compartment and fire scenario. These ignition sources (equipment types) are generically identified as ignition frequency bins. SAFE also calculates the fire sizes for example, heat release rates (HRR) for each fixed ignition source.

Once the total frequencies are calculated, you can apply severity factors to the ignition sources to adjust the total fire frequency. The SAFE calculation of severity factor can be overridden by manually entering an externally calculated severity factor.

Fire Scoping

The SAFE Fire Zone of Influence (ZOI) form calculates the range of possible fire-generated hazardous regions critical damage distances for: flame, flame irradiation region, fire plume, ceiling jet, and the hot gas layer, as represented in NUREG/CR-6850, Figure F-3.

NUREG/CR-6850, Figure F-3



Modeling

SAFE helps you manage the Fire PRA data and results and fire modeling tools necessary to evaluate a specific fire scenario.

Fires are modeled using tools such as FIVE Worksheets, NUREG-1805 FDTs, FDS, CFAST, etc. and the results are documented in SAFE. Input/output files generated outside of the system, using tools such as FDS® and Smokeview®, are linked in SAFE to the fire modeling records.

Additional Features

SAFE can generate logic statements for Cable and Equipment success path logics and system logic statements and will display a logic diagram for each of these logic statements.

Compliance

SAFE supports the following compartment screening methods as defined in NUREG/CR-6850:

1. **Qualitative**
2. **Quantitative with complete fire compartment burnout**
3. **Quantitative with screened ignition sources**
4. **Fire scenario based**

These screening methods become progressively more complex.

SAFE calculates the core damage and large early release frequencies for each fire compartment and fire scenario defined. This calculation combines the externally calculated CDF and LERF with the SAFE fire modeling and fire protection evaluations.

NFPA 805 requires that analyses be documented to demonstrate compliance with NFPA 805 that results be clearly and consistently described, and that sufficient detail be provided to allow future review of the analyses. The documentation must be retained for the life of the plant.

Using SAFE as a fire casualty evaluation of post-fire system availability automated analysis engine and a single repository of information simplifies the process of performing and later maintaining a risk-informed, performance based fire protection/ safe shutdown analysis.

For more information, contact Vincent Renzi at vrr@epm-inc.com or 508-532-7167

SAFE Version 5.9.0

SAFE DEPLOYMENT REQUIREMENTS:

Server:

Database Management System - Oracle® Version 9.x (or greater) or MS/SQL Server 2005 (or greater)

Operating System - Microsoft® Windows Server 2003, 2008 or Unix/Solaris

Disk Space - 5 GB

Memory - 1 GB (minimum)

Client:

Operating System - Microsoft® Windows 7, Vista, XP, 2000

Disk Space - 250 MB

Memory - 1 GB (minimum)

Oracle® Objects 2.3.x (or greater)

Microsoft® ADO 2.6



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