Department of Energy
Washington, DC 20585

February 2, 2006

The Honorable A. J. Eggenberger
Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, NW, Suite 700
Washington, D.C. 20004-2901

Dear Mr. Chairman:

The Department of Energy's (DOE) Implementation Plan (IP) for Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2004-2, *Active Confinement Systems*, requires DOE to develop a methodology and issue guidance for systematically reviewing and assessing the confinement ventilation systems for many of its defense nuclear facilities. This guidance is deliverable 8.5.4, *Safety Related Ventilation System Evaluation Guidance* and deliverable 8.7, *Non Safety Related Ventilation System Evaluation Guidance.* These deliverables were due December 16, 2005 and December 15, 2005, respectively. By letter to you dated December 15, 2005, DOE indicated that the deliverables would be combined into one document and be provided by January 31, 2006. Enclosed is that guidance document, *Ventilation System Evaluation Guidance for Safety-Related and Non-Safety-Related Systems.*

We appreciate the involvement and input provided by your staff. If you or your staff have any questions, please contact me at 301-903-0104.

Sincerely,

Richard Black
Director
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U. S. Department of Energy

Deliverables 8.5.4 and 8.7 of Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 2004-2

Ventilation System Evaluation Guidance for Safety-Related and Non-Safety-Related Systems

Washington, D.C. 20585

January 2006

Revision 0

REVISION LOG

Revision	Date	Page/Section	Change
0	January 2006	Whole Document	Initial Issue

FORWARD

1. This Department of Energy (DOE) guidance document has been approved for use by the Department of Energy, including the National Nuclear Security Administration (NNSA), and its contractors. Any reference to a document (e.g., DOE standards, orders, and guides) refers to the most current revision.

2. Beneficial comments (recommendations, additions, and deletions) and any pertinent data that may be of use in improving this document should be addressed to the following:

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3. This guidance document has been prepared in response to Defense Nuclear Facilities Safety Board Recommendation 2004-2, and the Department's corresponding Implementation Plan for addressing the recommendation. It has not been evaluated for use in applications other than for meeting Implementation Plan deliverables 8.5.4 and 8.7.

CONTRIBUTING PERSONNEL

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ABBREVIATIONS AND ACRONYMS

AEA	Atomic Energy Act
CEDE	committed effective dose equivalent
CTA	Central Technical Authority
CVS	Confinement Ventilation System
DID	defense in depth
DNFSB	Defense Nuclear Facilities Safety Board (Board)
DOE	Department of Energy
DSA	documented safety analysis
ED	expected dose
EG	evaluation guideline
FET	Facility Evaluation Team
HEPA	high efficiency particulate air
IP	implementation plan
IRP	Independent Review Panel
LCO	Limiting Conditions for Operation
LPF	leak path factor
MAR	material at risk
M_{EFF}	mitigation efficiency
MOI	maximally-exposed offsite individual
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
P_{EV}	event probability
PISA	potential inadequacy in safety analysis
PDSA	preliminary documented safety analysis
P_{MF}	probability of mitigation failure (i.e., net failure rate)
PSO	Program Secretarial Officer
SET	Site Evaluation Team
SC	safety class
SS	safety significant
SSC	structures, systems and components
UD	unmitigated dose
USQ	unreviewed safety question

1. Introduction

On December 7, 2004, the Defense Nuclear Facilities Safety Board (Board) issued Recommendation 2004-2 to the Department of Energy (DOE). Recommendation 2004-2 noted concerns with the confinement strategy utilized or planned for in several facilities to confine radioactive materials during or following accidents. The Board's main issue is that active confinement systems that rely on motive force and filters should be preferred in the safety basis control selection process over passive confinement systems that use facility structures and components (e.g., facility enclosure without the motive force). It asserts that passive confinement systems may not be effective in all accident scenarios to protect the public or collocated workers. The Board therefore recommended that DOE disallow reliance on passive confinement systems unless they can be justified to provide adequate protection under the circumstances. On August 22, 2005 DOE forwarded its implementation plan (IP) for Recommendation 2004-2 to the Board. The Board accepted the Department's IP on September 19, 2005.

The DOE IP for Recommendation 2004-2 proposed a methodology for systematically reviewing the ventilation systems at each of the sites. In accordance with the *Recommendation 2004-2 Exclusion Report* (Deliverable 8.3), those defense nuclear facilities that can be excluded from the analysis as a result of the nature of their operations will be eliminated from further evaluation. For hazard category 3 defense nuclear facilities with an active confinement ventilation system, a facility listing will be prepared and submitted for site or field office review and approval (Deliverable 8.4) and these facilities will also be excluded from further evaluation.

Remaining hazard category 2 and 3 facilities will complete a confinement ventilation system evaluation, either a *Safety-Related Ventilation System Evaluation* (Deliverable 8.6.1) or a *Non Safety-Related Ventilation System Evaluation* (Deliverable 8.8.1). The current plans will be to complete confinement ventilation system evaluations for two to four facilities as pilot facilities, and once these are complete to validate the path forward for the remaining hazard category 2 and 3 facilities.

The purpose of this document is to provide guidance to complete these evaluations, which will be referred to as the *Ventilation System Evaluation*. This evaluation will verify that the performance criteria identified for the ventilation system in the related Documented Safety Analysis Reports (DSAs) are appropriate, and can be met. As part of this assessment a determination will be made whether the installed system requires modification or upgrade. In addition, the system evaluation will also reaffirm the functional classification of the structures, systems, and components (SSCs) associated with the confinement ventilation system. Safety significant (SS) and safety class (SC) SSCs will be reviewed to determine if their designation was appropriate. Once the pilot evaluations are complete, a determination will be made regarding the need to revise this guidance document.

This document provides specific guidance regarding evaluations that will be performed for system designs, gap identification, and the development of a gap resolution strategy to

determine the cost and benefit of addressing the identified gaps to performance expectations identified for Recommendation 2004-2. This methodology delineates the issues to be reported and the format of the *Ventilation System Evaluation*. The review criteria are based on the Department's existing regulatory infrastructure, requirements, and methodologies established in 10 CFR Part 830, DOE Order 420.1B, DOE-STD-3009, and related guidance documents. The Recommendation 2004-2 Core Team assembled a subject matter expert group from various DOE sites and Program Secretarial Officers (PSOs) to review the ventilation system design criteria, codes and standards contained in DOE G 420.1-1, the DOE Nuclear Air Cleaning Handbook, and associated appropriate DOE Standards. The subject matter expert group reviewed the ventilation system codes and standards to understand and identify differences between those that would be derived for a non-safety-related design versus a safety-related design. Based on this review, a reasonable, workable list of generic ventilation system performance and/or design attributes was developed and is provided in this guidance document.

In addition to a set of performance and/or design attributes derived from current codes and standards, a second subject matter expert group developed a methodology to evaluate the cost/benefit considerations that are inherent in any DOE decision on potential system upgrades that may enhance performance. This group developed a cost/benefit analysis process that can be utilized to aid in selecting proposed modifications to ventilation systems, which is provided in this guidance document. The process can be used (where warranted for complex decision-making situations) to ensure the focus will be on those modifications to the active confinement ventilation system that are most likely to significantly improve their safety performance. The Department held a workshop to review the material developed by the subject matter expert groups to ensure the approach developed for completing the facility-specific system evaluations and the cost/benefit process represent workable approaches, and to finalize an adequate set of performance and/or design attributes. This workshop was necessary to ensure that the approach developed will avoid unnecessary repetition of DSA work and/or safety system operability reviews, and focus on appropriate physical aspects of confinement ventilation systems.

2. Applicability

The development of a *Safety-Related Ventilation System Evaluation* is limited to facilities that meet the following criteria:

- The facility/facility section was not excluded by the Site's *Recommendation 2004-2 Exclusion Report* submitted as required by Deliverable 8.3 of the Department's IP for Board Recommendation 2004-2.
- For Hazard Category 2 nuclear facilities, the facility/facility section has a safety-class or safety-significant active confinement ventilation system.

The development of a *Non-Safety-Related Ventilation System Evaluation* is limited to facilities that meet the following criteria:

- The facility/facility section was not excluded by the Site's *Recommendation 2004-2 Exclusion Report* submitted as required by Deliverable 8.3 of the Department's IP for Board Recommendation 2004-2.
- For Hazard Category 2 nuclear facilities, the facility/facility section does not have a safety-class or safety-significant active confinement ventilation system.
- For Hazard Category 3 nuclear facilities, the facility does not have an active confinement ventilation system.

Priority should be given to design and construction projects, including ongoing major modifications of existing facilities.

3. Ventilation System Evaluation Guidance

3.1 Overall Approach

As a result of numerous team discussions and workshops, an overall methodology was developed to assist facilities in planning and performing the activities necessary to develop a comprehensive *Ventilation System Evaluation* for safety-related or non-safety-related ventilation systems. These actions may not be necessary in all cases to adequately complete the evaluation but should be considered. Conversely, facilities may choose to implement additional project controls to expedite and monitor completion of system evaluation activities. Figure 3-1 *Evaluation Process Flow Chart* outlines the overall approach to be followed for the preparation and analysis required to be addressed in the *Ventilation System Evaluation.*

The evaluation process begins with a screening process to identify and remove from further consideration hazard category 3 facilities with an active[1] confinement ventilation system (CVS). These facilities are identified on a listing that is to be submitted for Central Technical Authority (CTA) and PSO concurrence and approval.

Initial activities will include a compilation of various technical documents and drawings to support the evaluation process, identification of system and subsystem boundaries, designation of team members and required training, and system walk downs.

In accordance with the Recommendation and the Department's IP, the functional classification and leak path factors associated with the CVS and support systems will be reviewed by an independent review panel (IRP) separate from the system evaluation.

Then, utilizing the ventilation system performance criteria, a system evaluation is performed. The approach for conducting the ventilation system evaluation is described further in this document, but in general the intent is to evaluate performance gaps between the existing system and the expected performance attributes defined either through the DSA or Table 5-1 *Ventilation System Performance Criteria.* The applicability and use of cost/benefit considerations for proposed modifications is also a part of the system evaluation (See section 4.4 *DSA Evaluation*).

The results of the evaluation are documented in a facility-level report and issued to the CTA and PSO for concurrence and approval.

[1] An active confinement ventilation system uses mechanical means (e.g, blower) to circulate air within, and remove air from a building or building space through filtration. Refer to the DOE Nuclear Air Cleaning Handbook

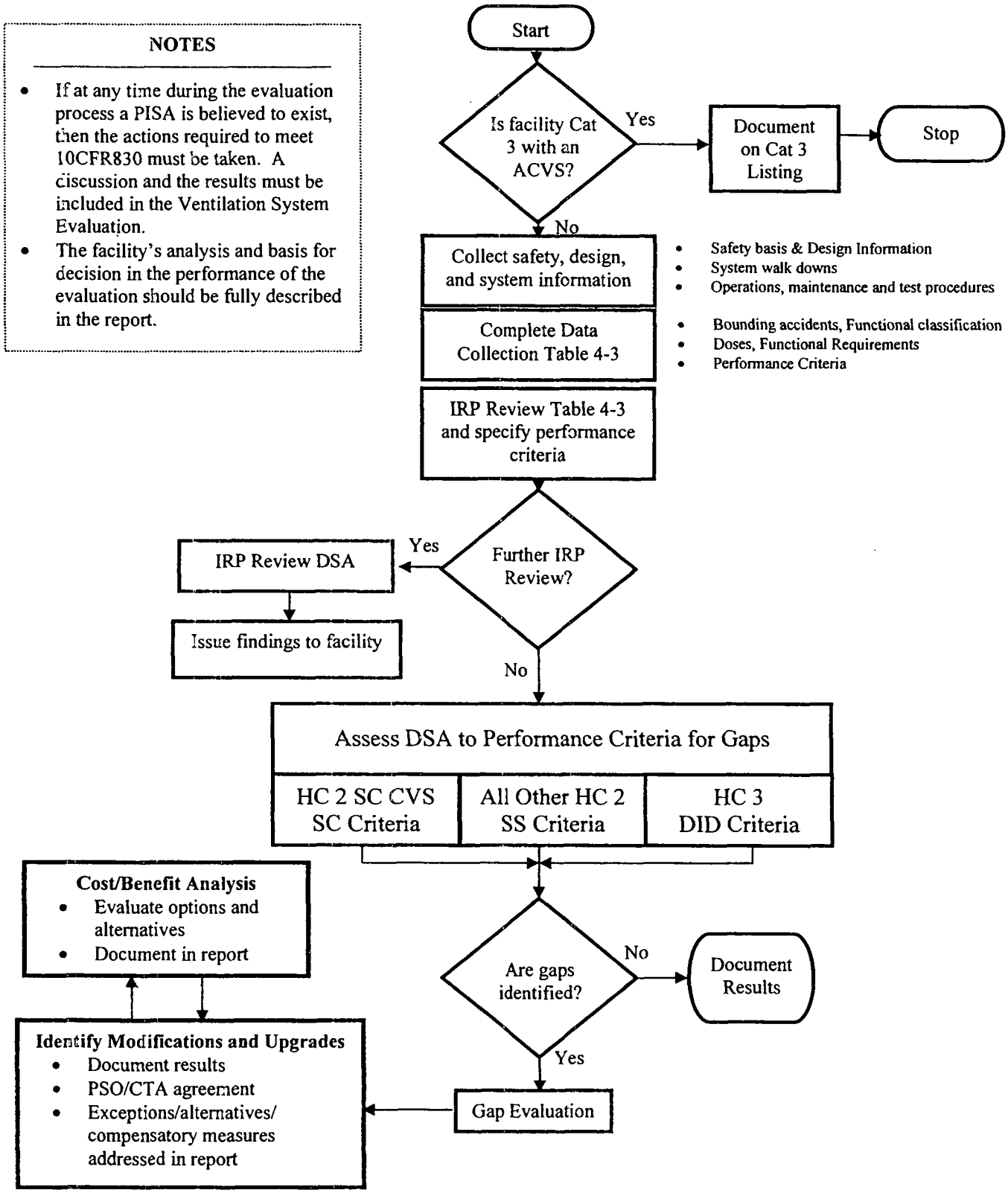


Figure 3-1 Evaluation Process Flow Chart

3.2 Backfit and Cost/Benefit Considerations

Both the Nuclear Regulatory Commission (NRC) and DOE develop and issue requirements and regulations designed to ensure that effective implementation of the requirements will result in adequate protection. Furthermore, NRC reactors and some non-reactor facilities and DOE reactor and non-reactor facilities are assessed through safety analyses processes to ensure that effective implementation of the requirements will result in reasonable assurance of adequate protection. DOE has promulgated 10 CFR Part 830, *Nuclear Safety Management*, Subpart B, *Safety Basis Requirements*, to establish these regulatory requirements. The term backfit means the modification of, or addition to, SSCs, or design of a facility, or the procedures or organization required to design, construct, or operate a facility, any of which may result from a new or amended provision in the DOE nuclear safety rule or the imposition of a DOE nuclear safety directive that is either new or different from a previous DOE position.

The NRC backfit regulation 10CFR50.109 states:

> *If there are two or more ways to achieve compliance with a license or the rules or orders of the Commission, or with written licensee commitments, or there are two or more ways to reach a level of protection which is adequate, then ordinarily the applicant or licensee is free to choose the way which best suits its purposes. However, should it be necessary or appropriate for the Commission to prescribe a specific way to comply with its requirements or to achieve adequate protection, then cost may be a factor in selecting the way, provided that the objective of compliance or adequate protection is met.*

Following approval of the safety basis and authorization of the facility/activity to begin operation, a potential inadequacy in the safety analysis (PISA) could lead to the determination that a safety analysis is either not bounding or is otherwise inadequate at a DOE facility. This would trigger the Unreviewed Safety Question (USQ) processes developed to meet 10 CFR 830.203 and possibly a reexamination of the safety analysis. If it is determined that the issue involves a PISA, contractors must place the facility in a safe condition, notify DOE and perform an analysis in accordance with 10 CFR 830.203.

Board Recommendation 2004-2 questioned the adequacy of the assumptions in the safety analysis for confinement ventilation systems at DOE facilities. In the IP for that recommendation, DOE stated that active confinement ventilation systems can provide added safety benefit and are normally the preferred alternative when a building confinement safety function is needed to provide adequate protection to the public or to collocated workers. The recommendation was accepted with the understanding that screening criteria would be developed to exclude certain facilities and operations from further review based on sound safety considerations. Facilities not excluded would be reviewed to ensure that the selected confinement strategy is properly justified and documented. Priority would be given to design and construction projects, including ongoing major modifications of existing facilities.

The determination of whether the cost/benefit process will be used will be based on the following general considerations:

1. Whether a modification is necessary to bring a facility into compliance with 10 CFR Part 830, *Nuclear Safety Management*;
2. Whether a modification is necessary to bring a facility into compliance with a previous and still valid commitment to DOE;
3. Whether a modification is necessary to address gaps that result from the system evaluation against the ventilation system performance criteria described in Section 5 of this document.

If any of these determinations are made, the cost/benefit process may be applied for cost-effectiveness purposes to determine which backfit or other strategy is to be implemented to address the gap. It should be recognized, however, that such determinations are not always clear, and are likely to require considerable judgment in application.

For new nuclear facilities (or where major modifications require an updated safety basis) DOE approval of the preliminary documented safety analysis (PDSA) should be based on:

1. A determination that the PDSA commits to the safety design criteria of DOE O 420.1B, *Facility Safety*, (or succeeding document) and
2. Demonstration that an active confinement ventilation system is chosen where identified to be necessary in the hazard analysis.

As new facilities and major modification are designed and constructed concurrent changes to the safety basis are expected and the determination of adequate protection is most formally recognized when the final safety basis is approved. In these cases it is expected that an active confinement ventilation system is the preferred option, and its design complies with the necessary design requirements consistent with its safety designation and with DOE O 420.1B. The conclusion of the confinement ventilation system evaluations should be evaluated to determine in hindsight whether specific upgrades identified are or are not necessary to comply with applicable DOE requirements. The design status of the facility and the nature of specific upgrades will affect the corresponding implementation cost estimate.

It is also recognized that there may be hazard category 2 nuclear facilities where the confinement ventilation system has not been designated as safety class or safety significant. For these cases recognition of where the project is in terms of the overall design process is important. For facilities that have progressed past Critical Decision 3 (undergoing construction), changes to the design for the confinement ventilation system will be difficult, as these facilities have an approved PDSA with an associated DOE safety evaluation report. These cases will be treated the same as an existing facility. For facilities that have progressed past Critical Decision 2 (undergoing final design) a determination will be made by the CTA/PSO on a case-by-case basis regarding whether cost/benefit process can be applied.

4. Ventilation System Evaluation Guidance

4.1 Team Organization and Resources

Dedicated personnel with adequate resources and support are crucial. Depending upon the site and the application of the exclusion criteria, there may be quite a few evaluations to be performed. In order to ensure continuity, the Site or Field Office Manager should consider the appointment of a Site Lead working with a Site Evaluation Team (SET). The SET would utilize facility expertise, as needed, to complete the individual evaluations. It is envisioned that both DOE, including National Nuclear Security Administration (NNSA), and contractor personnel would jointly serve on the teams and prepare the evaluations.

It is expected that the Site Lead will be a DOE employee, with both contractor and DOE personnel assisting in the evaluation(s). The Site Lead should have demonstrated experience managing an evaluation effort, as well as the requisite understanding of ventilation systems, safety basis and USQ processes, and facility processes. As a minimum, the Site Lead should be assisted by an individual with broad expertise in ventilation systems, and another with expertise in safety basis preparation and analysis activities for the various types of defense nuclear facilities.

Table 4-1 Site Evaluation Team
Site Lead
Ventilation System Subject Matter Expert
Safety Basis/Analyst Subject Matter Expert

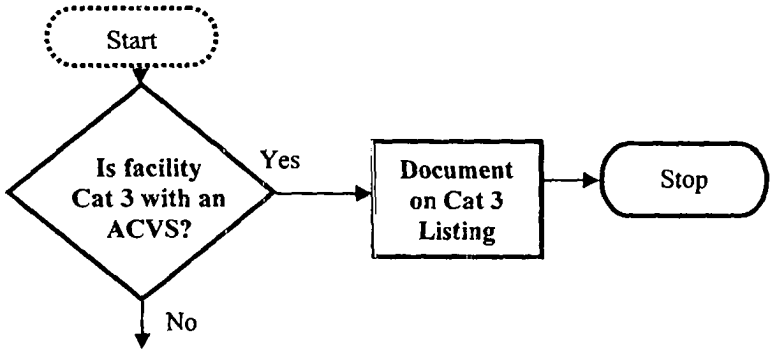
In preparation for an individual facility evaluation the Site Lead should augment the SET with additional facility personnel. As a minimum, the Facility Evaluation Team (FET) should consider the following facility-specific expertise.

Table 4-2 Facility Evaluation Team
Site Lead
Ventilation System Subject Matter Expert
Safety Basis/Analyst Subject Matter Expert
Facility Ventilation Cognizant System Engineer
Facility Safety Basis/Analyst Subject Matter Expert

The Site Lead may enlist the services of others, such as operations specialists, maintenance personnel, discipline engineers, etc., as required to support evaluation efforts; however, it is not necessary to specifically add these personnel to the FET.

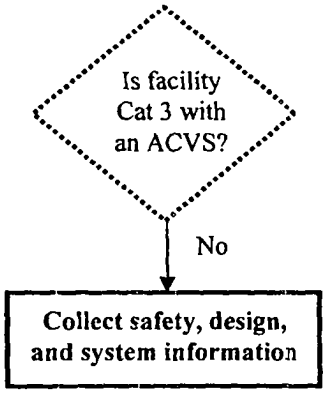
4.2 Initial Screening of Category 3 Facilities

Hazard category 3 nuclear facilities with an active CVS are not required to be evaluated as part of the Department's IP for Recommendation 2004-2. As such, each site office or program office shall prepare a listing of hazard category 3 facilities with an active CVS and submit this listing for concurrence and approval by the PSO and CTA (Deliverable 8.4). The identification of the site's hazard category 3 nuclear facilities with an active CVS (as defined in footnote 1 on page 4) should be completed and submitted for PSO and CTA concurrence and approval.



4.3 Collect System Information

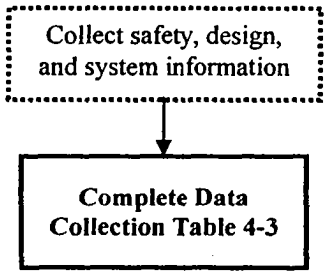
Once assembled, the SET and/or FET(s) should become familiar with several documents, such as the Department's Recommendation 2004-2 IP and this guidance document, the applicable DSAs and corresponding supporting safety evaluations, and other pertinent information identified by the leads. Depending upon several factors, such as the age of the confinement systems, the amount of detailed technical information will vary.



Personnel should collect and become familiar with system design documents, drawings, physical layout, safety analyses, past reviews and evaluations of system performance, modifications, operating and maintenance procedures, and DOE and industry standards and directives pertaining to ventilation systems. Ensuring adequate preparation time prior to commencing the evaluation should expedite the process and allow for better results. When gathering information the teams should do so with the objective of being able to fully address the ventilation system performance criteria identified in Table 5-1.

4.4 DSA Evaluation

The DSA evaluation is the first critical step in the overall system evaluation process. It is essential to understand how the confinement safety function has been relied on in the hazard and accident analysis and what decisions have been made about the functional classification of confinement ventilation systems. During the DSA evaluation phase, the team identifies specific information requested in Table 4-3, the *Data Collection Table.* This is the first phase of the evaluation process and consists primarily of a review of the DSA to collect information that will facilitate subsequent ventilation system evaluation,



Completing the Data Collection Table

A Recommendation 2004-2 working group developed a data table for SET and FETs to utilize when compiling specific data from safety basis documents (see Table 4-3). This table, referred to as the *Data Collection Table*, serves as a guide for ensuring completeness and consistency throughout DOE during the performance of the ventilation system evaluation. Table 4-3 should be filled out using the DSA and other safety basis documents. Instructions for completing the table follow (note that the numbers refer to specific column entries on Table 4-3):

1. The objective of this list is to summarize those accidents scenarios or events that drive performance requirements for the confinement system or strategy. For listing of accidents, this refers to accident scenarios, and when several of the same type (e.g., fires) exists, the bounding one of them encompassed within a common confinement system or strategy. This should be found in Chapter 3 of a STD-3009 DSA, or the equivalent if another 10 CFR 830 Subpart B DSA safe harbor method was used. Specifically, the information

should be found in hazard analysis tables described in section 3.3.2.3 and section 3.3.2.3.5 for (bounding) accident selection section.

2. For type of confinement, indicate which confinement strategy is used, active or passive. Where passive confinement is used, provide the leak path factor (LPF) that was used to evaluate its effectiveness. In an attachment to the table, provide a description of the assumptions used in assessing effectiveness and the analytical tool(s) used to calculate the LPF (e.g., MELCOR), if any (e.g., qualitative).
3. For bounding unmitigated dose, report the dose calculated for purposes of comparison to the Evaluation Guideline (EG) of 25 rem. Also provide dose calculation results for collocated workers, if available. Confirm that the methodology and assumptions/conditions of DOE-STD-3009 Appendix A were followed, or provide a description in an attachment of any alternate methods and assumptions/conditions that were used, including justifications for any deviations. Provide the mitigated dose, if available, and identify the basis for mitigation (e.g., filtration, decontamination factor, LPF, etc.)
4. Under confinement classification, identify the classification (SC, SS, or defense in depth [DID], or other designation for a classification less than safety significant). If the bounding unmitigated dose challenges the EG (i.e., is in the range of 1-25 rem) and the classification is not safety class, provide the rationale/justification in an attachment for the lesser classification. If the bounding unmitigated dose to the workers is documented as high (e.g., >100 rem committed effective dose equivalent (CEDE) at 100 meters for the collocated worker or prompt fatality, serious injury, or significant exposure to an immediate worker), and the classification is not safety significant provide the rationale/justification for the lesser classification.

   It is important that the boundaries and classification of the ventilation and support systems be fully described in an attachment. For example, a complete understanding is important when only portions of the confinement system are safety-related.

Table 4-3 Data Collection Table

Confinement Documented Safety Analysis Information										
Facility_____			Hazard Category ____				Performance Expectations			
Bounding Accidents [1]	Type Confinement[2]		Doses Bounding unmitigated/ mitigated [3]	Confinement Classification[4]			Function (see list)[5]	Functional Requirements[6]	Performance Criteria[7]	Compensatory Measures[8]
	Active	Passive		SC	SS	DID				

5. For functions, identify what function the confinement system is intended to perform per the DSA, from the following list:
    a. Confinement for public protection
    b. Confinement for collocated worker protection
    c. Exhaust of explosive mixtures
    d. In-facility worker protection
    e. Cooling
    f. Habitability
    g. Other (specify)

    This information should be found in sections 4.3.x.1 or 4.4.x.1 of a DOE-STD-3009 DSA or their equivalents for other DSA safe harbor methodologies, for safety class and safety significant confinement systems, respectively. For DID systems, the information can be deduced from the hazards analyses where they were identified as hazard controls.

6. Under performance expectation(s), define the functional requirements under which the confinement system is expected to provide its safety function. For example, fire, explosion, seismic, etc. This information can be found in sections 4.3.x.3 or 4.4.x.3 of a DOE-STD-3009 DSA or equivalents when other DSA safe harbor methods are used, for safety class and safety significant confinement systems. For DID systems, the information can be deduced from the hazards analyses where they were identified as hazard controls.

7. Under performance expectations, describe the performance criteria of the confinement system to perform its safety function when called upon, under the conditions of the performance expectations in item 6, above. When the evaluation reveals vulnerabilities (i.e., lack of assurance under certain circumstances), describe those vulnerabilities. This information can be found in sections 4.3.x.4 and 4.4.x.4 of a DOE-STD-3009 DSA or the equivalent sections of an alternate DSA safe harbor method for safety class and safety significant confinement systems. For DID confinement systems, list environments that the confinement system has not been qualified to perform under.

8. Under compensatory measures, for situations where the performance evaluation reveals vulnerabilities, describe what alternate methods have been identified to provide alternate methods of providing the safety function when the confinement system cannot. These could include such things as defense-in-depth systems, administrative controls, etc. This information should be able to be identified from the DOE-STD-3009 chapter 3 hazards analysis tables for the accident scenario(s) requiring the confinement function, and

possibly from the chapter 4 material describing the system evaluations (see item 7).

While the overall focus is on collecting data that reflects the credited safety functions in the confinement system, the Data Collection Table can also be used to document other functional attributes for the confinement system that may enhance system evaluation. This can be accomplished by including the attributes in the performance expectation columns of Table 4-3 at the end, or a separate table can be prepared that summarizes other confinement system functional attributes that should be recognized to enhance system evaluation. For example, the ventilation system may not be credited in the seismic analysis; however, the system is a PC-2 design. This represents an enhanced element of the system's functionality that may not be credited in certain bounding accidents.

Independent Review of Confinement Strategies

The data collected from a facility's safety basis document (Table 4-3 and supporting attachments) will be reviewed by the IRP. This review serves two purposes:

1. To specify which set of requirements (SC, SS, or DID) should be used to perform ventilation system evaluations; and
2. To identify facilities requiring a separate review. The determination of those facilities that require a separate review will be based on the considerations listed below in Table 4-4.

If determined to be necessary, the objectives of this separate review are to

1. Ensure that an appropriate confinement strategy is applied,
2. Validate that the functional classifications of the confinement systems are appropriate, and
3. When a passive confinement strategy has been applied, independently assess the appropriateness of the LPF used.

The IRP will be established by the 2004-2 Core Team with concurrence from the appropriate PSO and CTA and will ensure a consistent approach is applied across the complex while at the same time allow for unique characteristics and hazards associated with individual facilities to be considered. The IRP membership will consist of, at a minimum, a senior safety basis subject matter expert from each PSO organization, a senior safety basis subject matter expert from EH, and an independent LPF expert.

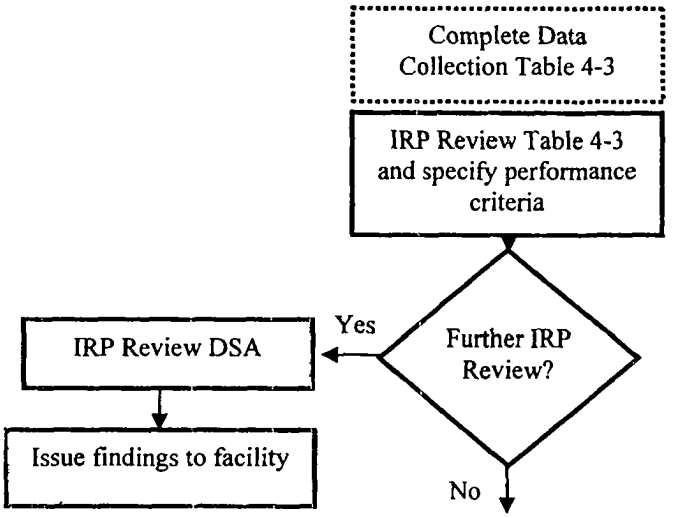


Table 4-4 Considerations for an IRP Review	
1.	An alternative methodology or deviations from the assumptions/conditions of DOE-STD-3009 Appendix A were used for calculating the unmitigated doses of accident scenarios for comparison to the 25 rem EG.
2.	The bounding unmitigated dose for an accident scenario that credits confinement challenges or exceeds the EG and depends on a passive confinement strategy.

Given the two considerations identified in Table 4-4, the IRP will determine if the facility requires a separate review. It is anticipated that those facilities with unmitigated consequences that challenge or exceed the EG, assume a LPF<1, and have a passive safety strategy are likely candidates for a separate review. It is also anticipated that those facilities with unmitigated consequences that challenge or exceed the EG, assume LPF=1, and have a passive safety strategy, will be requested to justify this situation to the IRP as part of determining if a separate review is needed. It is anticipated that this can be accomplished via telephone conferences with appropriate site office and facility personnel. Finally, the IRP may identify additional facilities that are requested to justify assumptions made in the DSA as summarized in Table 4-3. The IRP will prepare a listing of those facilities that require a separate review in parallel to the system evaluation discussed in section 5.1.

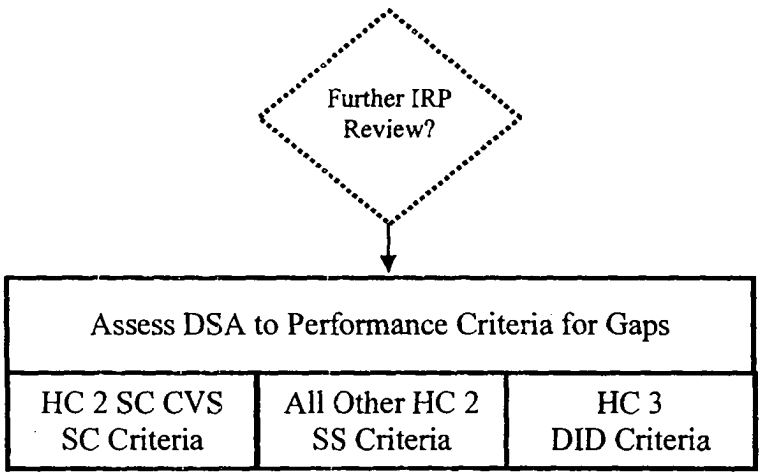
If a separate facility review is necessary, it will be completed by the IRP. The IRP will review the DSA in question to ensure that the Secretary's expectation that active building ventilation confinement systems are normally selected as the

preferred confinement strategy when a building confinement safety function is needed to provide adequate protection to the public or collocated workers.

The IRP will document the results of its review in a report that will be attached to the system evaluation report. The report will summarize the basis for conclusions reached, and will include recommendations, as needed, with respect to potential changes to be implemented. The potential changes will require formal evaluation by the appropriate line manager to determine what changes are required, and how they should be implemented.

5. System Evaluation

The purpose of the system evaluation process is to compare a selected CVS and its associated safety basis documents against certain generic performance criteria provided in this guidance document. These performance criteria are for evaluation purposes as part of the Department's response to Recommendation 2004-2, and are not to be considered as new requirements. However, these performance criteria reflect important attributes that should be considered closely in the design and construction of a new active CVS. Each CVS is to be evaluated using the process described in this guidance document to the appropriate safety functional classification expectations. To adequately perform the evaluation, the CVS must be defined – the system, its boundaries, support systems, and safety functional requirements.



To perform the evaluation, several items of input data are necessary. These include:

- The safety functional requirements of the CVS, as defined in the DSA
  - Specific safety functions
  - Environmental conditions (e.g., fire) under which safety functions must be accomplished
  - Specific accident scenarios (e.g., natural phenomena event) which the safety functions are credited
  - Support systems (e.g., electrical power) required for CVS to accomplish the credited safety function
- Necessary technical basis data on SSCs
  - Current system functional drawings and design
  - Important system component performance data
  - Filter attributes (type, flow capacity)

- System testing and surveillance requirements

5.1 Assessing the DSA and CVS against Performance Criteria and the Identification of Gaps

The system evaluation approach is intended to perform a functional review of the CVS. Functional design and performance attributes are defined to provide a structured approach to the evaluation and to address a generic set of attributes potentially applicable to a CVS. These attributes have been developed for safety class, safety significant, and defense in depth applications, and are provided in Table 5-1 *Ventilation System Performance Criteria*. As stated previously, these criteria are not to be considered as minimum design criteria or new requirements, but will be utilized for the Ventilation System Evaluation as a common point of comparison.

Based on a review of the completed Table 4-3 *Data Collection Table*, the IRP will select the appropriate criteria (i.e., safety class, safety significant, or defense in depth) to be utilized by the FET. The FET will then assess the DSA and system against the performance criteria to identify gaps between the expected performance criteria in Table 5-1 and the DSA expectations for ventilation system performance.

Generally, the IRP will adhere to the considerations identified below when selecting the performance criteria to be used. IRP considerations for selecting performance criteria are:

- Hazard category 2 nuclear facilities which challenge or exceed the EG will utilize the SC performance criteria.
- All other hazard category 2 nuclear facilities will utilize the SS performance criteria.
- The hazard category 3 nuclear facilities that have no active CVS will utilize the DID performance criteria. This process will be further explained.

The following model may be useful in understanding the types of gaps that may be encountered. As can be seen, not all gaps are of equal significance. For example, an identified gap between the Safety Basis Documents and the physical system installed would normally be of greater concern than the other types of gaps, and could result in a PISA.

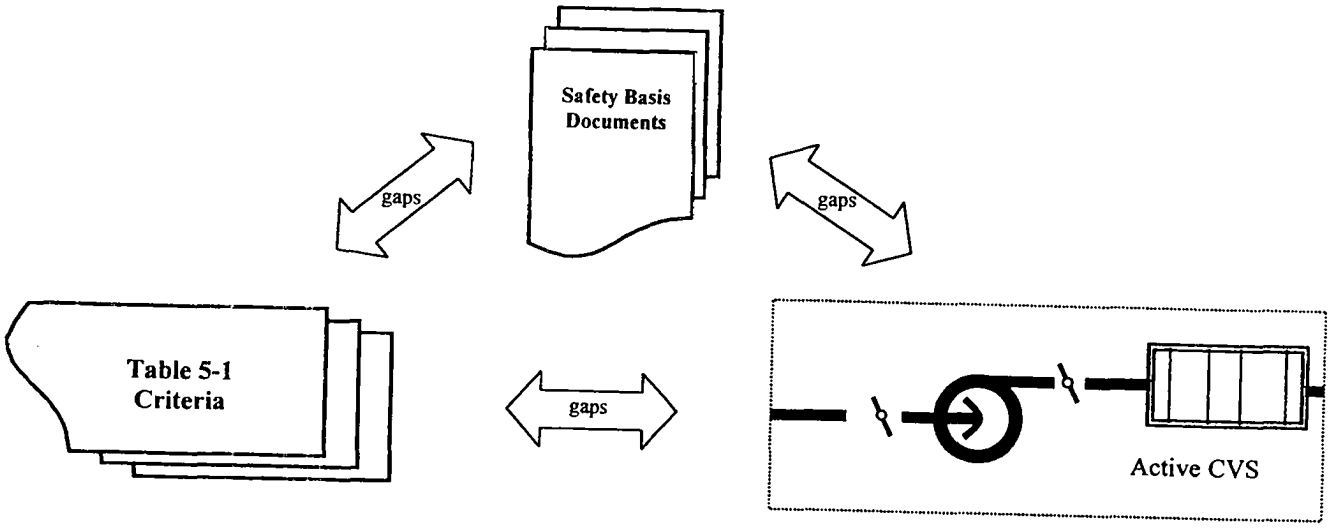


Table 5-1 VENTILATION SYSTEM PERFORMANCE CRITERIA					
EVALUATION CRITERIA	**SAFETY CLASS**	**SAFETY SIGNIFICANT**	**DEFENSE-IN-DEPTH/OTHER**	**DISCUSSION**	**REFERENCE**
Ventilation System – General Criteria					
Pressure differential should be maintained between zones and atmosphere.	Applies	Applies	Applies	Number of zones as credited by accident analysis to control hazardous material release; demonstrate by use considering potential in-leakage	DOE-HDBK-1169 (2.2.9) ASHRAE Design Guide
Materials of construction should be appropriate for normal, abnormal and accident conditions	Applies	Applies	Applies		DOE-HDBK-1169 (2.2.5) ASME AG-1
Exhaust system should withstand anticipated normal, abnormal and accident system conditions and maintain confinement integrity.	Applies	Applies	Applies	As required by accident analysis to prevent accident release	DOE-HDBK-1169 (2.4) ASHRAE Design Guide
Confinement ventilation systems shall have appropriate filtration to minimize release	Applies	Applies	Applies	Address: 1) Type of filter (e.g., HEPA, sand, sintered metal); 2) Filter sizing (flow capacity and pressure drop); 3) Decontamination Factor vs. accident analysis assumptions	ASME AG-1 DOE-HDBK-1169 (2.2.1)

Table 5-1 VENTILATION SYSTEM PERFORMANCE CRITERIA					
EVALUATION CRITERIA	**SAFETY CLASS**	**SAFETY SIGNIFICANT**	**DEFENSE-IN-DEPTH/OTHER**	**DISCUSSION**	**REFERENCE**
Ventilation System – Instrumentation and Control					
Provide system status instrumentation and/or alarms	Applies	Applies	Applies	Address key information to ensure system operability (e.g., system delta-P, filter pressure drop)	ASME AG-1 DOE-HDBK-1169 ASHRAE Design Guide (Section 4)
Interlock supply and exhaust fans to prevent positive pressure differential	Applies	Applies	Applies		DOE-HDBK-1169 ASHRAE Design Guide (Section 4)
Post accident indication of filter break-through	Applies	Applies	Does Not Apply	Instrumentation supports post-accident planning and response; should be considered critical instrumentation for SC	TECH-34
Reliability of control system to maintain confinement function under normal, abnormal and accident conditions	Applies	Applies	Applies	Address, for example, impacts of potential common mode failures from events that would require active confinement function.	DOE-HDBK-1169 (2.4)
Control components should fail safe	Applies	Applies	Applies		DOE-HDBK-1169 (2.4)
Resistance to Internal Events – Fire					
Confinement ventilation systems should withstand credible fire events and be available to operate and maintain confinement	Applies	Applies	Does Not Apply	**Required for new facilities;** as required by the accident analysis for existing facilities (discretionary) Must address protection of filter media.	DOE-HDBK-1169 (10.1) DOE-STD-1066

Table 5-1 VENTILATION SYSTEM PERFORMANCE CRITERIA					
EVALUATION CRITERIA	**SAFETY CLASS**	**SAFETY SIGNIFICANT**	**DEFENSE-IN-DEPTH/OTHER**	**DISCUSSION**	**REFERENCE**
Confinement ventilation systems should not propagate spread of fire	Applies	Applies	Applies	**Required for new facilities;** as required by the accident analysis for existing facilities (discretionary) Address fire barriers, fire dampers arrangement	DOE-HDBK-1169 (10.1) DOE-STD-1066
Resistance to External Events – Natural Phenomena – Seismic					
Confinement ventilation systems should safely withstand earthquakes	Applies	Applies	Does Not Apply	If the active CVS system is not credited in a seismic accident condition there is no need to evaluate that performance and/or design attribute for the confinement ventilation system (discretionary). Also, any seismic impact on the confinement ventilation system performance will be based on the current functional requirements in the DSA. NOTE: Seismic requirements may apply to Defense-in-Depth items indirectly for the protection of safety SSCs.	ASME AG-1 AA DOE O420.1B DOE-HDBK-1169 (9.2)
Resistance to External Events – Natural Phenomena – Tornado/Wind					
Confinement ventilation system should safely withstand tornado depressurization	Applies	Applies	Does Not Apply	If the active CVS is not credited in a tornado condition there is no need to evaluate that performance and/or design attribute for the confinement ventilation system (discretionary). Also, any tornado impact on the	DOE O420.1B DOE-HDBK-1169 (9.2)

Table 5-1 VENTILATION SYSTEM PERFORMANCE CRITERIA					
EVALUATION CRITERIA	**SAFETY CLASS**	**SAFETY SIGNIFICANT**	**DEFENSE-IN-DEPTH/OTHER**	**DISCUSSION**	**REFERENCE**
				confinement ventilation system performance will be based on the current functional requirements in the DSA.	
Confinement ventilation system should withstand design wind effects on system performance	Applies	Applies	Does Not Apply	If the active CVS is not credited in a wind condition there is no need to evaluate that performance and/or design attribute for the confinement ventilation system (discretionary). Also, any wind impact on the confinement ventilation system performance will be based on the current NP analysis in the DSA.	DOE O420.1B DOE-HDBK-1169 (9.2)
Other NP Events (e.g., flooding, precipitation)					
Confinement ventilation system should withstand other NP events considered credible in the DSA where the confinement ventilation system is credited	Applies	Applies	Does Not Apply	If the active confinement ventilation system is not credited for this event there is no need to evaluate that performance and/or design attribute for the confinement ventilation system (discretionary). Also, any wind impact on the confinement ventilation system performance will be based on the current NP analysis in the DSA.	DOE O420.1B DOE-HDBK-1169 (9.2)

Table 5-1 VENTILATION SYSTEM PERFORMANCE CRITERIA					
EVALUATION CRITERIA	**SAFETY CLASS**	**SAFETY SIGNIFICANT**	**DEFENSE-IN-DEPTH/OTHER**	**DISCUSSION**	**REFERENCE**
Range Fires/Dust Storms					
Administrative controls should be established to protect confinement ventilation systems from barrier threatening events	Applies	Applies	Does Not Apply	Ensure appropriately thought out response to external threat is defined (e.g., pre-fire plan)	DOE O420.1B
Testability					
Design supports the periodic inspection & testing of filters and housing, and tests and inspections are conducted periodically	Applies	Applies	Applies	Ability to test for leakage per intent of N510	DOE-HDBK-1169 (2.3.8) ASME AG-1 ASME N510
Instrumentation required to support system operability is calibrated	Applies	Applies	Applies	Credited instrumentation should have specified calibration/surveillance requirements. Non-safety instrumentation should be calibrated as necessary to support system functionality.	DOE-HDBK-1169 (2.3.8)
Integrated system performance testing is specified and performed	Applies	Applies	Does Not Apply	Required responses assumed in the accident analysis must be periodically confirmed including any time constraints	DOE-HDBK-1169 (2.3.8)

Table 5-1 VENTILATION SYSTEM PERFORMANCE CRITERIA					
EVALUATION CRITERIA	**SAFETY CLASS**	**SAFETY SIGNIFICANT**	**DEFENSE-IN-DEPTH/OTHER**	**DISCUSSION**	**REFERENCE**
Maintenance					
Filter service life program should be established	Applies	Applies	Applies	Filter life (shelf life, service life, total life) expectancy should be determined. Consider filter environment, maximum delta-P, radiological loading, age, and potential chemical exposure.	DOE-STD-1169 (3.1 & App C)
Single Failure					
Failure of one component (equipment or control) shall not affect continuous operation	Applies	Does Not Apply	Does Not Apply	Address potential failures (example failures - fan, backup power supply, switchgear)	DOE O 420.1B, *Facility Safety*, Chapter I, Sec. 3.b(8)
Automatic backup electrical power shall be provided to all critical instruments and equipment required to operate and monitor the confinement ventilation system	Applies	Does Not Apply	Does Not Apply		DOE-HDBK-1169 (2.2.7)
Backup electrical power shall be provided to all critical instruments and equipment required to operate and monitor the confinement ventilation system	Does Not Apply	Applies	Does Not Apply	NOTE: Safety Class is addressed through previous line.	DOE-HDBK-1169 (2.2.7)

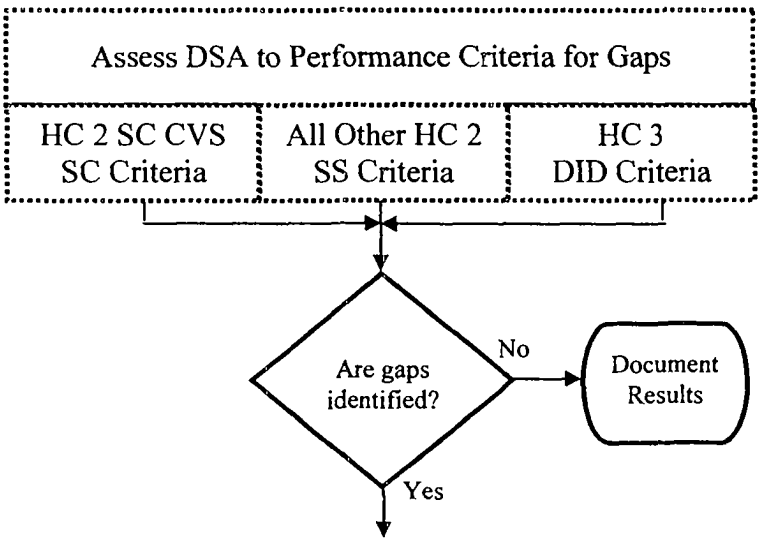
Table 5-1 VENTILATION SYSTEM PERFORMANCE CRITERIA					
EVALUATION CRITERIA	**SAFETY CLASS**	**SAFETY SIGNIFICANT**	**DEFENSE-IN-DEPTH/OTHER**	**DISCUSSION**	**REFERENCE**
Other Credited Functional Requirements					
Address any specific functional requirements for the confinement ventilation system (beyond the scope of those above) credited in the DSA	Applies	Applies	Does Not Apply		10 CFR 830, Subpart B

There is no intent to perform detailed design evaluations based on specific national consensus code and standard requirements or to reconstitute the design basis of the system. The evaluation approach is adapted from the Energy Facility Contractors Group's Safety System Design Adequacy, dated August 2004.

Each active CVS should be compared to the ventilation system performance criteria in Table 5-1, *Ventilation System Performance Criteria.* This table provides a functional and performance list of expected design or operational attributes for a typical CVS. Attributes in the table were derived from codes and standards requirements, subject matter expert input, and other ventilation system guidance. This table is organized around various elements of design, operation, maintenance, and testing. It is structured to provide a graded approach between functional classifications, meaning that safety class expectations are greater than safety significant expectations. For many of the attributes, reference is made to relevant DOE guidance or industry standards. These documents should be consulted, as needed. However, it is important to emphasize that the intent of the evaluation is not to perform a detailed comparison to applicable guides or standards, but to ensure that the functional attribute is satisfied. As stated above, the intent is not to reconstitute the design basis of the system.

It is possible that in order to evaluate system performance, some limited system analysis may be necessary if not available. The product of this step is the identification of gaps between the existing systems and the attributes in the matrix. These gaps will then be further evaluated against the safety functional requirements and for cost/benefit of potential modifications or compensatory measures.

Based on these attributes, gaps between these expected attributes and the installed system may be identified. These gaps reflect potential areas of improvement to the reliability and operability of the ventilation and supporting systems. Throughout this evaluation the SET and FET(s) must maintain consideration of any potential inadequacies in the safety analysis that may be identified. For these issues, the facility or site unreviewed safety question process takes precedence over this guidance document.



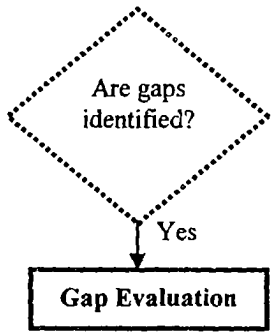
A system evaluation is required to be performed for those hazard category 3 nuclear facilities that (1) were not excluded from consideration in accordance with the Exclusion Reporting Process, and (2) do not have an active building CVS. The evaluation of these nuclear facilities will require a different approach from the hazard category 2 nuclear facilities. The fact that the facility was not excluded from consideration under Recommendation 2004-2 and has no active CVS is an important aspect of the entire Department response to this Recommendation. Obviously, many if not all of the DID attributes will represent a potential gap since the hazard category 3 nuclear facility has no active CVS. Therefore, the evaluation will need to assess the following:

1. A discussion of the confinement strategy described in the DSA. The discussion should address facility and co-located workers to the extent covered by the DSA.
2. A discussion should be provided that considers the DID attributes and corresponding benefits that would be realized if an active CVS was installed. In other words, if the facility installed an active CVS that met that specific attribute in Table 5-1, the evaluation should assess the risk and consequence benefit as a result of the system. This discussion should be provided for each of the applicable DID performance criteria.
3. Considering the benefits that could be realized with an active CVS (item 2 above), use the cost/benefit analysis for evaluating the modification, or other alternatives.

The IRP will select the appropriate column (safety class or safety significant) for hazard category 2 facilities. The ventilation system evaluation may identify gaps for one or more of the attributes listed in Table 5-1. As discussed in Section 5.2 *Gap Evaluation and Corrective Actions*, resolution of these gaps may be either mandatory or discretionary (i.e., subject to cost-effectiveness consideration). Those gaps that can be considered as discretionary are identified in the discussion column of Table 5.1, and are those where the active confinement ventilation system may not be credited for the applicable event. The SET and FET should clearly identify those attributes and their associated gaps so that subsequent review by the PSO or Core Team can focus on any action taken to address these gaps (see section 5.2 *Gap Evaluation and Corrective Actions*.

5.2 Gap Evaluation and Corrective Actions

In performing the gap analysis, if certain attributes are obviously not applicable under any of the accident scenarios considered in the DSA (identified as discretionary e.g., other natural phenomena events), the justification and discussion of the gap may be brief. **For new designs, all criteria should be addressed.**



It is expected that the gaps being evaluated will vary considerably in breadth and complexity. For example, a minor deficiency in system instrumentation is not a clear failure of a performance criterion. The expertise and judgement of the FET will be an important factor when differentiating between (1) required system modifications or other upgrades, and (2) system enhancements. The evaluation report will clearly identify and provide a basis for these determinations and should clearly identify those attributes from Table 5-1 that were considered mandatory.

The overall focus of the DSA Data Collection Table is in documenting the credited safety functions for the confinement system from the DSA. The Data Collection Table, or a supplemental table, may identify other functional attributes for the ventilation system that are not directly credited in the DSA.

When the FET determines that the system fails to satisfy a mandatory performance criterion, then corrective action is required. **Modifications to address these gaps must be implemented and are not candidates for cost/benefit considerations, except for cost-effectiveness purposes when evaluating various modification options and alternatives.**

The team will likely identify some issues that do not necessarily represent gaps with the system but are worthy of identifying to the facility for improving reliability or operability of the ventilation or support systems. These may result from reviews of past system operability studies, occurrence reports, and assessments. These observations should be collected during the evaluation period for later reporting. These opportunities for improvement may be associated with personnel training material, system procedures, etc.

5.3 Identify Modifications and Upgrades

Given that a gap has been identified, the facility must determine an appropriate upgrade evaluation to address it. Permanent physical modifications to systems are favored over programmatic controls, and in some cases a combination of both may be necessary. For physical modifications, the FET should provide detailed information of the actions necessary to resolve the gap. Where alternatives and other options exist, they should be fully described. For example, upgrading a filter to a higher quality capable of withstanding higher temperatures during certain accident conditions may be an alternative to installing other CVS components.

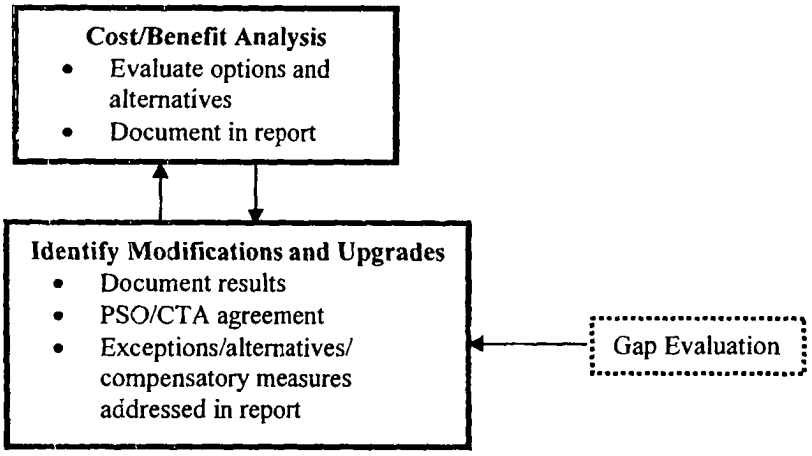
In some situations the corrective action to an identified gap may not require a physical modification. For example, it may be determined that certain instrumentation important for assuring operability is not being calibrated or the calibration is not fully effective (see Table 5-1). In this situation the proposed upgrade may be many combination of actions, such as the following:

- Ensure proper calibration is attained using the correct test equipment.
- Include the instrument in the site's instrument calibration program at the appropriate frequency.
- Revise associated calibration procedures.
- Train maintenance personnel in the proper technique/process for calibration.
- Institute a broader review of other safety-related systems for an "extent-of-condition" review.

As noted above, the system evaluation may also result in recommended changes to procedures, training, or other administrative actions. For example, it may be determined that improvements are needed in the content of ventilation system surveillance procedures, such as acceptance criteria and scope of testing. Again, the evaluation will fully describe these upgrades and, if necessary, identify implementation schedules and verification assessments.

The important point to be noted here is that the FET needs to fully evaluate and specifically describe those actions necessary to resolve the gap. Personnel reviewing the evaluation should have a clear understanding from the report of the extent of the actions necessary to resolve each gap. Required changes to procedures, training material, etc. should be as specific as necessary to adequately communicate to others the required disposition.

Upgrades associated with gaps between safety significant or safety class performance criteria as identified in the applicable DSA and actual system functionality must be implemented. They are not candidates for application of the cost/benefit process, except for cost-effectiveness purposes when evaluating various modification options and alternatives.



Application of the cost/benefit process for certain upgrades ensure limited resources are appropriately applied to those improvements that will yield the greatest improvement in the overall risk profile. The Recommendation 2004-2 Core Team and working groups developed a process, described in section 6 *Determining Cost/Benefit for Recommendation 2004-2 Implementation*, for performing this analysis. Other cost/benefit processes may exist and can be utilized at the discretion of the SET.

Upgrades and modifications to the ventilation and support systems should utilize existing site processes, such as backfit process, if they exist. The *Ventilation System Evaluation* will fully describe the implementation plan and any compensatory measures identified and established prior to full implementation of the modification. Summary level schedules for all upgrades should be included in the evaluation report.

5.4 Finalize Report

The facility evaluation and supporting attachments will be prepared in accordance with the format provided in this guidance document. The evaluation will include technical details of all recommended upgrades to equipment and programs and SSC functional classification analysis and changes. The appropriate site or field office will review and approve each *Ventilation System Evaluation*. The report should be forwarded to the appropriate CTA and PSO for review and concurrence.

5.5 Evaluation Report Format and Content

The evaluation report should include as a minimum the following sections. Personnel should attempt to restrict report content to support a classification of less than unclassified controlled nuclear information.

Cover and Title Page

[DOE Site]

[Facility Name]

Ventilation System Evaluation

[Revision and Date]

Review and Approval Page

Includes signatures of the Site Lead and Facility Evaluation Team DOE Field or Site Office Manager

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List of Tables

Definitions

Define important facility-specific terms, conditions, or modes helpful for understanding the evaluation.

Abbreviations and Acronyms

Executive Summary

The Executive Summary provides an overview of the facility ventilation system evaluation, presenting information to establish a top-level understanding of the results. It summarizes the significant findings (e.g., gaps, functional classification or leak path factor issues), major upgrades proposed, and any potential inadequacies in the safety basis identified during the evaluation and the outcome.

1. Introduction

This section provides background information regarding the facility and the ventilation confinement system(s) in place as they apply to the Recommendation 2004-2 Implementation Plan.

1.1 Facility Overview

Provide a general overview of the facility and mission, including hazard categorization (1 to 2 paragraphs).

1.2 Confinement Ventilation System/Strategy

Briefly describe the ventilation and supporting systems being evaluated. Provides a summary of system operation, location, age, availability of design information, past and proposed modifications, and other pertinent information. Summarize the conditions and scenarios from the DSA for which the confinement ventilation system is associated (2 to 3 paragraphs).

1.3 Major Modifications

For facilities undergoing major modification, fully describe the facility modifications and anticipated mission change(s), if any, associated with the modification (1 to 2 paragraphs).

2. Functional Classification Assessment

Discuss the appropriateness of the functional classification of the ventilation and supporting systems.

2.1 Existing Classification

The evaluation will identify the existing classification of SSCs pertaining to the ventilation and support systems.

2.2 Evaluation

Discuss the process and results of the evaluation of the functional classification of the ventilation and supporting systems.

2.3 Summary

Summarize the results of the evaluation of functional classifications.

3. System Evaluation

This section will fully describe the approach, findings, and other pertinent information relating to the evaluation of the confinement ventilation system.

3.1 Identification of Gaps

Describe in this section the evaluation of the confinement ventilation system against the ventilation system performance criteria. Identify the performance criteria (e.g., safety class, safety significant, or DID) selected by the IRP for evaluation. Identify those attributes that were considered as mandatory by the SET and FET.

3.2 Gap Evaluation

Describe in this section the evaluation performed on the identified gaps. If the evaluation resulted in a PISA, then a discussion of the actions taken and results must be included.

3.3 Modifications and Upgrades

For each of the identified gaps describe the modification or upgrade required for issue resolution. Provide the justification to fully explain the proposed actions to be taken. Include summary-level schedules for physical modifications, as well as

programmatic upgrades. When the cost/benefit process has been utilized, even when evaluating the cost-effectiveness of modification options and alternatives, an adequate description is required. The description should provide sufficient detail such that others reading the evaluation can understand the methodology, rationale, and basis for judgment.

Discuss any deficiencies or observations identified by the team that do not necessarily represent gaps between the performance criteria and the system functionality but indicate areas where improvements can be made. These areas for improvement could be related to physical layout, training material, procedures, etc. and should be included at the end of this section.

4. Conclusion

Summarize the results of the ventilation system evaluation, significant findings, and proposed corrective actions.

References

Attachments

Include the following:

- Facility Evaluation Team composition and biographical sketches
- Data Collection Table (Table 4-3) and supporting attachments
- Summary schedules for implementing upgrades
- Completed supporting evaluations (e.g., PISA) and documentation

6. Determining Cost/Benefit for Recommendation 2004-2 Implementation

6.1 Introduction

This discussion provides a cost-benefit evaluation method to help prioritize how the workable list of generic ventilation system performance and/or design expectations should be applied during system evaluations. It also provides focus on those cost-effective modifications to the active confinement ventilation system that are most likely to improve overall facility risk. It can be used to guide selection among alternative approaches. It can also be applied to other upgrades permitted to be collectively evaluated to select those which warrant implementation based on the contribution to facility safety.

The strategy will be to focus on semi-quantitative evaluation of public and onsite (co-located) worker impacts of proposed modifications based on the risks of facility operation as characterized in the approved DSA. The process will provide an index of the public and onsite worker safety benefit expressed as an expected fraction of the applicable public evaluation guideline (or a comparable guideline for the onsite worker) averted based on the modification. The index will be supplemented with qualitative evaluation of other pertinent benefit considerations. Recommendations will consider total benefit relative to the net cost of implementing each proposed modification.

The above strategy was selected at the workshop in October after consideration of a broad range of options for the cost-benefit evaluation specified in the DOE 2004-2 IP. Some of the perspectives from the workshop are discussed in this section to guide implementation of the model that was adopted.

To obtain a benefit score that can be converted to a dollar value, it is necessary to estimate the total dose averted by integrating over the population at risk. Participants at the workshop judged that the effort required to include the population at-risk with the DSA accident consequences was not warranted for this application. Participants noted that both the frequency and consequence information portrayed in the DSA are often the result of qualitative judgments; these judgments are sufficient to guide the control selection purpose of the hazards and accident analyses and similar judgments should suffice for cost-benefit determination and the selection of modifications for implementation.

The proposed model is therefore a simplification of this quantitative model, retaining only those elements needed to differentiate among modifications. Averted doses expressed as a fraction of the evaluation guideline dose and the probability of those dose savings are included recognizing that the value of averting a potential dose does depend on its likelihood[2].

[2] The established DOE control selection methodology expects high consequence doses to be averted even for lower frequency credible events and the proposed methodology includes provisions to be consistent

The Board's Recommendation reflected a conclusion that passive confinement is not as effective as an active confinement safety function (i.e., one relying upon safety significant or safety class forced ventilation through a high efficiency particulate air [HEPA] filter system) in some postulated accident scenarios. Potential modifications are expected to enhance active confinement ventilation systems whether designated as safety systems or not, perhaps upgrading weak-link components, adding redundancy, providing back-up electrical power, or enhancing natural phenomena resistance. In some instances, potential upgrades in the governing standards for an active CVS will need to be expressed as tangible performance impacts (e.g., reduced failure frequency). In a few instances, upgrades may also address known weaknesses in passive confinement systems (e.g., door seals, passive HEPA filtration pathways at the facility boundary) or reduce the hazard level in the postulated accident scenarios of concern (e.g., reduce batch process sizes and thus potential material at risk (MAR), eliminate certain fire or explosion risks). Such modifications would only be considered if removing or partially removing a current mission from a facility appeared more practical than upgrading the corresponding active CVS. Similarly, in some instances, Administrative Controls may prove effective in preventing or mitigating the postulated accidents of concern sufficiently to obviate otherwise complex active CVS modifications.

The chosen model for cost benefit must be sufficient to discriminate among options such as these, identifying those that are most effective in meeting the Department's objectives relative to their costs of implementation. Responsibility for selection of upgrades is assigned to PSOs in conjunction with the established CTA.

Cost-benefit evaluation will focus on the selection of proposed modifications that are alternative means of closing an identified gap and also on the selection of additional modifications that are cost-effective. Its use for both purposes will serve to calibrate the model for those other projects that may also be considered in the same facilities.

6.2 Cost-Benefit Methodology

The overall approach for Recommendation 2004-2 IP is to evaluate active CVS against generic ventilation system performance criteria to determine if there are "gaps" in implementation at specific facilities. Modifications will be developed by the assessment teams to address any such gaps. These modifications are the input to the cost-benefit evaluation process that includes the following key elements:

1. Establishing a cost-benefit evaluation team structured to make the judgments required for implementing the model. Participation on the team by someone familiar with the DSA analysis and by one or more others familiar with the facility design and its operations is important from this perspective. Representation by a member of the SET or FET would serve to ensure

with this practice. Probability cannot be ignored, however, as proposed modifications are expected to enhance reliability and their benefit can only be captured by including their impact on release probability. While doses are normalized to a fraction of the evaluation guideline to facilitate combining public and onsite worker benefits, to be consistent with the Board Recommendation 2004-2 Implementation Plan, the EG is not used as a design acceptance criterion in the modification selection process.

understanding of their findings. Required judgments should be made at team meetings based on discussions with backup personnel available to address questions that may come up.

2. Receive proposed modifications driven by the active CVS evaluation and ensure understanding of the underlying ventilation system performance criteria gaps and of the safety objective of each modification as it relates to the likelihood or consequences of a radiological release during accidents presented in the facility DSA. Performance uncertainties important to the proposed modifications should be clarified.
3. Determine DSA accidents that would be impacted by each proposed modification. Generally, as documented in the Data Collection Table, bounding and representative accidents in the DSA (typically DSA Section 3.4) will suffice to characterize the potential public safety benefits. These accidents will also suffice for onsite workers in some DSAs, while in others; the evaluated worker safety benefits will be presented in the hazards analysis instead (typically DSA Section 3.3). Either source may be used, but the accidents are generally a smaller and more specific set and thus are preferred when they afford sufficient detail to support benefit quantification.
4. Develop the benefit "score" for each proposed modification applying the scoring guidelines below (section 6.2.1) to estimate the accident frequency and consequence impacts. Note that most DSAs do not explicitly address potential failures of credited preventive or mitigative controls, but such failures are judged to be implicitly enveloped by the DSAs via the control selection process[3]. That process determines whether single or multiple controls are needed. Further, the design requirements of the selected safety SSCs are then established in DSA Chapter 4 and approved with the DSA. Thus, the DSA is considered to have accepted the failure potential of the approved SSC design. Modifications affecting multiple accidents will have a total benefit score based on the sum of benefits for each affected accident. A spreadsheet will facilitate scoring.
5. Evaluate the net cost impact of each proposed modification applying the cost guidelines below (section 6.2.2).
6. Evaluate other pertinent benefit factors applying the qualitative benefit guidelines below (section 6.2.3) to ensure their consideration in the modification selection process.
7. Assemble the cost-benefit information and present it in a format that will facilitate decision-making considering the presentation guidelines below (section 6.3). In preparing the presentation, compare the various modification rankings to ensure

[3] Thus, potential ventilation failures consistent with the DSA described active CVS design do not pose PISA conditions even though the failure scenarios were not specifically included in the hazards and accident analysis.

their relative scores are consistent (i.e., apply the sanity checking guidelines provided).

6.2.1 Scoring Guidelines

The principal concern underlying the Board Recommendation 2004-2 is the impact of active confinement ventilation on safety and therefore this is the primary benefit attribute of concern in developing a semi-quantitative cost-benefit model. Safety benefit scoring discussed in this section is thus the core of the cost-benefit evaluation. The proposed model is "semi-quantitative" in that the inputs can be estimated if they are not calculated in the DSA. These estimates will be judgments formed without calculation. An "informed qualitative approach" is preferred to reduce the scatter that otherwise results when individual's exercise uncalibrated judgment (e.g., use of scales labeled high, medium, low without calibration). The scoring section of this guide provides estimation techniques that may be used to calibrate such judgments at those DOE sites where DSAs afford little quantitative information.

As noted in the introduction, this model normalizes the potential dose to the public or onsite worker by dividing by the evaluation guideline. This EG based on DOE-STD-3009 is 25 rem for the public. Considering the precedent of the Office of Environmental Management's Nuclear Safety Risk Ranking and Control Selection Guidelines, which have been adopted into DOE-STD-1120-2005, a guideline of 100 rem at 100 meters is applied for significant consequences to an onsite receptor. The use of somewhat different normalization for the two potential receptors is judged appropriate given differences between workers and the public based on informed risk acceptance and training.

The expected dose to either receptor for a baseline accident is a function of four accident parameters that will drive the model:

1. Unmitigated dose (i.e., consequences) for the accident expressed in rem CEDE to the target receptor.
2. Probability of the accident occurring expressed as a fraction per year (e.g., an event in the *unlikely* bin has a probability of 10^{-2} to 10^{-4} with the 10^{-3} midpoint assumed absent more specific information). Credited preventive controls, if any are included in this probability without consideration of their failure potential (effectively they are assumed to be reliable).[4]
3. Mitigation efficiency for those mitigative controls that are credited in the baseline DSA expressed as a fraction (i.e., the ratio of unmitigated dose to mitigated dose if available, or 10^{-3} for a HEPA filter with credited efficiency of 99.9%).

[4] The equation which is used here can be modified to reflect the failure of preventive controls as well should that prove necessary to score the impact of a specific proposed modification accurately; to limit mathematical complexity, the model assumes that will not be necessary.

4. Probability of mitigation failure for those mitigative controls that are credited in the baseline DSA expressed as a fraction. The base failure rate is effectively reduced for continuously operating monitored systems whose random failure is likely to be detected and corrected while no accident is occurring; in these cases a net failure rate is used.

The expected consequence for a receptor is based on expected dose normalized by the applicable evaluation guideline, for each accident as given by the following equation employing these parameters:

$$\mathbf{EC = UD/EG \times P_{EV} \times \{P_{MF} + [(1 - P_{MF}) \times M_{EFF}]\}}$$

Where:

- EC is the expected consequence index (expressed as expected EG dose averted)
- UD is the unmitigated dose
- EG is the evaluation guideline
- P_{EV} is the event probability
- P_{MF} is the probability of mitigation failure (i.e., net failure rate)
- M_{EFF} is the mitigation efficiency

The first term in the { } brackets (i.e., P_{MF}) captures the expected dose when mitigation fails and the unmitigated dose is the consequence to the receptor, while the second longer term captures the expected mitigated dose when mitigation performs as expected as it does most of the time. Typically the first term will dominate the risk, but both are needed to encompass a broad range of possible modifications with different objectives.

The basic model will quantify this equation for each baseline accident affected by the modification and for the effects of the modification. The scoring then takes the difference between the sum over all affected accidents for each condition (i.e., baseline, modification) to derive the expected benefit. This will be done for both the public and the onsite worker.

That is: $$\mathbf{EB\ (expected\ benefit) = \sum EC_{baseline} - \sum EC_{modification}}$$

This quantification process is summarized in Table 6-1.

Table 6-1: Guidelines for Overall Model Quantification

Accident Parameter	Baseline Quantification	Modification Quantification
UD **Unmitigated Dose**	Use the value from the DSA if the accident is analyzed; otherwise estimate a value from the description in the hazard analysis (e.g., "above EG" is ~ twice EG while "well above" implies a factor of 5-10). Results for onsite workers can be scaled from public doses using the established ratio of overall dispersion for the two receptors. If the UD value is <~10% of the EG, drop the accident from consideration as such a dose is too low to drive a modification decision.	Most active CVS modifications will not affect the unmitigated dose and the baseline value will apply. If there are other modifications considered that reduce the available MAR, for example, these modifications would reduce the dose in proportion to the MAR reduction. This term will normally be unaffected by modifications but is needed to get the right expected consequences.
P_{EV} **Probability of event**	Use the value from the DSA if the accident is analyzed at a specific frequency; otherwise have the team estimate a value from the description in the hazard or accident analysis considering the assigned frequency bin and the description (e.g., use the low end of bin if that is stated, otherwise use the bin median: 10^{-1} for anticipated, 10^{-3} for unlikely, and 10^{-5} for extremely unlikely). The mitigated frequency should be used where credited preventive controls are not affected by a proposed modification (e.g., criticality frequency is reduced by double contingency provisions; fire frequency is reduced by combustible control).	Active CVS modifications will not affect the event probability and the baseline value will apply. Modify the DSA value only if the proposed modification is one intended to affect the event probability (e.g., the modification involves the addition of combustible controls to reduce fire risk). This term will normally be unaffected by modifications but, like the unmitigated dose, is needed to get the right expected consequences.
P_{MF} **Probability of mitigation failure**	Specific data from detailed modeling should be used if available; if not the generic guidelines in Table 6-2 may be used as a starting point. When the generic guidelines are used, discuss the specific system design to determine adjustments that may be appropriate. For example, a CVS with components vulnerable to failure in the postulated event (e.g., fire) may warrant a higher probability of failure.	Consider the valuations in Table 6-2 and interpolate for modifications that do not produce a complete order of magnitude change (e.g., a safety significant system upgraded with a few safety class features judged to have limited reliability impact might increase to 2×10^{-2}; see Table 6-4 for additional perspective on reliability impacts of possible modifications). Discuss the specific modification design to determine further adjustments that may be appropriate

Accident Parameter	Baseline Quantification	Modification Quantification
M_{EFF} Mitigation efficiency	The mitigation efficiency of credited CVS should be defined in the DSA (e.g., ratio of mitigated dose to unmitigated dose) or may be governed by LCOs (e.g., HEPA efficiency for safety active CVS). For uncredited active CVS, an efficiency could be estimated if necessary at a level perhaps lower than that typically achieved by safety systems (e.g., use ~0.1). If the credited mitigation is provided by passive Leak Path Factors, see discussion below and Table 6-3.	A modification providing a credited CVS safety significant system where previously there was none should afford a mitigation efficiency on the order of 10^{-3}. Values may be determined based on analogy to similar equipment at other facilities on the site. The addition of an additional bank of HEPA filters would also lower the mitigation efficiency although the benefit of a second bank is somewhat less than that of the first bank.

Table 6-2A: Guidelines for Determining Probability of Mitigation Failure

Mitigation System Type	Base Failure Rate[1]	Continuous Operation / Effectively Monitored[2]	Net Failure Rate[1]
Non-Safety	10^{-1}	No	10^{-1}
		Yes	10^{-2}
Safety Significant	10^{-2}	No	
		Yes	10^{-3}
Safety Class	10^{-3}	No	
		Yes	10^{-4}

Table 6-2A Notes

1. These values are generic approximations and should be replaced with calculated values when available or modified based on specific system considerations known to apply (See also Table 6-2B).

2. "Yes" can be assumed for a ventilation system when these conditions are met: (1) the active CVS operates continuously; (2) the active CVS is monitored sufficiently to ensure that failures are promptly detected (e.g., alarms provided); (3) accidents are infrequent and actions are taken to reduce their probability significantly during detected active CVS failures (e.g., hazardous operations suspended).

Table 6-2B: Guidelines for Determining Probability of Mitigation Failure

Credited (Safety) Mitigation System Type	Approximate Base Failure Rate
Active Mechanical/Electrical Engineered Safety Features without redundant design (e.g., single unit diesel generator, fire suppression system)	$\sim 10^{-2}$
Active Mechanical/Electrical Engineered Safety Features with redundant and/or independent design features	$10^{-3} - 10^{-4}$
Passive SSC	$\sim 10^{-3}$

In applying the methodology summarized in the above Tables, care must be taken to ensure that the proposed modification is represented as intended in the quantification process. An active CVS modification focused on the reliability of the existing system, for example, should affect only the probability of mitigation failure in Table 6-1 (the other three parameters should not be changed). A modification focused on improving the HEPA filtration efficiency on the other hand would affect only the mitigation efficiency parameter. A modification upgrading a non-safety system to a safety-significant CVS system would be expected to affect both the mitigation failure probability and the mitigation efficiency favorably, but still not to change the unmitigated dose or the event frequency. Appendix A *Examples of Cost-Benefit Scoring* provides some examples to illustrate the scoring process.

In the DOE 2004-2 IP, a preference is expressed for a safety active CVS over reliance upon passive leak path factors as the primary means of mitigating postulated internal radiological releases. One way to implement such a bias is to deliberately undervalue the effectiveness of passive systems that have been provided (i.e. put a thumb on the scale[5]) in deciding whether to proceed with proposed modifications. This approach does not require a determination that the credited passive confinement in an existing DSA is inadequate nor does it imply that a PISA exists. What it does do is make proposed modifications that would add a safety active CVS more attractive to see whether such a bias trips the balance in their favor for a specific existing facility. DOE intends a bias for new facilities that will not depend upon cost-benefit considerations. Table 6-3 proposes values that would implement such a bias via cost-benefit for existing facilities.

[5] A decision to depict the existing passive confinement as less-effective that the information supporting the DSA would indicate is a decision to increase the attractiveness of possible active CVS modifications in deciding how to proceed.

Table 6-3: Parameters for Existing Credit for Passive Leak Path Factors

Parameter	Recommendation
P_{MF}: Probability of mitigation failure	Passive mitigation is inherently reliable once the capability is established except for uncertainties such as use of doors in an emergency or allowed cracking of concrete in an earthquake that may have some impact. To be conservative assume a failure rate of 0.01 for credited passive confinement (see Table 6-3 Note).
M_{EFF}: Mitigation efficiency	Assume a minimal mitigation efficiency of 0.1 unless the actual value credited in the DSA is larger in which case the larger value should be used (see Table 6-3 Note).

Table 6-3 Note

Use values recommended by the expert review panel, if available.

To assist in the quantification of the impact of proposed modifications on the mitigation failure probability, Table 6-4 summarizes reliability engineering insights to guide the impact estimation.

Table 6-4: Quantifying the Impact of a Modification

Modification	Reliability Engineering Insights for Quantification
Provide improved system status information	Increases potential for active CVS random failure detection and correction prior to accident [might lower P_{MF} by a factor of 2 to 5 – see Table 6-2]; facilitates emergency response which can lower UD [e.g., might cut exposure time in half – effect on dose depends on release timing].
Modify CVS components for safe failure modes	Could lower the potential for active CVS random failure as mitigation might continue despite some failures [i.e., might lower P_{MF}] or might effectively lower UD by decreasing the potential dose even with the active CVS shutdown.
Provide CVS interlocks to preclude local positive pressure	Would provide some reduction in mitigation failure probability if positive pressure had been assumed to result in active CVS failure; principal impact is to protect personnel inside the facility (see Section 6.2.3).
Modify CVS for NPH survival	Lowers the potential for active CVS causal failure in the chosen NPH event to a negligible level [i.e., effectively sets P_{MF} to zero for the NPH event]
Provide for periodic system testing	Increases potential for active CVS random failure detection and correction prior to accident [might lower P_{MF} by factor of 2 to 5 – see Table 6-2]
Control HEPA filter service life	Would provide some reduction in mitigation failure probability if HEPA failure due to degradation with age had been assumed to result in active CVS failure
Modify design to accommodate single failures of CVS	Significantly lowers the potential for active CVS random failure [might lower P_{MF} by factor of ~10 – see Table 6-2]
Provide backup power for CVS instruments and control	Similar to improved status information above

Modification	Reliability Engineering Insights for Quantification
Provide backup power for CVS fans	Significantly lowers the potential for active CVS random failure [might lower P_{MF} by factor of ~10 – see Table 6-2]

Once the parameters have been estimated for both the baseline and post-modification conditions for each affected scenario, a consequence score can be calculated for each scenario and the total benefit can be determined applying the previously provided equations. A spreadsheet is ideal for this purpose (see Appendix A).

6.2.2 Cost Guidelines

Proposed modification cost is needed to differentiate those modifications that are most likely to be cost-effective from those that are not. Selection among competing modifications that afford comparable benefits will often be governed by cost when one must be chosen. Department facilities typically also have worthy alternative uses of funds that must be weighed prior to allocating available funding to specific proposed modifications.

Conceptually, each proposed modification would receive a rough order of magnitude cost estimate. Costs are expected to range from ~$50K to ~$50M, a three order of magnitude span. A qualitative scale considering project complexity can be constructed over approximately the same range in lieu of cost estimates (e.g., low, medium, or high) to provide preliminary discrimination among proposed modifications. Quantitative cost estimates will still be necessary for any that are selected for implementation. When a qualitative scale is used, care should be taken to minimize the introduction of bias or noise into the evaluation. Either form of cost estimation should consider the following factors as well as the normal project cost considerations (e.g., design, installation, operation, maintenance, future D&D):

- For an existing facility, the current configuration would be the baseline. An upgrade expected to improve facility availability significantly would yield cost savings via program efficiencies, partially offsetting its implementation cost. Conversely, a significant adverse availability impact on mission programs during construction would increase the net cost.
- The baseline for a proposed new facility is less evident until an adequate safety benchmark is established. As one example of a potentially unique consideration for a proposed new facility, reduced throughput (smaller batch size) might be an option to enhance safety, but the resulting extended mission should be viewed as an increase in the cost for such a modification to the baseline design.

6.2.3 Qualitative Benefit Guidelines

Prioritization typically involves multi-attribute decision making necessitating value judgments to reflect the tradeoffs among pairs of attributes. Elicitation of value judgments is itself a complex undertaking not judged to be warranted for this

application. Other considerations judged to be important can instead be indicated with a "+" or "-" on the benefit score supported by a brief description of each significant impact to ensure its qualitative consideration in ranking and sanity checking of the results. The workshop identified the following additional attributes as worthy of consideration when applicable:

- *Defense-in Depth:* Multiple barriers to hazardous material release are a proven concept in safety assurance resulting in a fault-tolerant and hence more robust design. The accident scenarios that might benefit directly from such capability are not always evident and the scoring model will tend not to value defense-in-depth, assuming that another barrier is adequately effective. Where a proposed modification is judged to significantly enhance the defense-in-depth posture of the facility, this should be noted and explained to ensure adequate consideration of this benefit attribute.
- *Facility (Immediate) Worker Safety:* Modifications that significantly improve facility worker safety must be identified. Most CVS modifications, for example, are expected to focus upon the limitation of releases from the facility and will be valued for their onsite worker impacts. Potential doses within a facility cannot be calculated reliably, and, further, evacuation is frequently effective in minimizing consequences to facility workers in any case. There will be projects, however, that are effective in protecting facility workers prior to evacuation and these benefits should be identified when they are applicable. A fully zoned interior ventilation system, for example, provides significant protection for facility workers in the event of an interior radiological release over a system serving only primary boundaries (e.g., gloveboxes and/or process components).
- *Environmental Protection:* Controls selected to protect onsite workers and the public typically suffice to protect the environment as well. A proposed modification with unique environmental implications should be identified for specific consideration in the selection process (positive or negative).
- *Regulatory Compliance or Public/Political Trust:* Each DOE Site has specific regulatory compliance and/or local public priorities that may be governed by local advisory groups, state requirements, or other federal agency requirements. A proposed modification that affects those priorities should be identified for specific consideration in the selection process (positive or negative). Examples include potential impacts on tribal grounds or areas of religious significance, issues of environmental justice, applicable compliance agreements, etc.
- *Safeguards/Security:* Considerations related to safeguards or security at some DOE Sites may be significant for specific proposed modifications (e.g., either the modification process or subsequent utilization could create the impact). A proposed modification with unique safeguards or security

implications should be identified for specific consideration in the selection process (positive or negative).

- *Mission:* The preferred means of reflecting mission impacts regarding facility availability (either during modification or afterwards) is through the net cost model. Any significant mission impacts (positive or negative) that can not be adequately reflected in that manner should be separately identified.

6.3 Presentation Guidelines

The above model involves many approximations and simplifications. With proper consideration in developing the inputs, however, it should suffice to separate those projects that afford high expected benefits from those with minimal value given their costs. It is not accurate enough to make fine distinctions and the initial scoring could produce a few ringers – projects that were misunderstood or otherwise mischaracterized. The objective and the value of the model should be to provide sufficient insight into how proposed modifications interact with the existing design and its DSA to enable the Department to make better upgrade decisions than might have been made without it. This section provides guidelines for testing the validity of the results and for displaying them in a fashion that will enhance their decision value.

6.3.1 Checking Results for Rationality

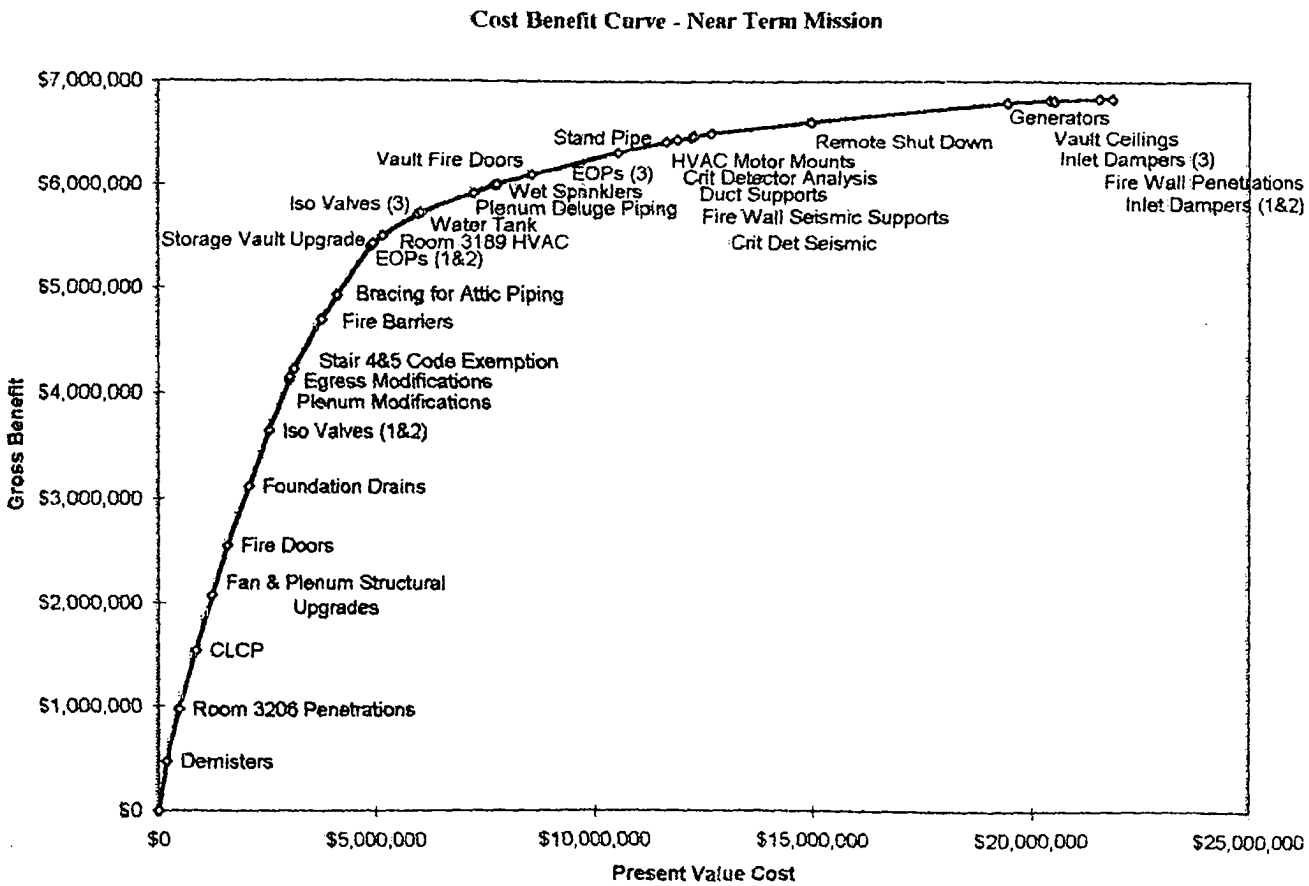
For an initial rationality check, rank-order the proposed modifications by benefit score and see if any appear to be out of place. If a modification expected to be valuable earned a low score or if a modification thought to be of limited value earned a high score, review the applicable scoring basis until the result is determined to be correct or it is corrected. Benchmarks on the scale can help this effort to put projects into perspective (see suggestions which follow). A similar screening based on cost can be performed with benchmarks preferably derived from measured costs of actual completed modifications. Modifications can also be grouped in various ways depending on their attributes (e.g., similar facilities, similar upgrades, etc) and their relative benefit and cost scores can be reviewed to see if they appear reasonable. Remember that the benefit scores are approximations and the cost estimates are rough so fine shades of distinction mean little. Resolve apparent discrepancies by reviewing the assigned scores or cost estimates and updating them if judged appropriate.

Appropriate benchmarks for benefit scoring include any modifications already adopted to address Recommendation 2004-2 gaps that require action and hypothetical projects that give some meaning to the scores. A benefit score of 1E-03, for example, corresponds to averting a dose of one EG at the midpoint of the *unlikely* frequency bin. Guidance in DOE-STD-3009 expects Technical Safety Requirement controls to address a dose of this magnitude, so this value is a familiar decision point. In fact, it might be used as a threshold to divide **high** from **moderate** benefit projects, if it is desired to use bins as part of the final selection algorithm (see Section 6.3.2). Similarly, a benefit score of 1E-5 (one EG averted at the midpoint of the *extremely*

unlikely bin) or 1E-6 (one EG averted at the low end of the *extremely unlikely* bin) indicate scores at which implementation is less likely to be appropriate. The 1E-5 value might be an appropriate threshold to differentiate **moderate** and **low** benefits in constructing bins.

Another reasonableness check that proved useful in the response to Board Recommendation 94-3 at Rocky Flats was to rank-order the complete set of potential modifications by their benefit/cost score ranging from highest to lowest. Note that, should a project end up with a negative cost score, it warrants consideration on its own merits without regard to benefit and need not be included in the rank ordered set. Prepare a plot of cumulative benefit/cost with the projects in rank order; the plot should show a marked trend toward diminishing returns with only those to the left of this point most worthy of consideration (see Figure 6-1 for an example from the Rocky Flats Building 371 study). As a rationality check using this plot, examine those projects on either side of the diminishing returns inflection point, verify their relative position, and pick a cut off for projects to be considered.

Figure 6-1: Sample Curve Showing Diminishing Returns for Sorted Projects



6.3.2 Presentation of Results

When sanity checking is complete ad the final scoring results are judged to provide adequate support for the decision process, the available results should be summarized in a format that visually conveys their information to a decision-maker. The figure above is one option. Another approach that has been used is to prepare a scatter plot of modification projects on a two-dimensional grid showing cost on one axis and safety benefit on the other. If benefit scores are divided into high-moderate-low as suggested above, costs can be similarly divided (e.g., low ranging from $50K to $500K, moderate ranging from $500K to $5M, high ranging from $5M to $50M). Modification projects, if any, with high benefit and low cost would be most attractive, while any with high cost and low benefit would be evidently not worth pursuing.

As another aid to calibrate the decision process, the model could be applied to some decisions that had already been made such as the original decision to provide active ventilation for some projects. The upgrades being considered could then be related to the benefit impact of this decision, perhaps as a percentage or, preferably, on the chosen visual display. In addition, the risk being mitigated by the proposed project could be compared with the accepted risk of facility operation (e.g., approximated as the sum of expected public rem times frequency for all events evaluated in the DSA). This could be determined by assuming a perfect project that eliminated remaining risk and determining its benefit via the adopted model. Clearly, a project addressing a significant fraction of the outstanding risk is more valuable than one with at most a limited impact.

To help each PSO evaluate cost-benefit results and rank/prioritize facility modifications, other modifications being considered at the site or complex-wide can be included for perspective. Whatever presentation method is chosen, other benefit considerations (Section 6.2.3) can be indicated with marks (e.g., +3 or -2) or colors to cue the applicability of supporting descriptive material that must be available to convey these considerations in summary form.

The staff preparing the presentation should provide recommendations discussing the pros and cons of their selection of the modification projects judged most worthy of consideration for final disposition by Department decision makers.

6.3.3 Selection Process

Drawing upon the chosen presentation, informed decisions can be made. The decision process should include input from the CTA and site personnel, giving global consideration to factors other than DOE 2004-2 IP, such as competing safety upgrades otherwise identified.

One other implementation plan requirement is that the cost benefit model be used to help prioritize how the workable list of generic ventilation system performance and/or design expectations should be applied during system evaluation. For the proposed options, the model would focus attention on quantifying the expected dose impact

(i.e., probability and consequences) of the changes considered. Changes with an intangible benefit (e.g., standards upgrade with no clear impact on reliability) would be de-emphasized, while those affecting higher probability, higher consequence accidents significantly would be prioritized.

6.4 Conclusion

Overall, the proposed cost-benefit model is judged to be suitable for the types of projects that need to be considered in carrying out the DOE 2004-2 IP and the final decision process envisioned therein.

7. References

The following references are provided as a convenience to the reader and list some of the applicable regulations, directives, and guidance documents associated with the preparation and review of Documented Safety Analyses.

Atomic Energy Act, U.S. Code: Title 42, Chapter 23, *Development and Control of Atomic Energy*

10 CFR Part 830, *Nuclear Safety Management*

DOE O 420.1B, *Facility Safety*

DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for use with DOE 420.1 Facility Safety*

DOE G 420.1-2, *Guide for the Mitigation of Natural Phenomena Hazards for DOE Nuclear Facilities and Non-Nuclear Facilities*

DOE G 421.1-2, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830*

DOE G 423.1-1, *Implementation Guide for Use in Developing Technical Safety Requirements*

DOE SEN-35-91, *Nuclear Safety Policy*

DOE-STD-1020-2002, *Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities*

DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*

DOE-STD-1022-94, *Natural Phenomena Hazards Characterization Criteria*

DOE-STD-1023-95, *Natural Phenomena Hazards Assessment Criteria*

DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, Change Notice 1

DOE-STD-1104-96, *Review and Approval of Nuclear Facility Safety Basis* Documents, Change Notice 1

DOE-STD-3009-94, *Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety Analysis Reports*, Change Notice 2

Energy Facilities Contractors Group, *Safety System Design Adequacy*, Submitted by Engineering Practices Working Group, August 2004

Appendix A

Examples of Cost-Benefit Scoring

The table below illustrates the application of the proposed model. The first example compares three proposed projects to provide credited safety active CVS in a facility that had previously relied upon passive Leak Path Factors. A fourth case illustrates the possible effect on the score of the bias proposed for historical reliance upon passive LPFs. The greatest benefit is achieved when a safety-class CVS system is provided (Case 1B, EB=0.051), but essentially the same benefit can be obtained with a safety-significant system (Case 1A, EB=0.050). A third case postulates the dedication of an existing non-safety system that achieves less than the target reliability and effectiveness of the safety-significant CVS (Case 1C, four times the mitigation failure rate, one-half the mitigation effectiveness, ~50% of the benefit). Cost data might favor Case 1C. A final case assumes that the existing passive LPF has a failure rate of 1E-04 and a mitigation efficiency of 1E-3 (vs. the default bias values of 1E-02 and 10%). These assumptions reduce the benefit of adding a safety class active CVS by over two orders of magnitude (Case 1D, EB=2.33E-04).

Modification Description	No.	UD Baseline	P_{EV} Baseline	P_{MF} Baseline	M_{EFF} Baseline	EC Baseline	UD after mod.	P_{EV} after mod.	P_{MF} after mod.	M_{EFF} after mod.	EC after mod.	Expected Benefit	Benefit Rank	Relative Effectiveness
Add SS active CVS with passive LPF in DSA for Anticipated fire in facility	1A- p	4	0.1	0.01	0.1	1.744E-3	4	0.1	1.00E-3	1.00E-3	3.198E-5	1.712E-3		
	1A-fw	450	0.1	0.01	0.1	4.905E-2	450	0.1	1.00E-3	1.00E-3	8.996E-4	4.815E-2		98.71%
	Total											4.986E-2	High	
Add SC active CVS with passive LPF in DSA for Anticipated fire in facility	1B- p	4	0.1	0.01	0.1	1.744E-3	4	0.1	1.00E-4	5.00E-4	9.599E-6	1.734E-3		
	1B-fw	450	0.1	0.01	0.1	4.905E-2	450	0.1	1.00E-4	5.00E-4	2.700E-4	4.878E-2		100.00%
	Total											5.051E-2	High	
Add reduced reliability SS active CVS with passive LPF in DSA for Anticipated fire in facility	1C- p	4	0.1	0.01	0.1	1.744E-3	4	0.1	4.00E-3	5.00E-2	8.608E-4	8.832E-4		
	1C-fw	450	0.1	0.01	0.1	4.905E-2	450	0.1	4.00E-3	5.00E-2	2.421E-2	2.484E-2		50.92%
	Total											2.572E-2	High	

Modification Description	No.	UD Baseline	P_{EV} Baseline	P_{MF} Baseline	M_{EFF} Baseline	EC Baseline	UD after mod.	P_{EV} after mod.	P_{MF} after mod.	M_{EFF} after mod.	EC after mod.	Expected Benefit	Benefit Rank	Relative Effectiveness
Add SC active CVS with passive LPF in DSA as analyzed (i.e., without bias) for Anticipated fire in facility	1D- p 1D-fw Total	4 450	0.1 0.1	1.00E-04 1.00E-04	0.001 0.001	1.760E-5 4.950E-4	4 450	0.1 0.1	1.00E-04 1.00E-04	5.00E-4 5.00E-4	9.599E-6 2.700E-4	7.999E-6 2.250E-4 2.330E-4	 Moderate	 0.46%

As another example, consider an analyzed glovebox fire during contact waste sorting at a repackaging facility with a recently approved DSA. The analyzed fire involves up to 25 plutonium-equivalent Curies in exposed combustible waste being handled on trays within the glovebox. The fire as analyzed is unlikely, bounding anticipated fires involving lesser quantities of material. The analyzed consequences to the public, without mitigation, are 0.51 while the unmitigated consequences to an onsite receptor at 100 meters are calculated to be 86 rem. A safety significant active CVS is credited for the scenario and mitigates the onsite receptor dose by a factor of 100. The proposed cost-benefit model provides the following insights regarding possible modifications to this system:

1. The unmitigated public dose is below ~10% of the EG and can be dropped from consideration (i.e., ~4% unmitigated, and 0.04% mitigated.
2. The DSA decision to require the safety significant ventilation system can be tested with the model and it earns an Expected Benefit score of 8.6E-04 or moderate (near the high threshold of 1E-03) for protection of an onsite receptor.
3. The potential benefit of upgrading the system to safety class, assuming the default values of P_{MF} and M_{EFF} are applicable, earns a low Expected Benefit score. Board Recommendation 2004-2 would not suggest making such an upgrade in this instance and therefore this result is consistent.

Modification Description	No.	UD Baseline	P_{EV} Baseline	P_{MF} Baseline	M_{EFF} Baseline	EC Baseline	UD after mod.	P_{EV} after mod.	P_{MF} after mod.	M_{EFF} after mod.	EC after mod.	Expected Benefit	Benefit Rank	Relative Effectiveness
Add SS active CVS per DSA for unlikely glovebox fire in waste facility	1A- p	0.51	0.001	1	0	0.000E+00	0.51	0.001	1.00E-3	1.00E-3	0.000E+0	0.000E+0		
	1A-fw	86	0.001	1	0	8.600E-4	86	0.001	1.00E-3	1.00E-3	1.719E-6	8.583E-4		
	Total											8.583E-4	Moderate	
Modify SS active CVS per DSA to SC for unlikely glovebox fire in waste facility	1B- p	0.51	0.001	1.00E-03	1.00E-03	0.000E+00	0.51	0.001	1.00E-4	5.00E-4	0.000E+0	0.000E+0		
	1B-fw	86	0.001	1.00E-03	1.00E-03	1.719E-06	86	0.001	1.00E-4	5.00E-4	5.160E-7	1.203E-6		
	Total											1.203E-6	Low	