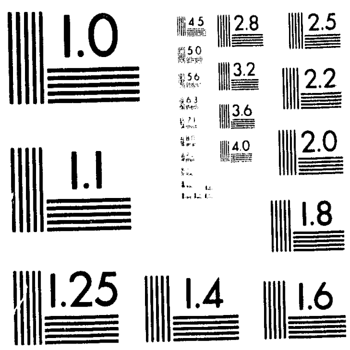
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Interaction Analysis Method for the Hanford Waste Vitrification Plant

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INTERACTION ANALYSIS METHOD FOR THE HANFORD WASTE VITRIFICATION PLANT

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ABSTRACT

In order to anticipate potential problems as early as possible during the design effort, a method for interaction analysis was developed to meet the specific hazards of the Hanford Waste Vitrification Plant (HWVP). The requirement for interaction analysis is given in DOE Order 6430.1B and DOE-STD-1021-92. The purpose of the interaction analysis is to ensure that non-safety class items will not fail in a manner that will adversely affect the ability of any safety class item to perform its safety function.

In the HWVP there are few structures, equipment, or controls that are safety class (those with a direct safety function, i.e., confinement of waste). In addition to damage due to failure of non-safety class items as a result of natural phenomena, threats to HWVP safety class items include the following: room flooding from firewater, leakage of chemically reactive liquids, high-pressure gas impingement from leaking piping, rocket-type impact from broken pressurized gas cylinders, loss of control of mobile equipment, cryogenic liquid spill, fire, and smoke. The time needed to perform the interaction analysis is minimized by consolidating safety class items into segregated areas. Each area containing safety class items is evaluated, and any potential threat to the safety functions is noted. After relocation of safety class items is considered, items that pose a threat are generally upgraded to eliminate the threat to the safety class items. Upgraded items are designed to not fail under the conditions being evaluated. Upgrading is the preferred option when relocation is not possible. Other options are to provide barriers, design the safety class item not to be damaged by failed items, or rely on redundancy and isolation from local threats. The upgraded features of non-safety class items are designed to the same quality standards as the safety class items.

An example will illustrate the method and application in the phased design, procurement, and construction environment of the HWVP.

INTRODUCTION

The interaction analysis for the Hanford Waste Vitrification Plant (HWVP) is an application of the requirements given in DOE-STD-1021-92 [7]. The interaction analysis begins after the locations of safety class items are determined within the facility. The HWVP uses a graded approach to safety classification. The threats to safety class items include natural phenomena hazards (NPH), internal accident conditions, and the failure effects of other items. The general approach at HWVP is to conservatively assume that all items exposed to a threat can cause interactions, unless designed for that threat.

REQUIREMENTS

Safety class items are systems, components, and structures that have been designed so they will perform required safety functions during and after NPH and accident conditions. The interaction analysis ensures that failure of other items, initially not designed for these conditions, will not prevent the safety class items from performing their required functions. The requirement for interaction analysis is given in DOE Order 6430.1A [1] and draft revision, DOE Order 6430.1B [2], under "Safety Class Criteria," Section 1300-3.2. The methodology for determining safety classification is given in DOE Order 5480.23 [3], which supersedes Order 5481.1B [4] for nuclear facilities. The DOE Order 5480.28 [5] sets requirements for protection against NPH. The requirements of DOE Order 5480.28 govern where there are inconsistencies with DOE Order 6430.1A relating to NPH.

The DOE Order 5480.28 prescribes a graded approach to safety, public health, and the environment. Performance categories must be established for the structures, systems, and components in a facility. Items are assigned to one of the five categories, depending on the relative importance of the item to safety, including health and environment. Items needed to protect the workers and public against radioactive or toxic materials are placed in the highest category, while items that endanger personnel in the event of collapse are placed in a lower category. Items in the higher categories are designed to provide a lower probability of failure. The DOE Order 5480.28 emphasizes the need for an interaction analysis in paragraph 10a(5).

The DOE Order 5480.23 is referenced by DOE Order 5480.28. (The predecessor document, DOE Order 5481.1B, is still referenced by DOE Order 6430.1A.) The DOE Order 5480.23 requires classification according to the following three categories:

1. Potential for significant offsite consequences
2. Potential for significant onsite consequences
3. Potential for only significant localized consequences.

The Hanford Site criteria document, MRP 5.46 [6], establishes four safety classifications. Like the classification categories defined in DOE Order 5480.23, the Hanford Site safety classification system is based on the consequences of unmitigated releases of radioactive and/or hazardous material. In a simplified form, the safety classifications are as follows:

- Safety Class 1 — Significant offsite radiological or environmental consequences (as defined in DOE Order 6430.1A), or significant offsite exposure to nonradiological hazardous materials by a release into the air or to soil, streams, and aquifers
- Safety Class 2 — Significant onsite radiological or nonradiological consequences, environmental threats, or exposure to personnel in the facility control room
- Safety Class 3 — Facility safety and health, or reportable releases to the environment
- Safety Class 4 — (Non-safety class) No significant importance to safety, health, or environmental protection.

The MRP 5.46 is based on DOE Order 6430.1A, complies with it, and extends the requirements of DOE Order 6430.1A. The terminology "safety class" used in DOE Order 6430.1A applies only to Hanford Site Safety Class 1. Nonradiological hazardous materials, including toxics, carcinogens, and pathogens, are not addressed in DOE Orders 6430.1A or 6430.1B. The MRP 5.46 provides direction relating to nationally recognized standards for nonradiological hazards. At the Hanford Site, Safety Class 2 was created because of special concerns for the onsite area. Onsite refers to the area within the Hanford Site reserve, but outside the facility boundary (except the facility control room). The site boundary is more than 16 km (10 mi) from the facility. There are many DOE facilities and offices on the site. Onsite consequences potentially affect many workers at other nearby facilities. Safety Class 3 concerns include occupational safety, health, and radiation shielding for HWVP personnel protection.

Hanford Site safety classification criteria and methodology seem to have anticipated the graded approach of DOE Orders 5480.23 and 5480.28, and DOE-STD-1021-92 [7].

The DOE-STD-1021-92, Section 2.5, "System Interaction Effects," provides a detailed methodology for preventing an item in a lesser performance category from adverse interaction with items in more important categories, once the interaction potential is discovered. Additional NPH requirements may be imposed on the lesser category item to preserve the performance goal of the more important items. In this case, the added requirements need only prevent the failure modes (or deviation from normal limits) of concern. The MRP 5.46 applies the same reasoning, extending to threats other than NPH.

The MRP 5.46 refers to UCRL-15910 [8] for criteria on NPH. The new DOE-STD-1020-92 [9] revises and supersedes UCRL-15910. The HWVP Safety Class 1 items are designed using the high-hazard facility requirements of UCRL-15910; Safety Class 2 items are designed using the moderate-hazard facility requirements.

In summary, the interaction analysis for HWVP provides an example for compliance with the recent DOE Orders and Standards.

HWVP FACILITY OVERVIEW

The HWVP is designed to vitrify treated high-level nuclear waste. The waste oxides are melted to become a homogeneous part of the borosilicate glass product. The glass product is poured from the melter into stainless steel canisters. The cooled canisters will be decontaminated, seal-welded, inspected, and temporarily stored at the facility until they are sent to a geologic repository. The plant waste feed is treated with formic acid, nitric acid, and other chemicals as required. The feed slurry is reacted, concentrated, mixed, and sampled in process tanks before going into the melter. Offgas systems treat the vented gas from the process tanks and melter to reduce radioactive and toxic materials to within allowable limits for stack release. Condensate from the process tanks and offgas systems are collected in a waste hold tank for further treatment at another facility. Contamination is confined by ventilation systems. Room air pressure is controlled in the different ventilation zones of the plant to direct airflow from uncontaminated areas toward areas of greater contamination. Air from the highest contaminated area, Zone I, is exhausted through high-efficiency particulate air filters into a continuously monitored stack. Diesel generators supply emergency power to the Zone I exhaust fans.

The potential hazards to onsite and offsite individuals come from the waste feed, melter contents, canister contents, formic acid, and liquid waste produced in the facility. The major Safety Class 1 items at the facility are as follows:

- Major confinement walls and large doors in the Vitrification Building
- Zone I exhaust system, including filters, fans, controls, isolation dampers, fan cooling, filter building major walls, fan house major walls, and stack
- Zone I emissions monitors and required vacuum system
- Emergency ac power and dc power to Safety Class 1 loads, such as the Zone I exhaust fans, controls and stack monitors
- Essential support systems for Safety Class 1 power, including ventilation for generators and switchgear
- Portions of the waste hold tank and building necessary to avoid leaks to the soil
- Controls necessary to prevent a steam explosion or unlimited flooding in the Vitrification Building or the below-grade Zone I exhaust system.

The only major Safety Class 2 items are piping and controls which prevent a large release of concentrated formic acid.

Less than 10% of the equipment and controls are Safety Class 1 or 2.

OBJECTIVES OF THE ANALYSIS

The purpose of the interaction analysis is to ensure that no Safety Class 2, 3, or 4 item could fail in a manner that will adversely affect the safety function of a Safety Class 1 item, and that no Safety Class 3 or 4 item could fail in a manner that will adversely affect the safety function of a Safety Class 2 item.

The analysis determines what design improvements will be incorporated to ensure the criteria requirements. The analysis answers the following questions.

- Where is the interaction analysis required?
- What are the potential effects on Safety Class 1 and 2 items?
- What design features require upgrading?
- What are the design requirements for these upgraded features?

Merely satisfying the criteria requirements is not enough. To be effective, the analysis method must have the following qualities:

- Timely discovery of interaction problems
- Avoidance of detailed, item-to-item evaluation of domino effects
- Ability to accommodate design development and revision
- Consideration of all accident threats, not just NPH, to safety class items.

As noted in DOE-STD-1021-92, Section 3.8(a), one analysis option is to develop a fault tree of a complex chain of events that threaten a Safety Class 1 or 2 item. This option is cost-effective only in special cases.

The second option mentioned in DOE-STD-1021-92 is an approximate evaluation of scenarios identified during a facility walkdown. Unfortunately, the cost of revising a facility that is ready for walkdown is many times greater than the cost of revising design specifications or drawings.

HWVP APPROACH

STARTING

The interaction analysis begins after the locations and routing of Safety Class 1 and 2 items are known (including controls and power). This stage of design development coincides with the design contractor's in-house design review. The interaction analysis is completed at the same time as the design review, so that necessary changes can be incorporated in the design sent for client review. At the time of the analysis, safety classifications of major structural elements have been determined, as well as fire ratings of walls and ceilings. For the post-earthquake internal flood condition, the maximum liquid depth has been calculated.

The analysis looks at one room or area at a time. Several procurement or construction bid packages may be associated with a single room. The room analysis is updated for each package issue. Where practical, conservative assumptions are made in the analyses for early packages to allow some flexibility for change.

LEVEL OF DETAIL

The design engineering contractor for HWVP had previously evaluated the effort required to prepare an item-to-item analysis of a building at another facility containing a mixture of Safety Class 1 and 3 items. For each specific threat condition, the interaction analysis determined which items posed a threat or propagated a threat to other items. For interactions caused by earthquake or fire, the analysis was time-consuming and difficult to check. The results had a large degree of uncertainty because of the randomness in propagation of impact. Furthermore, each time an item was relocated or significantly revised, the entire analysis had to be redone. From this evaluation, it was found that the cost of the item-to-item analysis was much greater than the cost of upgrading the seismic requirements of all of the Safety Class 3 items in the building, including fire protection.

The general approach at HWVP is to assume that all items in a room are exposed to any threat in that room and can transfer the threat, unless upgraded. This means that in general, we design conservatively so that we can simplify the analysis. The result is a more rugged design at lower total cost. Outside of the buildings, an item-by-item evaluation is made. However, the outside analysis is simple because there are few items and little potential for interaction. Inside buildings, item-by-item evaluations are made if the design team decides it would be cost-effective. If there had been many item-by-item evaluations, the design schedule would have been seriously affected (even more than the budget).

Safety Class 3 and 4 items are listed and analyzed together as much as possible. For example, floor-mounted fans might be considered together, rather than each one individually. Safety Class 3 and 4 items are analyzed together if they have the same potential effect on Safety Class 1 or 2 items, and if the same design solutions apply.

HAZARDS ADDRESSED

The analysis considers the following NPH threats: earthquake, extreme outdoor temperatures, snow and ice accumulation, wind and associated wind-driven missiles, and ashfall (from Mount St. Helens or other volcanoes in the Cascade Range). Tornadoes, outdoor flooding, and brush fire are not threats to this facility.

The analysis considers the following additional threats: fire (heat, smoke, and fumes), mobile equipment impact, liquid splashing, submergence (due to internal flooding), pipe whip and gas impingement from broken gas piping, impact from a broken high-pressure gas cylinder, and missiles from high-speed rotating equipment.

Nuclear criticality is not a concern because fissile material is very dilute in the facility feed. The feed composition will be tested before processing to ensure criticality safety. Explosion was not considered in the interaction analysis; instead, there were separate accident analyses for explosions. Mobile equipment is listed in each room to which it can move. Only the mobile equipment included in the design is considered; construction equipment and special maintenance equipment are not considered. Aircraft impact and a train accident on the spur line coming into the facility were considered in separate accident analyses. Liquid splashing can cause short-circuiting, corrosion, or sudden temperature change. Liquid nitrogen is carted into the laboratory in Dewar containers. Liquid loading on structures during internal flooding was evaluated in a separate accident analysis. The only source for pipe whip is from 150 psig steam and air lines. All of these additional threats could result from an earthquake, and some could occur at any time.

Several mechanisms for the propagation of impact (domino effects) were considered:

- Collapse of walls, ceilings, floors and other structures not rated for the NPH or accident condition (earthquake, fire, flooding, missile, etc.)
- Collapse, tipping, or sliding of floor-mounted items not designed for the NPH or accident condition
- Pendulum motion of wall- or ceiling-mounted items with anchors not designed to limit swing during a design basis earthquake (DBE).

Items designed for a DBE are expected not to fail, but could deflect far enough to cause impact with Safety Class 1 or 2 items. These deflections have been taken into account before the interaction analysis, in the seismic design of structures, piping, and equipment.

UPGRADED ITEMS

Before the interaction analysis, the design requirements on an item are tentatively determined according to the safety classification. All Safety Class 1 and 2 structural items are designed to maintain building environmental control or confinement after the appropriate DBE, design basis wind, and extreme weather conditions. Safety Class 1 structures are designed for the design basis ashfall. Also, Safety Class 1 and 2 structures are protected against the design basis fire and other conditions determined by accident analyses. Nonstructural items are designed only for the NPH and accident conditions that threaten necessary safety functions. For example, the Safety Class 1 safety valves on the steam boiler do not have to function during or after a DBE because there are Safety Class 1 interlocks that stop the boiler in the event of a DBE.

When the interaction analysis identifies an interaction that could interfere with a safety function, one design option is to upgrade the requirements for the item causing the interaction. In agreement with DOE-STD-1021-92, Section 2.5(c), upgraded design requirements only apply to those features of the items that are sufficient to prevent the interaction of concern, not necessarily to the entire item. The feature upgrades are designed for the specific NPH or accident conditions that pose a threat. The upgraded item need not continue to perform its normal function, but it must be designed not to fail in a way that prevents the Safety Class 1 or 2 item from performing necessary safety functions during the Safety Class 1 or 2 NPH or accident conditions. The Safety Class 1 and 2 level of quality assurance applies to the upgraded features.

The upgrading of the Canister Storage Building operating area structure is described briefly in the example near the end of this paper.

DESIGN PREPARATION

Analysis effort is reduced by thoughtful planning during the design process. In the first stage of equipment layout, Safety Class 1 and 2 equipment is consolidated into as few rooms as possible, within the redundancy and separation requirements.

Upgraded design details are used as standards wherever practical. For a small increase in material cost, all compressed gas bottle racks are designed for the Safety Class 1 DBE, whether the bottle would pose a threat to Safety Class 1 items. All Safety Class 1 and 2 items will be of splash-proof design, on the assumption that splashing is possible in virtually all rooms and outdoor areas.

Before the analysis begins, several layout guidelines are followed: avoid placing Safety Class 3 or 4 items above Safety Class 1 or 2 items, maintain as much distance as possible between Safety Class 1 or 2 items and others, and locate obvious sources of hazard as far as possible from Safety Class 1 and 2 items. Where items of different Safety Class are mixed, because of space limitations, additional guidelines are followed to minimize later analysis and revision.

ANALYSIS LOGIC

In each room or area, the need for analysis is reviewed. For each bid package, the project engineer prepares a list of all rooms and areas in the package. An interaction analysis is performed for each room or area with Safety Class 1 or 2 items. Even if the package has no Safety Class 1 or 2 items, an interaction analysis will be performed, based on the information available, to avoid interactions with items from other packages in the same room. The analysis for a room will be updated for each package affecting it.

The logic for the analysis is shown on the block diagram in Figure 1.

For each Safety Class 1 or 2 item in the room, the NPH and other threats listed under "Hazards Addressed" are considered separately. There is no interaction problem if there is no safety function required under those particular conditions, or if there is no possibility of that particular threat in the room.

In some cases, the design specialist responsible for an item will determine that an interaction will occur, but it is obvious that the damage will not be sufficient to affect the ability to perform safety functions. For example, ceiling-mounted lighting can be allowed to fail when there will be no problem to rugged equipment or structures below. In these cases, the design engineer documents that normal design is sufficient.

When there is the potential for an interaction problem, there are several design options to consider:

- Relocating either the affected or affecting items

- Adding the design requirement that the Safety Class 1 or 2 item be designed to function as required in the event of the adverse interaction(s)

- Using system redundancy and appropriate isolation to ensure that localized accidents will not affect the system safety function

- Upgraded features for the items posing a threat. The features are upgraded to meet Safety Class 1 or 2 requirements as appropriate to prevent interaction.

Where practical, prevention of an interaction is preferred over damage reduction. However, prevention of splashing or impact by small items is not considered practical at HWVP.

Safety Class 1 nonstructural items are fully redundant. Redundancy and isolation can protect against threats that are unlikely to occur in more than one room. There are sources of splashing in nearly every room with Safety Class 1 or 2 items, so it seems likely that splashing will occur many places after a DBE. On the other hand, the rooms with Safety Class 1 or 2 items have little potential for a fire, even after a DBE. There is little combustible material in the facility, other than wiring insulation and maintenance materials. The few existing combustible process materials, such as diesel fuel and concentrated formic acid, are localized and isolated by Safety Class 1 barriers.

Where relocation or protection by redundancy and isolation is not practical, the preferred option is to upgrade the items that pose a threat. The upgrading applies only to certain features of the item, as discussed under "Upgraded Items." Other options are considered by the design team only if suggested by one of the responsible design specialists. Any differences in approach are settled in the engineering review meeting for the analysis.

Documentation of the completed analysis is accomplished by tabulating the potential for interaction problems and design options chosen. One-letter abbreviations are used to indicate the disposition of each potential threat to each Safety Class 1 or 2 item:

<u>Key to abbreviations used in tabulation:</u>

No Safety Problem

c The indicated Safety Class 2, 3, and 4 items <u>cannot</u> pose this threat to Safety Class 1 or 2 items.

f There is no required safety <u>function</u> to be performed under this threat.

Design Solutions

R There are <u>Redundant</u> Safety Class 1 or 2 items. The redundant items are isolated so that the system is protected against a single occurrence of this local condition.

D Safety Class 1 and 2 items must be <u>Designed</u> to perform all safety functions under conditions caused by this threat.

B A <u>Barrier</u> protects safety Class 1 or 2 items against damage affecting safety functions caused by this threat.

U Safety Class 2, 3, or 4 items have <u>Upgraded</u> features (portions designed for specific Safety Class 1 or 2 requirements) to prevent failure caused by this threat from affecting the safety functions of Safety Class 1 or 2 items.

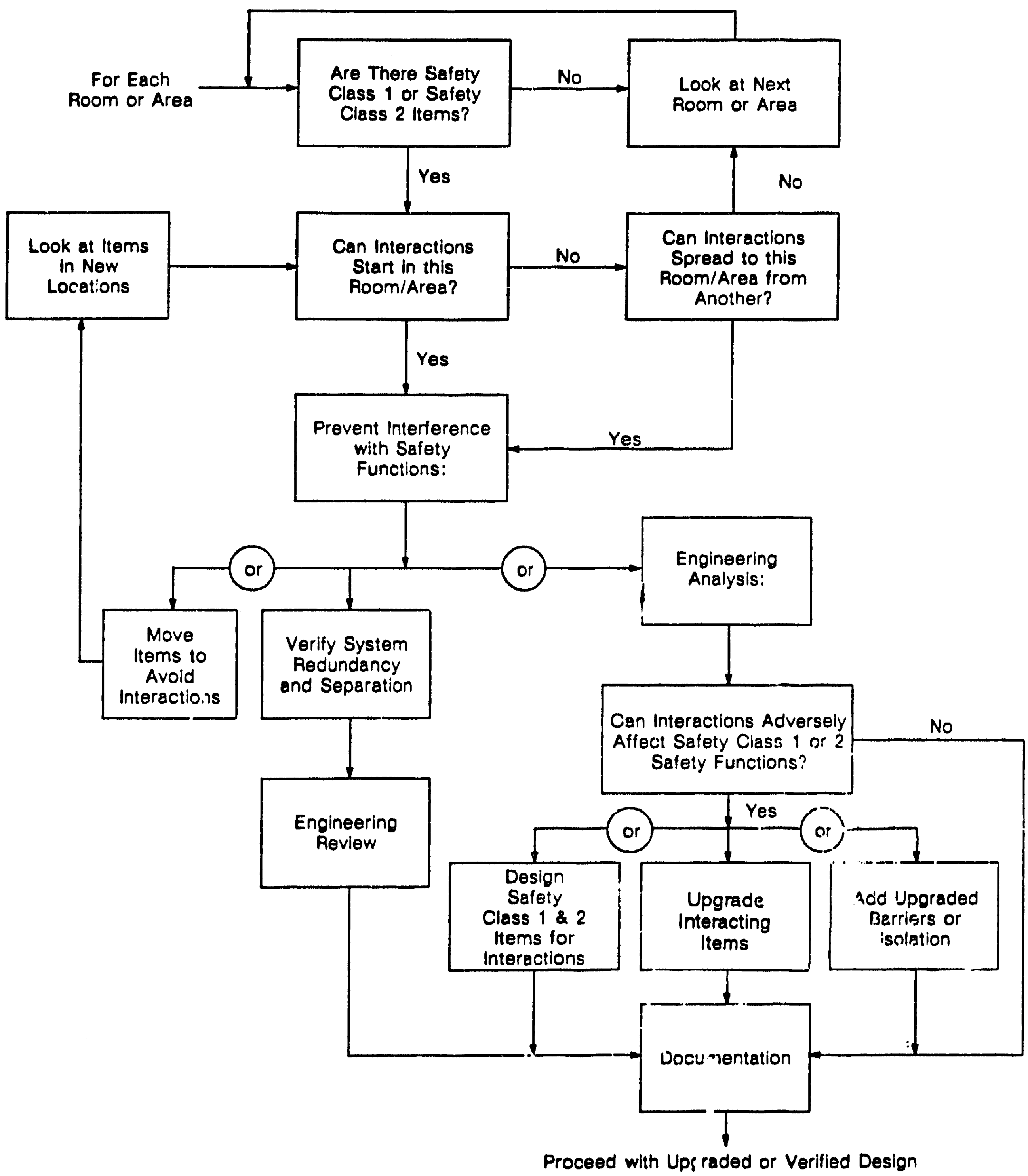
N <u>No special features</u> or protective barriers are provided for internal accidents because all other items which could fail under this threat have:

- been Upgraded to prevent failure, or
- had an engineering evaluation to verify that the safety functions of Safety Class 1 and 2 items will not be prevented by failure of other items.

SUPPORTING CALCULATIONS

After the interaction analysis, additional calculations may be required to be performed by the design engineers, or called for in specifications. Where there are additional design requirements on a Safety Class 1 or 2 item, calculations (or vendor testing) must show that the

Figure 1. Interaction Analysis Logic.



enhanced item will withstand the interactions. Where there are upgraded requirements on Safety Class 2, 3 or 4 items, calculations (or testing) must show that the upgraded item will not cause adverse interactions. Sometimes, the calculations will verify that the normal design is satisfactory.

INTERFACES

Interactions that cross a room boundary must be considered in both rooms. Sometimes, this will require followup in the analyses for future bid packages.

Failures caused by NPH or accident conditions in one room can affect items in other rooms if the room boundaries are not designed for the NPH, accident conditions, and resulting interaction failure effects. The structural engineer involved in the analysis notes any failure effect that could cause a breach in structural elements forming the room boundaries.

At the bottom of the analysis tabulation, rows are added to include items in other rooms that could be affected. These threats to the other rooms must be included in the other analyses. When the other rooms are in other bid packages, this requires that the threat conditions be noted on a followup list.

When interactions from an interfacing room in a different package can affect the room being analyzed, an analysis is performed for the interfacing room and is included with the package being analyzed.

FINAL WALKDOWN

The walkdown becomes the final verification that interaction effects were not overlooked. Analysis documentation and supporting design media are retained for the purpose of answering any concerns of the walkdown team. The walkdown team will consist of experts not affiliated with the design or construction contractors.

EXAMPLE

The Canister Storage Building operating area structure is located over the underground storage vault where canisters of vitrified waste are stored. The reinforced concrete vault is Safety Class 1. The operating area structure is Safety Class 3, based on its confinement function. A conservative evaluation determined that the operating area structure could damage the vault underneath if it were to collapse.

The tabulation of the analysis for the vault can be seen in Figure 2. Although the tabulation is convenient to work with, it is difficult to read directly. Because of this difficulty, the results of the analysis are taken from the tabulation and presented in a report. The tabulation is in the form of a matrix with structures, systems, and components in the rows. The NPH and accident conditions are indicated in the columns. The matrix addresses each item under each condition. The "Key to Abbreviations" explains the notation.

In this case, the operating area walls and ceiling have been upgraded (U) not to collapse during the Safety Class 1 DBE, design basis fire, design basis ashfall, and Safety Class 1 weather extremes (ice buildup or design basis wind with wind-blown missiles). The walls are protected by barricades (B) to prevent the shielded canister transporter vehicle from collapsing the wall by impact. The steel framework of the building and the barricades, but not the covering, are upgraded to Safety Class 1. All Basic and Supplementary requirements of ASME NQA-1-1989 [10] apply to the framework, barricades, and calculations which ensure that the structure will not collapse.

The shielded canister transporter has been upgraded not to tip over onto the vault during a Safety Class 1 DBE. During a fire, the rubber tires could be consumed, increasing the stress applied to the storage tubes and plugs. The transporter has no special features (N) to solve this potential problem. Instead, the tubes and plugs will be designed (D) for this condition, as well as misoperation of the transporter.

A D for any Safety Class 1 item indicates that it is designed for the failure of all Safety Class 3 items that have an N under that condition. The plugs on top of the tubes are designed for impact by the transporter. Other items in the "mobile equipment impact" column are not mobile; therefore c is indicated. The canisters and impact absorbers have c indicated where they are protected from the NPH or condition.

The transporter has a propane fuel tank which could become a missile in the event of failure. Although the transporter should be designed to prevent this, transporter design (in another package) had barely begun when the bid package for the building was completed. The canister storage tubes and plugs happened to be adequate for this missile impact, but the D under "gas cylinder impact" indicated that this had to be verified by calculation.

INTERACTION MATRIX

REV 01 CHANGES ARE CIRCLED (E350)

ROOM OR AREA: CANISTER STORAGE BUILDING VAULTS - ROOMS 004, 006, 009 — E350 PACKAGE (4 P26) PAGE 1 OF 1 DATE 6-3-93

ITEMS	SC	SS-1 OBE IMPACT	SS-2 OBE IMPACT	OBF & SMOKE	MOBILE EQUIP IMPACT	OUTDOOR HEATING	ASHFALL	SPLASHING	SUBMERGENCE	GAS/STEAM RELEASE	GAS CYLINDER IMPACT	OTHER ( )	ENGR REVIEW	COMMENTS
CANISTER STORAGE VAULTS	1	N	N	N	N	C	C	N	N	C	C			
CANISTER STORAGE TUBES	1	D	D	(D)	(D)	C	C	N	(D)	C	(D)		PRD	DESIGNED FOR CANISTER FORCES, SCT FORCE ON CANISTER AND TUBE IS LIMITED IN SPEC.
PLUGS FOR TUBES	1	D	D	(D)	(D)	C	C	D	D	C	(D)		RF	
CANISTERS	3	N	N	C	C	C	C	C	C	C	C			NOT DESIGNED OR ANALYZED BY FLUOR DANIEL
IMPACT ABSORBERS	3	N	N	C	C	C	C	C	C	C	C			
MISC. ITEMS OUTSIDE TUBES: TEMPERATURE MONITORING, COUPON SAMPLING PIPES, SUMP DRAIN LINE	3	N	N	C	C	C	N	N	N	C	C			NOT HEAVY ENOUGH TO DAMAGE TUBES OR VAULT.
ITEMS IN ROOM 110, ABOVE THE VAULTS:														
SHIELDED CANISTER TRANSPORTER (SCT) EXCEPT SAFETY CLASS 2 COMPONENTS	3	U	U	N	N	C	C	N	C	N	N		RG	MUST NOT TIP OVER ON VAULT MAY LOWER CASK BY ACCIDENT
OPERATING AREA WALLS & CEILING	3	U	U	(U)	B	U	U	C	C	C	C		RG	MUST NOT COLLAPSE ON VAULT OR SCT

ORIGINATOR: R. DESHOTELS - SYSTEMS ENGR.

REVIEWERS/DISCIPLINES: RAHE GRUBER - STRUCT. ENGR. (R.G.); Robert FAGES - MECH. ENGR. (R.F.)

2D/08457/3715

Figure 2. Example Tabulation.

The initials of the responsible design engineer indicate that the engineer agrees to the indicated upgrade, barrier, or enhanced design requirements for the item. The engineer is responsible for including the indicated design requirement in specifications and drawings.

SUMMARY

As stated in recent DOE criteria, interaction analysis is a necessary step in the determination of performance categories or safety classification. Interaction analysis is an important part of the graded approach to safety, public health, and environmental protection.

More progress is needed to develop effective approaches to meeting criteria requirements. The two approaches mentioned in DOE-STD-1021-92 have drawbacks: item-by-item analysis of complex chain-of-events is cost-effective only in special cases. Identification of problems by a facility walkdown misses opportunities for an earlier, more convenient fix.

The general approach at HWVP is to assume that all items in a room will be exposed to interactions and propagate interactions, unless the items are designed for the NPH or accident conditions. It is believed that this approach can be improved and adapted to other facilities.

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