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Department of Energy
Washington, DC 20585

March 2, 2010

The Honorable John E. Mansfield
Vice Chairman
Defense Nuclear Facilities Safety Board
625 Indiana Avenue, N.W.
Suite 700
Washington, DC 20004-2901

Dear Mr. Vice Chairman:

This letter is to notify you that the Office of Environmental Management (EM) has met Milestone 5.3.2 (*Issue Interim Guidance on Design and Operational Criteria for Sprinkler Systems*) of the Department of Energy's (DOE) Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 2008-1, *Safety Classification of Fire Protection Systems*.

On February 4, 2010, the EM Field Managers were directed to utilize the interim guidance for the design and operation of new Wet Pipe Sprinkler systems and supporting water supplies used in safety significant and safety class applications for new nuclear projects that have not reached Critical Decision-1 (CD-1) (see enclosure). This interim guidance describes an appropriate approach for implementing design and operation criteria for requirements specified in DOE Order 420.1B, *Facility Safety,* for safety significant and safety class systems.

If you have any further questions, please contact me at (202) 586-7709 or Dr. Steven L. Krahn, Deputy Assistant Secretary for Safety and Security Program at (202) 586-5151.

Sincerely,

Inés Triay

Inés R. Triay
Assistant Secretary for
Environmental Management

Enclosure

Department of Energy
Washington, DC 20585

February 4, 2010

MEMORANDUM FOR DISTRIBUTION

FROM: DAE Y. CHUNG
PRINCIPAL DEPUTY ASSISTANT SECRETARY
FOR ENVIRONMENTAL MANAGEMENT

SUBJECT: Deliverable for Defense Nuclear Facilities Safety Board Recommendation 2008-1, *Safety Classification of Fire Protection Systems*

Please utilize the attached guidance for the design and operation of new Wet Pipe Sprinkler systems and supporting water supplies used in safety significant and safety class applications for new nuclear projects that have not reached CD-1. This interim guidance (Attachments 1 and 2) describes an appropriate approach for implementing design and operation criteria for requirements specified in Department of Energy (DOE) Order 420.1B, *Facility Safety,* for safety significant and safety class systems. This guidance is being provided to meet Milestone 5.3.2 (*Issue Interim Guidance on Design and Operational Criteria for Sprinkler Systems*) of DOE's Implementation Plan for Defense Nuclear Facilities Safety Board Recommendation 2008-1.

The information in this guidance will be incorporated into a revision of DOE Standard 1066, *Fire Protection Design* that is currently in the planning stage.

If you have any further questions, please contact me or Dr. Steven L. Krahn, Deputy Assistant Secretary for Safety and Security Program at (202) 586-5151.

Attachments

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SEPARATION

PAGE

Attachment 1

U.S. Department of Energy

Interim Guidance on Design and Operational Criteria for Safety Class and Safety Significant Wet Pipe Sprinkler Systems

Milestone 5.3.1 Deliverable

Defense Nuclear Facilities Safety Board Recommendation 2008-1

Safety Classification of Fire Protection Systems

Washington, DC 20585

November 2009

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INTERIM GUIDANCE ON DESIGN AND OPERATIONAL CRITERIA FOR SAFETY CLASS AND SAFETY SIGNIFICANT WET PIPE SPRINKLER SYSTEMS

1. PURPOSE

The purpose of this document is to provide interim guidance on design and operational criteria for new safety class and safety significant Wet Pipe Sprinkler systems. Its objective is to provide guidance in areas of system design and operation that are not currently well defined in existing Department of Energy (DOE) Directives or Standards so that these issues will not have to be addressed on a project-by-project basis for new projects.

This interim guide was developed by a working group that was led by the technical component of DOE's Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2008-1, Core Team. The Core Team and its primary contributing working group members are listed in Appendix A.

The interim guidance may be issued by the Program Offices for new nuclear facility projects until final guidance and criteria can be issued through the DOE Directives or Standards systems.

Note that this guidance describes suggested non-mandatory approaches for meeting requirements that are promulgated elsewhere. Guides are not requirements documents and are not construed as requirements in any audit or appraisal for compliance with the parent Policy, Order, Notice, or Manual. Alternate approaches for meeting the requirements can be utilized.

2. APPLICABILITY AND SCOPE

This interim guide is intended for NEW Hazard Category 1, 2, and 3 nuclear facility projects which intend to utilize a new Wet Pipe Sprinkler system as a safety class or safety significant system. This guidance may also be useful as a tool for evaluating upgrades in the safety classification of existing sprinkler systems; however, this is not intended to apply to existing safety system installations that are not being upgraded.

3. DEFINITIONS

Safety Class Structures, Systems, and Components (SSCs): SSCs, including portions of process systems whose preventive or mitigative function, are necessary to limit radioactive hazardous material exposure to the public, as determined from safety analyses. [10 Code of Federal Regulation (CFR) 830.3]

Safety Significant SSCs: SSCs that are not designated as safety class SSCs, but whose preventive or mitigative function is a major contributor to defense in depth and/or worker safety as determined from safety analyses. [10 CFR 830.3]

Documented Safety Analysis (DSA): A documented analysis of the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety. [10 CFR 830.3]

4. REQUIREMENTS

General design criteria for safety class and safety significant systems specified in Chapter I of DOE Order (O) 420.1B, *Facility Safety,* are applicable to Wet Pipe Sprinkler systems utilized in safety significant and safety class applications. The following excerpts of these criteria are provided to illustrate the flow down and relationship of the general criteria from DOE O 420.1B to new specific criteria and guidance for Wet Pipe Sprinkler systems provided in this interim guide. However, any additional documents referenced in governing contracts should also be used in conducting design activities. Nothing in this guide relieves DOE Elements and Contractors from their responsibility to ensure all DOE O 420.1B requirements, including those summarized below, are met.

<u>DOE Order 420.1B</u>

- Safety analyses must be used to establish the identity and functions of safety class and safety significant SSCs.

- Nuclear facility design objectives must include multiple layers of protection to prevent or mitigate the unintended release of radioactive materials to the environment, otherwise known as defense in depth. Defense in depth must include applying conservative design margins and quality assurance (QA).

- Hazard Category 1, 2, and 3 nuclear facilities must be designed to facilitate inspections, testing, maintenance, repair, and replacement of safety SSCs as part of a reliability, availability, and maintainability program with the objective that the facility is maintained in a safe state.

- Safety SSCs and safety software must be designed, commensurate with the importance of the safety functions performed, to perform their safety functions when called upon and to meet the quality assurance program requirements of either 10 CFR 830, Subpart A, *Quality Assurance,* or DOE O 414.1C, *Quality Assurance*, as applicable.

- Safety class electrical systems must be designed to preclude single point failure.

Additionally, Chapter II of DOE O 420.1B requires that fire protection for DOE facilities, sites, activities, design, and construction must meet or exceed applicable building codes and codes and standards of the National Fire Protection Association (NFPA). As such, Wet Pipe Sprinkler Systems must meet or exceed the applicable NFPA codes and standards, including NFPA 13 along with all other support system requirements necessary to maintain system operability. Note that DOE O 420.1B also mandates that facilities meet "Highly Protected Risk" criteria and references DOE-Standard (STD)-1066, *Fire Protection Design Criteria* which includes supplemental design guidance for Wet Pipe Sprinkler systems.

DOE-STD-1189, *Integrating Safety into the Design Process,* which is required to be implemented in accordance with DOE O 413.3A, Change 1, *Program and Project Management for the Acquisition of Capital Assets,* outlines the process for ensuring safety is integrated early into the facility design process and for developing safety documentation to support safety design decisions. It also provides criteria for identifying safety class and safety significant systems and criteria for the seismic design of SSCs.

5. SPECIFIC DESIGN CRITERIA/GUIDANCE FOR WET PIPE SPRINKLER SYSTEM

This section discusses how the general design criteria from Chapter I of DOE O 420.1B apply to the design of sprinkler systems. It is formatted consistent with DOE Guide (G) 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for use with DOE O 420.1 Facility Safety*. Note that a summary of this guidance as utilized for (1) general use (e.g., non-nuclear); (2) safety significant applications; and (3) safety class applications, is provided in Appendix B.

5.1 Function of the Wet Pipe Sprinkler System

The safety class and safety significant function of the Wet Pipe Sprinkler system is defined in the DSA of the facility (typically in Chapter 4 of the DSA) and should include information regarding the size and type of fires that the system is designed for along with any specific considerations that may be required for the system to perform its intended function. For example, automatic water-based fire suppression systems are generally intended to limit fire spread but not necessarily extinguish it (unless special hazards are considered). If the safety analysis determines that emergency responder actions to complete extinguishment are a part of the safety class or safety significant function, then this should be identified as it could impact the design by adding alarm/ notification components. It is a good practice to include this information in a system design document, such as a system design description developed in accordance with DOE-STD-3024-98, *Content of System Design Descriptions*. Additionally, conditions under which the sprinkler system must remain operable to prevent or mitigate analyzed events (e.g., seismic and loss of power events) should also be documented. The NFPA-related design requirements should also be identified in the System Design Description.

5.2 System Boundary

The boundary of the safety class or safety significant Wet Pipe Sprinkler system should be defined such that it is clear which components are to be classified within the system. A boundary for sprinklers is typically determined at the system control valve or at the underground lead-in post indicator valve (PIV).

All piping should either be designed for the maximum pressure and design basis accident (DBA) conditions, or the design must show that failure of the piping or component not credited to be safety class or safety significant will not negatively impact the credited portions of the system. For example, for failure of pressure gages the design can include water discharged from a broken gage in the required flow rate capacity, and the total water discharged in the required water supply.

5.3 Support Systems

Per DOE O 420.1B, supporting systems must be identified. The water supply system is the most important support system and is discussed in detail in the companion guide to this interim guide, *Interim Guidance on Design and Operational Criteria for Water Supply Systems Supporting Safety-Class and Safety-Significant Fire Suppression Systems.*

As stated in the general criteria of DOE G 420.1-1 the support systems must be designed, fabricated, erected, and tested to standards and quality requirements commensurate with their importance to safety.

In some cases, safety SSCs rely upon support SSCs to perform their intended safety function. These support SSCs may be classified as safety class or safety significant SSCs. A safety class designation may be appropriate if the support system is necessary for the safety class SSC to operate (e.g., power) or the failure of the support system can lead to either failure or reduced availability of the safety class function. In general, in accordance with Section 5.1.2.1 of DOE G 420.1-1, the following classification criteria apply:

- Support SSCs to safety class SSCs must be classified as safety class if their failures can prevent a safety class SSC from performing its safety functions.

- Support SSCs to safety significant SSCs that mitigate or prevent accidents with the potential for significant onsite consequences should be classified as safety significant if their failures prevent a safety significant SSC from performing its safety functions.

- Support SSCs to safety significant SSCs that mitigate or prevent accidents with only the potential for significant localized consequences need not be classified as safety significant.

Examples of support systems (beyond the water supply system) may include the freeze protection system, alarm devices and associated trim, and pressure monitoring systems. As stated in the general criteria in DOE G 420.1-1, support systems must be designed, fabricated, erected, and tested to standards and quality requirements commensurate with their importance to safety.

Details supporting implementation of DOE O 420.1B and DOE G 420.1-1 for the freeze protection system, alarm trim, and water pressure monitoring system gauges are provided below.

5.3.1 Freeze Protection Systems

In most cases the freeze protection system should be classified at the same level as the safety sprinkler system. Examples of appropriate freeze protection systems may include heating the space, heat tracing, building insulation, anti-freeze and water circulation. An alternative option is to have the sprinkler system monitored by a low temperature alarm system that is classified at the same level as the safety sprinkler system in conjunction with the appropriate Technical Safety Requirement Limiting Condition for Operation. This requirement should ensure that compensatory actions are taken to warrant the operability of the sprinkler system upon loss of the freeze protection system during sub-freezing weather. The freeze protection system should be designed, fabricated erected, and tested to the standards consistent with that provided for the sprinkler system.

The freeze protection system does not need to be designed to preclude system failure given a single active component failure (even at the safety class level) if the facility owner can justify that there are adequate design features and/or controls to ensure that failure of the freeze protection would provide indication of its inoperability, and would not immediately impact operability of the sprinkler system. For instance, because of system failure alarms and compensatory measures, malfunctions are detected and corrected before the piping freezes. The operability of the freeze protection system should be included as a Limiting Condition for Operation in the Technical Safety Requirements.

5.3.2 Alarm Devices

Water flow indicating devices and associated trim support the Wet Pipe Sprinkler System by indicating that the system has operated. A flow alarm is commonly achieved by a water pressure alarm switch that is pressurized when the alarm check valve is unseated long enough to register an alarm. In general, the alarm will alert locally as well as remotely to summon emergency responders. These devices do not normally perform a safety function in that this equipment is not required for the sprinkler system to perform its safety function (deliver water to the fire). The sprinkler system should be designed to be able to deliver water to the fire at the full volume and pressures required with failure of these devices in any orientation (fail open/closed, pipe rupture).

5.3.3 Water Pressure Monitoring System

A water pressure monitoring system (sensors and associated local and/or remote indicating system) may support a wet pipe sprinkler system by providing notification when system water pressure is below minimal allowable levels. This equipment should be classified the same level as the sprinkler system it supports and should be designed, fabricated erected, and tested to standard industrial practices supplemented by additional QA provisions consistent with that provided for the sprinkler system.

5.4 Reliability/Redundancy/Single Failure Resistance

Section 5.1.1.2 of DOE G 420.1-1 states that the facility and its systems must be designed to perform all safety functions with the reliability indicated in the DSA and that the single–point failure criterion, requirements, and design analysis identified in American National Standard Institute/Institute of Electronics and Electrical Engineers (ANSI/IEEE) 379 must be applied during the design process as the primary method of achieving this reliability. Since ANSI/IEEE-379 does not have criteria for mechanical systems or non-reactor facilities, the following additional criteria should be applied for safety class and safety significant systems to further improve the reliability of the sprinkler system.

5.4.1 Reliability/Redundancy/Single Failure Resistance Criteria for Safety Class Components

Safety class Wet Pipe Sprinkler systems should be designed to prevent a single point failure such that redundancy is provided for active components (those which must change state in the performance of their safety function). Active components in sprinkler systems include the sprinklers, and any valves that must open or close during the performance of its nuclear safety function. Note that valves which are normally locked in the open position and/or electronically monitored are considered passive components as they are not required to change state in order for the sprinkler system to perform its intended function. Furthermore, in accordance with American Nuclear Society (ANS)/ANSI 58.9-1981, *Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems*, an active failure of a simple swing check valve does not have to be considered in the design because of their high reliability. Refer to ANS/ANSI 58.9-1981, Section 4 for details.

The system should be designed so that the failure of a single sprinkler would not result in the loss of safety function and that the failure of an active component in the flow path would not result in the loss of safety function. In a room with a single sprinkler, the addition of a second sprinkler may be necessary if the control of fire in that area is needed per the facility DSA. In rooms with multiple sprinkler heads, the impact of the loss of a single sprinkler head should be evaluated to ensure that it will not result in the loss of the sprinkler system from performing its safety class function.

Note: For maintainability (and availability) considerations, it may be appropriate to include some additional redundancy (e.g., so one component/train may be taken out of service for maintenance) for passive and active components.

5.4.2 Reliability/Redundancy/Single Failure Resistance Criteria for Safety Significant Components

Chapter II of DOE O 420.1B provides requirements for all fire protection systems at DOE facilities. Furthermore, it invokes NFPA standards as augmented by criteria in DOE-STD-1066, and fire protection criteria for Highly Protected Risks (e.g., as specified in FM Global data sheets[1]) and the conservative design criteria in Section 5.5. Safety significant components meeting these requirements are adequate to ensure the appropriate level of reliability. No additional consideration of redundancy or single failure resistance is necessary.

5.5 Conservative Design Margins

The following features should be applied to provide conservative design margins for new wet pipe fire sprinkler systems classified as safety class or safety significant. These items are additional items above the NFPA and DOE-STD-1066 requirements to enhance the reliability and availability of this type of fire protection system.

- Systems should have strainers to protect against debris if the water supply is prone to sediment or debris.
- All piping should be a minimum of American Society for Testing and Materials (ASTM) Schedule 40[2] steel for pipes 6 inches in diameter and smaller. For pipes above 6 inches in diameter Schedule 30 steel piping (minimum) should used.
- Protected areas should be designed to no less than Ordinary Hazard (Group 1) requirements (per NFPA 13) and should not exceed 130 square feet per sprinkler. For Ordinary Hazard (Group 2) and Extra Hazard occupancies, sprinkler coverage should not exceed 100 square feet per sprinkler.
- For Seismic Design Category 3 and above, a structural engineer should evaluate hanger and earthquake sway bracing configurations and locations where hangers and bracing are attached to the building if the sprinkler system is credited for a post seismic event per Chapter 3 of the DSA (Hazard and Accident Analysis).
- System should be designed to continuously monitor water system supply pressure to insure it does not drop below the system design required pressure. An example of continuous monitoring includes the fire pump monitoring systems.

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[1] FM Global (formally Factory Mutual) data sheets provide additional (beyond NFPA) fire protection design and operational criteria up.

[2] The ATSM schedule defines required pipe thickness.

- Spare parts for critical components should be maintained for use by maintenance personnel.

- The following components (which are allowed per NFPA) should not be utilized for safety significant and safety class applications because experience has shown these components to be prone to failure:[3]

    - Vane or paddle type of alarm devices;
    - On/off sprinklers;
    - Mechanical slip fittings; and
    - Cast Iron fittings (Fittings should be a minimum of malleable Iron per American Society of Mechanical Engineers (ASME) B16.3, *Malleable Iron Threaded Fittings*, where additional fitting strength is required.).

- The system static and residual pressures should meet the minimum design basis requirements plus the DOE-STD-1066 prescribed margin of 10 percent below the supply curve, but not less than 10 pounds per square inch.

- The system shall be designed by a professional engineer or a NICET Level III (or IV) technician using seismic criteria specified by the design authority.

5.6 Environmental Conditions

The environmental conditions under which the sprinkler must perform its function should be defined as part of the facility design process in accordance with DOE-STD-1189 and should be documented in the safety design documents (i.e., the Conceptual Safety Design Report, Preliminary Safety Design Report, and Preliminary Documented Safety Analysis, and finally the Documented Safety Analysis [DSA]) and facility fire hazards analysis. Since sprinklers are part of a facility, the facility design will address most of these issues. Documentation of environmental conditions should address the following items:

- Seismic;

- Other natural phenomena hazards (NPH) such as tornado, high winds, flooding and lightning, temperature (e.g., below freezing), and humidity;

- Facility hazards, such as internal flooding, explosions, fire, missile impacts, vehicle impacts, corrosive environments;

- Wildland fires; and

- Physical damage from adjacent equipment and systems (e.g., during a seismic event);

[3] If the user chooses to utilize these devices, then their potential impact should be evaluated including those discussed in section 5.8.

Additionally, water supply quality conditions (for example, chemical and microbiological induced corrosion) should be addressed. The system design should permit inspections and tests to detect potential water quality issues. For example, the design may include the installation of flushing connections, interior test plugs, inspection tees, sacrificial sprinklers (i.e., sprinklers that will be removed for inspection and testing), etc., to facilitate interior piping inspections and metallurgical system tests deemed necessary to validate any present (or future) water quality concerns.

Examples of design criteria that may be appropriate to address how environmental conditions can impact design include the following:

- Piping should be either galvanized or protected against external corrosion where exposed to adverse conditions; and

- Hanger or seismic bracing should either be galvanized or protected against corrosion where exposed to adverse conditions.

5.7 Seismic Design

DOE-STD-1189 Appendix A should be applied in determining the seismic classification of the system if the sprinkler system is credited for a post-seismic event per Chapter 3 of the DSA (which describes the Hazard and Accident Analysis). Supporting systems, e.g., the water supply system should also follow DOE-STD-1189 as identified in the DSA.

Per DOE-STD-1189, the design loads as determined from ANSI American Nuclear Society (ANS) 2.26-2004, *Categorization of Nuclear Facility Structures, Systems and Components for Seismic Design* and American Society of Civil Engineers/Structural Engineer Institute (ASCE/SEI) 43-05, *Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities* should be used to design the system, associated hangers and supports, and earthquake sway bracing. NFPA 13 adequately addresses design for seismic design category (SDC) 1 and 2. For SDC 3 and above, a structural engineer should evaluate the hanger and earthquake sway bracing configurations and attachments of these components to the similarly designed building structure. A qualified structural engineer utilizing the loads provided by the site seismic design authority should be used in conjunction with NFPA 13 to determine the hanger and earthquake sway bracing locations.

5.8 Interface Evaluation

Interfacing systems should be evaluated to ensure they do not impact the reliability, availability, or functionality of the system. For example, failure of the mechanical components associated with a flow switch should be evaluated to insure that a single failure of the active component will not disable the system and that failure of a passive component during DBAs is not credible. In addition, the impact of non-seismically qualified equipment on any seismically qualified sprinkler system should be evaluated. For example, the water supply for a non-safety class plenum spray system might be provided from the safety class sprinkler system for convenience. To be acceptable the water spray systems piping would have to meet the same seismic requirements as the sprinkler system, or it would have to be proven that a failure of the spray system's piping would not negatively impact the safety class portions of the system. This would be required even though the spray system was not credited to function during or following the DBA.

Connected portions of the system whose preventive or mitigative function is determined from safety analysis not to be necessary to limit radioactive or hazardous material exposure to the public can be omitted from safety class criteria only to the extent it can be established that credible failures do not exist that would compromise the safety class function of the system.

5.9 Quality Assurance

The QA requirements of 10 CFR 830 and DOE O 414.1C must be applied in the design, manufacture, and installation of fire protection systems. The site QA and/or project program can be utilized if it meets all of these requirements.

It is recognized that NFPA documents are principally developed to define design, hardware selection, and installation adequacy to perform fire protection functions. DOE requires that management controls be developed and applied in performing the various functions for assuring a quality fire protection system. QA plans are typically in place and have been approved for the site and/or project. Specific guidance for controlling quality-related activities that apply to the fire protection system installations may be beneficial to assure a quality installation that complies with the applicable safety classification level.

To support appropriate implementation of the site or project QA program relative to fire protection systems, the following topics should also be addressed (beyond what is specifically identified in DOE O 420.1B and referenced NFPA codes and standards):

- Document control (documents are stored properly to avoid damage, responsibility for completeness, maintenance and distribution are identified, etc.).
- Records of qualification of fire protection staff and control of qualification records.
- Procurement documentation and control of purchased items or services.
- Identification and control of components (e.g., sprinkler heads) per requirement 8 of NQA-1-2008, *Quality Assurance Requirements for Nuclear Facility Applications.*
- Handling, shipping and storage requirements for components.

- Control of nonconforming items to prevent inadvertent installation or use.
- Commercial grade dedication of components based upon third party testing and production monitoring.

QA programs should be audited in different phases (design, construction, start-up/acceptance testing, and operations) using DOE O 413.3 A.

Figure 1 illustrates the flow down of QA requirements to fire protection programs.

6. SPECIFIC OPERATIONAL (SURVEILLANCE, TESTING, MAINTENANCE, AND OPERATION) REQUIREMENTS

6.1 Technical Safety Requirements -- Limiting Condition for Operation

The following is an example "operability statement" and additional guidance that can be used in developing a Technical Safety Requirement Limiting Condition for Operation for both safety significant and safety class Wet Pipe Sprinkler systems:

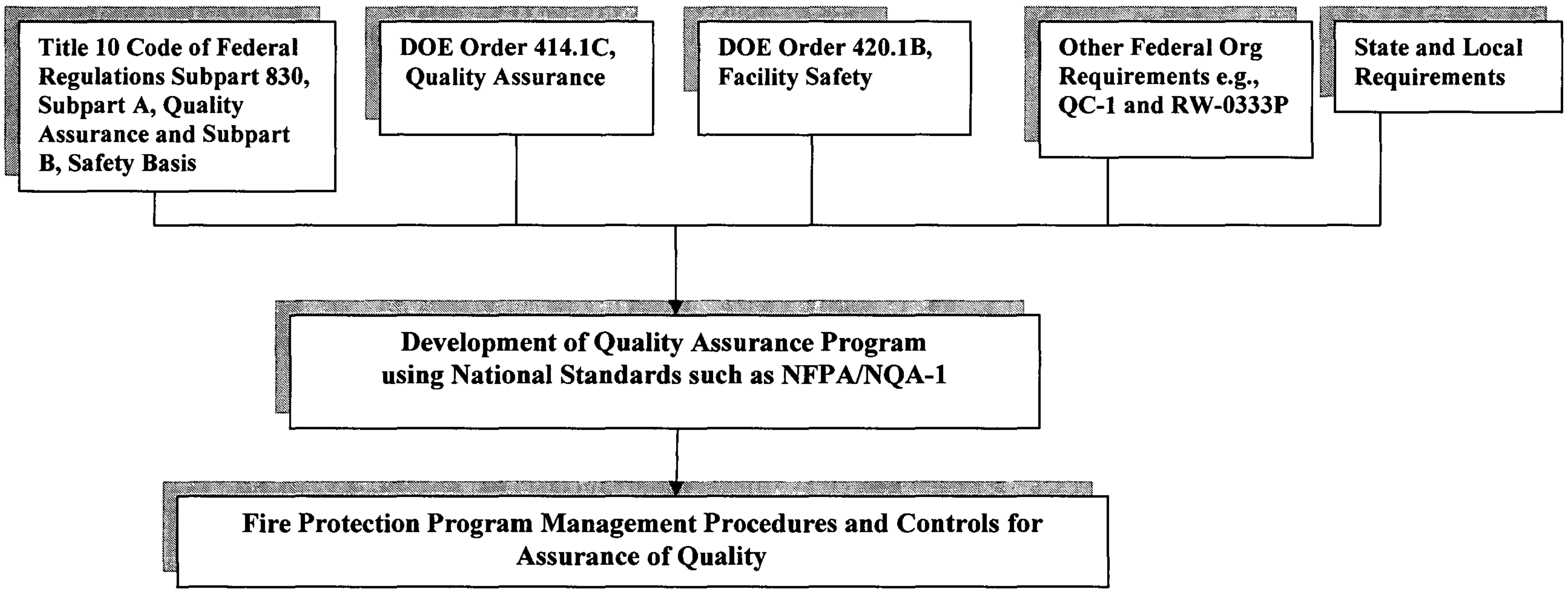
> "In order for a sprinkler system to be OPERABLE, the system must be supplied with an adequate water supply, with sufficient pressure and flow capability; distribution branches and sprinkler heads must be unobstructed so that the system is capable of controlling a fire as credited in the fire hazard analysis and DSA, and all sprinkler system Technical Safety Requirement surveillance requirements must be current."

It should be noted that a sprinkler system may be fully functional for property and life safety purposes but may be considered inoperable for nuclear safety purposes if a Limiting Condition for Operation for the nuclear process is not met.

6.2 TSR Surveillance and Testing Requirements

For safety class and safety significant sprinkler systems, the requirements in NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, should be used to establish Technical Safety Requirement surveillance requirements. In addition, personnel performing the inspection, testing, and maintenance should be appropriately qualified through activities such as the National Institute for Certification in Engineering Technologies and/or Authority Having Jurisdiction or Fire Marshal approved vendor equipment training programs.

Figure 1 – Flow Down of DOE Quality Assurance Requirements for Fire Protection Systems



APPENDIX A
Core Team and Primary Contributing Working Group Members

DNFSB Core Team (Technical Members)

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Matthew Cole
James Landmesser, Sr.
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Primary Contributing Working Group Members

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Robert Nelson
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APPENDIX B
Summary of Additional Wet Pipe Sprinkler Criteria and Guidance for Safety Class and Safety Significant Applications

DOE has established very stringent design requirements for fire protection systems utilized at all facilities (nuclear and non-nuclear). For fire protection systems utilized in safety significant and safety class applications in DOE nuclear facilities, additional requirements and criteria may need to be implemented to ensure very high levels of reliability with increased design margins and quality assurance.

The following provides a summary of the requirements, criteria and guidance for three levels of protections provided, i.e., general use (e.g., non-nuclear), safety significant, and safety class:

<u>General Use</u>
Local Building Codes
Facility Safety Order (DOE O 420.1B)
DOE-STD-1066, *Fire Protection Design Criteria*
Additional Highly Protected Risk Criteria; e.g., as defined in FM Global (formerly Factory Mutual) Data Sheets

<u>Safety Significant (Design)</u>
In addition to the criteria for general use, the following additional design requirements/guidance is applicable for Wet Pipe Sprinkler systems used in safety significant applications:

A. The following sprinkler components should not be used[4]:

- Vane or paddle type alarm devices;
- On/off sprinklers;
- Mechanical slip fittings; and
- Cast Iron fittings (Fittings should be a minimum of Malleable Iron per ASME B16.3 where additional fitting strength is required).

B. Strainers should be used for all systems connected to water supplies prone to sediment or debris.

C. Sprinkler piping should be a minimum of Schedule 40 steel for pipes 6 inches or less in diameter and Schedule 30 steel for pipe greater than 6 inches in diameter.

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[4] If the user chooses to utilize these devices, then their potential impact should be evaluated separately.

D. Areas should be designed to no less than Ordinary Group 1 requirements (per NFPA 13) and should not exceed 130 square feet per sprinkler. For Ordinary Group 2 and Extra Hazard occupancies, sprinkler coverage should not exceed 100 square feet per sprinkler.

E. For SDC 3 and higher, a qualified structural engineer should evaluate locations where hangers and earthquake sway bracing utilizing the loads provided by the site seismic design authority in conjunction with NFPA 13 criteria.

F. Environmental conditions should be defined and documented for sprinkler systems and the system should be designed to remain operable for those events they are relied on as specified in the DSA. Examples include:

- Seismic;
- Other natural phenomena hazards (NPH) such as high wind potential, tornados, flooding, lightning, low temperature and humidity;
- Facility hazards, such as internal flooding, explosions, fire outside the system boundary, missile and vehicle impacts, corrosive environments;
- Wildland fire;
- Physical damage from adjacent equipment and systems (for example – during a seismic event); and
- Water quality.

G. Wet Pipe Sprinkler support systems, such as freeze protection, must be classified as equal or superior to the classified Wet Pipe Sprinkler system or equipped with support system alarming devices connected to an alarming system that is classified as equal or superior to the classified Wet Pipe Sprinkler system.

H. To support appropriate implementation of the site or project QA program relative to fire protection systems, the following topics should be addressed (beyond what is specifically identified in DOE O 420.1B and referenced NFPA codes and standards):

- Document control (documents are stored properly to avoid damage, responsibility for completeness, maintenance and distribution are identified, etc.).
- Records of qualification of fire protection staff and control of qualification records.
- Procurement documentation and control of purchased items or services.

- Identification and control of components (e.g., sprinkler heads) per requirement 8 of NQA-1-2008, *Quality Assurance Requirements for Nuclear Facility Applications*.

- Handling, shipping and storage requirements for components.

- Control of nonconforming items to prevent inadvertent installation or use.

- Commercial grade dedication of components based upon third party testing and production monitoring.

I. The QA Program should be audited in different phases (design, construction, and operations) using DOE O 413.3A.

Safety Class (Design)
In addition to the criteria for general use and safety significant applications, the following additional design requirements/guidance is applicable for Wet Pipe Sprinkler systems used in safety class applications:

A. Active features of a sprinkler system must be designed to preclude a single point failure for safety class sprinkler systems if the component failure results in the system's inability to perform its safety function. Active features of a sprinkler system include the sprinklers themselves plus any other installed component that would exhibit a change in state.

B. There should be a minimum of two sprinklers in each area being protected.

Safety Significant (Operability)
Technical Safety Requirement (TSR) Limiting Conditions for Operation should be defined (including appropriate action statements to address situations when the system is inoperable). TSR Surveillance Requirements should be defined consistent with NFPA 25 Inspection Testing and Maintenance requirements.

Safety Class (Operability)
Technical Safety Requirement (TSR) Limiting Conditions for Operation should be defined (including appropriate action statements to address situations when the system is inoperable). TSR Surveillance Requirements should be defined consistent with NFPA 25 Inspection Testing and Maintenance requirements.

SEPARATION

PAGE

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Attachment 2

U.S. Department of Energy

Interim Guidance on Design and Operational Criteria for Water Supply Systems Supporting Safety Class and Safety Significant Fire Suppression Systems

Milestone 5.3.1 Deliverable

Defense Nuclear Facilities Safety Board Recommendation 2008-1

Safety Classification of Fire Protection Systems

Washington, DC 20585

November 2009

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INTERIM GUIDANCE ON DESIGN AND OPERATIONAL CRITERIA FOR WATER SUPPLY SYSTEMS SUPPORTING SAFETY CLASS AND SAFETY SIGNIFICANT FIRE SUPPRESSION SYSTEMS

1. PURPOSE

The purpose of this document is to provide interim guidance on design and operational criteria for water supply systems that support safety class and safety significant water based fire suppression systems. Its objective is to provide guidance in areas of system design and operation that are not currently well defined in existing Department of Energy (DOE) Directives or Standards so that these issues will not have to be addressed on a project-by-project basis for new projects.

This interim guide was developed by a working group that was led by the technical component of DOE's Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 2008-1, Core Team. The Core Team and primary contributing working group members are listed in Appendix A.

The interim guidance may be issued by the Program Offices for new nuclear facility projects until final guidance and criteria can be issued through the DOE Directives or Standards systems.

Note that this guidance describes suggested non-mandatory approaches for meeting requirements that are promulgated elsewhere. Guides are not requirements documents and are not construed as requirements in any audit or appraisal for compliance with the parent Policy, Order, Notice, or Manual.

2. APPLICABILITY AND SCOPE

This interim guide is intended for NEW Hazard Category 1, 2, 3 nuclear facility projects which intend to utilize a water supply system as a safety class or safety significant system. Because many new DOE facilities take advantage of existing infrastructure systems, this guidance may provide useful information for the use of these systems in safety significant or safety class applications.

For the purposes of this guide, a water supply system may include the water source/treatment, storage and pumping capabilities, and the piping network arranged to deliver water to the selected safety system.

3. DEFINITIONS

Safety Class Structures, Systems, and Components (SSCs): SSCs, including portions of process systems, whose preventive or mitigative function are necessary to limit radioactive hazardous material exposure to the public, as determined from safety analyses. [10 Code of Federal Regulation (CFR) 830.3]

Safety Significant (SS) SSCs: SSCs which are not designated as safety class SSCs but whose preventive or mitigative function is a major contributor to defense in depth and/or worker safety as determined from safety analyses. [10 CFR 830.3]

Documented Safety Analysis (DSA): A documented analysis of the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety. [10 CFR 830.3]

4. REQUIREMENTS

General design criteria for safety class and safety significant systems specified in DOE Order (O) 420.1B, *Facility Safety,* are applicable to water supply systems that support safety class and safety significant fire suppression systems. The following excerpts of these criteria are provided here to illustrate the flow down and relationship of the general criteria from DOE O 420.1B to new specific criteria and guidance for water supply that is provided in this interim guide. However, any additional documents referenced in governing contracts should also be used in conducting design activities. Nothing in this guide relieves DOE Elements and Contractors from their responsibility to ensure all DOE O 420.1B requirements, including those summarized below, are met.

<u>DOE Order 420.1B</u>

- Safety analyses must be used to establish the identity and functions of safety class and safety significant SSCs.

- Nuclear facility design objectives must include multiple layers of protection to prevent or mitigate the unintended release of radioactive materials to the environment, otherwise known as defense in depth. Defense in depth must include applying conservative design margins and quality assurance (QA).

- Hazard Category 1, 2, and 3 nuclear facilities must be designed to facilitate inspections, testing, maintenance, repair, and replacement of safety SSCs as part of a reliability, availability, and maintainability program with the objective that the facility is maintained in a safe state.

- Safety SSCs and safety software must be designed, commensurate with the importance of the safety functions performed, to perform their safety functions when called upon and to meet the quality assurance program requirements of either 10 CFR 830, Subpart A, *Quality Assurance*, or DOE O 414.1C, *Quality Assurance*, as applicable.

- Safety class electrical systems must be designed to preclude single point failure.

Additionally, Chapter II of DOE O 420.1B requires that fire protection for DOE facilities, sites, activities, design, and construction must meet or exceed applicable building codes and codes and standards of the National Fire Protection Association (NFPA). As such, site water supplies for general fire protection must meet or exceed NFPA codes and standards, such as NFPA 20, 22, 24 and 801 with all other support system requirements necessary to maintain system operability. Note that DOE O 420.1B also mandates that facilities meet "Highly Protected Risk" criteria and references DOE-Standard (STD)-1066, *Fire Protection Design Criteria*, which includes supplemental design guidance for water supplies.

DOE-STD-1189, *Integrating Safety into the Design Process,* which is required to be implemented in accordance with DOE O 413.3A, Change 1, *Program and Project Management for the Acquisition of Capital Assets,* outlines the process for ensuring safety is integrated early into the facility design process and developing safety documentation to support safety design decisions, and provides criteria for identifying safety class and safety significant systems and criteria for the seismic design of SSCs.

5. SPECIFIC DESIGN CRITERIA/GUIDANCE FOR WATER SUPPLY SYSTEMS

This section discusses how the general design criteria from Chapter I of DOE O 420.1B apply to the design of water supply systems. It is formatted consistent with DOE Guide (G) 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for use with DOE O 420.1 Facility Safety.*

There are several different basic arrangements for water supply that are typically used at DOE facilities. These include:

- Multipurpose (domestic/industrial/fire) water supply system outside of DOE control (e.g., a municipal water system);
- Multipurpose (domestic/industrial/fire) water supply system under DOE control;
- Dedicated (site/area wide) firewater supply system;
- Dedicated (building specific) firewater supply system; and
- Limited supply suppression systems specific to a protected hazard.

Appendix B describes these in more detail and provides schematics that can be useful in illustrating some of the design concepts discussed below. Note also that a summary of this guidance as utilized for (1) general use (e.g., non-nuclear), (2) safety significant applications, and (3) safety class applications is provided in Appendix C.

The type of water supply system should be justified based upon site- and facility-specific conditions as supported by the facility DSA, fire hazards analysis, water supply reliability analysis, and is subject to DOE review and approval in accordance with 10 CFR 830 requirements for approval of the safety basis for the Hazard Category 1, 2, and 3 nuclear facilities.

5.1 Function of the Water Supply System

The safety function of the water supply system must be defined in the DSA of the facility (typically in Chapter 4 of the DSA) and should include information regarding the required design flow, pressures, and duration to meet the safety class or safety significant performance requirements. Also, conditions under which the water supply system must remain operable (e.g., seismic and loss of power events) should also be specified. It is a good practice to include this information in a system design document such as a system design description developed in accordance with DOE-STD-3024-98, *Content of System Design Descriptions*.

5.2 System Boundary

The boundary of the safety class and safety significant water supply system should be defined such that it is clear which components are safety class, safety significant, and general industry use. The boundary of the safety class and safety significant water supply may start at the water source and include all components necessary to deliver water up to either a system control valve or the underground lead in Post Indicator Valve (PIV).

Boundaries between safety and non-safety systems water supply components should be identified, including identification of the means of isolation between the two. System boundaries should be described in the applicable system design description document. Piping and instrumentation drawings (P&ID) should be developed for each system that clearly delineates system interfaces and points of isolation.

5.3 Support Systems

As stated in the general criteria of DOE G 420.1-1 the support systems must be designed, fabricated, erected, and tested to standards and quality requirements commensurate with their importance to safety.

In some cases, safety SSCs rely upon support SSCs to perform their intended safety function. These support SSCs may be classified as safety class or safety significant SSCs. A safety class designation may be appropriate if the support system is necessary for the safety class SSC to operate (e.g., power) or the failure of the support system can lead to either failure or reduced availability of the safety class function. In general, in accordance with Section 5.1.2.1 of DOE G 420.1-1, the following classification criteria apply:

- Support systems to safety class systems must be classified as safety class if their failures can prevent a safety class system from performing its safety functions.
- Support systems to safety significant systems that mitigate or prevent accidents with the potential for significant onsite consequences should be classified as

safety significant if their failures prevent a safety significant system from performing its safety functions.

- Support systems to safety significant systems that mitigate or prevent accidents with the potential for significant localized consequences need not be classified as safety significant.

Examples of support systems may be municipal water supplies, water storage systems, water treatment systems, and electric power systems that supply power to water pumps. Details supporting implementation of DOE O 420.1B and DOE G 420.1-1 for a public water supply, water storage system, water treatment system, and electric power system are provided below.

5.3.1 Public Water Supplies

If an adequate municipal water supply is available, it is generally the least costly and may be the most reliable source for safety significant or safety class systems. Municipal water systems in urban communities are usually operated by a staff of experienced professionals with a culture of providing continuous availability of water. Many systems have multiple sources, pumps and tanks as well as valved and gridded piping so that alternate pathways are available in case of damage. Breaks are normally restored within hours. However, since DOE has little control over the design and operation of these systems, an analysis should be made to ensure the municipal water system will perform reliably in accordance with the DSA functional and reliability requirements and DOE O 420.1B in a manner that is equivalent to or exceeds that provided by stand alone systems controlled by DOE.

Note that general purpose systems for life safety, property protection, and program interruption typically rely on the fire department or utility personnel to establish an alternative supply if the primary supply is not available. If a safety significant or safety class system requires more immediate correction, a facility or hazard-specific water storage system may be necessary. Such a system can be designed to meet only the safety significant or safety class nuclear safety needs for its capacity and will not necessarily have to be designed to meet the capacity requirements of other requirements such as the Fire Prevention Code (NFPA 1), the Standard for Nuclear Facilities (NFPA 801), the Building Code, or the Standard for the Installation of Sprinkler Systems (NFPA 13). For example, if the nuclear safety objective can be met with a 500-gallon pressure tank within the facility, then the NFPA criteria that may dictate larger water supply tanks for facility fire safety do not need to apply to the design of the portion of the system which is only serving the safety significant or safety class function.

5.3.2 Water Treatment Systems

Water treatment systems are seldom within the safety significant or safety class boundary since the treated water in storage normally meets safety significant or safety class water capacity needs. However, treatment system may be required to meet safety significant or safety class criteria if water storage capacity is inadequate and the raw water source is not suitable for fire protection purposes.

5.3.3 Electric Power to Pumps

The electric power to fire pumps that are necessary to support the safety function will need to be classified at the same functional classification level (general duty, safety significant, or safety class) as the system they are supporting. For general duty and safety significant fire pumps, where there is not a diesel back-up, the electric power to the fire pumps should be fed from two separate utility connections or from a generator and a utility connection. The more usual arrangement is to install a diesel driver and pump which serves to back up an electric pump with a single source of power.

For safety class applications, in addition to the above, per DOE O 420.1B, the power electrical systems must be designed to preclude single point failure

5.4 Reliability/Redundancy/Single Failure Resistance

Section 5.1.1.2 of DOE G 420.1-1 states that a facility and its systems must be designed to perform all safety functions with the reliability indicated in the DSA and that the single–point failure criterion, requirements, and design analysis identified in American National Standard Institute/Institute of Electronics and Electrical Engineers (ANSI/IEEE 379) must be applied during the design process as the primary method of achieving this reliability. Since ANSI/IEEE 379 does not have criteria for mechanical systems or non-reactor facilities, the following criteria should be applied for safety class systems to further improve the reliability of the water supply system.

5.4.1 Safety Class Criteria

Safety class water supply systems should be designed such that redundancy is provided for active components (those which must change state to perform their function). Specifically, the system should be designed, such that the failure of any one single active system component, such as a pump or driver, cannot prevent the system from performing its intended safety function.

Components not required for the safety class function should not be classified as safety class. An example would be a jockey pump in a fire pump/jockey pump arrangement that only maintains system pressure up to the fire pump start point. In this case, the redundant fire pump may be used for safety class applications but the redundant jockey pumps would not be needed.

5.4.2 Safety Significant Criteria

Water supply systems designed to meet NFPA 20, NFPA 22, and/or NFPA 24 (as applicable) are generally appropriate for safety significant applications. These systems should be designed using Highly Protected Risk criteria and additional criteria in DOE-STD-1066.

Any of the five types of water supply systems identified in Section 5 can potentially be utilized for safety significant applications. This is discussed further in Appendix B.

5.5 Conservative Design Margins

The following features should be applied to provide conservative design margins for new water supply systems supporting safety class fire protection systems. These items are additional items above the NFPA and DOE-STD-1066 requirements to enhance the reliability and availability of safety class fire protection systems.

- Underground piping should be limited to cement-lined ductile iron (Class 52 minimum), polyvinyl chloride (PVC) piping (Dimension Ratio [DR]14), and high density polyethylene piping (DR9). Additional limitations of material type may be needed for seismic design.

- Where restraints are required and are not bounded by the restraining methods for the type of pipe selected, two separate means of joint restraint should be used (e.g., thrust blocks and mechanical retaining glands, rodding).

- Ferrous piping should be provided with corrosion protection in accordance with American Water Works Association (AWWA) standards, such as polyethylene wrap or cathodic protection.

- A stable pipe bed should be provided, such as backfilling around piping of 18 inches with sand bedding. Seismic design may dictate alternate arrangements.

- Sectional (except for hydrant connection valves) and sprinkler/standpipe control valves should be limited to factory assembled listed/approved post indicator valve assemblies (PIVAs).

- In-ground pipe identification systems should be provided (ribbon, trace wire, red mud etc.).

- Water pressure at strategic points should be monitored at a constantly attended location for catastrophic failure.

- Acceptance testing should include full suppression system demand flow at the base of the riser, using a temporary header if necessary.

5.6 Environmental Conditions

The environmental conditions under which the water supply must perform its function should be defined as part of the safety design process outlined in DOE-STD-1189 and should include:

- Natural hazards such as seismic events, tornado, high winds, flooding and lightning, temperature (e.g., below freezing), and humidity;
- Facility hazards, such as internal flooding, explosions, fire, missile impacts, vehicle impacts, and corrosive environments; and
- Wildland fire.

Additionally, water supply quality conditions (for example, chemical and microbiological induced corrosion) should be addressed. Therefore, system design should permit inspections and tests to detect potential water quality issues. For example, flushing connections, interior test plugs, inspection tees, etc., to facilitate interior piping inspections should be installed and metallurgical system tests deemed necessary to validate any present (or future) water quality concerns should be conducted.

An example of design criteria that may be appropriate to address how environmental conditions can impact design is that all exposed piping, such as an exterior backflow prevention device installed in areas which are not subject to freezing, could be either galvanized or protected against external corrosion where exposed to adverse conditions.

5.7 Seismic Design

DOE-STD-1189 Appendix A should be applied in determining the seismic classification of the system for new facilities.

The design criteria established for above ground fire suppression should be applied to all above ground water supply components (see DOE-STD-1066). Below ground piping systems should not be utilized as the safety significant or safety class water supply to support systems if they cannot function at the seismic design category of the system they are supporting.

5.8 Interface Evaluation

Interfacing systems should be evaluated to ensure they do not impact the availability, reliability or functionality of the system. Connected portions of the interfacing system to water supply system of a safety significant or safety class fire protection system, such as an outdoor hydrant loop, do not need to be classified as safety class and/or safety significant if it can be established that credible failures do not exist that would compromise the safety class function of the system. For example, while the functionality of a fire hydrant may not be required to be safety related, the hydrant pressure boundary may still be safety related if its failure could adversely affect the operability of the water supply system during an event.

5.9 Quality Assurance

The quality assurance requirements of 10 CFR 830 and DOE O 414.1C must be applied in the design, manufacture, and installation of new water supplies supporting safety class or safety significant fire protection systems. The site and/or project QA program can be utilized if it meets all of these requirements.

It is recognized that NFPA documents are principally developed to define design, hardware selection, and installation adequacy to perform fire protection functions. DOE requires that management controls be developed and applied in performing the various functions for assuring a quality system. QA plans are typically in place and have been approved for the site and/or project. Specific guidance for controlling quality-related activities that apply to system installations may be beneficial to assure a quality installation that complies with the applicable safety classification level.

To support appropriate implementation of the site or project QA program relative to fire protection systems, the following topics should be addressed (beyond what is specifically identified in DOE O 420.1B and referenced NFPA codes and standards) in the QA plan:

- Document control (documents are stored properly to avoid damage, responsibility for completeness, maintenance and distribution are identified, etc.).
- Records of qualification of fire protection staff and control of qualification records.
- Procurement documentation and control of purchased items or services.
- Identification and control of components (e.g., sprinkler heads) per requirement 8 of NQA-1-2008, *Quality Assurance Requirements for Nuclear Facility Applications*.
- Handling, shipping and storage requirements for components.
- Control of nonconforming items to prevent inadvertent installation or use.
- Commercial grade dedication of components based upon third party testing and production monitoring.

The QA program should be audited in different phases (design, construction, and operations) using the process established in DOE O 413.3A.

When municipal water supplies are utilized, it may not be possible to qualify individual components (e.g., underground pipes), however, there is typically a significant amount of data for the system that indicates that the essentially passive system will reliably function during the duration of the accidents for which it is called upon and will have a very high availability. This information can be utilized in performing a commercial-grade, dedication-like process where the critical function is defined as the availability of the system and the reliability to function on demand.

6. SPECIFIC OPERATIONAL (SURVEILLANCE, TESTING, MAINTENANCE, AND OPERATION) REQUIREMENTS

6.1 Technical Safety Requirements (TSRs) -- Limiting Condition for Operation

The following is an example "operability statement" that can be used in developing a Technical Safety Requirement Limiting Condition for Operation for both safety significant and safety class water supply systems:

> "A water supply system is operational when it is capable of supplying adequate water (flow, pressure, and duration) from the storage tank to the facility fire suppression system and all TSR required surveillances are current."

6.1 TSR Surveillance and Testing Requirements

For water supply systems, the requirements in NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection* Systems, apply. NFPA 20, 22, and 24 refer to NFPA 25 for inspection, testing, and maintenance frequencies. In addition to these requirements, TSR surveillances should also include:

- An NFPA 25-allowed method to confirm that sufficient water control valves upstream of the system (e.g., wet pipe sprinkler system) control valve or PIV are fully open (i.e., locking, tagging or monitoring);

- A means to ensure the interior of underground piping remains free of obstructions and available to provide a clear path from the supply to the sprinkler riser. (One method might be post maintenance flow testing after disturbing any portion of the underground or any underground valve manipulation); and

- A means to identify any unaccounted water supply system leakage, such as a jockey pump.

In addition, water supply quality conditions (for example, chemical, and microbiological induced corrosion) should also be addressed through appropriate inspection testing and maintenance activities. Such activities should include regular metallurgical system tests (at a frequency deemed necessary to ensure no unacceptable system degradation).

APPENDIX A

Core Team and Primary Contributing Working Group Members

DNFSB Core Team (Technical Members)

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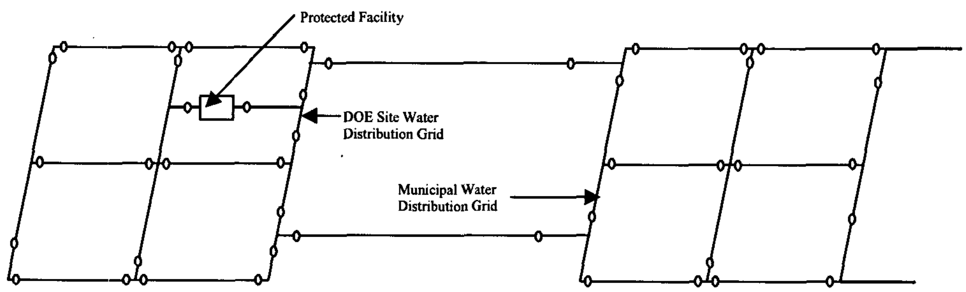
Walter Futrell	Bernie Till
Rodney Walker	Patrick Smith
Jim Streit	Rob Deschambeault
Craig Christenson	Randy Lanham

APPENDIX B

Typical Water Supply Arrangements

Water Supply Arrangement No. 1: Multipurpose (domestic/industrial/fire) water supply system tied to a municipal water provider outside of DOE control.

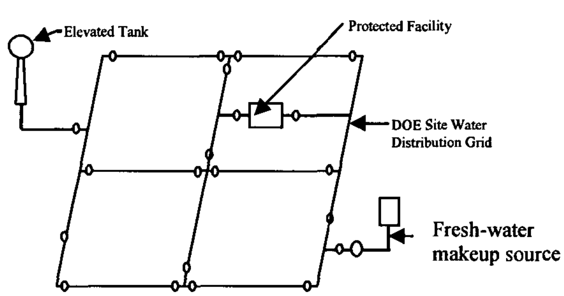
In this detail, water is obtained from a qualified municipal water purveyor.



This arrangement should not be utilized for safety class applications but is used for general purpose fire protection and may be used for safety significant applications if requirements for reliability and quality assurance are met. The reason that the system should not be used in safety class applications is that, even though the system is essentially passive, the lack of DOE control over the supply, makes it prudent to have additional (e.g., backup) system (which is under DOE control) to supply the facility. The use of this system for either safety significant or safety class applications raises concerns related to whether the municipality would be subject to DOE enforcement requirements that will need to be addressed. Finally, as discussed in Section 5.9, this arrangement also raises issues regarding where the safety class or safety significant boundary would be drawn. Notwithstanding all these difficulties, arguments have been made that municipal water supplies are extremely reliable, even more so than dedicated systems and should be allowed. If this is the case for a given site and facility, then it may be possible to provide a justification to utilize a municipal system, if all of the nuclear safety criteria can be met and the issues discussed above addressed.

Water Supply Arrangement No. 2: Multipurpose (domestic/industrial/fire) water supply system under DOE control.

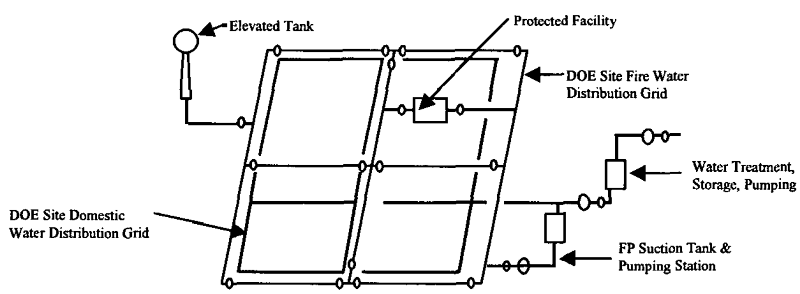
In this detail, water is obtained from a fresh-water source, such as a well or river, treated and then stored on site by both suction and elevated water storage tanks.



Similar to Arrangement 1 above, this arrangement should not be utilized for safety class applications but is used for general purpose fire protection and may be used in safety significant applications if requirements for reliability and quality assurance are met. The reason that the system should not be used in safety class applications is that, even though the system is essentially passive and under DOE control, it is not under the facility's control. Because it is not under the facility's control, it is prudent to have an additional backup system which is under the facility's control. Furthermore, as discussed in Section 5.9, this arrangement raises issues regarding where the safety class or safety significant boundary would be drawn.

Water Supply Arrangement No. 3: DOE Site supplied by a separate site-maintained fire water distribution network.

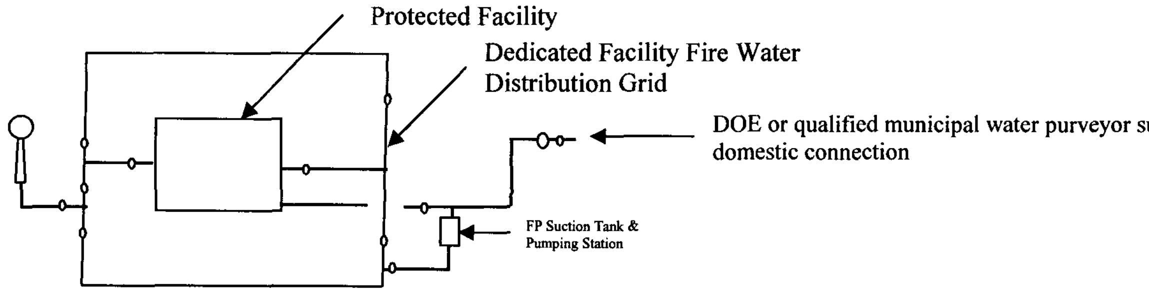
In this detail, water is obtained from a fresh-water source, such as a well or river, treated and then stored on site by both suction and elevated water storage tanks. The fire water and domestic water systems are separate. The only interface is the feeding of the fire water suction tank from the domestic water system.



Similar to Arrangement 2 above, this arrangement should not be utilized for safety class applications but is used for general purpose fire protection and may be used safety significant applications if requirements for reliability and quality assurance are met. The reason that the system should not be used in safety class applications is that, even though the system is essentially passive and under DOE control, it is not under the facility's control. Because it is not under the facility's control, it is prudent to have an additional backup system which is under the facility's control.

Water Supply Arrangement No. 4: DOE Protected Facility supplied by a dedicated fire water distribution network.

In this detail, water is obtained from a fresh-water source, such as a well or river, treated and then stored on site by both suction and elevated water storage tanks. The fire protection suction tank is sized to provide adequate water supply without reliance of the fill for the design basis fire.

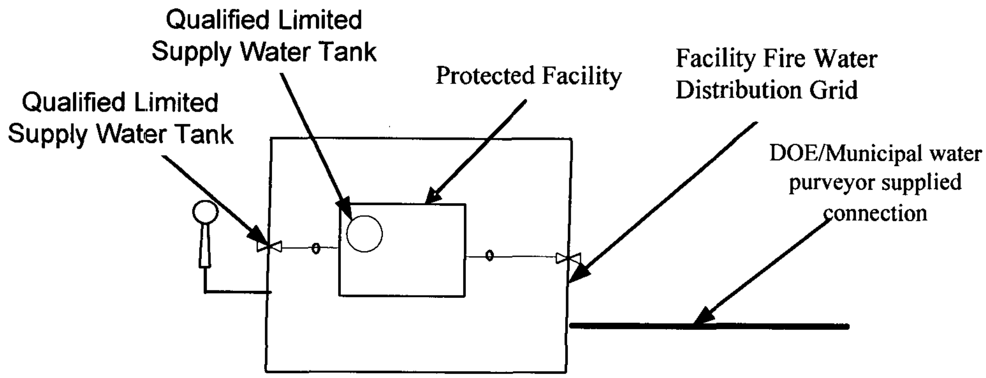


This arrangement could be utilized for safety significant applications if conditions specified in Section 5.3 of this guide are met. If the supplied system (e.g., wet pipe sprinkler) needs to operate in a seismic event (e.g., to mitigate a seismically induced fire), then the supply system must be qualified to the same level as the supplied system.

This arrangement may be appropriate for use in safety class applications with assurance that no active single failure could disable the system.

Water Supply Arrangement No. 5 - Hazard-specific limited supply water system.

Water system flow and capacity for property protection, program preservation, and life safety, etc. are specified by the Uniform Fire Prevention Code (NFPA 1), Standard for Fire Protection for Facilities Handling Radioactive Materials (NFPA 801), the Building Code, the Standard for the Installation of Sprinkler Systems (NFPA 13) or other general industrial standards. These standards typically require from several hundred thousand to several million gallons of water. None of these specify the amount of water needed to adequately protect a safety class or safety significant special hazard which must be determined on a case-by-case basis and justified in the FHA or DSA, taking into account issues such as criticality and spread of contamination. Nuclear safety objectives can often be achieved with much lower quantities of water. For example, 500 gallons may be sufficient to meet the safety class objective to protect a special hazard in a given facility. Such a limited supply could be provided by a single, passive, self-contained pressure tank within the facility, qualified to seismic and other safety class criteria (such as redundancy of active components), thus significantly limiting the safety class boundary. An additional water supply per the above codes and standards would be required to meet other fire protection objectives, but that additional supply is not required to meet safety class or safety significant criteria.


Qualified Limited
Supply Water Tank
Protected Facility
Facility Fire Water
Distribution Grid
Qualified Limited
Supply Water Tank
DOE/Municipal water
purveyor supplied
connection

APPENDIX C

Summary of Additional Water Supply Criteria and Guidance for Safety Class and Safety Significant Applications

DOE has established very stringent design requirements for fire protection systems utilized at all facilities (nuclear and non-nuclear). For fire protection systems utilized in safety significant and safety class applications in DOE nuclear facilities, additional requirements and criteria may need to be implemented to ensure very high levels of reliability with increased design margins and quality assurance.

The following provides a summary of the requirements, criteria and guidance for three levels of protections provided, i.e., general use (e.g., non-nuclear), safety significant, and safety class:

General Use
Local Building Codes
Facility Safety Order (DOE O 420.1B)
DOE-STD-1066, *Fire Protection Design Criteria*
Additional Highly Protected Risk Criteria; e.g., as defined in FM Global (formerly Factory Mutual) Data Sheets

Safety-Significant (Design)
In addition to the criteria for general use, the following additional design requirements/guidance is applicable for water supply systems used in safety significant applications:

A. Underground piping should be limited to cement lined ductile iron (Class 52 minimum), polyvinyl chloride (PVC) piping (Dimension Ratio [DR] 14), and high density polyethylene piping (DR9). Additional limitations of material type may be imposed for seismic design.

B. Where restraints are required, two separate means of joint restraint should be used (e.g., thrust blocks, mechanical, rodding).

C. Ferrous piping should be provided with corrosion protection such as polyethylene wrap or cathodic protection per AWWA standards.

D. A stable pipe bed such as backfilling around piping to a height of eighteen inches of sand bedding (from outside of piping) should be provided.

E. Sectional and sprinkler/standpipe control valves should be limited to factory assembled post indicator valve assemblies (PIVAs).

F. In-ground pipe identification systems should be provided (ribbon, trace wire, red mud etc.).