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February 6, 2013

New Safety Standards (SA) Outline (Draft)

For Public Comment

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(Caution)
- This document contains the new safety standards (Severe Accident Management) outline compiled based on the discussions by the “The Study Team on the New Safety Standards for Light Water Reactor for Electric Power Generation”.
- This document compiles regulatory requirements in a free format. Legislative structure, definitions of terms, and detailed provisions shall be determined in the future in accordance with legal examples.

Foreword

This section gives an overall view of the new regulatory requirements for severe accident management. Section1~4 and Section 6~9 are the requirements for reactor license permit and the details of them are mentioned in this draft. Section 5, 10 and11 are neither the requirements for reactor license permit nor the subjects of public comment, which will be considered further in the future.

(Countermeasures against Severe Core Damage)

1 Licensees shall take countermeasures against severe core damage assuming beyond the design basis accidents. (Hereinafter referred to as, “Countermeasures against Severe Core Damage”).

(Countermeasures against Containment Vessel Failure)

2 Licensees shall take countermeasures against Containment Vessel failure assuming a containment vessel failure mode considerable. (Hereinafter referred to as, “Countermeasures against Containment Vessel failure”).

(Countermeasures against Severe Fuel Damage in Spent Fuel Storage Pools)

3 Licensees shall take countermeasures against severe fuel damage in spent fuel storage pools assuming an accident considerable that may cause severe fuel damage in spent fuel storage pools. (Hereinafter referred to as, “Countermeasures against Fuel Damage in Spent Fuel Storage Pools”).

(Countermeasure against Severe Fuel Damage in a Reactor during Shutdown)

4 Licensees shall take countermeasures against severe fuel damage in a reactor during shutdown assuming an accident considerable that may cause severe fuel damage in a Reactor during Shutdown. (Hereinafter referred to as, “Countermeasure against Severe Fuel Damage in a Reactor during Shutdown”).

(Activities for improving safety margin)

5 Licensees shall take a measure to improve the safety margin of equipment for design basis requirement against natural phenomena and external human events, as far as reasonably practicable.

(Accident management with portable equipment, etc.)

6 Licensees shall establish procedures to cool reactor, containment vessel and spent fuel storage pools and minimize the release of radioactive material in the event of large-scale damage to the plant as a result of a large-scale natural disaster or act of terrorism, etc., such as the intentional airplane crash, and shall prepare a system for taking action as well as equipment, such as portable equipment, etc., in accordance with these procedures.

(Specific Safety Facilities)

7 Licensees shall construct robust specific safety facilities designed to withstand acts of terrorism, etc., such as the intentional airplane crash etc., in order to suppress the release of a large amount of radioactive material due to the containment vessel damage in the event severe core damage caused by acts of terrorism, etc., such as the intentional airplane crash etc.,

(Comprehensive Countermeasures for Suppression of Release)

8 Licensees shall prepare means to suppress the release of radioactive material to outside of the site in order to comprehensively manage various accidents such as severe core damage and Containment Vessel failure, or sever fuel damage in spent fuel storage pools

(Evaluation of the Effectiveness of Countermeasures against Severe Accidents)

9 Licensees shall establish optimal severe accident countermeasures such as below, considering not only accident sequence groups and containment vessel failure modes specified by the Nuclear Regulatory Authority (NRA) in advance but also those regarded as indicating significant core damage frequency and detrimental impact through implementation of internal event probabilistic risk assessment (PRA) (individual plant examination (IPE)) and external event PRA (individual plant examinations for external events (IPEEE)) at each plant. Licensees shall evaluate the effectiveness of those countermeasures for severe accident.

a. Countermeasures against severe core damage
b. Countermeasures against Containment Vessel failure
c. Countermeasures against severe fuel damage in spent fuel storage pools
d. Countermeasure against severe fuel damage in a reactor during shutdown

(Comprehensive Risk Assessment Including an Impact Assessment for beyond Design Basis External Events)

10 Licensees shall assess the impact on safety function by beyond design basis external events as well as by design basis internal and external events in accordance with the following methods and shall implement a comprehensive risk assessment for those events considering their voluntary activities.

a. Internal event PRA (IPE)
b. External event PRA (IPEEE)
c. Safety margin evaluation (so-called Stress Tests)
d. Airplane Crash impact assessment

(Reflection of the Latest Knowledge and Continuous Improvements)

11 Licensees shall continuously improve the safety of nuclear reactor facilities based on the results of comprehensive risk assessment considering the latest knowledge related to reactor safety.

New Safety Standard (SA) Outline Draft

1. Definitions (SA-related)

Terms used in this outline draft shall be defined as follows.

① "Equipment for design basis requirement" refers to, equipment newly installed in order to meet the requirements of the new safety standard (Design Basis) outline as specified separately.

② "Alternate equipment" refers to, equipment prepared to substitute required function in the event that Equipment for design basis requirement loses safety function for some reason.

③ "Portable alternate equipment" refers to, alternate equipment that can be moved. (Self-propelled equipment included).

④ "Permanent alternate equipment" refers to, alternate equipment that is not intended to be moved for use and already connected to the nuclear facilities in advance.

⑤ "Severe accident mitigation equipment" refers to, equipment used to prevent Containment Vessel failure after severe core damage.

⑥ "Beyond design basis accidents capable of severe core damage" refers to, an abnormal situation where safety related SSCs designed to manage design basis accidents have lost safety function resulting in the possibility of severe core damage and an abnormally huge amount of release of radioactive material from the nuclear facility. Even though considered extremely low the occurrence frequency, those accidents are assumed to evaluate the safety level of the nuclear facilities or the effectiveness of countermeasures for severe accident.

⑦ "Accident sequence group" refers to, the sub-categorization of accident sequences based on event progression and the similarity between accident mitigation operations.

⑧ "Containment vessel failure mode" refers to, the physical phenomena, the cause of containment vessel failure that may occur in conjunction with severe core damage and affect the containment vessel integrity.

⑨ "Specific safety facilities" refers to, facilities with function to suppress a large amount of radioactive material release caused by containment vessel failure in the event of severe core damage or almost damaged core as a result of acts of terrorism, etc., such as the intentional airplane crash, etc.

⑩ "Cliff edge" refers to, a large deviation from normal condition caused by rapid transient as a result of a small deviation in one parameter; that is an abrupt and dramatic deviation of NPP responding to a small fluctuation in input data. Furthermore, a small deviation refers to, the loss of function of a single equipment or system, damage to a single structure, a single operation error, or the limit values of plant parameters, such as temperature or pressure that could greatly alter plant conditions.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(1) Common Requirements

① Requirements for alternate equipment

[Basic Requirements]

(Capacity, environmental conditions and load conditions, operability)

1 Alternate equipment shall effectively function as required during beyond design basis accidents.

a. Alternate equipment shall be designed to have suitable capacity required to manage design basis accidents

b. Alternate equipment shall be designed to function as required with sufficient reliability under environmental and load conditions supposed during beyond design basis accidents

c. Alternate equipment shall be designed to guarantee operability under the conditions associated with beyond design basis accidents.

(Diversity and dispersed installation)

2 When installing alternate equipment particularly important to safety, both equipment for design basis requirement and alternate equipment shall be deployed dispersedly at the site and secure the diversity of drive power sources for them as necessary so as not to lose intended safety function due to common factors.
(Note: The need for this is mentioned for each countermeasure).

(Detrimental impact prevention)

3 Alternate equipment shall be installed so as not to cause any detrimental impact on equipment for design basis requirement.

(Easy Changeover)

4 Equipment and procedures shall be designed so as to allow easy and certain changeover from normal line configurations in the event that equipment for design basis requirement is used for a purpose of severe accident countermeasures other than its originally intended use.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(1) Common Requirements

② Requirements for portable alternate equipment

[Basic Requirements]

(Capacity)

1 Portable alternate equipment shall be designed with suitable capacity margins in accordance with equipment reliability to have the required capacity to manage beyond design basis accidents.

(Diversity)

2 Portable alternate equipment shall be as diverse as possible so as to substitute for equipment for design basis requirement and permanent alternate equipment.

(Reliable connections)

3 Measures shall be taken to standardize connection methods to ensure that portable alternate equipment and permanent equipment can be easily and surely connected and that such equipment can be used interchangeably between systems and units. Furthermore, multiple connections shall be prepared and the location of these connections shall be dispersed.

(Robust conduits, etc.)

4 Internal conduits, valves, and electric cables beyond the connection point shall have the same seismic resistance as equipment for design basis requirement for which they are to substitute.

(Storage places)

5 Portable alternate equipment shall be dispersed in different locations where are not easily impacted by external events (earthquakes, tsunami, etc.). Portable alternate equipment shall be stored in different locations from permanent alternate equipment.

(Field work environment)

6 The installation locations of portable alternate equipment shall enable the installation, connection, operation, and recovery work under conditions associated with beyond design basis accidents by selecting suitable place supposed not to be affected severely by the accident and enhancing the shielding performance.

(Securing access routes)

7 Access routes should be designed and managed effectively so as to ensure the availability of required access routes outside of buildings needed to transport portable alternate equipment.

[Requirement details]

(Capacity)

A Portable alternate equipment capacity margins for portable alternate power sources and portable cooling injection equipment shall be as follows.

(a) 200%/unit to provide two connections per unit.

(b) 100% backup during malfunctions and 100% standby exclusion through inspections and maintenance.

(c) 100% refers to performance that can effectively provide necessary function in the event of beyond design basis accidents.

(Robustness)

B “Having equal seismic resistance” refers to, the ability to maintain intended function even after suffering equal seismic motion.

(Storage places)

C Portable alternate equipment shall be stored in locations in consideration of intentional airplane crash. For example, locations isolated more than 100m from reactor buildings that would not be simultaneously affected along with the reactor building. Otherwise, locations should be robust enough to withstand an airplane crash.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(1) Common Requirements

③ Requirements for recovery work

[Basic Requirements]

(Securing spare parts, etc.)

1 So as to conduct replacement or maintenance of component particularly important to safety, suitable spare parts and tools necessary for replacing shall be secured.

(Storage place)

2 Spare parts shall be stored in dispersed locations withstanding the impact of external events (tsunami, earthquake, etc.).

(Securing access routes)

3 Access routes should be designed and managed effectively so as to ensure the availability of required access routes outside of buildings needed to confirm the damage status of equipment and perform recovery work.

[Requirement Details]

(Securing spare parts)

A “tools necessary for replacing” refers to, equipment necessary for operation under various weather conditions, etc., operational vehicle for removing debris, lighting equipment needed for night work.

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2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(1) Common Requirements

④ Requirements for permanent alternate equipment

[Basic Requirements]

(Improving reliability)

1 Even if portable alternate equipment can be used to maintain necessary function in the event that equipment particularly important to safety loses function, in order to further improve reliability, as a rule, permanent alternate equipment shall be installed. (Described in detail in the following pages)

(Robustness)

2 Permanent alternate equipment shall have the same earthquake and tsunami resistance as equipment for design basis requirement for which it is to substitute. Permanent alternate equipment shall be diverse in its application to the equipment for design basis requirement for which it is to substitute.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(1) Common Requirements

⑤ Miscellaneous requirements

[Basic Requirements]

(Permanent severe accident mitigation equipment)

1 Permanent severe accident mitigation equipment, such as filtered containment vessel venting system, etc., shall adhere to the requirements for alternate equipment even if it is not considered alternate equipment.

2 As a rule, permanent severe accident mitigation equipment may not be shared by more than two nuclear facilities. However, this rule shall not apply if risk can be reduced by sharing the equipment under the condition that no other detrimental impact is caused.

(Assistance)

3 Measures prepared in advance at a site (alternate equipment, spare parts, fuel, etc.) shall enable the continued management of an accident for seven days after occurrence of the event. A plan to enlist assistance from external organizations shall be created upon consultation and agreement by pertinent organizations. Measures prepared in advance outside the site (alternate equipment, spare parts, fuel, etc.) shall be able to provide assistance for six days after occurrence of the event.

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2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(2) Preparation of procedures, implementation of drills, and development of emergency response organizational system

[Basic Requirements]

Procedures shall be created in advance, personnel drill, and a necessary system for securing personnel created so as to allow an accident that exceeds design basis accidents to be dealt with accurately and flexibly.

[Requirement Details]

(Note: When licensing a nuclear reactor the following basic plan shall be confirmed along with the details of succeeding regulations, such as operational safety program approval.)

A Procedures shall be created in accordance with the following.

(a) Procedures shall compile types of information required to ascertain plant status in a limited amount of time and accurately make decisions in regard to the implementation of severe accident countermeasures, methods for obtaining this information, and judging criteria in preparation for the loss of all AC and DC power sources, and multiple failures of safety system devices and instrumentation.

(b) Procedures shall clarify in advance the standards for determining what operations should be prioritized in order to prevent core damage and containment vessel failure. (Including SLCS, sea water usage and venting.)

(c) Procedures shall be created appropriately for both operators and supporting organizations so as to allow the implementation of detailed severe accident countermeasures in accordance with the development of the event. Furthermore, if procedures are divided into multiple types in accordance with how an event develops the organization of these documents, as well as the standards for transitioning between procedures, shall be clarified.

(d) Measurable parameters used as standards for determining the implementation of actual severe accident countermeasures, such as water level, pressure, and temperature, etc., shall be clearly stated in the procedures. Furthermore, parameter behavior forecasts, impact assessment items, and monitoring parameters, etc., during implementation of severe accident countermeasures shall be compiled in the procedures.

(e) A procedure to manage an event at the point when precursors of the event are discovered (for example, reactor shut down and cooling operations when a large tsunami warning has been issued) shall be created.

B Drill shall conform to the following requirements.

(a) Since severe accident countermeasures must be diverse enough to manage various plant situations, education and drill related to such countermeasures shall enable trainees to improve their knowledge of the behavior of a plant during a severe accident.

(b) In addition to periodical education to improve the understanding of basic knowledge based on the role of each personnel, practice drills used to comprehensively confirm the effectiveness of severe accident countermeasure implementation organizations and support

organizations shall be planned.

(c) Along with acquiring on-the-job drill by replacing parts through voluntary maintenance and inspection activities implemented on a normal basis, personnel shall also become intimately familiar with the plant and spare parts through daily maintenance.

(d) Personnel shall be trained how to manage accidents under various conditions such as high radiation levels, and during the nighttime and in bad weather.

(e) Through normal maintenance and inspection activities personnel shall be trained and prepared so as to enable them to quickly use information and manuals related to equipment and equipment used during accidents.

C System for securing personnel

(a) The sharing of responsibilities and persons in charge of organizations implementing severe accident countermeasures and assisting organizations shall be established, and a system that enables the effective implementation of severe accident countermeasures created.

(b) Implementation organization refers to organizations that implement severe accident countermeasures, such as operators, and organizations that transport and operate alternate equipment.

(c) Implementation organizations shall be able to respond even in the event of simultaneous severe accidents at all units.

(d) Chief reactor engineers shall work full-time at each unit.

(e) Such supporting organizations as technical support organizations that give technical advice to the implementation organization, and operations support organizations that prepare an environment that allows the implementation organization to focus on severe accident countermeasures, etc., shall be created.

(f) Implementation organizations and support organizations shall be created under conditions that require implementation of severe accident countermeasures. Furthermore, the smooth summoning of personnel shall be enabled by implementing periodic call-out drill during which necessary personnel gathers at the plant in accordance with a system of communication even during nights and holidays.

(g) The functions of the severe accident countermeasure implementation organization and assisting organizations, as well as the function of each unit created within the assisting organizations shall be clarified and a leader established for each unit.

(h) The chain of command shall be clarified. Alternate chains of command shall also be prepared in the event that the commander, etc., is absent.

(i) Facilities and equipment shall be organized so as to effectively engage in the aforementioned implementation system.

(j) A system that allows supporting organizations to inform internal and external organizations as necessary of plant status and the status of implementation of severe accident countermeasures, and provide a wide variety of information shall be created.

(k) A system for receiving support outside the power station shall be constructed.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(3) Countermeasures for reactor shutdown

[Basic Requirements]

Prepare equipment and procedures for maintaining the integrity of the reactor coolant pressure boundaries and the containment vessel while maintaining reactor sub-criticality in order to prevent severe core damage in the event of an anticipated transient without scram (ATWS), or indications of such an event*.

[Requirement Details]

A "Indications of such an event" refers to, cases where it is assumed from changes in parameters, such as reactor output and reactor pressure, etc., that the reactor has not scrammed regardless of whether or not the reactor must be scramming (emergency reactor shutdown).

B "Equipment and procedures for maintaining reactor sub-criticality" refers to, the measures described below or measures that have the same or better effect.

Common to BWR, PWR

(Procedures)

(a) Manually scram the reactor in the event that ATWS indications are detected.

For BWR

(Permanent alternate equipment)

(b) Installation of an alternate control rod insertion circuit (ARI) independent from the reactor scram system from sensor output to final activator input.

(c) Installation of a device that automatically trips the reactor coolant recirculation pump in order to control reactor output in the event that ATWS indications are detected. The pump shall be manually tripped if it is not automatically tripped.

(d) Installation of a standby liquid control system (SLCS) response level control capability. Judging criteria for startup shall be clearly described.

(e) The SLCS shall be started manually in the event that unstable output vibrations are detected during an ATWS.

For PWR

(Procedure)

(f) If indications of an ATWS are detected the auxiliary feed water pump will be automatically started and the turbine tripped in order to suppress reactor output. If this fails, it shall be done manually.

(g) If indications of an ATWS are detected a sufficient amount of boric acid shall be inserted by chemical volume control equipment and emergency core cooling equipment.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(4) Countermeasures for cooling reactor at high pressure

[Basic Requirements]

The installation of equipment and procedures for cooling the reactor using alternate methods or by restoring reactor cooling function in order to prevent severe core damage in the event that reactor cooling function is lost when reactor coolant pressure boundaries are at high pressure.

[Requirement Details]

A "Equipment and procedures for cooling the reactor" refers to, the measures described below or measures with the same or better effect.

(Portable alternate equipment)

(a) Preparing measures (procedures, portable alternate equipment, equipment, etc.) for starting up the RCIC, emergency condenser (BWR), or turbine drive auxiliary feed water pump (PWR) through valve operation using portable alternate equipment on site (batteries, nitrogen tanks, etc.) and continuing operation for a sufficient period of time* assuming that all AC and DC power sources have been lost.

*: Time needed to prepare and implement "reactor coolant pressure boundary depressurization countermeasures" and "cooling countermeasures during reactor coolant depressurization".

(Field operation)

(b) Preparing measures (procedures, equipment, etc.) for starting up the RCIC, emergency condenser (BWR), or turbine drive auxiliary feed water pump (PWR) through valves operated by manpower in the field assuming cases where all AC and DC power sources have been lost and attempts to use alternate equipment resulted in failure.

(Restoration)

(c) Enabling startup of the high-pressure insertion system by connecting alternate AC power source and continuing operation for a sufficient period of time. (BWR)

(d) Enabling startup of the motorized auxiliary feed water pump by connecting alternate AC power source and continuing operation for a sufficient period of time. (PWR)

(Monitoring, control)

(e) Creating means (procedures, portable alternate equipment, equipment, etc.) for estimating reactor water level (BWR and PWR) and steam generator water level (PWR) assuming that all AC and DC power sources have been lost.

(f) Creating means (procedures, portable alternate equipment, equipment, etc.) for confirming the operational status of important safety equipment, such as the RCIC, assuming that all AC and DC power sources have been lost.

(g) Creating means (procedures, equipment, etc.) for controlling reactor water level and steam generator water level assuming that all AC and DC power sources have lost.

(Suppressing accident escalation)

(h) Creating procedures for injecting coolant from the standby liquid control system (SLCS) and control rod drive mechanism water pressure system (CRD) in order to suppress accident escalation.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(5) Countermeasures for depressurization of reactor coolant pressure boundaries

[Basic Requirements]

Preparing equipment and procedures, etc., for depressurizing reactor coolant pressure boundaries by restoring depressurization function, or by alternate means, in order to prevent severe core damage and containment vessel failure in the event that depressurization function is lost when reactor coolant pressure boundaries are at high pressure.

[Requirement Details]

A "Equipment and procedures, etc., for depressurizing reactor coolant pressure boundaries" refers to, the measures described below of measures with the same or better effect.

(Logic additions)

(a) Addition of depressurization automated logic for activating the automatic depressurization function of safety relief valves at low reactor water levels. (BWR).

(Portable alternate equipment)

(b) Manual equipment or portable alternate AC power source equipment shall be prepared so as to enable activation of the depressurization valves (relief safety valves (BWR), main steam relief valve and pressurizer relief valve (PWR)) and depressurization of reactor coolant pressure boundaries even in the event of DC power loss.

(c) Portable compressors or nitrogen tanks shall be prepared so as to enable activation of depressurization valves and depressurization of reactor coolant pressure boundaries if depressurization valves are air operated valves.

(d) The conditions that enable activation of depressurization valves shall be clarified.

(Recovery)

(e) Recovery procedures using alternate power sources shall be created so as to enable activation of depressurization valves and depressurization of reactor coolant pressure boundaries even in the event of DC power loss.

(SGTR)

(f) The aforementioned steam generator shall be isolated in the event of a steam generator tube rupture (SGTR). Procedures shall be created to enable depressurization of reactor coolant pressure boundaries through activation of pressurization relief valves, etc., in the event that the steam generator cannot be isolated. (PWR)

(ISLOCA)

(g) Damaged areas of reactor coolant pressure boundaries shall be isolated in the event of an interface system LOCA. Procedures shall be created that enable depressurization of reactor coolant pressure boundaries through activation of relief safety valves (BWR), main steam relief valves and pressurizer relief valves (PWR) in order to depressurize the reactor and suppress leaks of reactor coolant in the event that isolation is not possible.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(6) Countermeasures for cooling reactor at low pressure

[Basic Requirements]

The installation of equipment and procedures for cooling the reactor using alternate methods or by restoring reactor cooling function in order to prevent severe core damage and prevent containment vessel failure in the event that reactor cooling function is lost when reactor coolant pressure boundaries are at low pressure.

[Requirement Details]

A "Equipment and procedures for cooling the reactor" refers to, the measures described below or measures with the same or better effect.

(Alternate equipment)

(a) Alternate equipment shall be diverse and independent from equipment for design basis requirement and dispersed over a wide area.

(b) Portable alternate equipment shall be available and ready for use.

(c) Permanent alternate equipment that operates off of principles differing from equipment for design basis requirement shall be installed in order to manage cases where severe core damage is imminent.

(Recovery)

(d)Means for recovering equipment for design basis requirement through the connection of alternate AC power sources, etc., shall be devised.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(7) Countermeasures for securing an ultimate heat sink after an accident

[Basic Requirements]

The installation of equipment and procedures for carrying heat to an ultimate heat sink using alternate methods or by restoring ultimate heat sink system (UHSS) function in order to prevent severe core damage and containment vessel failure in the event that UHSS function is lost.

[Requirement Details]

A "Equipment and procedures for carrying heat to an ultimate heat sink" refers to, the measures described below or measures with the same or better effect.

(Core damage prevention)

(a) Alternate equipment shall be installed in order to prevent core damage.

(b) Alternate equipment shall be diverse and independent from equipment for design basis requirement and dispersed over a wide area.

(c) Assuming ultimate heat sink lost due to a loss of water intake function, at BWR's there should be sufficient time to connect an onsite alternate UHSS truck and carry heat to an ultimate heat sink within a fixed period of time during which reactor cooling function is maintained by forcing heat to accumulate in the suppression pool. Furthermore, at PWR's it shall be possible to carry heat to an ultimate heat sink by removing heat using secondary systems such as the turbine drive auxiliary feed water pump and main steam relief valves.

(Containment vessel failure prevention)

(d) Severe accident mitigation equipment shall be installed in order to prevent containment vessel failure.

(e) Transferring heat from the containment vessel vapor part (however, this excludes suppression chamber vapor parts in BWR's that have MARK-1 containment vessels) that are not impacted detrimentally by core meltdowns or submergence.

(f) In order to further improve reliability equipment shall be installed that is independent from the aforementioned severe accident mitigation equipment and dispersed over a wide area.

(Specific safety facilities)

B Use of alternate auxiliary cooling as the aforementioned means shall follow the following.

(a) Installation of alternate auxiliary cooling equipment.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(8) Countermeasures for cooling, depressurization and radioactive material mitigation of containment vessel (Containment vessel spray)

[Basic Requirements]

1 Installation of equipment and procedures for using containment vessel alternate coolant injection spray equipment in order to lower temperature and atmospheric pressure inside the containment vessel in order to prevent severe core damage in the event of beyond design basis accidents in conjunction with the loss of containment vessel atmospheric cooling function.

2 Installation of equipment and procedures for using containment vessel alternate coolant injection spray equipment in order to reduce the temperature, atmospheric pressure and radioactive material concentration inside the containment vessel in order to prevent containment vessel failure in the event of severe core damage .

[Requirement Details]

A "Containment vessel alternate coolant injection spray equipment" refers to, the measures described below or measures with the same or better effect.

(Portable alternate equipment)

(a) Portable containment vessel alternate coolant injection spray equipment shall be installed under the assumption that containment vessel coolant injection spray equipment that needs design standards (pumps or water sources) will lose function.

(b) Containment vessel alternate coolant injection spray equipment drive power sources shall be diversified and the equipment shall be dispersed over a wide area in order to ensure that the function of such equipment, including equipment for design basis requirement and alternate equipment, is not lost due to common factors.

(Permanent alternate equipment)

(c) Permanent containment vessel coolant injection spray equipment shall be installed in order to further improve reliability. (Specific safety facilities)

(Dual-use)

(d) Containment vessel alternate coolant injection equipment may be used for both purposes of preventing core damage and preventing containment vessel failure.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(9) Countermeasures for heat removal and depressurization of containment vessel

[Basic Requirements]

Installation of equipment and procedures for reducing the atmospheric pressure and temperature inside the containment vessel in order to prevent containment vessel failure in the event of severe core damage .

[Requirement Details]

A "Equipment and procedures for reducing the atmospheric pressure and temperature inside the containment vessel" refers to, the measures described below or measures with the same or better effect.

(a) Installation of filtered containment vessel venting system.

(Radioactive material reduction countermeasures)

(b) Filtered containment vessel venting system shall reduce the amount of radioactive material contained in exhaust.

(Flammable gas countermeasures)

(c) Filtered containment vessel venting system shall be equipped with countermeasures for preventing explosions due to flammable gases.

(Detrimental impact prevention)

(d) Piping of filtered containment vessel venting system shall not be shared with other systems, devices (for example, SGTS) or those of other units, etc. However, this need not be the case if there are no detrimental effects.

(Field operation)

(e) The isolation valves for filtered containment vessel venting system shall be able to be opened and closed easily and surely by manpower.

(f) Radiation protection countermeasures, such as shielding and isolation, etc., shall be implemented in order to enable operation of filtered containment vessel venting system in the field using only manpower and even in times of severe core damage.

(Portable alternate equipment)

(g) Measures, such as having required equipment and materials on hand nearby, etc., shall be implemented in order to enable operation of isolation valves for filtered containment vessel venting system even in the event of drive power loss.

(Rupture discs)

(h) Bypass valves shall be juxtaposed if rupture discs are to be used. However, this shall not apply to cases where rupture discs set to rupture at sufficiently low pressures are used so as

not to impede the use of filtered containment vessel venting system.

(Containment vessel connection position)

(i) It shall be possible to events of the containment vessel vapor part (however, this excludes suppression chamber vapor parts for BWR's that have MARK-I containment vessels) so as to avoid the impact of submersion or melted core material that may fall or be disbursed within the containment vessel.

(Radiation protection)

(j) Radiation protection countermeasures, such as shielding, etc., shall be implemented in order to reduce exposure from highly reactive filters, etc., after use.

(Specific safety facilities)

(k) Equipment for reducing the atmospheric pressure and temperature inside containment vessels shall be made redundant, and one piece of containment vessel filters/venting equipment shall be deemed a specific safety facility in order to further improve reliability.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(10) Countermeasures for cooling melted core fallen to the bottom of the containment vessel

[Basic Requirements]

Installation of equipment and procedures for injecting coolant into the bottom of the containment vessel in order to cool (suppress MCCI and the spread of core meltdown) melted core fallen to the bottom of the containment vessel and in order to prevent containment vessel failure in the event of severe core damage.

[Requirement Details]

A "Equipment and procedures for injecting coolant into the bottom of the containment vessel in order to cool (Suppress MCCI and the spread of core meltdown) melted core fallen to the bottom of the containment vessel" refers to, the measures described below or measures with the same or better effect.

(a) Installation of equipment for injecting coolant into the bottom of the containment vessel.

(b) Equipment for injecting coolant into the bottom of the containment vessel shall be redundant, diversified, independent, and dispersed over a wide area. (However, this shall exclude flow channels and piping above structures inside buildings.)

(c) Preparation of portable equipment for injecting coolant into the bottom of the containment vessel (example, pump trucks, pressure resistant hoses, etc.). (Flow channels inside buildings used for connecting portable equipment for injecting coolant into the bottom of the container vessel shall be laid out in advance.)

(d) Permanent equipment for injecting coolant into the bottom of the containment vessel shall be deemed as specific safety facilities in order to further improve reliability.

(e) This equipment shall be compatible with alternate AC power sources.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(11) Countermeasures against hydrogen explosions inside the containment vessel

[Basic Requirements]

Installation of equipment and procedures for preventing hydrogen explosions inside containment vessels in order to prevent containment vessel failure in the event of severe core damage.

[Requirement Details]

A "Equipment and procedures for preventing hydrogen explosions" refers to, the measures described below or measures with the same or better effect.

<BWR>

(a) Atmosphere inactivation.

<PWR reactor types that require it>

(b) Installation of hydrogen concentration control equipment.

(c) Hydrogen concentration control equipment shall be installed as specific safety facilities in order to further improve reliability.

<Common to both PWR and BWR>

(d) Explosion prevention equipment, radioactive material reduction equipment, and hydrogen and reactive material concentration measurement equipment shall be installed when discharging hydrogen gas outside the containment vessel.

(e) Installation of monitoring equipment that can measure to certain extent the possibility of fluctuations in hydrogen concentration during severe core damage.

(f) This equipment shall be compatible with alternate AC power sources.

(g) Creation of procedures for preventing hydrogen explosions caused by hydrogen and oxygen produced through the radiolysis of water following severe core damage .

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2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(12) Countermeasures against hydrogen explosions inside the reactor building, etc.

[Basic Requirements]

Installation of equipment and procedures for preventing damage to the reactor building and containment vessel annulus by a hydrogen explosion in the event of severe core damage.

[Requirement Details]

A "Equipment and procedures for preventing damage caused by a hydrogen explosion" refers to, the measures described below or measures with the same or better effect.

(a) Installation of hydrogen concentration control equipment or hydrogen release equipment with explosion prevention and reactive material reduction functions.

(b) Installation of monitoring equipment that can measure to certain extent the possibility of fluctuations in hydrogen concentration during envisioned accidents.

(c) This equipment shall be compatible with alternate AC power sources.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(13) Countermeasures for cooling, shielding and ensuring the sub-criticality of spent fuel storage pools

[Basic Requirements]

1 Installation of equipment and procedures for preventing criticality, shielding, and cooling the fuel in spent fuel storage pools in the event of beyond design basis accidents in conjunction with a loss of spent fuel storage pool cooling function or cooling water injection function, or the leak of a small amount of pool water.

2 Installation of equipment and procedures for mitigating fuel damage and preventing criticality in the event that spent fuel storage pool water level cannot be maintained due to a leak of a large amount of water.

[Requirement Details]

A "leak of a small amount of pool water" as mentioned in 1 refers to, a pool water leak envisioned as part of envisioned accident 2 defined in the "4.(2) Evaluation of the effectiveness of countermeasures against severe fuel damage in spent fuel storage pools. " A "leak of a large amount of water" refers to, a leak that exceeds the envisioned amount of pool water leaked as part of envisioned accident 2.

B The equipment and procedures mentioned in 1 above shall be the measures described below or measures with the same or better effect.

(a) The installation of alternate cooling water injection equipment.

(b) Alternate cooling water injection equipment shall be able to maintain pool water level even in the event of a loss of equipment for design basis requirement cooling, cooling water injection function and a small-scale leak.

(c) Portable alternate cooling water injection equipment (for example, cooling water injection line, pump trucks, shall be prepared as alternate cooling water injection equipment.

C The equipment and procedures mentioned in 2 above shall be the measures described below or measures with the same or better effect.

(a) The installation of spray equipment.

(b) Spray equipment shall be able to maintain few cooling even in the event that spent fuel storage pool water level cannot be maintained by alternate cooling water injection equipment.

(c) Spray equipment shall be prepared as portable spray equipment (for example, spray headers, spray lines, pump trucks).

D The monitoring of spent fuel storage pools shall follow the following in accordance with the equipment and procedures mentioned in 1 and 2 above.

(a) Spent fuel storage pool water level, pool water temperature, and air dose rate above the pool shall be able to be measured to the extent that these parameters will fluctuate as a result of an accident that exceeds design basis accidents.

(b) This measurement equipment shall be compatible with alternate AC power sources.

(c) Pool status shall be monitored by cameras.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(14) Countermeasures for securing make-up water and water sources

[Basic Requirements]

Installation of equipment and procedures that secures sufficient water sources necessary to deal with severe core damage and provides the necessary amount of water from these water sources to equipment for design basis requirement and alternate equipment in addition to equipment for design basis requirement were sources.

[Requirement Details]

A "Equipment and procedures that provide the necessary amount of water from these water sources to equipment for design basis requirement and alternate equipment in addition to equipment for design basis requirement were sources" refers to, the measures described below or measures with the same or better effect.

(a) Must be able to provide sufficient water from the time beyond design basis accidents occurs until it is managed.

(b) Multiple alternate freshwater sources (for example, water storage tanks, dams, reservoirs, etc.) shall be secured.

(c) The sea must be able to be used as a water source.

(d) Transfer routes from each water source are secured.

(e) Transfer hoses and palms from alternate water sources shall be prepared in advance.

(f) Water source changeover procedures shall be described to ensure that the water supply is not cut off.

(g) Alternate recirculation equipment shall be installed in order to make recirculation equipment, which uses the containment vessel as a water source, redundant. (PWR)

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2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(15) Countermeasures for securing electricity sources

[Basic Requirements]

The installation of equipment and procedures for securing electricity required to prevent severe core damage, prevent containment vessel failure, prevent spent fuel storage pool fuel damage, and prevent damage to fuel during reactor shutdown.

[Requirement Details]

A "Equipment and procedures for securing electricity required" refers to, the measures described below or measures with the same or better effect.

(Onsite DC power sources)

(a) Onsite permanent DC power source equipment shall be able to provide electricity for 8 hours without load cutoff. However, "without load cutoff" does not include cases where load can be easily cut off from the main control room. In addition, such equipment shall be able to provide electricity for the remaining 16 hours, for a total of 24 hours after cutting off unnecessary load.

(b) Installation of portable DC power source equipment that can provide electricity for 8 hours without load cutoff (not including cases where load can be easily cut off from the main control room), and in addition, can provide electricity for the remaining 16 hours, for a total of 24 hours after cutting off unnecessary load.

(c) One more on-site permanent DC power equipment system (third system) shall be installed in order to further improve reliability.

(Alternate power source equipment)

B Installation of alternate power source equipment.

(d) Alternate equipment, including Onsite DC power source equipment, shall be diverse (cooling type), independent and dispersed over a wide area.

(e) Portable alternate power sources (for example, power trucks, batteries) shall be made available and ready.

(f) There shall be sufficient time within a fixed period during which electricity can be supplied from Onsite DC power source equipment to connect portable alternate power sources and begin supplying electricity.

(g) Installation of permanent alternate power sources (for example, gas turbine generators, DC power source equipment, battery recharging equipment)

(Sharing electricity)

C Electricity shall be able to be shared between units

(a) Electric cables shall be laid out in advance and be able to be connected manually.

(b) Spare electric cables shall be prepared in case laid out electric cables cannot be used.

(Alternate on-site electric equipment)

D Installation of alternate on-site electric equipment (MCC, PC, MC, et.).

(a) Alternate onsite electric equipment, including equipment for design basis requirement, shall installed so that all of the on-site electric equipment does not lose function for a common reason, at least one system maintains function, and so that people can approach the equipment.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(16) Control room

[Basic Requirements]

(Control room)

1 Installation of equipment and procedures that enable operators to remain in the control room and respond to an event as much as possible in the event of severe core damage.

2 A secondary control room shall be installed in case operators cannot remain in the main control room.

[Requirement Details]

A "Equipment and procedures that enable operators to remain in the control room and respond to an event" refers to, the measures described below (when conforming through management (masks, tanks, etc.,) in addition to ventilation and shielded design of the control room), or measures with the same or better effect.

(a) Control room power sources (ventilation, lighting, etc.) shall allow electricity provision from alternate AC power sources.

(b) The livability of the control room in the case of severe core damage shall be evaluated as follows.

i) Livability should be assessed assuming the severest result obtained from successful accident sequence (containment vessel failure prevention countermeasures, such as filtered containment vessel venting system, etc., effectively function after severe core damage) from among the containment vessel failure modes envisioned in the evaluation of the effectiveness.

ii) Operators are wearing masks

iii) A shift system is employed

iv) Judging criteria shall be preventing operators from receiving an effective dose of no more than 100mSv over seven days.

(c) Furthermore, the livability of the secondary control room shall be evaluated in this manner assuming that the secondary control room must be used to manage the event in the case that containment vessel failure prevention countermeasures do not effectively function. In this instance, the assumed amount of release radioactive material shall be on par with that of the TEPCO Fukushima Daiichi NPS accident (for example, release volume from the reactor building shall be X% of inventory/hour X Y hours. Weather conditions of cumulative wind appearance frequency of Z%).

(d) The secondary control room shall be deemed a specific safety facility.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(17) Emergency response facilities

[Basic Requirements]

(Situation room)

Installation of equipment and procedures to allow the situation room to maintain function as a local command center, such as communicating with the relevant parties both inside and outside the power station, and accommodating required personnel, while giving necessary countermeasure instructions in the event of an accident that exceeds design basis accidents.

[Requirement Details]

A "Equipment and procedures to allow the situation room to maintain function as a local command center" refers to, the measures described below or measures with the same or better effect.

(a) The situation room shall be seismically isolated and not lose function as the result of a design standard earthquake, and it shall also not be impacted by design standard tsunamis.

(b) The situation room shall be compatible with alternate AC power sources.

(c) Equipment that allows reactor facility information necessary for countermeasure instructions to be ascertained shall be installed.

(d) The situation room should be equipped with equipment for countermeasure staff (dosimeters, masks, etc.) as shall enable sufficient radiation control.

(e) Records required for the deliberation of materials and countermeasures shall be on hand.

(f) Enough food and drinking water to continue activities for one week without outside assistance shall be stored in the situation room.

(g) The situation room shall be designed to be shielded, and have redundant and independent ventilation systems in order to ensure livability.

(h) The livability of the situation room during accidents that exceeds design standards shall be assessed as follows.

i) The assumed amount of release radioactive material shall be on par with that of the TEPCO Fukushima Daiichi NPS accident (for example, release volume from the reactor building shall be X% of inventory/hour X Y hours. Weather conditions of cumulative wind appearance frequency of Z%).

ii) Excluding cases where special protection measures have been implemented, the situation room shall be assessed under the assumption that countermeasure personnel will not be wearing masks inside the situation room when plumes pass overhead, etc.

iii) The shift system will be considered.

iv) Judging criteria shall prevent operators from receiving an effective dose of no more than 100mSv over seven days.

(i) Area sectioning shall be implemented so as to allow monitoring and the changing of work clothes while preventing contamination from being carried into the situation room of the emergency response facilities where the outside of the situation room has been contaminated by radioactive material.

2. Severe Accident Countermeasure Requirements
(Primary equipment for each countermeasure)
(18) Instrumentation facilities

[Basic Requirements]

Installation of equipment and procedures for estimating necessary plant data in the event that some normal and emergency instruments have malfunctioned due to beyond design basis accidents.

[Requirement Details]

A "Equipment and procedures for estimating necessary plant data" refers to, the measures described below or measures with the same or better effect.

B Furthermore, "necessary plant data" refers to, plant status information that must be ascertained in order to have core damage prevention countermeasures and containment vessel failure prevention countermeasures deliberated by operators succeed.

(a) Clarification of the capability of instruments to ascertain plant status under conditions of beyond design basis accidents. (Maximum measurable temperature, etc.)

(b) Preparation of means for estimating plant status in the event that the conditions mentioned above are exceeded.

i) Preparation of means for estimating temperature, pressure, and water level inside the reactor pressure vessel.

ii) Preparation of means for estimating the amount of cooling water injected into the reactor and reactor pressure vessel.

iii) Parameters needed to make such estimates should be prioritized in advance consideration of accuracy from among multiple parameters.

(c) Parameters required to manage beyond design basis accidents, such as temperature, pressure, water level, hydrogen concentration, and dose rate inside the reactor containment vessel shall be able to be monitored, measured, and recorded.

(d) Preparation of means for measuring and monitoring especially important parameters during loss of DC power sources (for example, testers, conversion charts, etc.).

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(19) Radiation monitoring facilities

[Basic Requirements]

1 Installation of equipment and procedures for monitoring, measuring, and recording radioactive material released from nuclear facilities and radiation conditions in the event of severe core damage.

2 Installation of equipment and procedures for measuring and recording wind direction and wind speed, etc.

[Requirement Details]

A "Equipment and procedures for monitoring, measuring, and recording radioactive material released from reactor facilities" refers to, the measures described below or measures with the same or better effect.

(a) Monitoring equipment shall be able to measure radioactive material and radiation assumed to be released in the event of core damage and containment vessel failure.

(b) A sufficient number of monitoring cars and portable alternate monitoring equipment shall be available and ready so as to substitute for monitoring posts in the event of function loss.

(c) Monitoring equipment shall be compatible with alternate AC power sources.

(Recovery work)

B Background radiation reduction countermeasures shall be deliberated so as to avoid situations where radiation levels cannot be measured due to contamination of the area after an accident.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(20) Communications equipment

[Basic Requirements]

Installation of equipment and procedures for communicating with necessary parties both within and outside the nuclear power plant in the event of beyond design basis accidents.

[Requirement Details]

A "Equipment and procedures for communicating with necessary parties" refers to, the measures described below or measures with the same or better effect.

(a) Communications equipment shall be compatible with alternate AC power sources.

2. Severe Accident Countermeasure Requirements

(Primary equipment for each countermeasure)

(21) Countermeasures for preventing off-site radioactive release

[Basic Requirements]

Installation of equipment and procedures for suppressing off-site radioactive release in the event of severe core damage and spent fuel storage pool fuel damage or failure of the containment vessel.

[Requirement Details]

A "Equipment and procedures for suppressing off-site radioactive release" refers to, the measures described below or measures with the same or better effect.

(a) Installation of equipment that allows the reactor building to be sprayed with water.

(b) Water spraying equipment shall be able to deal with aircraft fuel fires.

(c) Water spraying equipment shall be able to be moved and spray water on the reactor building from multiple directions.

(d) A quantity of water spraying equipment that equals half the number of plants onsite (rounded number) shall be prepared under the assumption that such equipment will be used simultaneously for multiple plants.

3. Accident Management for External Events beyond Design Basis

(1) Accident management with portable equipment, etc.

[Basic Requirements]

(Accident handling with portable equipment, etc.)

Procedures shall be created for the following items under editions where the plant has suffered large-scale damage due to a large-scale natural disaster or acts of terrorism such as the intentional airplane crash. Furthermore, equipment and a structure designed to enable these activities in accordance with the aforementioned procedures shall be prepared.

a. Activities to extinguish a large-scale fire

b. Countermeasures to mitigate fuel damage

c. Countermeasures to minimize the release of radioactive material

d. Countermeasures to maintain necessary water levels in the spent fuel storage pools and countermeasures to mitigate fuel damage

(Note) Requirements are described in “2. Severe Accident Countermeasure Requirements (Primary equipment for each countermeasure)”

[Requirement Details]

A Activities to extinguish a large-scale fire” refers to the following.

(a) The preparation of procedures for engaging in fire extinguishing activities using a foam release cannon under the assumption of an external fire resulting from the intentional airplane crash. (In the event that function is lost due to a fire inside the control building resulting from the intentional airplane crash, containment vessel failure shall be prevented by specific safety facilities. Refer to the following pages)

B The creation of procedures that envision a large-scale natural disaster for the following items from “2. Severe Accident Countermeasure Requirements (Primary equipment for each countermeasure)”.

(4) Cooling countermeasures when reactor coolant is at high pressure

(5) Depressurization countermeasures for reactor coolant pressure boundaries

(6) Cooling countermeasures when reactor coolant is at low pressure

(7) Countermeasures for securing an ultimate heat sink after an accident

(8) Containment vessel cooling, depressurization and radioactive material mitigation countermeasures

(9) Containment vessel heat removal and depressurization countermeasures
(10) Countermeasures for cooling melted core fallen to the bottom of the containment vessel
(11) Countermeasures for preventing hydrogen explosions inside the containment vessel
(12) Countermeasures for preventing hydrogen explosions inside the reactor building, etc.
(13) Countermeasures for cooling, shielding and ensuring the sub-criticality of spent fuel storage pools
(14) Countermeasures for securing make-up water and water sources
(15) Countermeasures for securing electricity sources
(21) Countermeasures for preventing off-site radioactive release

C Creation of procedures for the items above that envision acts of terrorism, such as the intentional airplane crash.

3. Accident Management for External Events beyond Design Basis

(2) Specific safety facilities

[Basic Requirements]

(Definitions)

○ "Specific safety facilities" refers to, facilities that function to suppress the release of a large amount of radioactive material due to damage of the containment vessel in the event that the core is, or may be, remarkably damaged as a result of terrorism, etc., such as the intentional airplane crash, etc. (Reprint)

(Specific safety facility requirements)

1 Specific safety facilities must be installed in accordance with the following.

a. Specific safety facilities shall be equipped with adequate measures for preventing the loss of necessary function due to the intentional crashing of a large airplane into the reactor building.

b. Specific safety facilities shall be equipped with adequate measures for preventing the loss of necessary function due to standard seismic motion and standard tsunamis.

c. Specific safety facilities shall be installed with equipment required to prevent containment vessel failure.

d. Equipment shall be designed so as to allow use over a fixed period of time.

(Creation of a system that allows specific safety facility function to be maintained)

2 A system that allows specific safety facility function to be maintained shall be created.

[Requirement Details]

A "Specific safety facilities shall be equipped with adequate measures for preventing the loss of necessary function due to the intentional crashing of a large airplane into the reactor building" mentioned in 1.a. refers to, for example, ensuring that Specific safety facilities are far enough away from the reactor building (for example over 100 m) so as to prevent simultaneous failure of both facilities, or the housing of specific safety facilities in a robust structure that can withstand the intentional airplane crash.

B "Specific safety facilities shall be equipped with adequate measures for preventing the loss of necessary function due to standard seismic motion and standard tsunamis" mentioned in 1.b. refers to, applying the same design standard allowable limits for design standard seismic motion and standard tsunamis (for example, applying design standard margins for standard seismic motion), but implementing countermeasures that differ in character from design standard protective measures (diversity). For example, whereas equipment for design basis requirement have rigid structures, specific safety facilities shall be seismically isolated, have earthquake resistant structures, and shall be housed in buildings that are guaranteed to be

watertight or in buildings located on high ground.

C The requirements of 1.a. and 1.b. need not be satisfied by a single facility and may rather be satisfied by multiple facilities.

D "Specific safety facilities shall be installed with equipment required to prevent containment vessel failure" mentioned in 1.c. refers to the following equipment.

(Normal plant examples)

(a) Depressurization function for reactor coolant pressure boundaries: Equipment for reactor depressurization operation from secondary control room

(b) Core internal meltdown cooling function: Equipment for injecting low pressure cooling water inside the reactor

(c) Function for cooling melted core material that has fallen to the bottom of the containment vessel: Equipment for cooling water injection into the bottom of the containment vessel

(d) Containment vessel cooling/depressurization/radioactive material reduction function: Equipment for injecting cooling water into containment vessel sprays

(e) Containment vessel heat removal/depressurization function: Filters/venting (excluding exhaust stacks)

(f) Support function: Power source equipment, instrument equipment, secondary control room, communications equipment

(g) Equipment related to the equipment mentioned above (example: depressurization valves, pipes, etc.)

(h) The secondary control and shall have controlling function for controlling operation of "equipment required to prevent containment vessel failure".

(i) Communication equipment shall be installed in the secondary control room and enable communication with the main control room, on-site situation room and other necessary departments.

(j) Power source equipment shall provide electricity to "equipment required to prevent containment vessel failure" and shall fulfill the requirements for Specific safety facilities mentioned in 1.a. and 1.b.. Portable alternate power sources and permanent alternate power sources shall be able to be connected to the aforementioned power source equipment. Furthermore, even though power source equipment is part of specific safety facilities it shall be able to be leveraged in the event of the possibility of severe core damage .

E The "fixed period of time" mentioned in 1.d. refers to, the period of time until outside assistance can be received (for example, at least seven days). Equipment shall be designed with sufficient capacity to enable functioning of necessary equipment.

4. Evaluation of the Effectiveness of Countermeasures against Severe Accidents

(1) Evaluation of the effectiveness of countermeasures against severe core damage

[Basic Requirements]

(Evaluation of the effectiveness of countermeasures against severe core damage)

1 Licensees must assume beyond design basis accidents which may cause severe damage to the core, and perform an evaluation of the effectiveness of countermeasures against core damage in regards to the following.

a. The capability to prevent the core from being severely damaged and sufficiently cool it.
b. Pressures to which reactor coolant pressure boundaries are subjected are below maximum use pressures or pressure limits.
c. Pressures to which containment vessel boundaries are subjected are below maximum use pressures or pressure limits.
d. Temperatures to which containment vessel boundaries are subjected are below maximum use temperatures or temperature limits.

(Evaluation of the effectiveness of countermeasures against containment vessel failure)

2 Licensees must devise countermeasures for preventing damage to the containment vessel assuming containment vessel failure mode that may occur in conjunction with severe core damage. (Hereinafter referred to as, “Containment Vessel failure Prevention Countermeasures”). (Reprint)

3 Licensees must confirm the effectiveness of countermeasures against containment vessel failure.

[Requirement Details]

(Evaluation of the effectiveness of countermeasures against severe core damage)

A “beyond design basis accidents which may cause severe damage to the core” refers to, the following accident sequence groups during which structures, systems and devices that are required to be designed to not hinder reactor safety in the event of abnormally dramatic changes during operation or a design basis accident have lost safety functions, and there is the possibility of severe core damage . Furthermore, the accident sequence groups of (a) must be covered regardless of the deliberation results of the accident sequence groups of (b).

(a) Accident sequence groups described by the Nuclear Regulatory Authority

i) BWR

・High-pressure/low pressure cooling water injection function loss
・High-pressure cooling water injection/depressurization function loss
・All AC power loss (including “All AC/DC power source loss”)
・Decay heat removal function loss
・Reactor shutdown function loss
・Cooling water injection function loss during LOCA
・Containment vessel bypass (interface system LOCA)

ii) PWR
・Secondary system heat removal function loss
・AC power loss (including “All AC/DC power source loss”)
・Rector auxiliary cooling water system function loss
・Containment vessel heat removal function loss
・Reactor shutdown function loss
・ECCS cooling water injection function loss
・ECCS recirculation function loss
・Containment vessel bypass (interface system LOCA, steam generator tube rapture)

(b) Accident sequence groups that produce significantly frequent core damage selected through individual plant internal event probabilistic risk assessment (PRA) and external event PRA (that are applicable).
i) Assessed through individual plant internal event probabilistic risk assessment (PRA) and external event PRA, or similar methods.
ii) If as a result accident sequence groups that cause a significant frequency or impact and are not included in the accident sequence groups described by the Nuclear Regulatory Authority are identified, they shall be added as accident sequence groups that require countermeasures.

B “The capability to prevent the core from being remarkably damaged and sufficiently cool it” refers to, fulfillment of the following requirements. However, this shall not apply to cases where sufficient scientific evidence has been offered in regards to the maximum temperature of fuel cladding tubes and the amount of oxidation.
(a) Fuel cladding tube maximum temperature shall be below 1200℃.
(b) The amount of oxidation of fuel cladding tubes shall be less than 15% of the thickness of the cladding tube prior to remarkable oxidation reaction.

C The requirements of 1.b. need not be fulfilled if the cause of the event is loss of reactor coolant pressure boundary, such as LOCA.

D The basis for and adequacy of using pressure limits and temperature limits as judging criteria must be proven.

E Core damage prevention countermeasure efficacy assessments shall follow “Core Damage Prevention Countermeasure Efficacy Assessment Standard Assessment Methods (tentative name)”.

(Evaluation of the effectiveness of countermeasures against containment vessel failure)

F “Containment vessel failure mode” mentioned in the second paragraph refers to the following. Furthermore, the containment vessel failure modes of (a) must be covered regardless of the deliberation results of the containment vessel failure modes of (b).

(a) Containment vessel failure modes described by the Nuclear Regulatory Commission

i) Static load caused by atmospheric pressure/temperature (containment vessel over-pressurization/over-heating)

ii) High pressure melted matter release/direct heating of containment vessel atmosphere

iii) Interaction of melted fuel outside the reactor and coolant

v) Direct contact with containment vessel (shell crash)

vi) Interaction between melted core and concrete

(b) Containment vessel failure modes that produce significantly frequent failure selected through individual plant internal event probabilistic risk assessment (PRA) and external event PRA (that are applicable).

i) Assessed through individual plant internal event probabilistic risk assessment (PRA) and external event PRA, or similar methods.

ii) If as a result containment vessel failure modes that cause a significant frequency or impact and are not included in the containment vessel failure modes described by the Nuclear Regulatory Authority are identified, they shall be added as accident sequence groups that require countermeasures.

G “effectiveness of countermeasures against containment vessel failure” refers to the fulfillment of the following requirements, as necessary, for the containment vessel failure modes mentioned above.

(a) Pressures to which containment vessel boundaries are subjected shall fall below maximum use pressures or pressure limits.

(b) Temperatures to which containment vessel boundaries are subjected shall fall below maximum use temperatures or temperature limits.
(c) Total release volume of radioactive material shall not exceed release volume performance requirement values.
(d) Reactor coolant pressure shall be reduced to below 2.0MPa until reactor pressure vessel failure.
(e) Containment vessel boundary function shall not be lost due to heat/mechanical load resulting from the quick interaction between melted fuel outside the reactor and coolant.
(f) Prevention of the detonation of hydrogen that may cause containment vessel failure.
(g) Fulfillment of the requirements of (a) even in the event that flammable gas accumulates and burns.
(h) Melted core material that has fallen on top of the floor of the containment vessel shall not spread across the floor and come in direct contact with the containment vessel boundary.
(i) The support function of containment vessel structural parts and primary containment vessel boundary function shall not be lost due to corrosion caused by core meltdown.

H The basis for and adequacy of using pressure limits and temperature limits as determination standards must be proven.

I "Prevention of the detonation of hydrogen that may cause containment vessel failure" mentioned in (f) shall fulfill the following requirements.
(a) Hydrogen concentration inside the containment vessel shall fall below 13vol% converted under dry conditions and oxygen concentration shall fall under 5vol%.

J Evaluation of the effectiveness of countermeasures against containment vessel failure shall follow the "Containment Vessel failure Prevention Countermeasure Efficacy Assessment Standard Assessment Methods (tentative name)".

4. Evaluation of the Effectiveness of Countermeasures against Severe Accidents

(2) Evaluation of the effectiveness of countermeasures against severe fuel damage in spent fuel storage pools

[Basic Requirements]

(Evaluation of the effectiveness of countermeasures against severe fuel damage in spent fuel storage pools)

1 Licensees must devise countermeasures for preventing severe damage to fuel assuming the possibility of an accident that that may cause severe damage to fuel stored in spent fuel storage pools (Hereinafter referred to as, “Pool Fuel Damage Prevention Countermeasures”). (Reprint)

2 Licensees must evaluate the efficacy of the Pool Fuel Damage Prevention Countermeasures mentioned in the preceding paragraph and confirmed that they meet the following requirements.

a. Top of active fuel is submerged

b. A water level that shields radiation is maintained

c. Sub-criticality is maintained

[Requirement Details]

A “An accident that that may cause severe damage to fuel stored in spent fuel storage pools” refers to, the following accidents that have the potential to damage fuel stored in spent fuel storage pools.

(a) Envisioned accident 1:

Pool water temperature rises and water level drops due to evaporation as the result of a malfunctioning auxiliary feed system (required by design standards) causing auxiliary feed failure.

(b) Envisioned accident 2:

A small amount of cool water is lost due to the siphoning effect, etc., and pool water level decreases.

B Spent fuel storage pool fuel damage prevention countermeasure efficacy assessments shall follow the “Spent Fuel Storage Pool Fuel Damage Prevention Countermeasure Efficacy Assessment Standard Assessment Methods (tentative name)”.

4. Evaluation of the Effectiveness of Countermeasures against Severe Accidents

(3) Evaluation of the effectiveness of countermeasure against severe fuel damage in a shutdown reactor

[Basic Requirements]

(Evaluation of the effectiveness of countermeasure against severe fuel damage in a shutdown reactor)

1 Licensees must devise countermeasures for preventing damage to fuel assuming the possibility of an accident that that may cause damage to fuel in shutdown reactors (Hereinafter referred to as, “Shutdown Fuel Damage Prevention Countermeasures”). (Reprint)

2 Licensees shall assess the effectiveness of the Shutdown Fuel Damage Prevention Countermeasures” mentioned in the preceding paragraph and confirm that they fulfill the following requirements.

a. Top of active fuel is submerged

b. A water level that shields radiation is maintained

c. Sub-criticality is maintained

[Requirement Details]

A “Accident that may cause damage to fuel in shutdown reactors” refers to, the following accidents that may result in damage to fuel in shutdown reactors. Furthermore, the accident sequence groups of (a) must be covered regardless of the deliberation results of the accident sequence groups of (b).

(a) Accident sequence groups described by the Nuclear Regulatory Authority

i) Decay heat removal function loss (loss of cooling function during shutdown caused by RHR)

ii) Loss all AC power

iii) Reactor coolant leak

iv) Loss of function to maintain reactors sub-criticality

(b) Accident sequence groups that produce significantly frequent fuel damage selected through individual plant internal event probabilistic risk assessment (PRA) during shutdown.

i) Assessed through individual plant PRA during shutdown or other compatible methods.

ii) If as a result accident sequence groups that cause a significant frequency or impact and

are not included in the accident sequence groups described by the Nuclear Regulatory Authority are identified, they shall be added as accident sequence groups that require countermeasures.

B Shutdown reactor fuel damage prevention countermeasure effectiveness assessments shall follow the “Shutdown Reactor Fuel Damage Prevention Countermeasure Efficacy Assessment Standard Assessment Methods (tentative name)”.