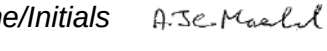
UK EPR	Title: PCSR – Sub-chapter 14.7 – Fault and Protection Schedule **UKEPR-0002-149 Issue 03**
Total number of pages: 61	Page No.: I / III
Chapter Pilot: F. CERRU *Name/Initials*  *Date 26-11-2012*	
Approved for EDF by: A. MARECHAL *Name/Initials*  *Date 26-11-2012*	Approved for AREVA by: G. CRAIG *Name/Initials*  *Date 26-11-2012*

REVISION HISTORY

Issue	Description	Date
00	First issue.	27-06-2009
01	Removal of RESTRICTED classification	11-06-2010
02	Consolidated Step 4 PCSR update: - Minor editorial changes - Update and addition of references - Consistency with UK classification approach - New section 4 added, “Adequacy of design to protect the plant against faults – ALARP discussion” added	29-03-2011
03	Consolidated PCSR update: - References listed under each numbered section or sub-section heading numbered [Ref-1], [Ref-2], [Ref-3], etc - Minor editorial changes - Update of Fault Schedule (Table 1) to reflect changes in classification, new PCC events, diversity analyses - Update of Appendix 1 to cover diverse means available to reach a long-term safe shutdown state	26-11-2012

For information address:

AREVA NP SAS
Tour AREVA
92084 Paris La Défense Cedex
France

EDF
Division Ingénierie Nucléaire
Centre National d'Equipement Nucléaire
165-173, avenue Pierre Brossolette
BP900
92542 Montrouge
France

TABLE OF CONTENTS

SUB-CHAPTER 14.7 – FAULT AND PROTECTION SCHEDULE

This sub-chapter provides a summary of the fault and protection schedule for the UK EPR. It also gives an insight into the principles used to define the protection system set-points and those applied to modify or deactivate settings during changes in the reactor state. Sections 1 and 2 of this sub-chapter describe the fault and protection schedule, which illustrates two main features of the EPR design:

- the rationale and justification for the initiating events considered within the EPR design of protection and mitigation provisions due to their potentially unacceptable consequences (section 1);

- the different defence lines provided by the EPR design. Section 2 provides a justification of the comprehensiveness of the fault protection. The fault and protection schedule is given in Sub-chapter 14.7 – Table 1, which includes the initiating events and sequences, their frequencies, the classified safety systems that protect against them and the overall protection claims.

The fault schedule focuses on risks to the public; therefore, the fault schedule is based on the accidents described in Chapters 14 and 16. It also includes the analysis of the functional diversity of Sub-chapter 16.5.

Section 3 of the present sub-chapter provides information on the protection system settings and the principles applied to the deactivation or resetting of protection settings at low power states.

Section 4 of this sub-chapter provides information on the ALARP discussion regarding the adequacy of the UK EPR design to protect the plant against faults.

Section 5 of this sub-chapter provides an overall conclusion.

1. LIST OF INITIATING EVENTS

1.1. INTRODUCTION

As an evolutionary reactor, the list of design basis faults considered within the EPR design basis is based on an initial list of design basis faults considered in early PWRs and additions arising from 30 years of operational feedback from international PWR fleet (studies, operations and interaction with safety authorities). Incorporation of experience feedback has provided the list of design basis faults considered with some additional robustness.

With regard to NSSS internal events (fault studies) a review of the initial basis for the fault schedule, and the main subsequent additions, are provided below.

1.2. NSSS DESIGN CONDITIONS (PCC EVENTS)

The initial approach to the PCC event list was an implementation of the principles set out by the committee N-18 of the American Standards Institute (ANSI N-18, 1973). Based on the defence in depth concept (three levels at that time), it introduced a categorisation of internal events based on a rough concept of “anticipated frequency” (based on the frequency expected in operation during plant life and from consideration of bounding hypothetical events).

FRATEC 01 (1979) [Ref-1] presents the FRAMATOME methodology for the definition of the initiating events list and the basis for its claim to provide an exhaustive list of faults. A comparison is also made to the application of the ANSI N-18 for US PWRs. After defining normal operating parameters, events which could cause them to vary outside of normal bounding values are identified, without trying to enumerate all the failures liable to adversely affect the nuclear steam supply system. These events are arranged into several families regarding the operating parameter they first affect. The more significant transient of each family with respect to challenges to the protection system and engineered safety feature is finally considered as a design basis event or accident.

It should be noted that the aim of PCC analysis is to define the design requirements for safety systems (protection systems for category 2 events and main safeguard systems for category 3 and 4 events), which are designed subject to specific stringent rules such as the Single Failure Criterion (SFC), and the assumption of bounding consequences. This is why the consideration of additional scenarios, that were not included in the initial list, has not led systematically to a change in the list, since the additional design provisions required to reach an acceptable level of consequences may not impact on the performance of main systems or the bounding consequences of the event.

For example, the interface Loss Of Coolant Accident (LOCA) did not challenge the initial design of the Safety Injection System (RIS [SIS]) based on “normal” LOCA, or the definition of bounding bypass consequences via Steam Generator Tube Rupture (SGTR), and consequently it was not added to the PCC list. Similarly when, with the introduction of the EPR, the definition of PCCs was extended to introduce the concept of a frequency range, no significant update of the list of PCC events analysis was required.

The main subsequent additions to the FRATEC 01 approach were linked to changes in “design rules” (e.g. SFC, i.e. redundancy requirement at the component level) shifting to “safety analysis rules” (e.g. the requirement to assume an “aggravating failure” i.e. a redundancy requirement at the function level). Other examples were extension of the scenario duration through the operator action phase, and the introduction of additional event combinations involving Loss Of Offsite Power (LOOP).

Changes to the list of events were made related to the experience feedback and changes in system design options.

EPR specific options led to transients being added or excluded from the Design Basis Assessment (DBA) list that was used for in service French Nuclear Power Plants (NPP). The changes were in three main categories as follows:

1) Changes resulting from EPR constitutive options, such as:

- consideration of transients occurring in the different plant states led to PCC events for outages being introduced as design basis accidents (these were considered as beyond design basis accidents in previous French NPPs, and consequently analysed using less stringent rules);

- consideration of transients in auxiliary buildings, which led to the introduction of fuel pool transients, and transients in the effluent treatment building and the nuclear auxiliary building.

2) Changes due to design improvements in the EPR that had a direct impact on the list of design basis faults. An example was application of the break preclusion principle that led to the exclusion of 2-A LOCA from the PCC list. LOCA outside the containment was added to the DBA list to address the specific EPR design of the residual heat removal system function, which is provided by the safety injection system.

3) Changes due to the application of PSA early in the design process, which impacted on the justification of the list itself and on the way transients were arranged into the different PCC categories.

The use of PSA also impacted the list of RRC-A events considered, as mentioned below.

1.3. CORE-MELT RISK REDUCTION CATEGORY (RRC-A EVENTS)

The origin of the list of scenarios involving multiple failures (called RRC-A sequences in the EPR approach) was a French Safety Authority (ASN) request for consideration of design extension conditions representative of the total loss of main redundant systems (power supply, heat sink, SG feedwater, long term RIS [SIS] and reactor trip through Anticipated Transients Without Scram). PCC-4 criteria were imposed, but less stringent rules were accepted.

Later on, other scenarios were added at the request of the ASN, generally to illustrate the robustness of the defence in the EPR design (drainage of two SGs, initially corresponding to the SFC exception on main steam isolation valves; multiple SGTRs combined with Main Steam Line Break).

Eventually, a connection was made with the probabilistic analysis, and with the periodic safety review process, by considering the main PSA level 1 sequences (see PCSR Sub-chapter 15.1). The concept of an RRC-A feature was introduced to give assurance that any system making a significant contribution to reduction in the core melt risk would be safety classified. The corresponding RRC-A list has thus become a self-evolving list, on the basis of the PSA revisions issued for the purpose of periodic safety reviews. The current status of this EPR list is a combination of the initial deterministic approach and of an early implementation of the probabilistic definition. The justification for the claim that the initiating event list used in the Level 1 PSA is comprehensive is presented in section 4 of Sub-chapter 15.1 (NSSS internal events).

1.4. SEVERE ACCIDENTS (RRC-B EVENTS)

The main characteristics of the EPR design approach to severe accidents are:

- postulated low-pressure core melt scenarios are defined to support the design of dedicated mitigation systems (RRC-B features list);
- “Practical elimination” (IAEA terminology) of large early releases is sought via design measures introduced to prevent direct containment heating, prompt criticality, steam and hydrogen explosions, containment bypass, fuel melting in the fuel building. Probabilistic calculations are may be used to justify design measures, but cannot be used in isolation, without corresponding design measure being introduced;
- specific stringent radiological criteria are associated with severe accidents consequences (limited need for sheltering or food restrictions, no need for emergency evacuation or permanent relocation in the vicinity of the site);
- global design effectiveness is confirmed via a level 2 PSA.

1.5. CONCLUSIONS

The list of PCC and RRC events considered in the EPR safety approach arises from two objectives: compliance with design rules (main protection and safeguard systems) and demonstration by safety analyses. An absolute claim on the exhaustiveness of the event lists considered is not possible. However the extensive review and development of the event lists over many years, and the recent use of PSA analyses, give confidence that this mainly deterministic design approach has captured the potential consequences of all significant initiating events that could occur.

2. JUSTIFICATION OF THE COMPREHENSIVENESS OF FAULT PROTECTION

2.1. INTRODUCTION

In this section, the safety measures are identified and justified and their consistency with defence in depth concept is explained.

This chapter identifies the safety functional requirements applicable to the safety measures, the categorisation of the functions, and the classification of the systems, structures or components that contribute to the safety measure. A distinction is made between the lines of defence (first line consisting of preventive measures, main line consisting of protective measures and back up line consisting of back-up safety measures).

The safety measures described in this chapter are illustrated and detailed for each transient considered, in Sub-chapter 14.7 – Tables 1 and 2. For each initiating event, the fault schedule table gives the associated Plant Condition Category (PCC) or Risk Reduction Category (RRC) which bounds the resulting fault transient. It also identifies the PCSR section where the fault transient is considered, and, for each phase of the transient, the protection systems which perform the different required safety functions in the different defence lines.

2.2. DEFENCE IN DEPTH

A defence in depth concept, described in Sub-chapter 3.1, is applied at the design stage of the EPR. It leads to the implementation of five levels of defence in the engineered safety systems and components, as follows:

- level 1 is a combination of conservative design, quality assurance, high quality of fabrication and high level of surveillance activities (controls, monitoring) to prevent departures from normal plant operation;

- level 2 consists of the implementation of protection devices which make it possible to detect and correct the effects of deviations from normal operation or the effects of system failures. This defence level is aimed at ensuring the integrity of the fuel cladding and that of the primary cooling system so as to prevent anticipated operational occurrences from escalating to accident conditions;

- level 3 consist of safeguard systems, protection devices and operating procedures which make it possible to control the consequences of accidents that may occur so as to contain radioactive material and prevent occurrence of severe accidents;

- level 4 comprises measures aimed at preserving containment integrity and controlling severe accidents;

- level 5 includes, in the event of the failure of previous levels of defence, all measures for protecting the public against the effects of significant radiological discharges.

Defence levels 2 and 3 are the only ones relevant to the lines of defence considered in the fault analysis. The preventive line of defence, as described below, is associated with level 2, while both the main and back-up lines of defence are associated with level 3. Note that it is not the purpose of the present sub-chapter to consider mitigation of severe accidents, radiological consequences or containment integrity (third barrier) issues.

2.3. DEFENCE LINES

2.3.1. First line of defence (prevention)

As defined in Sub-chapter 3.1, the second level of defence in depth involves detecting and correcting the effects of deviations from normal operation and the effects of systems failures. For that purpose the following are implemented in normal operation:

- core and RCP [RCS] automatic control functions;
- monitoring of limiting conditions of operation (LCOs)
- automatic limitation functions for core and RCP [RCS] parameters.

The core and reactor control functions implement corrective action by activation of safety or non-safety systems whenever a perturbed situation is detected. For example, in the following actions could be implemented:

- opening of the Main Steam Bypass GCT [MSB] following a secondary pressure disturbance;
- triggering of the pressuriser spray system or the pressuriser heaters following a primary pressure disturbance;
- house-load operation following a loss of external power supply;

Additionally, LCO surveillance functions are implemented. An LCO surveillance function indicates or limits the variation of a process parameter such that the initial conditions of operation at the onset of a postulated initiating event are maintained as pre-supposed in the safety analyses. The LCO therefore bounds the operating range.

After exceeding the LCO, an alarm is displayed and automatic "passive" countermeasures that do not induce a power decrease are actuated (blockage of rod withdrawal, blockage of turbine load increase …). In case these passive countermeasures and the operator actions that follow the alarm display do not enable the restoration of the authorised operating condition, automatic "active" countermeasures are actuated (partial trip[1], dilution stop, turbine load reduction …).

These countermeasures are actuated with a time delay to allow fast operating transients, such as power level steps and load rejections, to succeed.

The analysis of design basis events does not take into account the beneficial aspects of functions ensured by systems involved in the preventive line (as they are generally not safety classified for that purpose).

[1] Fast power reduction achieved by the dropping of a certain number of RCCAs and consistently adjusting the turbine setpoint to reduce generator power on secondary side

2.3.2. Main defence line (protection)

If the effect of systems comprising the preventive line is insufficient to control the deviation, and to return the core to safe conditions, a Reactor Trip (RT) is initiated by the Protection System (RPR [PS]) [Ref-1] and engineered safety systems may be actuated.

As defined in Sub-chapter 3.2, three physical states are defined corresponding to shutdown conditions to be attained in design basis events (PCC) and RRC-A sequences.

These make it possible to establish a hierarchy of the functions used to attain shutdown conditions:

- **controlled state:** the core is subcritical (a return to short-term criticality before operator actions leading simply to low nuclear power may acceptable on a case by case basis for a few events), heat removal is assured on a short-term basis, for example via steam generators, core water inventory is stable, radioactive discharges remain acceptable,

- **safe shutdown state**: the core is subcritical, residual heat is being removed on a long-term basis, radioactive discharges remain acceptable,

- **final state**: the core is subcritical, residual heat is being removed via primary or secondary systems, radioactive discharges remain acceptable.

Note that controlled and safe shutdown states are applicable to PCC conditions while the final state is used only in RRC-A analyses.

As a general rule for the design basis events, only the action of safety classified systems is assumed when demonstrating compliance with the PCC or RRC-A acceptance criteria as indicated in the criteria for Structure, Systems and Components classification provided in Sub-chapter 3.2.

In order to introduce redundancy within the line of protection, the RPR [PS] is divided into two sub-systems, A and B.

For reactor trip signals processed in the RPR [PS], the following design rules are applied:

- for any PCC-2 condition which initiates an RT, if the main initiation signal is processed in one sub-system, a second initiating signal is processed in the opposite sub-system[2],

- a sensor used for a main initiation signal for RT in a sub-system cannot be used by the second initiating signal in the opposite sub-system.

It may be necessary to inhibit an automatic signal to cancel actions initiated by the signal, for example to shut down a pump after automatic start-up by the RPR [PS]. This can be done by resetting or by using permissives.

[2] With the exception of the partial loss of core coolant flow where no additional RT is required.

A reset is an operator action to clear the memory of a stored automatic signal. In most cases, a reset does not imply any automatic action but only allows manual control of the system. For actuators that receive commands from the protection system, these commands have priority over post-accident manual actions. In this case, the reset of the protection system command is necessary to allow manual operation of the actuators in the control room in a post-accident situation on the safe path. In some specific cases, a permissive instead of a reset is used to inhibit signals coming from the protection system. A description of resets is given in section 3.5 of this sub-chapter.

Permissives can also be introduced to authorise the activation or deactivation of certain protection signals depending on the current status of the reactor. A permissive is a condition to be satisfied, based on the information given by a set of sensors. A permissive is produced as soon as its associated condition is satisfied.

There are two types of permissives, depending on whether the associated actions are performed automatically or manually:

- if the permissive is of the "automatic action" type, its validation (or invalidation) leads to automatic performance of the related actions,
- if the permissive is of the "manual action" type, its validation (or invalidation) does not lead to any automatic action, but allows the operator to perform the related actions manually.

A given permissive can be of the manual type with respect to activation, and of the automatic type with respect to deactivation, or vice versa.

Permissive signals have the same safety classification as the protective actions they inhibit. A description of permissives is given in section 3.6 of this sub-chapter.

2.3.3. Back-up line of defence

In accordance with the defence in depth principles and the HSE SAPs (notably FA.15), additional safety measures are introduced that aim to further reduce the risk of core melt, which could be caused typically by multiple failures such as total loss of a safeguard system.

To achieve such goal, the approach adopted is to ensure that a diverse means can be used as a back-up whenever the total failure of a safeguard system induces a significant risk of core melt. The event sequences that fall into this category are identified by Probabilistic Safety Assessment. Depending on the type of sequence, the diverse system may be another, already existing system, or an additional system specifically introduced to prevent the risk of core melt. For the additional systems, due to the low probability of the event sequences considered, it is acceptable to apply less stringent design requirements than for the normal safeguard systems and a safety classification consistent with the principles described in Sub-chapter 3.2 is adopted.

The deterministic analysis of the Risk Reduction Category A (RRC-A) event sequences provides the basis for the specification of the required characteristics and performance of the diverse systems.

Diversity can be provided between the trains of a redundant system or by another system, diverse from the system it has to back up. Both solutions are adopted for the EPR. Safety systems and functions have been designed applying functional diversity: the intention is to provide, whenever possible, a diverse system which can perform the desired function and bring the plant back to a safe condition in the highly unlikely event of all the redundant trains of a system becoming totally unavailable.

For frequent events (PCC-2) for which no back-up line has been identified, arguments are given in Sub-chapter 14.7 – Table 1 for why this situation is still acceptable from a safety point of view.

3. PROTECTION SYSTEM I&C ARCHITECTURE

This section describes the basic architecture of the I&C systems used to actuate the EPR control and protection functions, and explains the principles used to define protection system settings, and to modify or deactivate settings during changes in the reactor state.

3.1. SAFETY FUNCTIONS

To structure the Primary/Secondary (P/S) I&C functions, a hierarchy is used.

It is based on the objective of preventing or minimising the release of radioactivity to the environment during transients, by ensuring the integrity of the three barriers:

- the fuel cladding;
- the reactor coolant system;
- the containment.

The safety functions to be achieved to ensure a safe control of the plant can be divided into the five following basic safety functions or “control modes” [Ref-1].

- Reactivity control;
- Reactor heat removal;
- RCP [RCS] integrity;
- RCP [RCS] inventory control;
- Containment of radioactivity.

3.2. TYPES OF I&C FUNCTIONS

The I&C functions are divided into six hierarchical categories:

- Level 1 : Control I&C functions;
- Level 2 : Limiting Conditions of Operation (LCO) surveillance I&C functions;
- Level 3 : Limitations I&C functions;
- Level 4 : Protection I&C functions;
- Level 5 : Post Accident Management I&C functions;
- Level 6: RRC I&C functions.

3.2.1. Control I&C functions

The control I&C functions are those functions, which act on controlled parameters in order to follow control setpoints in all plant conditions.

Control I&C functions are Non-Classified (NC)

3.2.2. LCO surveillance I&C functions

The LCO surveillance I&C functions are those functions which are implemented to initiate (manually or automatically) in cases of violation of LCO. The functions contribute to maintaining the initial conditions within the limits adopted in the safety analyses.

3.2.3. Limitation I&C functions

The limitation I&C functions are functions which are implemented to initiate corrective measures (manually or automatically) in case the operating point comes too close to the protection system thresholds (avoidance of protection action).

The main objective of these functions is to improve the plant availability by terminating abnormal transients at an early stage in order to avoid actuation of a protection action.

The beneficial effect of limitation functions is not taken into account in safety analyses, under the rules applied in accident analysis. However credit for their role can be taken in probabilistic studies of certain transients.

3.2.4. Protection I&C functions

The protection I&C functions are functions which are implemented to mitigate the consequences of a Postulated Initiating Event (PIE) automatically after its detection. They include automatic actuation of protection actions and safety-grade systems, and automatic control of these actions during the short term accident phase. This phase is considered to last for 30 minutes after the occurrence of the first significant alarm following detection of the PIE.

The short term phase is the time period where the protection actions must be automatic. The EPR design is that automation of the protection actions should enable the controlled state to be reached after an accident, and to be maintained as long as it is required for safety purposes. Therefore there is no reliance on operator action to bring the plant to a safe stable state, manual actions being required to transfer the plant from the controlled state to the safe shutdown state.

The above requirements ensure automation of protection functions in the short term post-accident phase, but do not mean that beneficial operator actions are precluded: beneficial manual actions either to anticipate automatic actions, or to improve the mitigation level, are desirable, and these are permitted when they are in accordance with emergency operating guidelines.

3.2.5. Post accident management I&C functions

The post-accident I&C functions are the functions required to bring the plant from the controlled state to the safe shutdown state and to maintain it.

In the safety analyses, a manual action from the main control room cannot be credited within the 30 minutes after the first significant information given to the operator.

Thus, if actions to bring the plant to the safe shutdown have to be undertaken before 30 minutes, the required post-accident I&C functions must be automatic. Otherwise, manual post-accident functions are considered sufficient..

3.2.6. RRC I&C functions

The RRC I&C functions are those functions, which are implemented to mitigate the consequences of an RRC event (an RRC event could be either a PIE combined with a common cause failure or an event involving multiple coincident PIEs). The RRC I&C functions include either manual or automatic actuation of reactor trip and/or the safeguard systems, the control of these actions, or the simple detection of an accident which requires manual intervention from the operator more than 30 minutes after the first significant alarm.

3.3. BASIS FOR THE DEFINITION OF AN I&C FUNCTION

The concept of I&C functions is used to structure I&C tasks into small functional units such that each unit:

- gives a complete representation of a functional objective (safety objective or operational objective);
- can be classified according to its degree of safety importance;
- comprises the smallest entity form sensor to actuator to achieve its functional objective;
- is as far as possible independent from other units and therefore easily exchangeable.

The full set of I&C functions provides a modular functional structure for the I&C which forms the basis of the overall I&C architecture and enables process engineers to verify whether the postulated events are controlled and mitigated in the expected manner.

An I&C function must be as simple as possible.

It must rely on parameters as close as possible to:

- the physical phenomenon under control,
- a symptom-based approach.

An I&C function must rely on an event-based approach, when required.

An I&C function must be designed to avoid Non-unequivocally Safety Oriented (NUSO) I&C functions as far as possible. The NUSO definition is given in section 3.4.1

3.4. SET OF I&C FUNCTIONS

3.4.1. NUSO functions

When two I&C functions, with the same classification, perform opposing actions within the same safety system, the one which has priority over the other one is called Non-unequivocally Safety Oriented (NUSO). All other I&C functions are called Unequivocally Safety Oriented (USO).

The faulty actuation of NUSO, during many events, significantly lessens or impairs the actual plant safety level, because it prevents from the action of an other I&C function which is needed to mitigate the accident.

Due to their potential negative impact on safety when spuriously actuated, the NUSO I&C functions shall be designed in a way to minimise the probability of spurious action.

3.4.2. Setpoints scales

Setpoints result from the hierarchical organisation of I&C functions described above.

The overall I&C design approach to ensure a high level of plant safety is based on:

- consideration of the channel accuracy,
- consideration of the response time of the I&C function,
- the threshold margin to ensure plant reliability in case of failure of the dedicated I&C function,
- application of the single failure criterion to I&C systems,
- priority requirements between different I&C functions.

In Sub-chapter 14.7 - Figures 1 and 2, examples of setpoint scales with the corresponding actions are shown.

3.5. RESET OF AUTOMATIC PROTECTION FUNCTIONS

3.5.1. Definition

A reset is an operator action to clear the memory of a stored automatic signal. It may be necessary to inhibit an automatic signal to cancel actions initiated by the signal. In most cases, a reset does not imply any automatic action but only allows a manual control of the system. When actuators receive commands from the protection system, these commands have priority over manual actions. In this case, the reset of the protection system command is necessary to allow manual operation of the actuators in the control room in a post-accident situation on the safe path.

Note

As mentioned above, in general there is priority of automatic commands generated in PS over manual commands performed by the operator.

Most memories used are of two types:

- "reset priority" memories, for which the reset inhibits a signal if the conditions that govern signal activation are met at the time of actuation of the reset.
- "priority set" memories, for which the reset does not inhibit the signal, but inhibits storage of the signal if the conditions that determine signal activation are not met at the time of actuation of the reset.

3.5.2. Principles

Reset requirements with respect to protection system commands are defined in accordance with two basic hypotheses:

- the protection system issues non-reversible commands. This means that an initiated action is not ended even if the initiating conditions are no longer present.
- signals originated from the protection system are not stored as routine. Conditions for storage have to be defined individually for each signal.

3.5.3. Reset description

Resets (and associated memories) are analysed with respect to two types of initiating signals:

- Non-spurious commands

A reset must be configured only if the protection command is stored, since it must be possible to cancel the protection system command to return to normal operation once the required conditions are met. This reset will be of the non-priority type, except in special cases.

- Spurious commands.

There are two kinds of spurious commands: pulse-type and permanent: the approach for the first kind of command is the same as for non-spurious commands and permanent ones have a very low probability.

The concept of single failure is incorporated into the design of resets required on the safe path in a post-accident situation.

A 2 fold redundancy is chosen for resets that are configured for actions on the safe path in a post-accident situation. No redundancy is necessary for resets that are configured for actions not on the safe path in a post-accident situation (except in special cases).

In some specific cases, a permissive instead of a reset is used to inhibit signals coming from the protection system.

3.6. PERMISSIVE SIGNALS

3.6.1. Definitions

Permissives are introduced to authorise the activation or deactivation of certain protection signals, according to the current operating status of the plant unit. Consequently, certain manual or automatic actions, related to the permissive, are authorised or not.

As these deactivations are detrimental to safety when the reactor is at power, they are authorised only in certain conditions, called permissives.

Each permissive is associated with a key. The permissive corresponds to the condition to be satisfied, and the key launches the actions authorised by the permissive. There are two types of permissives, depending on whether the key triggers automatic or manual actions. A given permissive can be of the manual type with respect to activation, and be automatic with respect to deactivation, or vice versa.

Permissives are identified by the letter P followed by a suffix. Permissives related to PS protection functions are for example: P12, P14, P15... Keys are identified by the word KEY (upper cases) followed by the same suffix as the associated permissive (e.g. KEY12 for P12).

3.6.2. Principles

It must be possible to perform the actions associated with the permissives in normal operating conditions and in post-accident phases. Therefore, validation of permissives and KEY actuation by the operator is possible from both the PICS (Process Information and Control System) and the SICS (Safety Information and Control System). The PICS and SICS are the systems which allow the display of information from the different I&C automation systems in the main control room.

3.6.3. Permissive list

Examination of permissive requirements with respect to P/S related protection functions has led to definition of the following list (non exhaustive):

NAME	USE
P12	Inhibition of signals for return to cold shutdown
P13	Inhibition of signals for draining or filling of SGs during cold shutdown
P14	Authorisation to connect LHSI in RHR mode
P15	Activation of loop level protection
P16	Authorisation to switch RIS [SIS] cold to hot leg injection
P17	Activation of cold overpressure protection
P18	Authorisation to open transfer blowdown lines between SG
P19	Authorisation to perform secondary depressurisation

4. ADEQUACY OF DESIGN TO PROTECT THE PLANT AGAINST FAULTS – ALARP DISCUSSION

4.1. OVERVIEW OF PLANT PROTECTION

As described in section 2, several lines of defence are implemented in the design of the EPR. Deterministic protection aims at preventing any core damage and limits the radioactive release outside the containment. The main line of defence is designed on the basis of the fault studies in Sub-chapters 14.3 to 14.5. The overview of plant protection is then provided in the fault and protection schedule.

4.2. ANALYSIS OF FUNCTIONAL DIVERSITY

In order to ensure a high level of plant safety, the main line of defence is completed by a diverse line of protection which results from the RRC-A approach and the functional diversity analyses presented in Sub-chapters 16.1 and 16.5. These analyses ensure that two diverse lines of protection are sufficient to protect the plant for each frequent fault considered in the fault studies in Sub-chapters 14.3 and 14.4.

The results of these functional analyses are also provided in the fault and protection schedule.

4.3. RADIOLOGICAL CONSEQUENCES

The radiological consequences study presented in Sub-chapter 14.6 allows comparison with the SAP requirements. It demonstrates the adequacy of the design to protect the environment and people from radiation exposure consistent with the UK regulations for effective dose.

In addition to these studies, a Probabilistic Safety Assessment of the radiological releases and consequences allows an assessment of the plant protection by comparing the resulting doses and the frequency of releases (Sub-chapter 15.5). Demonstration, using a PSA model, that the nuclear safety risk from an EPR meets the BSO risk targets is considered to be an important element in the overall demonstration that the ALARP principle is met by the EPR (see Sub-chapter 17.4).

5. CONCLUSION

The safety measures described in this sub-chapter are illustrated and detailed for each transient considered in the fault schedule. This fault schedule illustrates that the plant is protected by two diverse lines of protection for the most frequent events as detailed in the analyses of functional diversity provided in Sub-chapter 16.5. The efficiency of the plant to protect people and the environment from radiation exposure is highlighted in the deterministic radiological consequences analyses provided in Sub-chapter 14.6 and the probabilistic analyses provided in Sub-chapter 15.5. These two contributions form an important element in the demonstration that the ALARP principle is met by the UK EPR.

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (1/29)

No.	Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE							Comments
	Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function Based on EPR process and international practice for PWR	Safety Cat.	Lower Level Safety Function Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)	Safety Functional Groups					Lower Level Safety Function Combination of the Plant Level Safety Function with the conditions of operations (normal, incident, accident)	Safety Functional Groups					Supporting study	
		Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item		Safety class	System Req.			Item		Safety class	Syst Req.			
3	Decrease in Reactor coolant flow																							
POWER OPERATIONS	(1) - Partial loss of core coolant flow (loss of one RCP) (2) - Forced decrease of reactor coolant flow (4 pumps)	PCC-2 $10^{-2}<f(r.y)$	1 - 5.9.10-2	1 - 14.3.8	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	Reactor trip - auto Actuation (1) - Low-low loop flow rate in one loop (2) - Low RCP speed in 2/4 loops Low Loop Flow Rate in 2 of 4 loops Front. Syst. CRDM		Class 1	F1A	PS	High concentrated and high pressure boron injection	Emergency boron injection into the core - diversified Actuation ATWS signal (N-3 rod drop) Front. Syst. EBS		Class 2	F2	PS	ATWS LOOP covers	
																	Negative reactivity fast insertion	Reactor trip - auto Actuation Low RCP speed Front. Syst. CRDM		Class 2	F2	SAS		
						x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	Turbine Trip Actuation RT checkback Front. Syst. Turbine admission valves		Class 1	F1A	PS	RCS overcooling protection	MSIV closure Actuation SG P Front. Syst. MSIV		Class 1	F1A	PS	Excessive increase in steam flow study	
						x						Full load MFW isolation (4SG) Actuation RT checkback Front. Syst. Full load MFW isolation valves		Class 1	F1A	PS		Full load MFW isolation (4SG) Actuation RT checkback Front. Syst. Full load MFW isolation valves		Class 2	F2	SAS	SAS order in case of ATWS following PS failure	
		PCC-3 $10^{-4}<f(r.y)<10^{-2}$	2 - -	2 - 14.4.9	Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation SG P Front. Syst. MSRT		Class 1	F1A	PS	Heat removal by Low Head Emergency Core Cooling System (ECCS)	Opening of severe accident discharge line Actuation Manual Front. Syst. PDS		Class 2	F2	SAS	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
						x						EFW actuation (1 train) + SG Blowdown Isolation Actuation SG L Front. Syst. EFWS injection lines & storages		Class 1	F1A	PS		SIS [RIS] in cold leg Actuation Manual Front. Syst. MHSI + LHSI		Class 2	F1B	SAS		
																		RCP stop - Manu Activ. & Elec Manual Front. Syst. RCP		Class 2	F1B	SAS		
					Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment	A	Essential component protection	SG Pressure Control - Overpressure protection Actuation SG P Front. Syst. MSRT		Class 1	F1A	PS	Essential component protection	SG safety valves opening Actuation Passive Front. Syst. MSSV		Class 1	F1A	-	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
	Reactor coolant Pump seizure (blocked rotor) & Reactor coolant pump shaft break	PCC-4 $10^{-6}<f(r.y)<10^{-4}$	-	14.5.8 14.5.9	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	Reactor trip - auto Actuation Low-low loop flow rate in one loop Front. Syst. CRDM		Class 1	F1A	PS	N/A - diversity is applied to frequent initiating event above 10^{-3}/r.y						Reactor coolant pump shaft break consequences bounded by Reactor Coolant Pump seizure (locked rotor)	
						x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	Turbine Trip Actuation RT checkback Front. Syst. Turbine admission valves		Class 1	F1A	PS								
												Full load MFW isolation (4SG) Actuation RT checkback Front. Syst. Full load MFW isolation valves		Class 1	F1A	PS								
					Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation SG P Front. Syst. MSRT		Class 1	F1A	PS								
						x						EFW actuation (1 train) + SG Blowdown Isolation Actuation SG L Front. Syst. EFWS injection lines & storages		Class 1	F1A	PS								
					Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure	A	Essential component protection	SG Pressure Control - Overpressure protection Actuation SG P Front. Syst. MSRT		Class 1	F1A	PS								
					Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	Hot overpressure protection Actuation Passive Front. Syst. PSV		Class 1	F1A	-								
	Emergency Operating Procedure	All	N/A	All	Reactivity Control		x		Shutdown and maintain core sub-criticality	B	Compensation for shutdown moderator effect	Emergency boron injection into the core - Manual Actuation Manual Front. Syst. EBS		Class 2	F1B	SAS	See Appendix A						In case of Shaft break, the possibility to have a LOCA is managed by the actuation of MHSI by the operator. This manual actuation is Class 2	
					Heat removal		x		Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation Manual Front. Syst. MSRT		Class 2	F1B	SAS								
										B	Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	RCS depressurisation by PZR safety valves Activ. & Elec Manual Front. Syst. PSV		Class 2	F1B	SAS								
							x			B		RHR connection and start-up (no SI signal) Activ. & Elec Manual Front. Syst. RHRS		Class 2	F1B	SAS								

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (2/29)

	No.	Fault description	References: Category	References: Frequency	References: PCSR Ref.	Main Safety Function	Transient phases: Cont. state	Transient phases: Safe state	Transient phases: Final state	SAFETY FUNCTION: Plant Level Safety Function (Based on EPR process and international practice for PWR)	SAFETY FUNCTION: Safety Cat.	MAIN LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	MAIN LINE: Safety Functional Groups: Item	MAIN LINE: Safety Functional Groups: Safety class	MAIN LINE: Safety Functional Groups: System Req.	DIVERSE LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	DIVERSE LINE: Safety Functional Groups: Item	DIVERSE LINE: Safety Functional Groups: Safety class	DIVERSE LINE: Safety Functional Groups: Syst Req.	DIVERSE LINE: Supporting study	Comments
	Reactivity power distribution																				
POWER OPERATIONS		Uncontrolled RCCA bank withdrawal at power Uncontrolled RCCA bank withdrawal from HZP RCCA misalignment up to rod drop Start-up of an inactive reactor coolant loop at an improper temperature CVCS malfunction that results in a decrease in boron concentration in the reactor coolant * Uncontrolled single RCCA withdrawal	PCC-2 $10^{-2}<f(r.y)$ or PCC-3 $10^{-4}<f(r.y)<10^{-2}(r.y)$	- for all but 7.10-3 for CVCS malfunction 1.35.10-3 for single RCCA withdrawal	14.3.9 14.3.10 14.3.11 14.3.12 14.3.13 14.4.13	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	Reactor trip - auto Actuation: DNBR (slowest transient), High NF rate of change (fastest transients) Front. Syst.: CRDM	Class 1	F1A	PS	High concentrated and high pressure boron injection	Emergency boron injection into the core - diversified Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	Class 2	F2	PS	ATWS cover	
							x									Negative reactivity fast insertion	Reactor trip - auto Actuation: High AO, High neutron flux HL P Front. Syst.: CRDM	Class 2	F2	SAS		
							x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	Turbine Trip Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS	RCS overcooling protection	MSIV closure Actuation: SG P Front. Syst.: MSIV	Class 1	F1A	PS	Excessive increase in steam flow study	* for CVCS malfunction resulting in a decrease in boron concentration, please refer to the CVCS malfunction in shutdown mode for main mitigative feature and diversity
							x						Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS		Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 2	F2	SAS	SAS order in case of ATWS following PS failure	
						Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Heat removal by Low Head Emergency Core Cooling System (ECCS)	Opening of severe accident discharge line Actuation: Manual Front. Syst.: PDS	Class 2	F2	SAS	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
							x						EFW actuation (1 train) + SG Blowdown Isolation Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS		SIS [RIS] in cold leg Actuation: Manual Front. Syst.: MHSI + LHSI	Class 2	F1B	SAS		
							x										RCP stop - Manu Activ. & Elec: Manual Front. Syst.: RCP	Class 2	F1B	SAS		
						Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure	A	Essential component protection	SG Pressure Control - Overpressure protection Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Essential component protection	SG safety valves opening Actuation: Passive Front. Syst.: MSSV	Class 1	F1A	-	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
		Inadvertent loading of a fuel assembly in an improper position	PCC-3 $10^{-4}<f(r.y)<10^{-2}(r.y)$	2.10^{-3}	14.4.8	N/A				If the incorrect fuel loading pattern is not detected prior to power operations, it could lead to a change in the power distribution predicted for the core design and thereby exceed the safety limits. Detection methods do not fit in fault schedule format - see PCSR for further details.												
		Spectrum of RCCA ejection accidents	PCC-4 $10^{-6}<f(r.y)<10^{-4}(r.y)$	-	14.5.5	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	Reactor trip - auto Actuation: High NF rate of change Front. Syst.: CRDM	Class 1	F1A	PS	N/A - diversity is applied to frequent initiating event above 10^{-2}/r.y	N/A					
							x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	Turbine Trip Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS							
							x						Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS							
						Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS							
							x						EFW actuation (1 train) + SG Blowdown Isolation Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS							
						Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure	A	Essential component protection	SG Pressure Control - Overpressure protection Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS							
						Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	Hot overpressure protection Actuation: Passive Front. Syst.: PSV	Class 1	F1A	-							

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (3/29)

No.	Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE					Comments
	Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
		Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.			
	Reactivity power distribution																				
SHUTDOWN MODE	Emergency Operating Procedure	All	N/A	All	Reactivity Control		x		Shutdown and maintain core sub-criticality	B	Compensation for shutdown moderator effect	Front. Syst. Emergency boron injection into the core - Manual Actuation: Manual Front. Syst.: EBS	Class 2	F1B	SAS	See Appendix A			N/A		In case of Shaft break, the possibility to have a LOCA is managed by the actuation of MHSI by the operator. This manual actuation is Class 2
					Heat removal		x		Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS						
										B	Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	RCS depressurisation by PZR Activ. & Elec.: Manual Front. Syst.: PSV	Class 2	F1B	SAS						
							x			B		RHR connection and start-up (no Activ. & Elec.: Manual Front. Syst.: RHRS	Class 2	F1B	SAS						
					Confinement		x		N/A												
	CVCS malfunction that results in a decrease in	PCC2 f>10⁻²/(r.y)	7.10⁻²	14.3.13	Reactivity Control			x	Prevention of uncontrolled positive reactivity insertion into the core	A	Anti-dilution protection	Anti-dilution isolation Actuation: Cb Front. Syst.: CVCS	Class 1	F1A	PS	Anti-dilution protection	Anti-dilution isolation diversified Actuation: Manual Front. Syst.: CVCS	Class 2	F2	SAS		
	Uncontrolled rod cluster control assembly (RCCA) bank withdrawal (states B, C & D)	PCC3 10-4/(r.y)<f<10-2/(r.y)	-	14.4.12	N/A				A specific protection function aims at making these scenarios impossible - it is no longer studied												
	Boron dilution due to a non-isolable rupture of a heat exchanger tube (states B, C & D)	PCC-4 10-6/(r.y)<f<10-4/(r.y)	-	14.5.12	Reactivity Control	x			Prevention of uncontrolled positive reactivity insertion into the core	A	Anti-dilution protection	Alarm Actuation: High NF rate of change Front. Syst.: PS	Class 1	F1A	PS	N/A - diversity is applied to frequent initiating event above 10-3/r.y					In such events, heat removal and confinement main safety functions are not impaired. Consequently, detailed information is not presented
												Anti-dilution isolation Actuation: Cb Front. Syst.: CVCS	Class 1	F1A	PS						
							x			B	Anti-dilution protection	Isolation of HP cooler in case of dilution (P RRI > P RCV) Actuation: Manual Front. Syst.: CVCS	Class 2	F1B	SAS	Isolation of HP cooler in case of leak (P RRI < P RCV) is provided as defense-in-depth in some case of leak to limit high release of radioactiviy liquid inside containement.					
											Anti-dilution protection	Isolation of one RHR train Actuation: Cb Front. Syst.: CVCS	Class 2	F1B	SAS						
	Non CVCS homogeneous dilution with failure of dilution source	RRC-A	-	16.1.3.10	Reactivity Control			x	Prevention of uncontrolled positive reactivity insertion into the core	B	Anti-dilution protection	Charging pump suction switchover to IRWST Actuation: Manual Front. Syst.: CVCS	Class 2	F2	SAS	N/A - diversity is applied to frequent initiating event above 10-3/r.y					

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (4/29)

No.	Input to classification: Fault description	References: Category	References: Frequency	References: PCSR Ref.	Main Safety Function	Transient phases: Cont. state	Transient phases: Safe state	Transient phases: Final state	SAFETY FUNCTION: Plant Level Safety Function (Based on EPR process and international practice for PWR)	Safety Cat.	MAIN LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	Safety Functional Groups: Item		Safety class	System Req.	DIVERSE LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	Safety Functional Groups: Item		Safety class	Syst Req.		Supporting study	Comments
Increase in RCS inventory																							
POWER OPERATIONS	CVCS malfunction causing increase in reactor coolant inventory	PCC-2 f>10-2/(r.y)	-	14.3.14	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto**		Class 1	F1A	PS	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified**		Class 2	F2	PS	ATWS cover	These parts of transient are provided in case of isolation of charging line and seal injection would fail leading to PZR filling. Consequently, such information does not fully belong to the main line of defense.
												Actuation	PZR L PZR P					Actuation	ATWS signal (N-3 rod drop)				
												Front. Syst.	CRDM					Front. Syst.	EBS				
																	Negative reactivity fast insertion	**Reactor trip - auto**		Class 2	F2	SAS	
																		Actuation	HL P				
																		Front. Syst.	CRDM				
						x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip**		Class 1	F1A	PS	RCS overcooling protection	**MSIV closure**		Class 1	F1A	PS	Excessive increase in steam flow study	
												Actuation	RT checkback					Actuation	SG P SG L				
												Front. Syst.	Turbine admission valves					Front. Syst.	MSIV				
						x						**Full load MFW isolation (4SG)**		Class 1	F1A	PS		**Full load MFW isolation (4SG)**		Class 2	F2	SAS	SAS order in case of ATWS following PS failure
												Actuation	RT checkback					Actuation	RT checkback				
												Front. Syst.	Full load MFW isolation valves					Front. Syst.	Full load MFW isolation valves				
					Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling**		Class 1	F1A	PS	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident**		Class 2	F2	SAS	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A
												Actuation	SG P					Actuation	Manual				
												Front. Syst.	MSRT					Front. Syst.	PDS				
						x						**EFW actuation (1 train) + SG**		Class 1	F1A	PS		**SIS [RIS] in cold leg**		Class 2	F1B	SAS	
												Actuation	SG L					Actuation	Manual				
												Front. Syst.	EFWS injection lines & storages					Front. Syst.	MHSI + LHSI				
						x												**RCP stop - Manu**		Class 2	F1B	SAS	
																		Activ. & Elec	Manual				
																		Front. Syst.	RCP				
					Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure	A	Essential component protection	**SG Pressure Control - Overpressure protection**		Class 1	F1A	PS	Essential component protection	**SG safety valves opening**		Class 1	F1A	-	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
												Actuation	SG P					Actuation	Passive				
												Front. Syst.	MSRT					Front. Syst.	MSSV				
					Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	**Isolation of charging line**		Class 1	F1A	PS	RCS overpressure protection	**Hot overpressure protection**		Class 1	F1A	-	Primary overpressure studies of Sub-chapter 3.4.1.5 illustrate	The isolation of charging line is the main line of defense in such transient
												Actuation	PZR L					Activ. & Elec	Passive				
												Front. Syst.	CVCS isolation valve					Front. Syst.	PSV				
						x						**Isolation of MCP seal injection**		Class 1	F1A	PS		**Hot overpressure protection**		Class 1	F1A	-	
												Actuation	PZR L					Activ. & Elec	Passive				
												Front. Syst.	CVCS isolation valve					Front. Syst.	PSV				
	Emergency Operating Procedure				Reactivity Control		x		Shutdown and maintain core sub-criticality	B	Compensation for shutdown moderator effect	**Emergency boron injection into the core - Manual**		Class 2	F1B	SAS	See Appendix A						Normally, in such event there is no need to reach a safe shutdown state
												Actuation	Manual										
												Front. Syst.	EBS										
					Heat removal		x		Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling**		Class 2	F1B	SAS							
												Actuation	Manual										
												Front. Syst.	MSRT										
							x			B	Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	**RHR connection and start-up (no SI signal)**		Class 2	F1B	SAS							
												Activ. & Elec	Manual										
												Front. Syst.	RHRS										

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (5/29)

Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE								
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				C&I platform	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups					Supporting study	Comments
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.				
Decrease in RCS water inventory																								
CVCS malfunction causing decrease in reactor coolant inventory (state A)	PCC-2 f>10-2/(r.y)	7.10-3	14.3.14	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: PZR L, DNBR, HL P Front. Syst.: CRDM	Class 1	F1A	PS	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified** Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	Class 2	F2	PS	ATWS SB provided in technical report about diversity	Question remains about SB-LOCA with break on EBS (capacity of the EBS tanks).
								Shutdown and maintain core sub-criticality	A							Negative reactivity fast insertion	**Reactor trip - auto** Actuation: HL P Front. Syst.: CRDM	Class 2	F2	SAS		
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS	RCS overcooling protection	**MSIV closure** Actuation: SG P Front. Syst.: MSIV	Class 1	F1A	PS	Excessive increase in steam flow study	
					x						**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS		**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 2	F2	SAS	SAS order in case of ATWS following PS failure	
					x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Water injection into the RCS	**SG Pressure Control - Cooling - Auto (MSRT)** Actuation: SIS signal [PZR P] Front. Syst.: MSRT	Class 1	F1A	PS	Water injection into the RCS	**SG Pressure Control - Cooling - Manu** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS	Covered by LOCA (BREAK SIZE UP TO 20 CM2) WITH FAILURE OF THE PARTIAL COOL-DOWN SIGNAL (STATE A) - PCSR Sub-chapter 16.1.3.3.6	A diversified way to control the SG pressure could use the fact that the 4 MSRTs are independent and that the PS is working or the manual opening of the MSRTs
					x						**MHSI injection - Auto** Actuation: SIS signal [PZR P] Front. Syst.: MHSI	Class 1	F1A	PS		**LHSI in cold leg** Actuation: Manual Front. Syst.: LHSI	Class 2	F1B	SAS	Covered by LOCA (BREAK SIZE UP TO 20 CM2) WITHOUT MHSI (STATE A) - PCSR Sub-chapter 16.1.3.3.7	
				Heat removal	x				A	Prevention of RCS drainage through auxiliary lines	**Isolation of CVCS letdown line (RCS isolation SI sequence)** Actuation: SIS signal [PZR] Front. Syst.: CVCS letdown valve	Class 1	F1A	PS	Prevention of RCS drainage through auxiliary lines	**Isolation of CVCS letdown line** Actuation: Manual Front. Syst.: CVCS letdown valve	Class 2	F1B	SAS	-	
					x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident discharge line** Actuation: Manual Front. Syst.: PDS	Class 2	F2	SAS	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
					x						**EFW actuation (1 train) + SG Blowdown Isolation** Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS		**SIS [RIS] in cold leg** Actuation: Manual Front. Syst.: MHSI + LHSI	Class 2	F1B	SAS		
					x											**RCP stop - Manu** Activ. & Elec: Manual Front. Syst.: RCP	Class 2	F1B	SAS		
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Essential component protection	**SG safety valves opening** Actuation: Passive Front. Syst.: MSSV	Class 1	F1A	-	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
				Confinement	x			Limit the release of radioactive material from the reactor containment	A	Containment building isolation	**Containment isolation stage 1 /** Actuation: SIS signal [PZR P] Front. Syst.: Containment isolation valves	Class 1	F1A	PS	No need for diversity in case of CVCS malfunction - there is no direct release into the containment						
Inadvertent opening of a pressurizer safety valve	PCC-3 10-4/(r.y)<f<10-2/(r.y)	1.68.10-3	14.4.3	N/A				This transient is fully covered by the SB LOCA in state A.																

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (6/29)

Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE							
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				C&I platform	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups					Supporting study	Comments
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.				
Decrease in RCS water inventory																							
Small break (not greater than DN50) including a break occuring on the Extra Boration System injection line (State A)	PCC-3 10^{-4}/(r.y)<f<10^{-2}/(r.y)	6.10^{-4}	14.4.5	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	Reactor trip - auto Actuation: PZR P, HL P Front. Syst.: CRDM	Class 1	F1A	PS	High concentrated and high pressure boron injection	Emergency boron injection into the core - diversified Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	Class 2	F2	PS	ATWS cover	Question remains about SB-LOCA with break on EBS (capacity of the EBS tanks).
					x			Shutdown and maintain core sub-criticality	A						Negative reactivity fast insertion	Reactor trip - auto Actuation: HL P Front. Syst.: CRDM	Class 2	F2	SAS		
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	Turbine Trip Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS	RCS overcooling protection	MSIV closure Actuation: SG P Front. Syst.: MSIV	Class 1	F1A	PS	Excessive increase in steam flow study	
					x						Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS		Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 2	F2	SAS	SAS order in case of ATWS following PS failure	
				Heat removal	x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Water injection into the RCS	SG Pressure Control - Cooling - Auto (MSRT) Actuation: SIS signal [PZR P] Front. Syst.: MSRT	Class 1	F1A	PS	Water injection into the RCS	SG Pressure Control - Cooling - Manu Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS	Covered by LOCA (BREAK SIZE UP TO 20 CM2) WITH FAILURE OF THE PARTIAL COOL-DOWN SIGNAL (STATE A) - PCSR Sub-chapter 16.1.3.3.6	A diversified way to control the SG pressure could use the fact that the 4 MSRTs are independent and that the PS is working or the manual opening of the MSRTs
					x						MHSI injection - Auto Actuation: SIS signal [PZR P] Front. Syst.: MHSI	Class 1	F1A	PS		LHSI in cold leg Actuation: Manual Front. Syst.: LHSI	Class 2	F1B	SAS	Covered by LOCA (BREAK SIZE UP TO 20 CM2) WITHOUT MHSI (STATE A) - PCSR Sub-chapter 16.1.3.3.7	
					x				A	Prevention of RCS drainage through auxiliary lines	Isolation of CVCS letdown line (RCS isolation SI sequence) Actuation: SIS signal [PZR P] Front. Syst.: CVCS letdown valve	Class 1	F1A	PS	Prevention of RCS drainage through auxiliary lines	Isolation of CVCS letdown line Actuation: Manual Front. Syst.: CVCS letdown valve	Class 2	F1B	SAS	-	
					x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Heat removal by Low Head Emergency Core Cooling System (ECCS)	Opening of severe accident Actuation: Manual Front. Syst.: PDS	Class 2	F2	SAS	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
					x						EFW actuation (1 train) + SG Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS		SIS [RIS] in cold leg Actuation: Manual Front. Syst.: MHSI + LHSI	Class 2	F1B	SAS		
					x											RCP stop - Manu Activ. & Elec: Manual Front. Syst.: RCP	Class 2	F1B	SAS		
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or	A	Essential component protection	SG Pressure Control - Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Essential component protection	SG safety valves opening Actuation: Passive Front. Syst.: MSSV	Class 1	F1A	-	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
				Confinement	x			Limit the release of radioactive material from the reactor containment	A	Containment building isolation	Containment isolation stage 1 / Actuation: SIS signal [PZR P] Front. Syst.: Containment isolation valves	Class 1	F1A	PS	Containment building isolation	Containment isolation Actuation: Manual Front. Syst.: Containment isolation valves	Class 2	F1B	SAS		Containment isolation stage 2 is not considered since the containment pressure does not increase sufficiently
Loss of primary coolant outside the containment	PCC-3 10-4/(r.y)<f<10-2/(r.y)	-	14.4.11	Confinement	x			Limitation of radioactive release outside containment from radioactive auxiliary systems	A	Due to the numerous events possible, the fault schedule does not present them. The leaks are terminated after detection by alarms in Fuel Building or Nuclear Auxiliary Buildings. The operator isolates the corresponding pipes from the Main Control Room.												

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (7/29)

Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE						Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				C&I platform	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item		Safety class	System Req.			Item	Safety class	Syst Req.			
Decrease in RCS water inventory																						
Intermediate and large break LOCA (up to the surge linebreak, in states A and B)	**PCC-4 10-6/(r.y)<f<10-4/(r.y)**	**6.10^{-4} ($20-45cm^2$) $1.6.10^{-5}$ ($45-180cm^2$) $1.3.10^{-6}$ ($180-830cm^2$)**	**14.5.6**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: PZR P, HL P Front. Syst.: CRDM		**Class 1**	**F1A**	**PS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					In case of IB/LB LOCA, the Safety Injection plays a role in reactivity control by providing borated water. Depending on the size of the break, the LHSI and accumulators will empty more or less rapidly
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves		**Class 1**	**F1A**	**PS**						
					x						**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves		**Class 1**	**F1A**	**PS**						
				Heat removal	x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Water injection into the RCS	**SG Pressure Control - Cooling - Auto (MSRT)** Actuation: SIS signal [PZR P] Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**						
											MHSI injection - Auto Actuation: SIS signal [PZR P] Front. Syst.: MHSI		**Class 1**	**F1A**	**PS**						
											IRWST borated water storage, collect, filtration Actuation: Passive Front. Syst.: IRWST systems		**Class 1**	**F1A**	**PS**						
											IRWST cooling Actuation: Passive Front. Syst.: IRWST systems		**Class 1**	**F1A**	**PS**						
											LHSI injection in cold leg - Auto Actuation: SIS signal [PZR P] Front. Syst.: LHSI		**Class 1**	**F1A**	**PS**						
											Accumulators injection Actuation: Passive Front. Syst.: Accumulators		**Class 1**	**F1A**	**PS**						
					x				A	Prevention of RCS drainage through auxiliary lines	**Isolation of CVCS letdown line (RCS isolation SI sequence)** Actuation: SIS signal [PZR P] Front. Syst.: CVCS letdown valve		**Class 1**	**F1A**	**PS**						
					x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**						
					x						**EFW actuation (1 train) + SG Blowdown isolation** Actuation: SG L Front. Syst.: EFWS injection lines & storages		**Class 1**	**F1A**	**PS**						
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**						
											RCP stop - Auto Actuation: DP over RCP + SIS signal Front. Syst.: RCP		**Class 1**	**F1A**	**PS**						
				Confinement	x			Limit the release of radioactive material from the reactor containment	A	Containment building isolation	**Containment isolation stage 1 / RCPB isolation** Actuation: SIS [PZR P] Passive Front. Syst.: Containment isolation valves		**Class 1**	**F1A**	**PS**						
											Containment isolation stage 2 Actuation: SIS signal [PZR P] Front. Syst.: Containment isolation valves		**Class 1**	**F1A**	**PS**						

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (8/29)

Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE						
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				C&I platform	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	Comments
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state					Item	Safety class	System Req.				Item	Safety class	Syst Req.		
Decrease in RCS water inventory																						
Emergency Operating Procedure	All	N/A	All	Reactivity Control		x		Shutdown and maintain core sub-criticality	B	Compensation for shutdown moderator effect	Emergency boron injection into the core - Manual Actuation: Manual Front. Syst.: EBS	Class 2	F1B	SAS	See Appendix A						MHSI stop (1 train) is indicated combinated to RHRS actuation since it is one of the condition to connect RHRS in such case. LHSI injection in HL is only used in case of LB LOCA.
				Heat removal		x		Maintain sufficient Reactor Coolant System water inventory for core cooling	B	Water injection into the RCS	LHSI injection in HL Actuation: Manual Front. Syst.: LHSI	Class 2	F1B	SAS								
						x		Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS								
						x			B	Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	MHSI stop (1 train) Actuation: Manual Front. Syst.: MHSI	Class 2	F1B	SAS								
						x			B		MHSI injection on large miniflow Actuation: Manual Front. Syst.: MHSI	Class 2	F1B	SAS								
						x			B		LHSI switch to RHR mode (1 train) Activ. & Elec: Manual Front. Syst.: RHRS	Class 2	F1B	SAS								
				Confinement		x		N/A	B	Containement isolation are already effective due to automatic actuation. In case of such automatic actuation failed, the operator can perform the containment isolation												
LOCA up to 20 cm^2 with loss of partial cooldown signal (at power)	RRC-A	-	16.1.3.6	Reactivity Control			x	Shutdown and maintain core sub-criticality	B	Negative reactivity fast insertion	Reactor trip - auto Actuation: PZR P, HL P Front. Syst.: CRDM	Class 1	F1A	PS	N/A - diversity is applied to frequent initiating event above 10-3/r.y						The EOP followed by the operator is similar to the one presented for PCC event in such case
							x	Prevention of uncontrolled positive reactivity insertion into the core	B	RCS overcooling protection	Turbine Trip Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS								
							x				Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS								
				Heat removal			x	Maintain sufficient Reactor Coolant System water inventory for core cooling	B	Water injection into the RCS	SG Pressure Control - Cooling Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS								
							x				MHSI injection - Auto Actuation: SIS signal [PZR P] Front. Syst.: MHSI	Class 1	F1A	PS								
							x		B	Prevention of RCS drainage through auxiliary lines	Isolation of CVCS Low Pressure letdown line (RCS isolation SI sequence) Actuation: SIS signal [PZR P] Front. Syst.: CVCS letdown valve	Class 1	F1A	PS								
							x	Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS								
							x				LHSI switch to RHR mode (1 train) Activ. & Elec: Manual Front. Syst.: RHRS	Class 2	F1B	SAS								
							x			Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	IRWST cooling Actuation: SIS signal [PZR P] Front. Syst.: RHRS	Class 1	F1A	PS								
							x				Accumulators injection Actuation: Passive Front. Syst.: Accumulators	Class 1	F1A	PS								
							x				LHSI injection in CL Actuation: SIS signal [PZR P] Front. Syst.: LHSI	Class 2	F1B	PS								
							x				IRWST borated water storage, collect, filtration Actuation: Passive Front. Syst.: IRWST systems	Class 1	F1A	PS								
							x			Heat removal by Steam Generators - Emergency shutdown mode	EFW actuation (1 train) + SG Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS								
				Other			x	Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	B	Essential component protection	SG Pressure Control - Overpressure protection Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS								
											RCP stop - Auto Actuation: DP over RCP + SIS signal Front. Syst.: RCP	Class 1	F1A	PS								
				Confinement			x	Limit the release of radioactive material from the reactor containment	B	Containment building isolation	Containment isolation stage 1 / Actuation: SIS signal [PZR P] Front. Syst.: Containment isolation valves	Class 1	F1A	PS								

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (9/29)

Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE						Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups			C&I platform	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.			
Decrease in RCS water inventory																						
LOCA up to 20 cm² without MHSI (at power)	RRC-A	-	16.1.3.7	Reactivity Control			x	Shutdown and maintain core sub-criticality	B	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: PZR P HL P Front. Syst.: CRDM	Class 1	F1A	PS	N/A - diversity is applied to frequent initiating event above 10-3/r.y						The EOP followed by the operator is similar to the one presented for PCC event in such case without MHSI isolation
							x	Prevention of uncontrolled positive reactivity insertion into the core	B	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS							
							x				**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS							
				Heat removal			x	Maintain sufficient Reactor Coolant System water inventory for core cooling	B	Water injection into the RCS	**SG Pressure Control - Cooling** Actuation: SIS signal [PZR P] Front. Syst.: MSRT	Class 1	F1A	PS							
							x				**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS							
							x				**LHSI injection in CL** Actuation: SIS signal [PZR P] Front. Syst.: LHSI	Class 1	F1A	PS							
							x		B	Prevention of RCS drainage through auxiliary lines	**Isolation of CVCS letdown line (RCS isolation SI sequence)** Actuation: SIS signal [PZR P] Front. Syst.: CVCS letdown valve	Class 1	F1A	PS							
							x	Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS							
							x				**LHSI switch to RHR mode (1 train)** Activ. & Elec: Manual Front. Syst.: RHRS	Class 2	F1B	SAS							
							x			Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	**IRWST cooling** Actuation: SIS signal [PZR P] Front. Syst.: RHRS	Class 1	F1A	PS							
							x				**Accumulators injection** Actuation: Passive Front. Syst.: Accumulators	Class 1	F1A	PS							
							x				**LHSI injection in CL** Actuation: SIS signal [PZR P] Front. Syst.: LHSI	Class 2	F1B	PS							
							x				**IRWST borated water storage, collect, filtration** Actuation: Passive Front. Syst.: IRWST systems	Class 1	F1A	PS							
							x			Heat removal by Steam Generators - Emergency shutdown mode	**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS							
				Other			x	Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	B	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS							
											RCP stop - Auto Actuation: DP over RCP + SIS signal Front. Syst.: RCP	Class 1	F1A	PS							
				Confinement			x	Limit the release of radioactive material from the reactor containment	B	Containment building isolation	**Containment isolation stage 1 /** Actuation: SIS signal [PZR P] Front. Syst.: Containment isolation valves	Class 1	F1A	PS							

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (10/29)

Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE						
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups			C&I platform	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	Comments
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.			
Decrease in RCS water inventory																						
LOCA up to 20 cm^2 without LHSI (at power)	RRC-A	-	16.1.3.8	Reactivity Control			x	Shutdown and maintain core sub-criticality	B	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: PZR P, HL P Front. Syst.: CRDM	Class 1	F1A	PS	N/A - diversity is applied to frequent initiating event above 10-3/r.y						In such case, due to the loss of LHSI, the cooling is made by the CHRS [EVU] with a cooling of the IRWST. The MHSI are switched to large min flow lines. The cooling is then ensured by a circulation between the cooled IRWST, the MHSI injection and the break.
							x	Prevention of uncontrolled positive reactivity insertion into the core	B	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS							
							x				**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS							
				Heat removal			x	Maintain sufficient Reactor Coolant System water inventory for core cooling	B	Water injection into the RCS	**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS							
							x				**MHSI injection - Auto** Actuation: SIS signal [PZR P] Front. Syst.: MHSI	Class 1	F1A	PS							
							x		B	Prevention of RCS drainage through auxiliary lines	**Isolation of CVCS letdown line (RCS isolation SI sequence)** Actuation: SIS signal [PZR P] Front. Syst.: CVCS letdown valve	Class 1	F1A	PS							
							x	Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS							
							x				**LHSI switch to RHR mode (1 train)** Activ. & Elec: Manual Front. Syst.: RHRS	Class 2	F1B	SAS							
							x			Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	**IRWST cooling** Actuation: SIS signal [PZR P] Front. Syst.: RHRS	Class 1	F1A	PS							
							x				**Accumulators injection** Actuation: Passive Front. Syst.: Accumulators	Class 1	F1A	PS							
							x				**LHSI injection in CL** Actuation: SIS signal [PZR P] Front. Syst.: LHSI	Class 2	F1B	PS							
							x				**IRWST borated water storage, collect, filtration** Actuation: Passive Front. Syst.: IRWST systems	Class 1	F1A	PS							
							x			Heat removal by Steam Generators - Emergency shutdown mode	**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS							
				Other			x	Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	B	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS							
											RCP stop - Auto Actuation: DP over RCP + SIS signal Front. Syst.: RCP	Class 1	F1A	PS							
				Confinement			x	Limit the release of radioactive material from the reactor containment	B	Containment building isolation	**Containment isolation stage 1 / RCPB isolation** Actuation: SIS signal [PZR P] Front. Syst.: Containment isolation valves	Class 1	F1A	PS							

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (11/29)

Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE							
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function	Safety Cat.	Lower Level Safety Function	Safety Functional Groups				C&I platform	Lower Level Safety Function	Safety Functional Groups					Supporting study	Comments
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state	Based on EPR process and international practice for PWR		Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)		Item	Safety class	System Req.		Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)		Item	Safety class	Syst Req.			
Decrease in RCS water inventory																							
SHUTDOWN MODE	Uncontrolled RCS level drop (states C3, D)	PCC2 f>10^{-3}(r.y)	1.10^{-2}	14.3.16	Heat removal	x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Water injection into the RCS	MHSI injection - auto Actuation: SIS signal [RCS L] SIS signal [ΔPsat] Front. Syst.: MHSI	Class 1	F1A	PS	Water injection into the RCS	MHSI injection - auto Actuation: Diversified RCS L Front. Syst.: MHSI	Class 2	F2	SAS	-	
					Heat removal	x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Prevention of RCS drainage through auxiliary lines	Isolation of CVCS letdown line (RCS isolation SI sequence) Actuation: SIS signal [RCS L] SIS signal [ΔPsat] Front. Syst.: CVCS letdown valve	Class 1	F1A	PS	Prevention of RCS drainage through auxiliary lines	Isolation of CVCS letdown line (RCS isolation SI sequence) Actuation: Diversified RCS L Front. Syst.: CVCS letdown valve	Class 2	F2	SAS		
	Small break (not greater than DN 50) including a break occurring on the Extra Boration System injection line (state B)	PCC3 10-4/(r.y)<f<10-2/(r.y)	-	14.4.5	Heat removal	x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Water injection into the RCS	MHSI injection - Auto Actuation: SIS signal [ΔPsat] Front. Syst.: MHSI	Class 1	F1A	PS	Water injection into the RCS	MHSI injection Actuation: Manual Front. Syst.: MHSI	Class 2	F1B	SAS	-	No challenge of reactivity control function
										A	Prevention of RCS drainage through auxiliary lines	Isolation of CVCS letdown line (RCS isolation SI sequence) Actuation: SIS signal [ΔPsat] Front. Syst.: CVCS letdown valve	Class 1	F1A	PS	Prevention of RCS drainage through auxiliary lines	Isolation of CVCS letdown line Actuation: Manual Front. Syst.: CVCS letdown valve	Class 2	F1B	SAS		
					Other	X			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	RCP stop - Auto Actuation: DP over RCP + SIS signal Front. Syst.: RCP	Class 1	F1A	PS	Essential component protection	RCP stop - Manu Activ. & Elec: Manual Front. Syst.: RCP	Class 2	F1B	SAS		
					Confinement	x			Limit the release of radioactive material from the reactor containment	A	Containment building isolation	Containment isolation stage 1 / Actuation: SIS signal [ΔPsat] Front. Syst.: Containment isolation valves	Class 1	F1A	PS	Containment building isolation	Containment isolation Actuation: Manual Front. Syst.: Containment isolation valves	Class 2	F1B	SAS		
	Small break LOCA (not greater than DN 50) including a break in the EBS injection line (states C1, C2)	PCC-4 10-6/(r.y)<f<10-4/(r.y)	-	14.5.7	N/A				This transient is similar to the SB LOCA in state B, in terms of systems actuation. One MHSI pump is sufficient to manage the sequence.														
	Isolable Safety Injection System break (≤ DN 250) in residual heat removal mode (states C, D)	PCC-4 10-6/(r.y)<f<10-4/(r.y)	-	14.5.14	Heat removal	x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Water injection into the RCS	MHSI injection - Auto Actuation: SIS signal [RCS L] SIS signal [ΔPsat] Front. Syst.: MHSI	Class 1	F1A	PS	N/A - diversity is applied to frequent initiating event above 10-3/r.y	Only the main features of the mitigation are presented. The heat removal is ensured thanks ot the other RHRS trains. Reactivity control is not impaired. There is no specific EOP since the transient occur in shutdown state.					
										A	Prevention of RCS drainage through auxiliary lines	Isolation of CVCS letdown line (RCS isolation SI sequence) Actuation: SIS signal [RCS L] SIS signal [ΔPsat] Front. Syst.: CVCS letdown valve	Class 1	F1A	PS							
						x				A	Heat removal from containment by Containment Heat Removal system (CHRS)	Start-up of IRWST pool cooling by Actuation: Manual Front. Syst.: CHRS	Class 2	F2	SAS							
					Confinement	x			Limit the release of radioactive material from the reactor containment	A	Containment building isolation	Containment isolation stage 1 / Actuation: SIS signal [RCS L] SIS signal [ΔPsat] Front. Syst.: Containment isolation valves	Class 1	F1A	PS							
	Uncontrolled RCS level drop without SI signal from PS (in shutdown state)	RRC-A	-	16.1.3.9	Heat removal			x	Maintain sufficient Reactor Coolant System water inventory for core cooling	B	Prevention of RCS drainage through auxiliary lines	Isolation of CVCS letdown line Actuation: RCS L Front. Syst.: CVCS letdown valve	Class 3	F2	PS	N/A - diversity is applied to frequent initiating event above 10-3/r.y	Only the main features of the mitigation are presented. The heat removal is ensured thanks ot the RHRS trains. Reactivity control is not impaired. There is no specific EOP since the transient occur in shutdown state.					

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (12/29)

No.	Input to classification: Fault description	References: Category	References: Frequency	References: PCSR Ref.	Main Safety Function	Transient phases: Cont. state	Transient phases: Safe state	Transient phases: Final state	SAFETY FUNCTION: Plant Level Safety Function (Based on EPR process and international practice for PWR)	SAFETY FUNCTION: Safety Cat.	MAIN LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	MAIN LINE: Safety Functional Groups: Item	MAIN LINE: Safety Functional Groups: Safety class	MAIN LINE: Safety Functional Groups: System Req.	DIVERSE LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	DIVERSE LINE: Safety Functional Groups: Item	DIVERSE LINE: Safety Functional Groups: Safety class	DIVERSE LINE: Safety Functional Groups: Syst Req.	DIVERSE LINE: Supporting study	Comments
Steam Generator Tube Rupture																				
POWER OPERATIONS	Steam Generator tube rupture (1 tube)	PCC-3 10-4/(r.y)<f<10-2/(r.y)	9.8.10^{-4}	14.4.6	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip** Actuation: PZR P Manual Front. Syst.: CRDM	Class 1	F1A	PS	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified** Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	Class 2	F2	PS	ATWS cover	The occurrence of SG level as RT depends on the level of power of the plant is operated. Manual RT of main line is actuated by operator on KRT V/P detecors which are class 1 (F1A).
						X			Shutdown and maintain core sub-criticality	A					Negative reactivity fast insertion	**Reactor trip - auto** Actuation: HL P Front. Syst.: CRDM	Class 2	F2	SAS		
						x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS	RCS overcooling protection	**MSIV closure** Actuation: SG P Front. Syst.: MSIV	Class 1	F1A	PS	Excessive increase in steam flow study	
						x						**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS		**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 2	F2	SAS	SAS order in case of ATWS following PS failure	
					Heat removal	x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Water injection into the RCS	**SG Pressure Control - Cooling - Auto (MSRT)** Actuation: SIS signal [PZR P] Front. Syst.: MSRT	Class 1	F1A	PS	Water injection into the RCS	**SG Pressure Control - Cooling - Manu** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS	Covered by LOCA (BREAK SIZE UP TO 20 CM2) WITH FAILURE OF THE PARTIAL COOL-DOWN SIGNAL (STATE A) - PCSR Sub-chapter 16.1.3.3.6	
						x						**MHSI injection - Auto** Actuation: SIS signal [PZR P] Front. Syst.: MHSI	Class 1	F1A	PS		**LHSI in cold leg** Actuation: Manual Front. Syst.: LHSI	Class 2	F1B	SAS	Covered by LOCA (BREAK SIZE UP TO 20 CM2) WITHOUT MHSI (STATE A) - PCSR Sub-chapter 16.1.3.3.7	
	Steam Generator tube rupture (2 tubes in 1 SG) (State A)	PCC-4 10-6/(r.y)<f<10-4/(r.y)	2.10^{-4}	14.5.10		x			Prevention of RCS drainage through auxiliary lines	A	Prevention of RCS drainage through auxiliary lines	**Isolation of CVCS letdown line (RCS isolation SI sequence)** Actuation: SIS signal [PZR P] Front. Syst.: CVCS letdown valve	Class 1	F1A	PS	Prevention of RCS drainage through auxiliary lines	**Isolation of CVCS letdown line** Actuation: Manual Front. Syst.: CVCS letdown valve	Class 2	F1B	SAS	-	
						x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS	-	The operator may perform a fast cooldown with the 3 unaffected SGs to cool down the plant. This action will be performed locally after 1 hour. The combination of SGTR + failure of all MSRT leads to a transient enough unfrequent to limit the requirements in terms of diversity.
						x						**EFW actuation (1 train) + SG Blowdown isolation** Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS		**EFW actuation (1 train)** Actuation: Manual Front. Syst.: EFWS	Class 2	F1B	SAS		
					Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Essential component protection	**SG safety valves opening** Actuation: Passive Front. Syst.: MSSV	Class 1	F1A	-	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
					Confinement	x			Limit the release of waste and airborne radioactive material	A	Limitation of radioactive release outside containment from radioactive Steam Generator	**Steam line isolation (1SG)** Actuation: SG L + PCD finished Front. Syst.: MSIV	Class 1	F1A	PS	Limitation of radioactive release outside containment from radioactive Steam Generator	**Steam line isolation (1SG)** Actuation: Manual Front. Syst.: MSIV	Class 2	F1B	SAS	-	In case of failure of MSRTa setpoint increase and SGa isolation, the operator can also isolate the unaffected SGs by closing the other MSIV in case of single failure of the MSIV of SGa
						x						**Isolation of CVCS charging line** Actuation: SG L + PCD finished Front. Syst.: CVCS	Class 1	F1A	PS		**Isolation of CVCS charging line** Actuation: Manual Front. Syst.: CVCS	Class 2	F1B	SAS		
						x						**MSRT setpoint increase - Auto** Actuation: SG L + PCD finished Front. Syst.: MSRT	Class 1	F1A	PS		**MSRT setpoint increase - Manu** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS		
	Emergency Operating Procedure	All	N/A	All	Reactivity Control		x		Shutdown and maintain core sub-criticality	B	Compensation for shutdown moderator effect	**Emergency boron injection into the core - Manual** Actuation: Manual Front. Syst.: EBS	Class 2	F1B	SAS	See Appendix A					MHSI stop (1 train) is indicated combined with RHRS actuation since it is one of the conditions to connect RHRS in such case. The same reasoning is applied for the opening of MSRT of the SGa to perform the depressurization of both RCS and SGa in the end of the transient. LHSI injection in HL is only used in case of LB LOCA.
					Heat removal		x		Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS						
							x			B	Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	**MHSI stop (1 train)** Actuation: SIS signal [PZR P] Front. Syst.: MHSI	Class 2	F1B	SAS						
							x			B		**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRTa	Class 2	F1B	SAS						
							x			B		**LHSI switch to RHR mode (1 train)** Activ. & Elec: Manual Front. Syst.: RHRS	Class 2	F1B	SAS						
					Confinement		x		Limit the release of waste and airborne radioactive material	B	Limitation of radioactive release outside containment from radioactive Steam Generator	**Steam line isolation (1SG)** Actuation: Manual Front. Syst.: MSIV	Class 2	F1B	SAS						
							x					**MSRT setpoint increase** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS						
					Other		x		Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	B	Essential component protection	**EFWS isolation (1 train)** Actuation: Manual Front. Syst.: EFWS injection lines & storages	Class 2	F1B	SAS						
												Transfer line opening between two Actuation: Manual Front. Syst.: EFWS injection lines & storages	Class 2	F1B	SAS						

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (13/29)

Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE							Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function	Safety Cat.	Lower Level Safety Function	Safety Functional Groups					Lower Level Safety Function	Safety Functional Groups					Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state	Based on EPR process and international practice for PWR		Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)		Item	Safety class	System Req.		Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)		Item	Safety class	Syst Req.			
Increase in Heat Removal																							
Feedwater malfunction - T_{mfws} decrease	**PCC-2 f>10-2/(r.y)**	**> 1.10^{-2}**	**14.3.1**	**N/A**				Transient not studied in the PCSR - part of Site Licensing															
Feedwater malfunction - Q_{mfws} increase	**PCC-2 f>10-2/(r.y)**	**> 1.10^{-2}**	**14.3.2**	**N/A**				Transient not studied in the PCSR - part of Site Licensing															
Excessive increase in secondary steam flow	**PCC-2 f>10-2/(r.y)**	**$7.5.10^{-2}$**	**14.3.3**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: DNBR or HCPL Front. Syst.: CRDM	**Class 1**	**F1A**	**PS**	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified** Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	**Class 2**	**F2**	**PS**	PCSR Sub-chapter 16.1.3.3.1 - ATWS Excessive increase in steam flow by rod drop failure	
					x			Shutdown and maintain core sub-criticality	A						Negative reactivity fast insertion	**Reactor trip - auto** Actuation: SG L Front. Syst.: CRDM	**Class 2**	**F2**	**SAS**		
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	**Class 1**	**F1A**	**PS**	RCS overcooling protection	**MSIV closure** Actuation: SG P Front. Syst.: MSIV	**Class 1**	**F1A**	**PS**	Excessive increase in steam flow study	
					x						**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 1**	**F1A**	**PS**		**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 2**	**F2**	**SAS**	SAS order in case of ATWS following PS failure	
Small steam system piping failure to SG	**PCC-3 10-4/(r.y)<f<10-2/(r.y)**	**2.10^{-3}**	**14.4.1**		x						**Low load MFW isolation (1SG)** Actuation: SG P Front. Syst.: Low load MFW isolation valves	**Class 1**	**F1A**	**PS**		**Low load MFW isolation (1SG)** Actuation: Manual Front. Syst.: Low load isolation valves	**Class 2**	**F2**	**SAS**		
					x						**Steam line isolation (1SG)** Activ. & Elec: SG P Front. Syst.: MSIV	**Class 1**	**F1A**	**PS**		**Steam line isolation (1SG)** Activ. & Elec: Manual Front. Syst.: MSIV	**Class 2**	**F1B**	**SAS**	-	
				Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident** Actuation: Manual Front. Syst.: PDS	**Class 2**	**F2**	**SAS**	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
					x						**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages	**Class 1**	**F1A**	**PS**		**SIS [RIS] in cold leg** Actuation: Manual Front. Syst.: MHSI + LHSI	**Class 2**	**F1B**	**SAS**		
					x											**RCP stop - Manu** Activ. & Elec: Manual Front. Syst.: RCP	**Class 2**	**F1B**	**SAS**		
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**	Essential component protection	**SG safety valves opening** Actuation: Passive Front. Syst.: MSSV	**Class 1**	**F1A**	**-**	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
				Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	**Hot overpressure protection** Actuation: Passive Front. Syst.: PSV	**Class 1**	**F1A**	**-**	RCS overpressure protection	**Hot overpressure protection** Activ. & Elec: Passive Front. Syst.: PSV	**Class 1**	**F1A**	**-**	Primary overpressure studies of Sub-chapter 3.4.1.5 illustrate	

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (14/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE						Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.			
Increase in Heat Removal																					
Inadvertent opening of a SG relief train or of a Safety valve (state A)	**PCC-3 10-4/(r.y)<f<10-2/(r.y)**	**> 10^{-3}**	**14.4.4**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: DNBR or HCPL Front. Syst.: CRDM	**Class 1**	**F1A**	**PS**	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified** Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	**Class 2**	**F2**	**PS**	PCSR Sub-chapter 16.1.3.3.1 - ATWS Excessive increase in steam flow by rod drop failure	
					x				A	High concentrated boron injection	**Emergency boron injection into the core - Auto** Activ. & Elec: SG P Front. Syst.: EBS	**Class 1**	**F1A**	**PS**	High concentrated and high pressure boron injection	**Emergency boron injection into the core - manu** Actuation: Manual Front. Syst.: EBS	**Class 2**	**F2**	**PS**		
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	**Class 1**	**F1A**	**PS**	RCS overcooling protection	**MSIV closure** Actuation: SG P Front. Syst.: MSIV	**Class 1**	**F1A**	**PS**	Excessive increase in steam flow study	
					x						**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 1**	**F1A**	**PS**		**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 2**	**F2**	**SAS**	SAS order in case of ATWS following PS failure	
					x						**Low load MFW isolation (1SG)** Actuation: SG P Front. Syst.: Low load MFW isolation valves	**Class 1**	**F1A**	**PS**		**Low load MFW isolation (1SG)** Actuation: Manual Front. Syst.: Low load isolation valves	**Class 2**	**F2**	**SAS**		
					x						**Steam line isolation (1SG)** Activ. & Elec: SG P Front. Syst.: MSIV	**Class 1**	**F1A**	**PS**		**Steam line isolation (1SG)** Activ. & Elec: Manual Front. Syst.: MSIV	**Class 2**	**F1B**	**SAS**	-	
					x						**MSRT isolation (1 SG isolation** Activ. & Elec: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**		**MSRT isolation (1 SG isolation** Activ. & Elec: Manual Front. Syst.: MSRT	**Class 2**	**F1B**	**SAS**	-	
				Heat removal	x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Water injection into the RCS	**SG Pressure Control - Cooling - Auto (MSRT)** Actuation: SIS signal [PZR P] Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**	Water injection into the RCS	**SG Pressure Control - Cooling - Manu** Actuation: Manual Front. Syst.: MSRT	**Class 2**	**F1B**	**SAS**	-	
					x						**MHSI injection - Auto** Actuation: SIS signal [PZR P] Front. Syst.: MHSI	**Class 1**	**F1A**	**PS**		**LHSI in cold leg** Actuation: Manual Front. Syst.: LHSI	**Class 2**	**F1B**	**SAS**	-	
					x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident discharge line** Actuation: Manual Front. Syst.: PDS	**Class 2**	**F2**	**SAS**	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
					x						**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages	**Class 1**	**F1A**	**PS**		**SIS [RIS] in cold leg** Actuation: Manual Front. Syst.: MHSI + LHSI	**Class 2**	**F1B**	**SAS**		
					x											**RCP stop - Manu** Activ. & Elec: Manual Front. Syst.: RCP	**Class 2**	**F1B**	**SAS**		
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**	Essential component protection	**SG safety valves opening** Actuation: Passive Front. Syst.: MSSV	**Class 1**	**F1A**	**-**	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (15/29)

Input to classification								SAFETY FUNCTION		MAIN LINE						DIVERSE LINE							
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups					Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups					Supporting study	Comments
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state					Item	Safety class	System Req.				Item	Safety class	Syst Req.			
Increase in Heat Removal																							
Steam system line break (states A and B)	**PCC-4 10-6/(r.y)<f<10-4/(r.y)**	**-**	**14.5.2**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: dP/dt Front. Syst.: CRDM		**Class 1**	**F1A**	**PS**								
					x				A	High concentrated boron injection	**Emergency boron injection into the core - Auto** Activ. & Elec: SG P Front. Syst.: EBS		**Class 1**	**F1A**	**PS**								
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves		**Class 1**	**F1A**	**PS**								
					x						**Full load MFW isolation (4 SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves		**Class 1**	**F1A**	**PS**								
					x						**EFW isolation (1 SG)** Actuation: Manual Front. Syst.: EFWS injection lines		**Class 1**	**F1A**	**PS**								
					x						**Steam line isolation (1SG)** Activ. & Elec: dP/dt, SG P Front. Syst.: MSIV		**Class 1**	**F1A**	**PS**								
				Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Activ. & Elec: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**								
					x						**EFW actuation (1 train) + SG Blowdown Isolation** Activ. & Elec: SG L Front. Syst.: EFWS injection lines & storages		**Class 1**	**F1A**	**PS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y			
					x			Maintain sufficient reactor coolant system water inventory for core cooling	A	Water injection into the RCS	**SG Pressure Control - Cooling - Auto** Activ. & Elec: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**								
											MHSI injection - Auto Activ. & Elec: PZR P Front. Syst.: MHSI		**Class 1**	**F1A**	**PS**								
									A	Prevention of RCS drainage through auxiliary lines	**RCS isolation** Activ. & Elec: SIS signal Front. Syst.: CVCS letdown valve		**Class 1**	**F1A**	**PS**								
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**								
				Confinement	x			Limit the release of radioactive material from the reactor containment	A	Containment building isolation	**Containment isolation stage 1** Actuation: SIS signal [PZR P] Front. Syst.: Containment isolation valves		**Class 1**	**F1A**	**PS**								
											Containment isolation stage 2 Actuation: SIS signal [PZR P] Front. Syst.: Containment isolation valves		**Class 1**	**F1A**	**PS**								
Inadvertent opening of a SG relief train or Safety valve (state B)	**PCC-4 10-6/(r.y)<f<10-4/(r.y)**	**-**	**14.5.4**	**N/A**						Transient covered by Steam piping break													
Emergency Operating Procedure	**All**	**N/A**	**All**	**Reactivity Control**		x		Shutdown and maintain core sub-criticality	B	Compensation for shutdown moderator effect	**Emergency boron injection into the core - Manual** Actuation: Manual Front. Syst.: EBS		**Class 2**	**F1B**	**SAS**	See Appendix A	N/A					
						x			B	RCS overcooling protection	**Low load MFW isolation (4SG)** Actuation: Manual Front. Syst.: Full load MFW isolation valves		**Class 2**	**F1B**	**SAS**								
						x					**Steam line isolation (1SG)** Activ. & Elec: Manual Front. Syst.: MSIV		**Class 2**	**F1B**	**SAS**								
				Heat removal		x		Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRT		**Class 2**	**F1B**	**SAS**								
									B	Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	**RCS depressurisation by PZR** Activ. & Elec: Manual Front. Syst.: PSV		**Class 2**	**F1B**	**SAS**								
						x			B		**RHR connection and start-up (no SI signal)** Activ. & Elec: Manual Front. Syst.: RHRS		**Class 2**	**F1B**	**SAS**								

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (16/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE							
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	Comments
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item		Safety class	System Req.		Item		Safety class	Syst Req.			
Decrease in Heat Removal																						
Turbine Trip **Loss of condenser vacuum**	**PCC-2 f>10-2/(r.y)**	**2.5.10^{-1}** **1.5.10^{-1}**	**14.3.4** **14.3.5**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: PZR P, SG P Front. Syst.: CRDM		**Class 1**	**F1A**	**PS**	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified** Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS		**Class 2**	**F2**	**PS**	PCSR Sub-chapter 16.1.3.3.1 - ATWS LOFW by rod drop failure covers the ATWS LOCV	ATWS are not postulated for PCC-3 and PCC-4 events
					x			Shutdown and maintain core sub-criticality	A						Negative reactivity fast insertion	**Reactor trip - auto** Actuation: HL P Front. Syst.: CRDM		**Class 2**	**F2**	**SAS**		
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves		**Class 1**	**F1A**	**PS**	RCS overcooling protection	**MSIV closure** Actuation: SG P Front. Syst.: MSIV		**Class 1**	**F1A**	**PS**	Excessive increase in steam flow study	**TT initiating event**
					x						**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves		**Class 1**	**F1A**	**PS**		**Full load MFW isolation (4SG)** Actuation: RT checkback SG L Front. Syst.: Full load MFW isolation valves		**Class 2**	**F2**	**SAS**	SAS order in case of ATWS following PS failure	
					x						**Steam line isolation (1SG)** Activ. & Elec: SG P Front. Syst.: MSIV		**Class 1**	**F1A**	**PS**		**Steam line isolation (1SG)** Activ. & Elec: Manual Front. Syst.: MSIV		**Class 2**	**F1B**	**SAS**	-	Only in case of loss of condenser (1) due to the single failure on MSRIV and small feedwater system piping (3) due to the break.
					x						**MSRT isolation (1 SG isolation valve closure)** Activ. & Elec: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**		**MSRT isolation (1 SG isolation valve closure)** Activ. & Elec: Manual Front. Syst.: MSRT		**Class 2**	**F1B**	**SAS**	-	Only in case of loss of condenser (1), due to the single failure on MSRIV
				Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident discharge line** Actuation: Manual Front. Syst.: PDS		**Class 2**	**F2**	**SAS**	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
					x						**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages		**Class 1**	**F1A**	**PS**		**SIS [RIS] in cold leg** Actuation: Manual Front. Syst.: MHSI + LHSI		**Class 2**	**F1B**	**SAS**		
					x												**RCP stop - Manu** Activ. & Elec: Manual Front. Syst.: RCP		**Class 2**	**F1B**	**SAS**		
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**	Essential component protection	**SG safety valves opening** Actuation: Passive Front. Syst.: MSSV		**Class 1**	**F1A**	**-**	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
				Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	**Hot overpressure protection** Actuation: Passive Front. Syst.: PSV		**Class 1**	**F1A**	**-**	RCS overpressure protection	**Hot overpressure protection** Activ. & Elec: Passive Front. Syst.: PSV		**Class 1**	**F1A**	**-**	Primary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
Loss of normal feedwater flow	**PCC-2 f>10-2/(r.y)**	**6.25.10^{-3}**	**14.3.7**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: **SG L**, PZR P Front. Syst.: CRDM		**Class 1**	**F1A**	**PS**	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified** Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS		**Class 2**	**F2**	**PS**	PCSR Sub-chapter 16.1.3.3.1 - ATWS LOMFW	A partial trip may occur before actuation of the RT on loss of normal feedwater. See Total Loss of FeedWater sequence below
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves		**Class 1**	**F1A**	**PS**	RCS overcooling protection	**MSIV closure** Actuation: SG P Front. Syst.: MSIV		**Class 1**	**F1A**	**PS**	Excessive increase in steam flow study	
				Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident discharge line** Actuation: Manual Front. Syst.: PDS		**Class 2**	**F2**	**SAS**	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
					x						**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages		**Class 1**	**F1A**	**PS**		**SIS [RIS] in cold leg** Actuation: Manual Front. Syst.: MHSI + LHSI		**Class 2**	**F1B**	**SAS**		
					x												**RCP stop - Manu** Activ. & Elec: Manual Front. Syst.: RCP		**Class 2**	**F1B**	**SAS**		
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT		**Class 1**	**F1A**	**PS**	Essential component protection	**SG safety valves opening** Actuation: Passive Front. Syst.: MSSV		**Class 1**	**F1A**	**-**	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
				Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	**Hot overpressure protection** Actuation: Passive Front. Syst.: PSV		**Class 1**	**F1A**	**-**	RCS overpressure protection	**Hot overpressure protection** Activ. & Elec: Passive Front. Syst.: PSV		**Class 1**	**F1A**	**-**	Primary overpressure studies of Sub-chapter 3.4.1.5 illustrate	

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (17/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE								
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups					Supporting study	Comments
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.				
Increase in Heat Removal																							
Small feedwater system piping failure	PCC-3 10-4/(r.y)<f<10-2/(r.y)	2.10^{-3}	14.4.1	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	Reactor trip - auto Actuation: HCPL / DNBR SG P Front. Syst.: CRDM	Class 1	F1A	PS	High concentrated and high pressure boron injection	Emergency boron injection into the core - diversified Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	Class 2	F2	PS	PCSR Sub-chapter 16.1.3.3.1 - ATWS LOFW	ATWS are not postulated for PCC-3 and PCC-4 events
					x			Shutdown and maintain core sub-criticality	A						Negative reactivity fast insertion	Reactor trip - auto Actuation: high neutron flux HL P Front. Syst.: CRDM	Class 2	F2	SAS		
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	Turbine Trip Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS	RCS overcooling protection	MSIV closure Actuation: SG P Front. Syst.: MSIV	Class 1	F1A	PS	Excessive increase in steam flow study	
					x						Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS		Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 2	F2	SAS	SAS order in case of ATWS following PS failure	
					x						Steam line isolation (1SG) Activ. & Elec: SG P Front. Syst.: MSIV	Class 1	F1A	PS		Steam line isolation (1SG) Activ. & Elec: Manual Front. Syst.: MSIV	Class 2	F1B	SAS	-	
				Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Heat removal by Low Head Emergency Core Cooling System (ECCS)	Opening of severe accident discharge line Actuation: Manual Front. Syst.: PDS	Class 2	F2	SAS	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
					x						EFW actuation (1 train) + SG Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS		SIS [RIS] in cold leg Actuation: Manual Front. Syst.: MHSI + LHSI	Class 2	F1B	SAS		
					x											RCP stop - Manu Activ. & Elec: Manual Front. Syst.: RCP	Class 2	F1B	SAS		
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	SG Pressure Control - Overpressure protection Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Essential component protection	SG safety valves opening Actuation: Passive Front. Syst.: MSSV	Class 1	F1A	-	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
				Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	Hot overpressure protection Actuation: Passive Front. Syst.: PSV	Class 1	F1A	-	RCS overpressure protection	Hot overpressure protection Activ. & Elec: Passive Front. Syst.: PSV	Class 1	F1A	-	Primary overpressure studies of Sub-chapter 3.4.1.5 illustrate	The overpressure protection is ensured thnaks to the 3 PSVs. It can be demonstrated that no CCF will impair the
Inadvertent closure of one / all main steam isolation valves	PCC-3 10-4/(r.y)<f<10-2/(r.y)	1 MSIV: 1.8.10^{-2} All MSIV: 2.10^{-3}	14.4.7	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	Reactor trip - auto Actuation: PZR P SG P Front. Syst.: CRDM	Class 1	F1A	PS	High concentrated and high pressure boron injection	Emergency boron injection into the core - diversified Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	Class 2	F2	PS	PCSR Sub-chapter 16.1.3.3.1 - ATWS LOFW	
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	Turbine Trip Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS	RCS overcooling protection	MSIV closure Actuation: SG P Front. Syst.: MSIV	Class 1	F1A	PS	Excessive increase in steam flow study	
					x						Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS		Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	Class 2	F2	SAS	-	
				Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Heat removal by Low Head Emergency Core Cooling System (ECCS)	Opening of severe accident discharge line Actuation: Manual Front. Syst.: PDS	Class 2	F2	SAS	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
					x						EFW actuation (1 train) + SG Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS		SIS [RIS] in cold leg Actuation: Manual Front. Syst.: MHSI + LHSI	Class 2	F1B	SAS		
					x											RCP stop - Manu Activ. & Elec: Manual Front. Syst.: RCP	Class 2	F1B	SAS		
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	SG Pressure Control - Overpressure protection Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Essential component protection	SG safety valves opening Actuation: Passive Front. Syst.: MSSV	Class 1	F1A	-	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
				Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	Hot overpressure protection Actuation: Passive Front. Syst.: PSV	Class 1	F1A	-	RCS overpressure protection	Hot overpressure protection Activ. & Elec: Passive Front. Syst.: PSV	Class 1	F1A	-	Primary overpressure studies of Sub-chapter 3.4.1.5 illustrate	

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (18/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE						Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state					Item	Safety class	System Req.		Item	Safety class	Syst Req.			
Increase in Heat Removal																					
Feedwater line break	PCC-4 10-6/(r.y)<f<10-4/(r.y)	-	14.5.3	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: dP/dt SG L Front. Syst.: CRDM		Class 1	F1A	PS	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
					x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves		Class 1	F1A	PS						
					x						**Steam line isolation (1SG)** Activ. & Elec: dP/dt Front. Syst.: MSIV		Class 1	F1A	PS						
				Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT		Class 1	F1A	PS						
					x						**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages		Class 1	F1A	PS						
					x						**Re-alignment of EFWS pump discharge & suction** Actuation: Manual Front. Syst.: EFWS injection lines & storages		Class 1	F1A	-						
				Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT		Class 1	F1A	PS						
				Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	**Hot overpressure protection** Actuation: Passive Front. Syst.: PSV		Class 1	F1A	-						
Emergency Operating Procedure	All	N/A	All	Reactivity Control		x		Shutdown and maintain core sub-criticality	B	Compensation for shutdown moderator effect	**Emergency boron injection into the core - Manual** Actuation: Manual Front. Syst.: EBS		Class 2	F1B	SAS	See Appendix A					* Only the EFWS of the SG affected by the FeedWater Line Break is isolated - whatever the size of the break.
				Heat removal		x		Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRT		Class 2	F1B	SAS						
						x			B	Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	**EFW isolation*** Actuation: Manual Front. Syst.: EFWS injection lines		Class 1	F1A	PS						
						x			B		**RCS depressurisation by PZR safety valves** Actuation: Manual Front. Syst.: PSV		Class 2	F1B	SAS						
						x			B		**RHR connection and start-up (no SI signal)** Activ. & Elec: Manual Front. Syst.: RHRS		Class 2	F1B	SAS						
				Confinement		x		N/A													

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (19/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE					Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.			
Increase in Heat Removal																					
Total Loss Of the Cooling Chain leading to a leakage on RCP [RCS] pumps seals (state A) **TLOCC in state D**	**RRC-A**	**-**	**16.3.5** **16.3.5.11**	**Reactivity Control**			x	Shutdown and maintain core sub-criticality	B	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: Low RCP speed Low RCS loop flowrate Front. Syst.: CRDM	**Class 1**	**F1A**	**PS**	See Appendix A						This part of transient is valid as long as the cooling of MHSI pumps is efficient (~5 minutes). Later the MHSI are lost and the end of the transient is similar to the RRC-A sequences SB LOCA with loss of MHSI. However, in case of TLOCC, there is a need to consider a diverse cooling chaing constituted by the 2 LHSI trains connected to the diverse cooling chain with EVU/SRU. TLOCC in state D relies on the CHRS [EVU] capacities to remove heat with the same features as the one of TLOCC in state A.
							x	Prevention of uncontrolled positive reactivity insertion into the core	B	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves **Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 1**	**F1A**	**PS**							
				Heat removal			x	Maintain sufficient Reactor Coolant System water inventory for core cooling	B	Water injection into the RCS	**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRT **MHSI injection - Auto** Actuation: SIS signal [PZR P] Front. Syst.: MHSI **SG Pressure Control - Cooling** Actuation: SIS signal [PZR P] Front. Syst.: MSRT **LHSI injection diversified** Actuation: Manual Front. Syst.: LHSI	**Class 2** **Class 1** **Class 2**	**F1B** **F1A** **F2**	**SAS** **PS** **SAS**						
							x	Prevention of RCS drainage through auxiliary lines	B	Prevention of RCS drainage through auxiliary lines	**Isolation of CVCS letdown line** Actuation: SIS signal [PZR P] Front. Syst.: CVCS letdown valve	**Class 1**	**F1A**	**PS**							
							x	Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**							
							x				**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages	**Class 1**	**F1A**	**PS**							
							x			Heat removal from containment by Containment Heat Removal system (CHRS)	**Start-up of IRWST pool cooling by CHRS** Actuation: Manual Front. Syst.: CHRS	**Class 2**	**F2**	**SAS**							
				Confinement			x	Limit the release of radioactive material from the reactor containment	B	Containment building isolation	**Containment isolation** Actuation: Manual Front. Syst.: Containment isolation valves	**Class 2**	**F1B**	**SAS**							
Loss of one cooling train of the SIS / RHRS in RHR mode (states C & D)	**PCC-2 f>10-2/(r.y)**	**> 1.10^{-2}**	**14.3.17**	**Heat removal**	**x**			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal in shutdown mode by Residual Heat Removal System (RHRS)	Transient without any consequences as 2 LHSI / RHRS in operation are sufficient to guarantee heat removal - the operator can actuate another RHR train - Class 2				The diversity can be illustrated by the Total Loss of Cooling Chain sequences						

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (20/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE						Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state					Item	Safety class	System Req.			Item	Safety class	Syst Req.		
Increase in Heat Removal																					
Total Loss Of FeedWater	RRC-A	-	16.1.3.3	Reactivity Control			x	Shutdown and maintain core sub-criticality	B	Negative reactivity fast insertion	**Partial and Reactor trip - auto** Actuation Front. Syst.	Mismatch between reactor power and ARE flow SG L CRDM	Class 3	F2	RCSL/PS	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
							x	Prevention of uncontrolled positive reactivity insertion into the core	B	RCS overcooling protection	**Turbine Trip** Actuation Front. Syst.	RT checkback Turbine admission valves	Class 1	F1A	PS						
				Heat removal			x	Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident discharge line** Actuation Front. Syst.	Manual PDS	Class 2	F2	SAS						
							x				**SIS [RIS] in cold leg** Actuation Front. Syst.	Manual MHSI + LHSI	Class 2	F1B	SAS						
							x				**Containment isolation** Actuation Front. Syst.	Manual Containment isolation valves	Class 2	F1B	SAS						
							x				**IRWST borated water storage,** Actuation Front. Syst.	Passive IRWST systems	Class 1	F1A	PS						
							x				**IRWST cooling** Actuation Front. Syst.	Manual MHSI + LHSI	Class 1	F1A	PS						
							x				**RCP stop - Manu** Activ. & Elec Front. Syst.	Manual RCP	Class 2	F1B	SAS						
				Other			x	Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	B	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation Front. Syst.	SG P MSRT	Class 1	F1A	PS						
				Confinement			x	Limit the release of radioactive material from the reactor containment	B	Containment building isolation	**Containment isolation** Actuation Front. Syst.	Manual Containment isolation valves	Class 2	F1B	SAS						
							x	Maintain integrity of the Reactor Coolant Pressure Boundary	B	RCS overpressure protection	**Hot overpressure protection** Actuation Front. Syst.	Passive PSV	Class 1	F1A	-						

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (21/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE						Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state					Item	Safety class	System Req.		Item	Safety class	Syst Req.			
Increase in Heat Removal																					
Total Loss Of the Cooling Chain leading to a leakage on RCP [RCS] pumps seals (state A) **TLOCC in state D**	**RRC-A**	**-**	**16.3.5** **16.3.11**	**Reactivity Control**			x	Shutdown and maintain core sub-criticality	B	Negative reactivity fast insertion	**Reactor trip - auto** Actuation Front. Syst.	 Low RCP speed Low RCS loop flowrate CRDM	**Class 1**	**F1A**	**PS**	See Appendix A						
							x	Prevention of uncontrolled positive reactivity insertion into the core	B	RCS overcooling protection	**Turbine Trip** Actuation Front. Syst. **Full load MFW isolation (4SG)** Actuation Front. Syst.	 RT checkback Turbine admission valves RT checkback Full load MFW isolation valves	**Class 1**	**F1A**	**PS**							
				Heat removal			x	Maintain sufficient Reactor Coolant System water inventory for core cooling	B	Water injection into the RCS	**SG Pressure Control - Cooling** Actuation Front. Syst. **MHSI injection - Auto** Actuation Front. Syst. **SG Pressure Control - Cooling** Actuation Front. Syst. **LHSI injection diversified** Actuation Front. Syst.	 Manual MSRT SIS signal [PZR P] MHSI SIS signal [PZR P] MSRT Manual LHSI	**Class 2** **Class 1** **Class 1** **Class 2**	**F1B** **F1A** **F1A** **F2**	**SAS** **PS** **PS** **SAS**							This part of transient is valid as long as the cooling of MHSI pumps is efficient (~5 minutes). Later the MHSI are lost and the end of the transient is similar to the RRC-A sequences SB LOCA with loss of MHSI. However, in case of TLOCC, there is a need to consider a diverse cooling chaing constituted by the 2 LHSI trains connected to the diverse cooling chain with EVU/SRU.
							x	Prevention of RCS drainage through auxiliary lines	B		**Isolation of CVCS letdown line** Actuation Front. Syst.	 SIS signal [PZR P] CVCS letdown valve	**Class 1**	**F1A**	**PS**							
							x	Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation Front. Syst. **EFW actuation (1 train) + SG** Actuation Front. Syst.	 SG P MSRT SG L EFWS injection lines & storages	**Class 1**	**F1A**	**PS**							TLOCC in state D relies on the CHRS [EVU] capacities to remove heat with the same features as the one of TLOCC in state A.
							x			Heat removal from containment by Containment Heat Removal system (CHRS)	**Start-up of IRWST pool cooling by CHRS** Actuation Front. Syst.	 Manual CHRS	**Class 2**	**F2**	**SAS**							
				Confinement			x	Limit the release of radioactive material from the reactor containment	B	Containment building isolation	**Containment isolation** Actuation Front. Syst.	 Manual Containment isolation valves	**Class 2**	**F1B**	**SAS**							
Loss of one cooling train of the SIS / RHRS in RHR mode (states C & D)	**PCC-2 f>10-2/(r.y)**	**> 1.10^{-2}**	**14.3.17**	**Heat removal**	**x**			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal in shutdown mode by Residual Heat Removal System (RHRS)	Transient without any consequences as 2 LHSI / RHRS in operation are sufficient to guarantee heat removal - the operator can actuate another RHR train - Class 2					The diversity can be illustrated by the Total Loss of Cooling Chain sequences						

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (22/29)

No.	Input to classification: Fault description	References: Category	References: Frequency	References: PCSR Ref.	Main Safety Function	Transient phases: Cont. state	Transient phases: Safe state	Transient phases: Final state	SAFETY FUNCTION: Plant Level Safety Function (Based on EPR process and international practice for PWR)	SAFETY FUNCTION: Safety Cat.	MAIN LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	MAIN LINE: Safety Functional Groups: Item	MAIN LINE: Safety Functional Groups: Safety class	MAIN LINE: Safety Functional Groups: System Req.	DIVERSE LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	DIVERSE LINE: Safety Functional Groups: Item	DIVERSE LINE: Safety Functional Groups: Safety class	DIVERSE LINE: Safety Functional Groups: Syst Req.	DIVERSE LINE: Supporting study	Comments
Electrical power supply																				
POWER OPERATIONS	Short-term LOOP (<2 hours)	PCC-2 f>10-2/(r.y)	6.10^{-2}	14.3.6	Reactivity Control	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: Low RCP speed Low RCS loop flowrate Front. Syst.: CRDM	Class 1	F1A	PS	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified** Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	Class 2	F2	PS	PCSR Sub-chapter 16.1.3.3.1 - ATWS LOOP	ATWS are not postulated for PCC-3 and PCC-4 events
						x									Negative reactivity fast insertion	**Reactor trip - auto** Actuation: Low RCP speed Front. Syst.: CRDM	Class 2	F2	SAS		
						x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS	RCS overcooling protection	**MSIV closure** Actuation: SG P Front. Syst.: MSIV	Class 1	F1A	PS	Excessive increase in steam flow study	MFWS is lost due to the initiating event - no isolation is required.
	Long-term LOOP (>2 hours)	PCC-3 10-4/(r.y)<f<10-2/(r.y)	1.10^{-3}	14.4.2	Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident discharge line** Actuation: Manual Front. Syst.: PDS	Class 2	F2	SAS	PCSR Sub-chapter 16.1.3.3.4 or 16.1.3.3.3 for electrical supply diversity (see below RRC-A Station Black-out)	The electrical supply of the systems is made by the 2h batteries and the 4 EDGs. In case of failureof the 4 EDGs there are 2 Station Black-out diesels starting the EFWS pumps of trains 1 and 4.
						x						**EFW actuation (1 train) + SG Blowdown Isolation** Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS		**SIS [RIS] in cold leg** Actuation: Manual Front. Syst.: MHSI + LHSI	Class 2	F1B	SAS		
						x						**EDG start-up** Actuation: LOOP Front. Syst.: UDG-DG	Class 1	F1A	PS		**RCP stop - Manu** Activ. & Elec: Manual Front. Syst.: RCP **UDG-DG start-up** Actuation: Manual Front. Syst.: UDG-DG	Class 2 Class 2	F1B F2	SAS -		
					Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS	Essential component protection	**SG safety valves opening** Actuation: Passive Front. Syst.: MSSV	Class 1	F1A	-	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
					Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	**Hot overpressure protection** Actuation: Passive Front. Syst.: PSV	Class 1	F1A	-	RCS overpressure protection	**Hot overpressure protection** Activ. & Elec: Passive Front. Syst.: PSV	Class 1	F1A	-	Primary overpressure studies of Sub-chapter 3.4.1.5 illustrate	The overpressure protection is ensured thanks to the 3 PSVs. It can be demonstrated that no CCF will impair the operation of the 3 PSVs at the same time.
	Emergency Operating Procedure	All	N/A	All	Reactivity Control		x		Shutdown and maintain core sub-criticality	B	Compensation for shutdown moderator effect	**Emergency boron injection into the core - Manual** Actuation: Manual Front. Syst.: EBS	Class 2	F1B	SAS	See Appendix A					Whatever the length of the LOOP, the safety systems actuated are supported by batteries and EDGs allowing
					Heat removal		x		Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS							
							x			B	RCS pressure decrease by Energy discharge from pressurizer	**RCS depressurisation by PRZ safety valves** Actuation: Manual Front. Syst.: PSV	Class 2	F1B	SAS							
							x			B	Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	**RHR connection and start-up (no** Activ. & Elec: Manual Front. Syst.: RHRS	Class 2	F1B	SAS							
	Station Black-out in state A	RRC-A	-	16.1.3.3	Reactivity Control			x	Shutdown and maintain core sub-criticality	B	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: Low RCP speed Low RCS loop flowrate Front. Syst.: CRDM	Class 1	F1A	PS	N/A - diversity is applied to frequent initiating event above 10-3/r.y						
								x	Prevention of uncontrolled positive reactivity insertion into the core	B	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS							
					Heat removal			x	Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling - manual** Actuation: Manual Front. Syst.: MSRT	Class 2	F1B	SAS						The electrical supply of the systems is made by the 2h batteries and the 2 Station Black-out diesels starting the EFWS pumps of trains 1 and 4. This heat removal is performed with only two SG after 30 minutes.	
								x				**EFW header opening** Actuation: Manual Front. Syst.: EFWS injection lines & storages	Class 2	F1B	-							
								x				**EFW actuation (1 train) + SG Blowdown Isolation** Actuation: Manual Front. Syst.: EFWS injection lines & storages	Class 2	F1B	SAS							
								x		B		**UDG Diesel start-up** Actuation: Manual Front. Syst.: UDG diesels	Class 2	F2	SAS							
					Other			x	Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	B	Essential component protection	**SSSS [DEA] actuation** Actuation: RCP T Front. Syst.: SSSS	Class 3	F2	PAS							
								x				**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS							
					Confinement			x	Maintain integrity of the Reactor Coolant Pressure Boundary	B	RCS overpressure protection	**Hot overpressure protection** Actuation: Passive Front. Syst.: PSV	Class 1	F1A	-							
SHUTDOWN MODE	Long-term LOOP in state C (>2 hours)	PCC-4 10-6/(r.y)<f<10-4/(r.y)	-	14.5.1	Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal in shutdown mode by Residual Heat Removal System (RHRS)	This heat removal is ensured once the EDGs have been automatically started - this automatic start is Class 1									The automatic start-up of the EDGs ensure the heat removal with the LHSI/RHRS trains

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (23/29)

No.	Input to classification: Fault description	References: Category	References: Frequency	References: PCSR Ref.	Main Safety Function	Transient phases: Cont. state	Transient phases: Safe state	Transient phases: Final state	SAFETY FUNCTION: Plant Level Safety Function (Based on EPR process and international practice for PWR)	SAFETY FUNCTION: Safety Cat.	MAIN LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	MAIN LINE: Safety Functional Groups: Item	MAIN LINE: Safety Functional Groups: Safety class	MAIN LINE: Safety Functional Groups: System Req.	DIVERSE LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	DIVERSE LINE: Safety Functional Groups: Item	DIVERSE LINE: Safety Functional Groups: Safety class	DIVERSE LINE: Safety Functional Groups: Syst Req.	DIVERSE LINE: Supporting study	Comments
ATWS																				
ATWS FOLLOWING ROD FAILURE	ATWS rod failure - Excessive increase in steam flow	RRC-A	-	16.1.3.1.1	Reactivity Control			x	Shutdown and maintain core sub-criticality	B	Negative reactivity fast insertion	Reactor trip - auto Actuation: SG dP/dt Front. Syst.: CRDM BLOCKAGE	Class 2	F2	PS					
								x			High concentrated and high pressure boron injection	Emergency boron injection into Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	Class 2	F2	PS					
								x				Isolation of CVCS tank Actuation: ATWS signal Front. Syst.: CVCS tank	Class 2	F2	PS					
								x	Prevention of uncontrolled positive reactivity insertion into the core	B	RCS overcooling protection	Turbine Trip Actuation: BT checkback Front. Syst.: Turbine admission valves	Class 1	F1A	PS					
								x				Full load MFW isolation (45G) Actuation: BT checkback Front. Syst.: Full load MFW isolation valves	Class 1	F1A	PS					
					Heat removal			x	Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	SG Pressure Control - Cooling Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS					
								x				EFW actuation (1 train) + SG Blowdown Isolation Actuation: SG L Front. Syst.: EFWS injection lines & storages	Class 1	F1A	PS					
								x				RCP stop - auto Activ. & Elec.: ATWS + SG L Front. Syst.: RCP	Class 2	F2	PS					
					Other			x	Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	B	Essential component protection	SG Pressure Control - Overpressure protection Actuation: SG P Front. Syst.: MSSV	Class 1	F1A	-					
								x		B		SG Pressure Control - Overpressure protection Actuation: SG P Front. Syst.: MSRT	Class 1	F1A	PS					
					Confinement			x	Maintain integrity of the Reactor Coolant Pressure Boundary	B	RCS overpressure protection	Hot overpressure protection Actuation: Passive Front. Syst.: PSV	Class 1	F1A	-					
	ATWS rod failure - Loss Of Main FeedWater	RRC-A	-	16.1.3.1.2	Despite some differences in the thermal hydraulic transient, the systems involved in the mitigation of the accident are similar to the ATWS Excessive increase in steam flow															
	ATWS rod failure - Loss Of Offsite Power	RRC-A	-	16.1.3.1.3	Despite some differences in the thermal hydraulic transient, the systems involved in the mitigation of the accident are similar to the ATWS Excessive increase in steam flow															
	ATWS rod failure - RCV [CVCS] malfunction that leads to a decrease in the boron concentration of the primary coolant	RRC-A	-	16.1.3.1.4	Despite some differences in the thermal hydraulic transient, the systems involved in the mitigation of the accident are similar to the ATWS Excessive increase in steam flow										N/A - diversity is applied to frequent initiating event above 10-3/r.y					
	ATWS rod failure - Uncontrolled RCCA bank withdrawal	RRC-A	-	16.1.3.1.5	Despite some differences in the thermal hydraulic transient, the systems involved in the mitigation of the accident are similar to the ATWS Excessive increase in steam flow															
ATWS BY ANOTHER (POSTULATED) FAILURE (STATE A)	ATWS PS - Excessive increase in steam flow	RRC-A	-	16.1.3.2.1	Such ATWS are managed by diversified RT in the PAS. The systems involved in the mitigation of the sequences are similar to the ones involved in the mitigation of the related PCC events described in the fault schedule															
	ATWS PS - Loss Of Main FeedWater	RRC-A	-	16.1.3.2.2																
	ATWS PS - Loss Of Offsite Power	RRC-A	-	16.1.3.2.3																
	ATWS PS - RCV [CVCS] malfunction that leads to a decrease in the boron concentration of the primary coolant	RRC-A	-	16.1.3.2.4																
	ATWS PS - Uncontrolled RCCA bank withdrawal	RRC-A	-	16.1.3.2.5																

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (24/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE							
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups					Supporting study	Comments
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.				
Fuel pool transients																						
Loss of one train of the fuel pool cooling system (FPCS) or of a supporting system (state A)	**PCC-2**	**f>10-2/(r.y)**	**14.3.18**	**Heat removal**		x		Maintain heat removal from fuel stored outside the reactor coolant system but within the site	B	Fuel pool heat removal	**Start-up of a FPCS main train** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**	Fuel pool heat removal	**Manual start-up of the FPCS 3rd train** Actuation: Manual Front. Syst.: FPCS	**Class 2**	**F2**	**SAS**		
Long term LOOP, fuel pool cooling aspects (state A)	**PCC-3**	**10-4/(r.y)<f<10-2/(r.y)**	**14.4.14**	**Heat removal**		x		Maintain heat removal from fuel stored outside the reactor coolant system but within the site	B	Fuel pool heat removal	**Start-up of a FPCS main train** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**	Fuel pool heat removal	**Manual start-up of the FPCS 3rd train** Actuation: Manual Front. Syst.: FPCS	**Class 2**	**F2**			
Loss of one train of the fuel pool cooling system (FPCS) or of a supporting system (state F)	**PCC-3**	**10-4/(r.y)<f<10-2/(r.y)**	**14.4.15**	**Heat removal**		x		Maintain heat removal from fuel stored outside the reactor coolant system but within the site	B	Fuel pool heat removal	**Start-up of a FPCS main train** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y						
Draining via the RCV [CVCS] draining line (state E)	**PSA initiator RO 40 reconciliation**	**f = 1.8.10-3/(r.y)**	**Spent Fuel Pool PSA**	**Heat removal**	x	x		Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A + B	Fuel pool heat removal	**Manual isolation of the CVCS unloading line** Actuation: Manual Front. Syst.: CVCS	**Class 1**	**F1A**	**-**	Fuel pool heat removal	**Automatic isolation of SIS/RHR suction line (only one valve automatically closed isolating the erroneous lining)** Actuation: Water level in the reactor building transfer compartment Front. Syst.: SIS/RHR	**Class 1**	**F1A**			**Another diverse line:** Analogical measurement of water level in the spent fuel pool (class 2) + Manual isolation of SIS/CVCS erroneous lining (class 1)
											Automatic detection of water level in the spent fuel pool with a setpoint of +18.90 m Actuation: Spent fuel pool water level Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**		**Water make-up to the fuel pool by Classified Fire Fighting Water Supply System** Actuation: Manual Front. Syst.: Classified Fire Fighting Water Supply System	**Class 2**	**F1B**			
																Manual start-up of a FPCS main train Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**			
Voluntary draining of the reactor building pool, Spent Fuel Pool not isolated (state D or F)	**PSA initiator RO 40 reconciliation**	**3.0.10-3/(r.y)**	**Spent Fuel Pool PSA**	**Heat removal**	x	x		Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A + B	Fuel pool heat removal	**RB pool drain lines isolation valves manual closing** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**	Fuel pool heat removal	**FPCS purification pumps switch-off (F2)** Actuation: Water level in the spent fuel pool with a setpoint of +18.60 m Front. Syst.: FPCS	**Class 2**	**F2**			**Another diverse line:** Analogical measurement of water level in the spent fuel pool (class 2) + [Manual FPCS purification pumps switch-off (class 3) or Manual closing of the transfer tube isolation valve (class 1 but no redundancy)]
Inadequately prepared transfer between the loading pit and the fuel building transfer compartment (state A)	**PSA initiator RO 40 reconciliation**	**1.5.10-3/(r.y)**	**Spent Fuel Pool PSA**	**Heat removal**		x		Maintain heat removal from fuel stored outside the reactor coolant system but within the site	B	Fuel pool heat removal	**FB pool drain lines isolation valves automatic closing** Actuation: Water level in the spent fuel pool with a setpoint of +18.40 m Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**	Fuel pool heat removal	**FPCS purification pumps switch-off (F2)** Actuation: Water level in the spent fuel pool with a setpoint of +18.60 m Front. Syst.: FPCS	**Class 2**	**F2**			**Two other diverse lines:** A) Analogical measurement of water level in the spent fuel pool (class 2) + Manual FPCS purification pump switch-off (class 3) B) Analogical measurement of water level in the spent fuel pool (class 2)
Piping failure on a purification line in the fuel building (state A to F)	**PCC-3**	**10-4/(r.y)<f<10-2/(r.y)**	**14.4.16**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**FB pool drain lines isolation valves automatic closing** Actuation: Water level in the spent fuel pool with a setpoint of +18.40 m Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
					x				A	Fuel pool heat removal	**Siphon-breakers on suction & drainage pipes of FB pool purification lines** Actuation: Passive Front. Syst.: FPCS	**-**	**-**	**-**							

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (25/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE						Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function	Safety Cat.	Lower Level Safety Function	Safety Functional Groups				Lower Level Safety Function	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state	Based on EPR process and international practice for PWR		Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)		Item	Safety class	System Req.	Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)		Item	Safety class	Syst Req.		
Fuel pool transients																					
Piping failure on a purification line in the reactor building (state E)	**PCC-3**	**10-4/(r.y)<f<10-2/(r.y)**	**14.4.16**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**RB pool drain lines isolation valves manual closing** Actuation: Water level in the reactor building transfert compartment with a setpoint of +17.90 m Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y						
					x				A	Fuel pool heat removal	**Siphon-breakers on drainage pipes of FB pool purification lines** Actuation: Passive Front. Syst.: FPCS	-	-	-							
Piping failure on a skimming line in the fuel building (states A to F)	**PCC-3**	**10-4/(r.y)<f<10-2/(r.y)**	**14.4.16**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**Drainage stop at the suction & drainage pipes low level of the skimming line** Actuation: Passive Front. Syst.: FPCS	-	-	-	N/A - diversity is applied to frequent initiating event above 10-3/r.y						
Piping failure on a fuel pool water makeup line in the fuel building (states A to F)	**PCC-3**	**10-4/(r.y)<f<10-2/(r.y)**	**14.4.16**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**Drainage stop at the makeup pipe low level** Actuation: Passive Front. Syst.: FPCS	-	-	-	N/A - diversity is applied to frequent initiating event above 10-3/r.y						
Piping failure on a skimming line in the reactor building (state E)	**PCC-3**	**10-4/(r.y)<f<10-2/(r.y)**	**14.4.16**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**Floating device removal** Actuation: Manual Front. Syst.: FPCS	-	-	-	N/A - diversity is applied to frequent initiating event above 10-3/r.y						
Piping failure on a main cooling train (states A to F)	**PCC-3**	**10-4/(r.y)<f<10-2/(r.y)**	**14.4.16**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**Siphon-breakers on suction & drainage pipes of FPCS train** Actuation: Passive Front. Syst.: FPCS	-	-	-	N/A - diversity is applied to frequent initiating event above 10-3/r.y						
						x			B		**Main FPCS operating pump automatic trip** Actuation: Water level in the spent fuel pool with a setpoint of +18.0 m Front. Syst.: FPCS	**Class 2**	**F1B**	**SAS**							
						x			B		**Broken FPCS train suction line isolation** Actuation: Manual Front. Syst.: FPCS	**Class 2**	**F1B**	-							
						x			B		**Instrumentation lances compartment draining to the IRWST** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**							
						x			B		**MHSI injection** Actuation: Manual Front. Syst.: MHSI	**Class 1**	**F1A**	**PS**							
						x			B		**Fuel pool water make-up** Actuation: Manual Front. Syst.: Classified Fire Fighting Water Supply System	**Class 2**	**F1B**	**SAS + local actions**							
						x			B		**Start-up of a FPCS main train** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**							
Piping failure on the third FPCS train (state A)	**PCC-3**	**10-4/(r.y)<f<10-2/(r.y)**	**14.4.16**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**Drainage stop at the suction pipe low level of the FPCS third train** Actuation: Passive Front. Syst.: FPCS	-	-	-	N/A - diversity is applied to frequent initiating event above 10-3/r.y						
						x			B		**Main FPCS operating pump automatic trip** Actuation: Water level in the spent fuel pool with a setpoint of +18.0 m Front. Syst.: FPCS	**Class 2**	**F1B**	**SAS**							
						x			B		**3rd train suction line isolation** Actuation: Manual Front. Syst.: FPCS	**Class 2**	**F1B**	-							
						x			B		**Fuel pool water make-up** Actuation: Manual Front. Syst.: Classified Fire Fighting Water Supply System	**Class 2**	**F1B**	**SAS + local actions**							
						x			B		**Start-up of a FPCS main train** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**							

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (26/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE					Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.			
Fuel pool transients																					
Isolatable SIS break (<250 mm) in RHR mode (state E)	**PCC-4**	**10-6/(r.y)<f<10-4/(r.y)**	**14.5.15**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**SIS/RHR suction pipe isolation valve automatic closing** Actuation: Water level in the reactor building transfert compartment with a setpoint of +17.90 m Front. Syst.: SIS	**Class 1**	**F1A**	**PS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
						x			B	Fuel pool heat removal	**Main FPCS operating pump automatic trip** Actuation: Water level in the spent fuel pool with a setpoint of +18.0 m Front. Syst.: FPCS	**Class 2**	**F1B**	**SAS**						
						x			B	Fuel pool heat removal	**Fuel pool water make-up** Actuation: Manual Front. Syst.: Classified Fire Fighting Water Supply System	**Class 2**	**F1B**	**SAS + local actions**						
						x			B	Fuel pool heat removal	**Start-up of a FPCS main train** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**						
Non isolatable small break(<50mm) on a line connected to the primary cooling (state E)	**PCC-4**	**10-6/(r.y)<f<10-4/(r.y)**	**14.5.15**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**MHSI injection** Actuation: Manual Front. Syst.: MHSI	**Class 1**	**F1A**	**PS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
					x				A		**RB pool overflow lines opening** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**						
					x				A		**Instrumentation lances compartment draining to the IRWST** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**						
					x				A		**Reactor building floor drain exhaust lines 1 and 2 automatic isolated** Actuation: Water level in the spent fuel pool with a setpoint of +18.9 m Front. Syst.: RPE	**Class 1**	**F1A**	**PS**						
						x			B		**Main FPCS operating pump automatic trip** Actuation: Water level in the spent fuel pool with a setpoint of +18.0 m Front. Syst.: FPCS	**Class 2**	**F1B**	**SAS**						
						x			B		**Fuel pool water make-up** Actuation: Manual Front. Syst.: Classified Fire Fighting Water Supply System	**Class 2**	**F1B**	**SAS + local actions**						
						x			B		**Start-up of a FPCS main train** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**						
Loss of the two main trains of the Fuel Pool Cooling System during shutdown for refuelling (state F)	**RRC-A**	**-**	**16.1.3.13**	**Heat removal**			x	Maintain heat removal from fuel stored outside the reactor coolant system but within the site	B	Fuel pool heat removal	**Manual start-up of the 3rd train** Actuation: Manual Front. Syst.: FPCS	**Class 2**	**F2**	**SAS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
Station Blackout - FPCS aspects (States E & F)	**RRC-A**	**-**	**16.1.3.13**	**Heat removal**			x	Maintain heat removal from fuel stored outside the reactor coolant system but within the site	B	Fuel pool heat removal	**Manual start-up of the 3rd train** Actuation: Manual Front. Syst.: FPCS	**Class 3**	**F2**	**SAS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
							x		B		**UDG-DG start-up** Actuation: Manual Front. Syst.: UDG-DG	**Class 2**	**F2**	**-**						

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (27/29)

No.	Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE							Comments
	Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups					Supporting study	
		Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state				Item	Safety class	System Req.			Item	Safety class	Syst Req.				
	MISCELLANEOUS																						
POWER OPERATIONS	**Spurious actuation of PZR spray leading to a decrease in RCS pressure**	**PCC-2 f>10-2/(r.y)**	**4.2.10-3**	**14.3.15**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: PZR P DNBR Front. Syst.: CRDM	**Class 1**	**F1A**	**PS**	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified** Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	**Class 2**	**F2**	**PS**	ATWS cover	
																Negative reactivity fast insertion	**Reactor trip - auto** Actuation: HL P Front. Syst.: CRDM	**Class 2**	**F2**	**SAS**		
						x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	**Class 1**	**F1A**	**PS**	RCS overcooling protection	**MSIV closure** Actuation: SG P Front. Syst.: MSIV	**Class 1**	**F1A**	**PS**	Excessive increase in steam flow study	
						x						**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 1**	**F1A**	**PS**		**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 2**	**F2**	**SAS**	SAS order in case of ATWS following PS failure	
					Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident discharge line** Actuation: Manual Front. Syst.: PDS	**Class 2**	**F2**	**SAS**	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
						x						**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages	**Class 1**	**F1A**	**PS**		**SIS [RIS] in cold leg** Actuation: Manual Front. Syst.: MHSI + LHSI	**Class 2**	**F1B**	**SAS**		
						x											**RCP stop - Manu** Activ. & Elec: Manual Front. Syst.: RCP	**Class 2**	**F1B**	**SAS**		
					Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**	Essential component protection	**SG safety valves opening** Actuation: Passive Front. Syst.: MSSV	**Class 1**	**F1A**	**-**	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
					Confinement	x			Maintain integrity of the fuel cladding	A	Prevention of unacceptable core power distribution	**Normal spray isolation** Actuation: PZR P Front. Syst.: Normal spray valves	**Class 1**	**F1A**	**PS**	Prevention of unacceptable core power distribution	**Normal spray isolation** Actuation: Manual Front. Syst.: Normal spray valves	**Class 2**	**F1B**	**SAS**		
	Spurious actuation of PZR heaters leading to an increase in RCS pressure	**PCC-2 f>10-2/(r.y)**	**9.8.10-4**	**14.3.15**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: PZR P PZR L Front. Syst.: CRDM	**Class 1**	**F1A**	**PS**	High concentrated and high pressure boron injection	**Emergency boron injection into the core - diversified** Actuation: ATWS signal (N-3 rod drop) Front. Syst.: EBS	**Class 2**	**F2**	**PS**	ATWS cover	
																Negative reactivity fast insertion	**Reactor trip - auto** Actuation: HL P Front. Syst.: CRDM	**Class 2**	**F2**	**SAS**		
						x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	**Class 1**	**F1A**	**PS**	RCS overcooling protection	**MSIV closure** Actuation: SG P Front. Syst.: MSIV	**Class 1**	**F1A**	**PS**	Excessive increase in steam flow study	
						x						**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 1**	**F1A**	**PS**		**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 2**	**F2**	**SAS**	SAS order in case of ATWS following PS failure	
					Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**	Heat removal by Low Head Emergency Core Cooling System (ECCS)	**Opening of severe accident discharge line** Actuation: Manual Front. Syst.: PDS	**Class 2**	**F2**	**SAS**	Sequences of primary bleed and feed detailed in case of Total Loss Of FeedWater RRC-A	
						x						**EFW actuation (1 train) + SG** Actuation: SG L Front. Syst.: EFWS injection lines & storages	**Class 1**	**F1A**	**PS**		**SIS [RIS] in cold leg** Actuation: Manual Front. Syst.: MHSI + LHSI	**Class 2**	**F1B**	**SAS**		
						x											**RCP stop - Manu** Activ. & Elec: Manual Front. Syst.: RCP	**Class 2**	**F1B**	**SAS**		
					Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**	Essential component protection	**SG safety valves opening** Actuation: Passive Front. Syst.: MSSV	**Class 1**	**F1A**	**-**	Secondary overpressure studies of Sub-chapter 3.4.1.5 illustrate	
					Confinement	x			Maintain integrity of the Reactor Coolant Pressure Boundary	A	RCS overpressure protection	**Hot overpressure protection** Actuation: Passive Front. Syst.: PSV	**Class 1**	**F1A**	**-**	RCS overpressure protection	**Hot overpressure protection** Activ. & Elec: Passive Front. Syst.: PSV	**Class 1**	**F1A**	**-**	PCSR Sub-chapter 3.4.1.5.2.2	
	Leak in the gaseous waste processing system	**PCC3 10-4/(r.y)<f<10-2/(r.y)**	**3.10-4**	**14.4.10**	These transients are not detailed from a thermal hydraulic point of view. There are discussed in the frame of radiological consequences Sub-chapter 14.6																		
	Fuel handling accident	**PCC-4 10-6/(r.y)<f<10-4/(r.y)**	**1.10-4**	**14.5.11**																			
	Rupture of radioactivity-containing systems in the Nuclear Auxiliary Building	**PCC-4 10-6/(r.y)<f<10-4/(r.y)**	**< 1.10-4**	**14.5.13**																			

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (28/29)

Input to classification								SAFETY FUNCTION		MAIN LINE					DIVERSE LINE					Comments
Fault description	References			Main Safety Function	Transient phases			Plant Level Safety Function *Based on EPR process and international practice for PWR*	Safety Cat.	Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Lower Level Safety Function *Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident)*	Safety Functional Groups				Supporting study	
	Category	Frequency	PCSR Ref.		Cont. state	Safe state	Final state					Item	Safety class	System Req.			Item	Safety class	Syst Req.		
Fuel pool transients																				
Isolatable SIS break (<250 mm) in RHR mode (state E)	**PCC-4**	**10-6/(r.y)<f<10-4/(r.y)**	**14.5.15**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**SIS/RHR suction pipe isolation valve automatic closing** Actuation: Water level in the reactor building transfert compartment with a setpoint of +17.90 m Front. Syst.: SIS	**Class 1**	**F1A**	**PS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
						x			B	Fuel pool heat removal	**Main FPCS operating pump automatic trip** Actuation: Water level in the spent fuel pool with a setpoint of +18.0 m Front. Syst.: FPCS	**Class 2**	**F1B**	**SAS**						
						x			B	Fuel pool heat removal	**Fuel pool water make-up** Actuation: Manual Front. Syst.: Classified Fire Fighting Water Supply System	**Class 2**	**F1B**	**SAS + local actions**						
						x			B	Fuel pool heat removal	**Start-up of a FPCS main train** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**						
Non isolatable small break(<50mm) on a line connected to the primary cooling (state E)	**PCC-4**	**10-6/(r.y)<f<10-4/(r.y)**	**14.5.15**	**Heat removal**	x			Maintain heat removal from fuel stored outside the reactor coolant system but within the site	A	Fuel pool heat removal	**MHSI injection** Actuation: Manual Front. Syst.: MHSI	**Class 1**	**F1A**	**PS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
					x				A		**RB pool overflow lines opening** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**						
					x				A		**Instrumentation lances compartment draining to the IRWST** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**						
					x				A		**Reactor building floor drain exhaust lines 1 and 2 automatic isolated** Actuation: Water level in the spent fuel pool with a setpoint of +18.9 m Front. Syst.: RPE	**Class 1**	**F1A**	**PS**						
						x			B		**Main FPCS operating pump automatic trip** Actuation: Water level in the spent fuel pool with a setpoint of +18.0 m Front. Syst.: FPCS	**Class 2**	**F1B**	**SAS**						
						x			B		**Fuel pool water make-up** Actuation: Manual Front. Syst.: Classified Fire Fighting Water Supply System	**Class 2**	**F1B**	**SAS + local actions**						
						x			B		**Start-up of a FPCS main train** Actuation: Manual Front. Syst.: FPCS	**Class 1**	**F1A**	**PS**						
Loss of the two main trains of the Fuel Pool Cooling System during shutdown for refuelling (state F)	**RRC-A**	**-**	**16.1.3.1.3**	**Heat removal**			x	Maintain heat removal from fuel stored outside the reactor coolant system but within the site	B	Fuel pool heat removal	**Manual start-up of the 3rd train** Actuation: Manual Front. Syst.: FPCS	**Class 2**	**F2**	**SAS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
Station Blackout - FPCS aspects (States E & F)	**RRC-A**	**-**	**16.1.3.1.3**	**Heat removal**			x	Maintain heat removal from fuel stored outside the reactor coolant system but within the site	B	Fuel pool heat removal	**Manual start-up of the 3rd train** Actuation: Manual Front. Syst.: FPCS	**Class 3**	**F2**	**SAS**	N/A - diversity is applied to frequent initiating event above 10-3/r.y					
							x		B		**UDG-DG start-up** Actuation: Manual Front. Syst.: UDG-DG	**Class 2**	**F2**	**-**						

SUB-CHAPTER 14.7 - TABLE 1: FAULT AND PROTECTION SCHEDULE TABLE: FAULTS AT FULL POWER (29/29)

No.	Input to classification: Fault description	References: Category	References: Frequency	References: PCSR Ref.	Main Safety Function	Transient phases: Cont. state	Transient phases: Safe state	Transient phases: Final state	SAFETY FUNCTION: Plant Level Safety Function (Based on EPR process and international practice for PWR)	SAFETY FUNCTION: Safety Cat.	MAIN LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	MAIN LINE: Safety Functional Groups: Item	MAIN LINE: Safety Functional Groups: Safety class	MAIN LINE: Safety Functional Groups: System Req.	C&I platform	DIVERSE LINE: Lower Level Safety Function (Combination of the Plant Level Safety Function and the conditions of operations (normal, incident, accident))	DIVERSE LINE: Safety Functional Groups: Item	DIVERSE LINE: Safety Functional Groups: Safety class	DIVERSE LINE: Safety Functional Groups: Syst Req.	DIVERSE LINE: Supporting study	Comments
Decrease in RCS water inventory																					
	4 break (10cm²) at RCP seals and loss of one safeguard train	**tbd**	**tbd**	**tbd**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: PZR P, HL P Front. Syst.: CRDM	**Class 1**	**F1A**	**PS**	Covered by the events "Partial loss of core coolant flow (Loss of one reactor coolant pump)", "Forced decrease of reactor coolant flow (four pumps)" and "Small break LOCA (< DN 50) including a break occurring on the extra boration system injection line (states A and B)"					
						x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	**Class 1**	**F1A**	**PS**						
						x						**Full load MFW isolation (4SG)** Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 1**	**F1A**	**PS**						
					Heat removal	x			Maintain sufficient Reactor Coolant System water inventory for core cooling	A	Water injection into the RCS	**SG Pressure Control - Cooling - Auto (MSRT)** Actuation: SIS signal [PZR P] Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**						
						x						**MHSI injection - Auto** Actuation: SIS signal [PZR P] Front. Syst.: MHSI (3 pumps)	**Class 1**	**F1A**	**PS**						
						x				A	Prevention of RCS drainage through auxiliary lines	**Isolation of CVCS letdown line (RCS isolation SI sequence)** Actuation: SIS signal [PZR P] Front. Syst.: CVCS letdown valve	**Class 1**	**F1A**	**PS**						
						x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**						
						x						**EFW actuation (1 train) + SG Blowdown** Actuation: SG L Front. Syst.: EFWS injection lines & storages (3 pumps available)	**Class 1**	**F1A**	**PS**						
					Other	x			Prevent the failure or limit the consequences of failure of a structure, system or component whose failure could cause the impairment of a safety function	A	Essential component protection	**SG Pressure Control - Overpressure protection** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**						
					Confinement	x			Limit the release of radioactive material from the reactor containment	A	Containment building isolation	**Containment isolation stage 1 / RCPB** Actuation: SIS signal [PZR P] Front. Syst.: Containment isolation valves	**Class 1**	**F1A**	**PS**						
	Partial loss of core coolant flow and loss of one safeguard train	**tbd**	**tbd**	**tbd**	**Reactivity Control**	x			Shutdown and maintain core sub-criticality	A	Negative reactivity fast insertion	**Reactor trip - auto** Actuation: Low-low loop flow rate in one loop Front. Syst.: CRDM	**Class 1**	**F1A**	**PS**						
						x			Prevention of uncontrolled positive reactivity insertion into the core	A	RCS overcooling protection	**Turbine Trip** Actuation: RT checkback Front. Syst.: Turbine admission valves	**Class 1**	**F1A**	**PS**						
												Full load MFW isolation (4SG) Actuation: RT checkback Front. Syst.: Full load MFW isolation valves	**Class 1**	**F1A**	**PS**						
					Heat removal	x			Transfer heat from the reactor coolant to the ultimate heat sink	A	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**						
						x						**EFW actuation (1 train) + SG Blowdown** Actuation: SG L Front. Syst.: EFWS injection lines & storages (3 pumps available)	**Class 1**	**F1A**	**PS**						
					Other	x			Prevent the failure or limit the consequences of failure of a structure, system or	A	Essential component protection	**SG Pressure Control - Overpressure** Actuation: SG P Front. Syst.: MSRT	**Class 1**	**F1A**	**PS**						
	Emergency Operating Procedure	**All**	**N/A**	**All**	**Reactivity Control**		x		Shutdown and maintain core sub-criticality	B	Compensation for shutdown moderator effect	**Emergency boron injection into the core - Manual** Actuation: Manual Front. Syst.: EBS	**Class 2**	**F1A**	**SAS**	See Appendix A					
					Heat removal		x		Maintain sufficient Reactor Coolant System water inventory for core cooling	B	Water injection into the RCS	**LHSI injection in HL** Actuation: Manual Front. Syst.: LHSI	**Class 2**	**F1B**	**SAS**						
							x		Transfer heat from the reactor coolant to the ultimate heat sink	B	Heat removal by Steam Generators - Emergency shutdown mode	**SG Pressure Control - Cooling** Actuation: Manual Front. Syst.: MSRT	**Class 2**	**F1B**	**SAS**						
							x			B	Heat removal in shutdown mode by Residual Heat Removal system (RHRS)	**MHSI stop (1 train)** Actuation: Manual Front. Syst.: MHSI	**Class 2**	**F1B**	**SAS**						
							x			B		**MHSI injection on large miniflow** Actuation: Manual Front. Syst.: MHSI	**Class 2**	**F1B**	**SAS**						
							x			B		**LHSI switch to RHR mode (1 train)** Activ. & Elec: Manual Front. Syst.: RHRS	**Class 2**	**F1B**	**SAS**						
					Confinement		x		N/A	B	Containment isolation are already effective due to automatic actuation. In case of such automatic actuation failed, the operator can perform the containment isolation											

SUB-CHAPTER 14.7 - TABLE 2

Fault and Protection Schedule Table – Definitions

Abbreviation	-	Description	Reference	Event annual frequency	Potential Consequences without mitigation (1)
PCC-1	Anticipated Operational Occurrence (AOO) conditions (PCC-3 to 10^{-3} included)	Plant Condition Category 1	Normal operations	-	-
PCC-2		Plant Condition Category 2	Reference transients	10^{-2}/(reactor.year) > f	Local loss of cladding integrity Local fuel pellets melting
PCC-3	Accident conditions	Plant Condition Category 3	Reference incidents	10^{-4}/(reactor.year) < f < 10^{-2}/(reactor.year)	Global core melting Global loss of cladding integrity Fuel dispersion
PCC-4		Plant Condition Category 4	Reference accidents	10^{-6}/(reactor.year) < f < 10^{-4}/(reactor.year)	

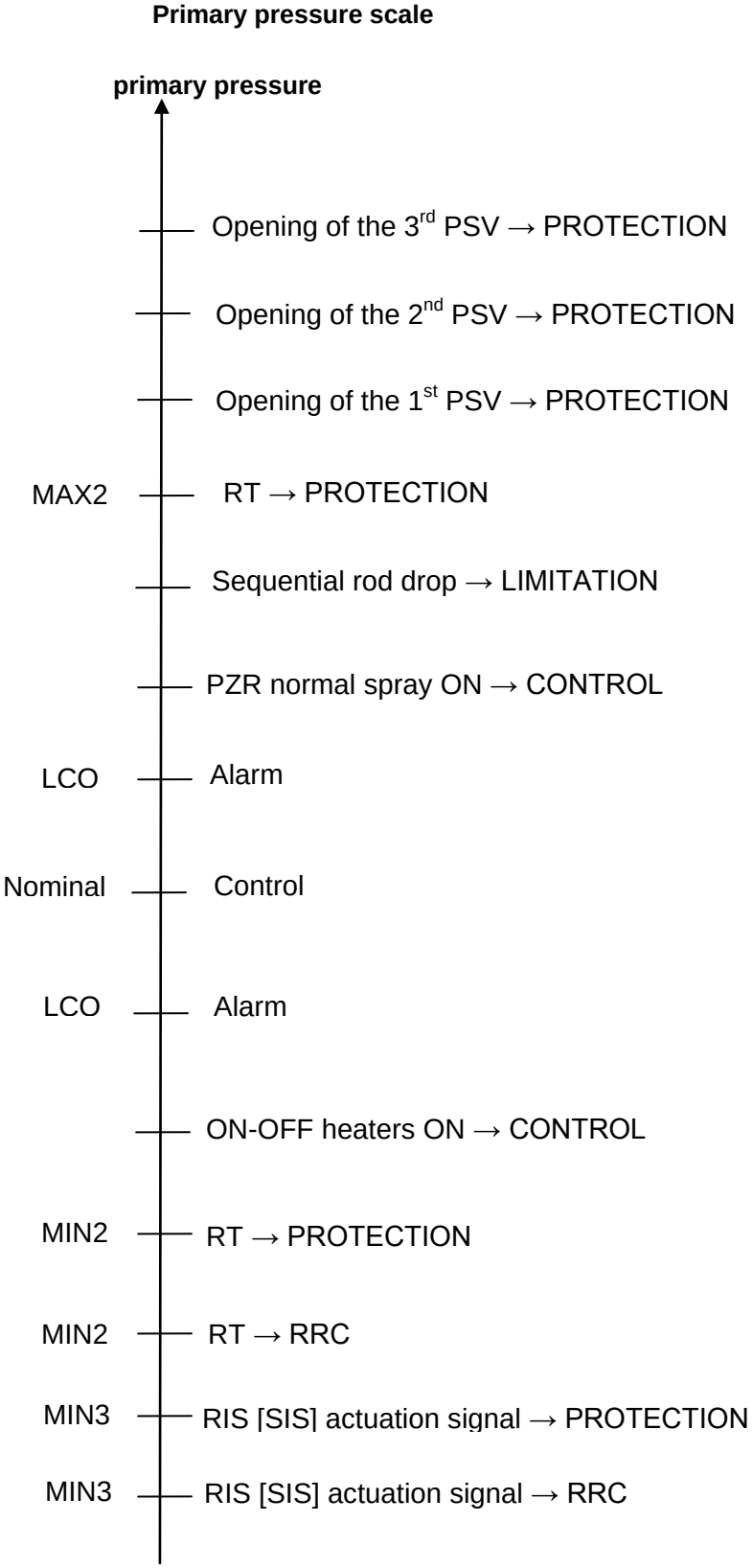
Note (1). Consequences of each transient are estimated when cumulating event with SFC (PCC-2, PCC-3 and PCC-4) and LOOP (PCC-3 and PCC-4)

SUB-CHAPTER 14.7 - TABLE 3

Fault and Protection Schedule Table (Abbreviations)

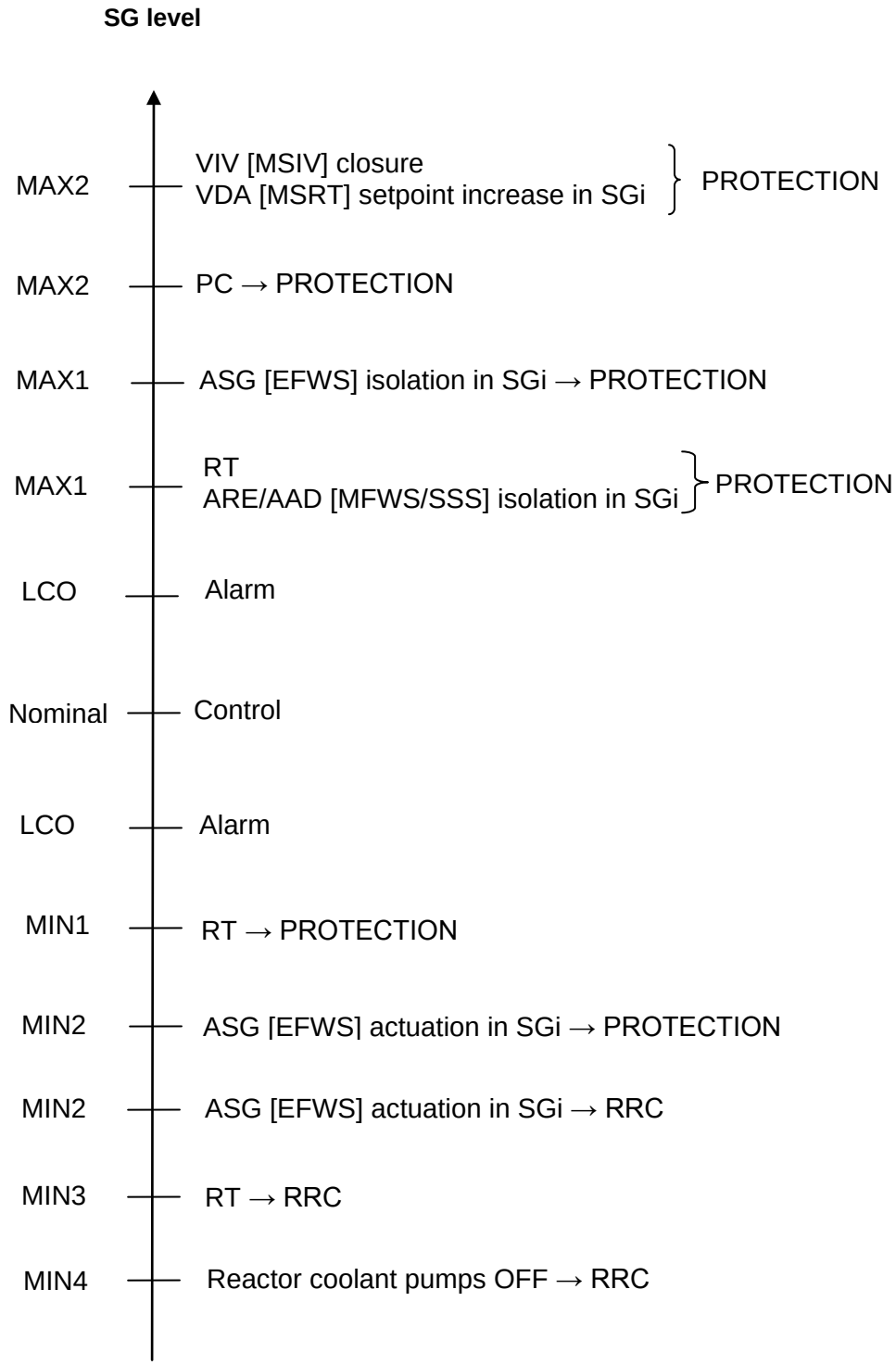
Abbreviation	Description	ECS code
ACCU	Accumulator	
AO	Axial Offset	
ATWS	Anticipated Transient Whithout Scram	
CHRS	Containment Heat Removal System	EVU
Cont P	High containment pressure	
CVCS	Chemical And Volume Control System	RCV
DNBR	Departure of Nucleate Boiling Ratio	
EBS	Extra Borating System	RBS
EDG	Emergency Diesel Generator	LHP/Q/R/S
EFWS	Emergency FeedWater System	ASG
FB	Fuel Building	
FCD	Fast Cooldown	
FPCS	Fuel Pool Cooling System	PTR
HCPL	High Core Power Level	
HL P	Hot Leg Pressure	
HLPD	High Linear Power Density	
LCO	Limiting Condition of Operation	
LHSI	Low Head Safety Injection	
MFWS	Main FeedWater System	ARE
MFWS LL	Main FeedWater System Low Load	
MHSI	Medium Head Safety Injection	
MSB	Main Steam Bypass	GCT
MSIV	Main Steam Isolation Valve	
MSRIV	Main Steam Relief Isolation Valve	
MSRT	Main Steam Relief Train	VDA
MSSV	Main Steam Safety Valve	
NF	Neutron Flux	
PAS	Process Automation System	
PCD	Partial Cooldown	
PDS	Primary Depressurisation System	
PSV	Pressuriser Safety Valve	
PT	Partial Trip	
PZR	Presuriser	
PZR L	Pressuriser Level	
PZR P	Pressuriser Pressure	
RB	Reactor Building	
RCP	Reactor Coolant Pump	
RCS	Reactor Coolant System	RCP
RT	Reactor trip - auto	
SAS	Safety Automation System	
SBO - DG	Station BlackOut Diesel Generator	LJP/S
SG	Steam Generator	
SG L	Steam Generator Level	
SG P	Steam Generator Pressure	
SIS	Safety Injection System	RIS
SSS	Start-up and Shutdown System	AAD
SSSS	Stand Still Seal System	DEA
TT	Turbine Trip	

SUB-CHAPTER 14.7 - FIGURE 1



SUB-CHAPTER 14.7 - FIGURE 2

SG level scale



SUB-CHAPTER 14.7 - APPENDIX 1

Diversity in Emergency Operating Procedure

This appendix assesses the diverse means available to reach a stable state from the controlled state for all the frequent faults. The controlled state is characterised by short-term heat removal capacity, core sub-criticality and stable core coolant inventory. Hence, the starting point of the analysis is that the controlled state has been reached following the postulated initiating event (PIE) and that no failure of any system has occurred up to that point, other than the system leading to the PIE. Consequently, the three main safety functions, i.e. reactivity control, heat removal and containment, are already ensured – notably the confinement of radioactive materials.

The following analysis first explains the necessary steps to connect to the RRA [RHRS] and then reviews all the frequent events, by event family, to perform the demonstration of diversity. As the emergency operating procedures described in the PCC fault analyses correspond to the safe path, the analysis intends to demonstrate that the feed and bleed procedure is adequate to provide the diversity of the safe path. Subsequently, the objective is not necessarily to demonstrate a safe shutdown state on RRA [RHRS] but it is to achieve a long-term non-hazardous stable state, in which the core is sub-critical, residual heat is removed by primary or secondary systems and off-site radioactive discharges remain acceptable.

A.1. - RRA [RHRS] Connection

The RRA [RHRS] connecting conditions are reached when the reactor coolant system hot leg temperature is lower than 180°C and the hot leg pressure is lower than 32 bar abs.

Four actions must be performed to reach the safe shutdown state from the controlled state:

- RCP [RCS] boration to ensure the core is sub-critical as the temperature and the pressure in the reactor coolant system decrease to reach RRA [RHRS] connecting conditions
- RCP [RCS] depressurisation
- RCP [RCS] cooldown
- Connection to the RRA [RHRS].

The analysis is performed for the frequent postulated initiating events (PIEs).

The operational system used to perform the boration is the RCV [CVCS]. It is Class 3 and therefore cannot be credited in the safety analyses. The RBS [EBS] is the safety classified means of performing the boration to ensure long-term sub-criticality. Should the RBS [EBS] fail, the boration can be performed by a combination of Class 2 systems. For instance, boration can be performed by the bleed and feed procedure, which uses the safety injection system RIS [SIS] and the severe accident discharge lines.

The operational system used to perform the depressurisation of the reactor coolant system is the normal or the auxiliary spray. The depressurisation of the reactor coolant system can also be performed by the safety classified pressuriser safety valves (PSV). Should the pressuriser safety valves fail, the depressurisation of the reactor coolant system can be performed by the Primary Depressurisation System (PDS). However, the PDS actuation requires the use of the RIS [SIS] to compensate for the flow lost through the PDS and to maintain the RCP [RCS] inventory.

The cooldown of the reactor coolant system is performed during normal operation by the main steam bypass. The safety classified means to cooldown the reactor coolant system are the VDAs [MSRT]s. Should they fail, the bleed and feed procedure is actuated if the plant situation cannot be stabilised without the VDA [MSRT]s.

The connection to RRA [RHRS] can be performed only if the LHSI pumps are available, as one LHSI train is necessary to ensure the residual heat removal. Should the LHSI pumps not be available, the residual heat can be removed via the steam generators fed by the ASG [EFWS] and using the VDA [MSRT]s. MHSI may be required to maintain the reactor coolant system inventory.

The use of a diverse line may not always be necessary as the plant can be maintained in a controlled state. In particular, this is true in cases where:

- the automatic actions mitigate the PIE, or
- the integrity of the reactor coolant system and the secondary side are not impaired so that their inventories can be maintained after a controlled state is reached.

In these cases, the residual heat is removed by the secondary side in the long term because the steam generator water inventory is high and the reactor coolant system inventory is stable. Typically, the case of a spurious reactor trip falls into this category and is not analysed here any further.

The water volume in the ASG [EFWS] tanks provide sufficient inventory to ensure heat removal for 24 hours at hot shutdown. The ASG [EFWS] tanks can be refilled with water during that time, via the JAC (fire fighting water supply) system.

A.2. - Frequent postulated initiating events

Frequent PIEs are analysed in the following sections in the light of the arguments provided above to demonstrate that a suitably classified diverse line exists to bring the plant to a long-term non-hazardous stable state.

A.2.1. - Increase in RCP [RCS] inventory

The postulated initiating event considered is:

- RCV [CVCS] malfunction causing an increase in reactor coolant inventory

For this event, the diverse line is not necessary as the plant is in a stable state after mitigation of the initiating event by automatic actions, such as isolation of the RCV [CVCS] charging line on high pressuriser level.

In a similar manner to the situation after a reactor trip, the plant is stabilised and can subsequently be maintained in a long-term stable state.

A.2.2. - Decrease in RCS inventory

The postulated initiating events considered are:

- RCV [CVCS] malfunction causing decrease in reactor coolant inventory (state A)
- Inadvertent opening of a pressuriser safety valve

- Small break (not greater than DN 50) including a break occurring on the Extra Boration System injection line (State A)

In the case of the RCV [CVCS] malfunction, the initiating event is mitigated by automatic actions, such as letdown isolation. The plant can remain in the hot shutdown condition in the long term, even in the event of failure of a system needed to reach the safe shutdown state. Moreover, reaching the RRA [RHRS] connecting conditions under these conditions is bounded by the SB LOCA case.

The case of the inadvertent opening of a pressuriser safety valve is similar to that of the SB LOCA in the phase from the controlled state to the safe shutdown state since at that stage, the PSV opening discharges steam in a similar manner to the SB LOCA case.

Therefore, the analysis is carried out for the case of the SB LOCA. The controlled state is reached when the MHSI flow compensates for the break flow rate and the RCP [RCS] inventory is stable. This ensures sufficient boration in the reactor coolant system. The table below presents the main and diverse lines of the different stages necessary to reach the safe shutdown state.

	Main line	**Diverse line**
RCP [RCS] boration	Emergency boron injection into the core – Manual	RIS [SIS] + PDS
RCP [RCS] cooldown	SG Pressure Control – Cooling (VDA [MSRT])	Not necessary
RRA [RHRS] connection	Stop MHSI (1 train) - manual	No diversity
RRA [RHRS] connection	LHSI switch to RHR mode (1 train)	MHSI + EVU [CHRS] + VDA [MSRT] + ASG [EFWS]

Main and Diverse Lines to Reach Safe Shutdown State

A.2.3. - Increase in heat removal

The postulated initiating events considered are:

- Feedwater malfunction – causing a reduction in feedwater temperature
- Feedwater malfunction – causing an increase in feedwater temperature
- Excessive increase in steam flow
- Inadvertent opening of a SG relief train (state A)

For the feedwater malfunction events, as soon as the initiating event is mitigated, by reactor trip and full load main feedwater isolation, the plant is stabilised. The transfer to the safe shutdown state is bounded by the excessive increase in steam flow event.

The inadvertent opening of a SG relief train is mitigated by the closure of the main steam relief train control valve. The plant is then stabilised and heat can be removed by the remaining VDA [MSRT]s. The transfer to the safe shutdown state is performed in the same way as other events in which the integrity of the reactor coolant system or the steam lines is not impaired.

The table below presents the main and diverse lines used to reach a safe shutdown state.

	Main line	Diverse line
RCP [RCS] boration	Emergency boron injection into the core - Manual	RIS [SIS] + PDS
-	Low Load ARE [MFWS] isolation (4 SGs) – manual	Not necessary
RCP [RCS] cooldown	SG Pressure Control – Cooling (VDA [MSRT])	RIS [SIS] + PDS
-	Steam line isolation (1 SG) – auto	No diversity
RCP [RCS] depressurisation	RCP [RCS] depressurisation by pressuriser safety valves	RIS [SIS] + PDS
RRA [RHRS] connection	RRA [RHR] connection and start-up (no SI signal)	VDA [MSRT] + ASG [EFWS]

Main and Diverse Lines to Reach a Safe Shutdown State

A.2.4. - Decrease in heat removal

The postulated initiating events considered are:

- Turbine trip
- Loss of condenser vacuum
- Loss of normal feedwater flow
- Small feedwater system piping failure
- Inadvertent closure of one or all main steam isolation valves

The turbine trip is bounded by the loss of condenser vacuum. The latter event leads to a reactor trip. Under these conditions, the plant can remain in this hot shutdown state as long as boration is performed and water is provided to the steam generators.

The inadvertent closure of one or all VIV [MSIV]s event leads to a similar scenario with the additional isolation of the steam generators. After reactor trip, the plant can remain in the hot shutdown state as long as water is provided to the steam generators.

The bounding event is the loss of main feedwater due to the lower steam generator inventory. Regarding the loss of main feedwater, if the RBS [EBS] is unavailable, the plant is stabilised by the use of the ASG [EFWS] and VDA [MSRT]. The transfer to the safe shutdown state is not necessary as the ASG [EFWS] tank can be supplied with additional water to remove the heat from the reactor coolant system.

Should the PSVs fail, the increase in RCP [RCS] heat is removed by the secondary side as demonstrated by the analysis of closure of the 4 VIV [MSIV]s without PSV in the short term. In the long term, as the failure is postulated on the PSVs, the RCP [RCS] heat can be removed by the ASG [EFWS] and the VDA [MSRT]s. The plant is stabilised in this configuration. The same is true if there is a failure on the LHSI (RHR). The plant is stabilised in a non-hazardous stable state and maintenance can be performed on the equipment.

The table below presents the main and diverse lines used to reach a safe shutdown state.

	Main line	Diverse line
RCP [RCS] boration	Emergency boron injection into the core – Manual	RIS [SIS] + PDS
RCP [RCS] cooldown	SG Pressure Control – Cooling (VDA [MSRT])	RIS [SIS] + PDS
RCP [RCS] depressurisation	RCP [RCS] depressurisation by pressuriser safety valves	RIS [SIS] + PDS
RRA connection	RHR connection and start-up (no SI signal)	VDA [MSRT] + ASG [EFWS]

Main and Diverse Lines to reach a Safe Shutdown State

A.2.5. - Electrical power supply fault

The postulated initiating event considered is:

- Short-term loss of off-site power (LOOP)

This case is similar to those identified above, as the short-term LOOP leads to a decrease in heat removal. Therefore, the table in section A2.4 above presents the main and diverse lines used to reach a safe shutdown state.

Moreover, the additional failure that can be combined with the LOOP is the loss of the EDGs. It is demonstrated in PCSR Sub-chapter 16.1 that, in the event of Station Black Out, the safe shutdown state can be reached. Additional details are provided below.

To reach the safe shutdown state, the systems used must be supplied by power in the long term. This is true for:

- RBS [EBS]
- ASG [EFWS]
- RIS [SIS]

The VDA [MSRT]s and PSVs (solenoid pilots) are supplied by two-hour batteries.

Moreover, the two pilots of the third PSV are supplied by electrical divisions 1 and 4, which are supplied by Ultimate Diesel Generators (UDGs). The two pilots must open to actuate the safety valve.

Similarly, the main steam relief control valves of steam lines 1 and 4 are supplied by UDGs.

The LOOP leads to the loss of the reactor coolant pumps, Main Feedwater System (ARE [MFWS]) and turbine trip. Therefore, the ASG [EFWS] and VDA [MSRT]s are necessary to mitigate the event. The heat exchange in the steam generators ensures that the reactor coolant flows by natural circulation due to the temperature difference between the core and the steam generators. Therefore, heat removal is ensured as long as the water inventory in the steam generator is sufficient. The plant can be stabilised in the hot shutdown state.

A.2.6. - Steam generator tube rupture

In the case of steam generator tube rupture, the controlled state is reached when the leak is compensated by RCP [RCS] water make-up. In the fault studies, SGTR scenarios are demonstrated up to the end of the short-term phase where the SGTR leak flowrate is terminated by establishing a pressure balance between the RCP [RCS] and the affected SG (SGa).

The plant can remain in this condition in the long term, without further actions. Boration has been performed by the RIS [SIS], or the RCV [CVCS] if it is operational, which is more onerous because it prevents RIS [SIS] actuation.

The reactor coolant system inventory is stable due to the RCV [CVCS] or the RIS [SIS] and three steam generators contribute to the residual heat removal.

Radioactive releases are stabilised by isolation of the affected steam generator. If operational systems are available, they can be used to perform their functions. Therefore, the plant can remain in a long-term stable state. Cooldown occurs without intervention in the steam generators due to heat losses and causes the temperature of the reactor coolant system to reduce naturally, allowing the possibility of repairing the impaired systems.

A.2.7. - Reactivity transients

The postulated initiating events considered are:

- Uncontrolled RCCA bank withdrawal at power
- Uncontrolled RCCA bank withdrawal from Hot Zero Power (HZP)
- RCCA misalignment up to control rod drop
- Start-up of an inactive reactor coolant loop at an incorrect temperature
- RCV [CVCS] malfunction that results in a decrease in boron concentration in the reactor coolant
- Uncontrolled single RCCA withdrawal

These events lead to a reactor trip and do not impair the integrity of the reactor coolant system and the secondary side so that their inventories can be maintained after the controlled state is reached. Therefore, the non-hazardous stable state can be maintained in the long term.

A.3. - Conclusions

The use of diverse means to reach the long-term non-hazardous stable state has been demonstrated, when necessary, for all the frequent initiating events. The feed and bleed procedure is used in most cases to ensure depressurisation, cooldown and boration. In the other cases, the plant can remain in a long-term non-hazardous stable state.

Note: Class 1 manual actions with F1A architecture requirements are not required to reach the safe shutdown state. If they are provided to reach the safe shutdown state, it is due to their implementation in order to reach the controlled state in the following PCCs: steam line break, feedwater line break, piping failure on a main cooling train (states A to F).

Note: Since the initiating event frequencies for the "loss of support systems" events have not yet been determined, the diverse line for the Emergency Operating Procedures is not analysed in this revision of the Fault Schedule.

SUB-CHAPTER 14.7 – REFERENCES

External references are identified within this sub-chapter by the text [Ref-1], [Ref-2], etc at the appropriate point within the sub-chapter. These references are listed here under the heading of the section or sub-section in which they are quoted.

1. LIST OF INITIATING EVENTS

1.2. NSSS DESIGN CONDITIONS (PCC EVENTS)

[Ref-1] Prouillac. Justification of the internal events list for the design conditions of the NSSS. Fratec 01 Revision E. AREVA. June 1980. (E).

2. JUSTIFICATION OF THE COMPREHENSIVENESS OF FAULT PROTECTION

2.3. DEFENCE LINES

2.3.2 Main defence line (protection)

[Ref-1] P. Martinet. Reactor Trip Concept. NLE-F DC 124 Revision B. June 2008. AREVA. (E).

3. PROTECTION SYSTEM I&C ARCHITECTURE

3.1. SAFETY FUNCTIONS

[Ref-1] L. Carfantan. EPR UK - Definition of P/S I&C functions. NEPR-F DC 469 Revision A. April 2009. AREVA. (E).