RCC-E A Design Code for I&C and Electrical Systems

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Abstract: RCC-E a design code for I&C and electrical systems

The paper deals with the stakes and strength of the RCC-E code applicable to Electrical and Instrumentation and control systems and components as regards dealing with safety class functions.

The document is interlacing specifications between

Owners, safety authorities, designers, and suppliers

IAEA safety guides and IEC standards.

The code is periodically updated and published by French Society for Design and Construction rules for Nuclear Island Components (AFCEN).

The code is compliant with third generation PWR nuclear islands and aims to suit with national regulations as needed in a companion document.

The Feedback experience of Fukushima and the licensing of UKEPR in the framework of Generic Design Assessment are lessons learnt that should be considered in the upgrading of the code.

The code gathers a set of requirements and relevant good practices of several PWR design and construction practices related to the electrical and I&C systems and components, and electrical engineering documents dealing with systems, equipment and layout designs.

Comprehensive statement including some recent developments will be provided about:

- Offsite and onsite sources requirements including sources dealing the total loss of off sites and main onsite sources.

- Highlights of a relevant protection level against high frequencies disturbances emitted by lightning strokes,

Interfaces data used by any supplier or designer such as site data, rooms temperature, equipment maximum design temperature, alternative current and direct current electrical network voltages and frequency variation ranges, environmental conditions decoupling data,

- Environmental Qualification process including normal, mild (earthquake resistant), harsh and severe accident ambient conditions. A suit made approach based on families, which are defined as a

combination of mission time, duration and abnormal conditions (pressure, temperature, radiation), enables to better cope with Environmental Qualifications.

- Electrical equipment separation requirements and isolation and decoupling solutions.

1. Introduction

The nuclear safety of the nuclear power stations is articulated around a certain number of important aspects for the maintenance and the improvement of the level of safety. The following fields are very largely dependent:

- standardization and the development of the codes,
- The standardization facilitates the analysis of the experience feedback and vice versa, the benefit drawn from the experience feedback and all the more considerable as the standardization is high.
- The international exchanges contribute significantly in the research and the experience feedback.

French nuclear industry (owners and industrialists) mobilizes engineers and technicians whose work is devoted to safety: organization, studies, tests, monitoring, audits internal and external, etc.

The roles of the various partners are summarized:

- the public authorities define the general objectives of safety,
- the owner proposes technical methods to reach them and justifies them,
- the public authorities make sure of the adequacy of these methods to the laid down objectives,
- The owner implements the approved provisions.
- The public authorities check the good implementation of the provisions.

The presentation hopes to contribute to clarify the relationship of trust brought by the standardization, the development of the codes in answer to technical recommendations of the Safety Authorities.

2. Standardization

The standardization initiated by EDF with the fossil power plants during the Sixties was implemented for the nuclear plants. It consists to build units identical with the differences limited to the site adaptation (riverside or seaside), the nuclear steam supply systems, the turbo-generator group and the same suppliers provide all the equipment and circuits identical. Three great series were launched:

- PWR 900, 34 units
- PWR 1300, 20 units
- PWR 1450, 4 units

The generic studies, evaluations of safety, manufacturing drawings, the equipment of machine, manufacturing methods, of construction, are deadened on all the series, of reproducible quality and faster to implement. The spare parts are the same ones for all the series. The erection teams are acquainted with the methods; the procedures of control are applicable to all the series, the operating teams trained on simulators.

The generic defects, i.e. common to all the power plants of the series cost sometimes expensive. The experience shows that the systematic vigilance and inspections make it possible to be alerted of certain defects before they degenerate and to bring their solutions adapted on the NPP series or the whole NPP fleet.

To maintain the principle of standardization, the detail improvements made to a NPP of a series are then implemented to all the NPP of the series, to keep the standardized series of plants.

3. Regulations Codes and Standards

A series of directives fixes rules and practical technical as regards with nuclear safety are emitted by the NNSA, lay down the general objectives, and are relatively very few. It is up to industry to propose the application methods that are subjected to the NNSA approval. The figure 1 shows an example of regulatory pyramid.

A series of directives fixe rules as regards nuclear safety. It deals with four important topics:

- the equipment under pressures,
- the organization of quality,
- withdrawals and discharges from nuclear facilities,
- Nuisances and external risks arising from operation of nuclear facilities.

Two on four themes are related to design and construction codes:

- With regard to the equipment under pressure, nuclear installations include two of them: on the one hand, those, which are nuclear, field specific, i.e. those that confine of the radioactive releases, on the other hand those of the conventional field that are not specific nuclear installations.
- As regards quality, the rules of assurance and organization of the quality, which the owners shall follow at the three stages of the design, the construction, and the exploitation of the nuclear installation. It is indeed fundamental for the safety that the nuclear island either built in strict conformity with the specifications fixed at the time of its design. It is the object of the provisions known as "of quality assurance" reinforced by the IAEA GSR3 guide and its updating under drafting.

The safety options are specified by the NNSA when reviewing a project basic design. The recommendations put forth by the NNSA that define in various technical fields of the objectives of safety and describe practices that they judge satisfactory to respect these objectives.

The codes of nuclear industry such as the *Rules of Design and Construction (RCC) and* EPR Technical Codes (ETC) provide the set of the rules, codes, and standards that the owner implements at the time of the design, the realization, and the start-up of the important equipment for safety. The owners and manufacturers have developed "Rules of Design and Construction" (RCC) which concretely transpose the requirements of the regulations while reflecting the industrial good practice. The RCC and ETC cover the following fields:

- RCC-M: Rules of design and construction applicable to the mechanical components for the pressurized water reactors,
- RCC-MRx: Rules of design and construction applicable to the mechanical components for the fast and 4th generation reactors,
- RCC-E: Rules of design and construction applicable to the electrical and I&C equipment,
- RCC-C Rules of design and construction applicable to the fuel assemblies,

Initially had been created codes for the following fields:

- RCC-G: Rules of design and construction applicable to civil works engineering,
- RCC-I: Rules of design and construction applicable to fire protection,

They were replaced respectively by the codes:

- ETC-C: EPR Civil Technical Codes for works,
- ETC-F: EPR Technical Codes for Fire protection.

One specific to the in-service inspection and maintenance:

- RSE-M: In-Service Inspection Rules for Mechanical Components of PWR Nuclear Islands

These rules are written and published by French Association for the rules of design, construction, and monitoring in exploitation of the Nuclear Steam Supply System (AFCEN), in which in particular EDF, AREVA NP and CEA take part.

The NNSA carries out the evaluation of the codes and their revisions.

4. RCC-E

History The coding process related to nuclear island was undertaken in April 1978 under the leadership of EDF and AREVA NP (ex-FRAMATOME) and with the participation of the principal industrialists implied in the realization of the nuclear program. Thirty plants of the French nuclear program were already in construction or service. The practices of design and construction were already highly standardized. A high level of quality had been reached and maintained in spite of the difficulties of realization of a so wide program. These practices were dispersed in a great number of technical specifications established by the manufacturers and checked by the architect-owner EDF. The implementation of this code aimed:

- to simplify the circuits of approval of the documents,
- to fix a precise contractual base,
- to improve the effects of the standardization,
- to enable doing offers for the exportation,
- To clarify the applicable rules for the NNSA.

The development of the RCC-E allowed a wide dialog between owner (EDF), the manufacturers, and the various suppliers whose objective was to examine from every angle the "state of Art". The industrialists were not ready to let a code specifying requirements on a part of their know-how; finally, they ended up collaborating in its development. The RCC-E gathers in one document the generic rules making possible to specify the various packages, electrical equipment, and instrumentation and control equipment contributing to safety classified functions. These requirements are defined for a safety redundancy of a pressurized water reactor. Project Data Books respectively supplement the generic rules for the NPP in exploitation and the EPR, 3rd generation of NPP.

Design Experience and references: The RCC-E was used:

- in France for the NPP series PWR 1300, PWR 1450 and EPR, i.e. 13 NPPs,
- In South Korea, South Africa and China. France for the PWR900 sold, i.e. 10 NPPs,
- in China for the

- CPR 1000 Program, 19 NPPs (HongYangHe 4*1000MW, Ningde 4*1000MW, Yangjiang 4*1000MW, Fuqing 2*1000MW, Fangjiashan 2*1000MW)
- EPR Taishan 2*1650MW

The appropriation of the RCC-E 2005 and its translation were undertaken by China in 2009.

Actually, the RCC-E code has been used for the design and construction of above 50 NPPs.

The 2012 version is the sixth edition of RCC-E. It is applicable to existing NPP and NPP 3rd generation EPR. The later shall be used for UK EPR.

Project Data books supplement rules generic rules with specific characteristics to existing NPP or NPP 3rd generation EPR.

The scope of application of the requirements is the activities of design, manufacture, and construction and of maintenance. The industrial architect, engineering of NPPs, the installation engineering departments, the clients and the manufacturers and suppliers follow the RCC-E. The applicability of the RCC-E can be summarized through the

The referenced standards, International standards account for 84% of the standards used. Few remaining French standards correspond to requirements that are not yet within the international standardization.

The input data result from the safety analyses report and the national technical regulations. They include/understand in particular

- the definition of the characteristics of the extra high voltage grid-NPP interface,
- the project industrial policy,
- the project safety classification,
- the number of safety train, and
- The accidents envelopes of basic design accidents and severe accidents.

The documentation used is described and contents defined for some the engineering documents:

- Electric systems,
- I&C control systems,
- Equipment and its manufacturing and environmental qualification,
- Layout engineering
- Engineering documentation.

Electrical equipment and/or I&C equipment contributing to safety-classified functions are powered by power and control sources that fulfil the requirements concerning:

- the independence of the off-site electric sources,
- the sizing of the power transformers,
- the sizing of the on-site power sources (standby sources, ultimate power sources, DC and AC vital sources)
- the coordination of the characteristics of the plant electric network (voltage, current and insulation),
- the personnel safety and the equipment protection against the electromagnetic interferences,
- the electric separation between equipment of different safety classes,
- guarantee of availability of the equipment and functions,

- Interchangeability of the materials,
- Use of smart devices.

The I&C equipment, contributing to the safety functions implemented in the reactor protection system fulfils in more the requirements:

- Of I&C general architecture,
- Of development and qualification of the programmed software system according to the required safety class,
- Engineering of the human factor,
- Means of control, communications, and safety information in control rooms.

The demonstration of equipment environmental qualification An electromechanical chain (figure 3) defines the list of equipment to be qualified. The proof, that equipment withstands the environmental conditions, is provided by conformity to the establishment of qualification requirements that rely on:

- Agreement of a supplier and its material,
- Establishment of a program of qualification based on one of the following methods, analysis, the analogy, modelling, tests of the type (preferred solution) or a combination of these methods qualification.
- Documentation associated with the process of qualification, identification of the qualified model and its manufacturing processes and of control, the guarantee of compliance of the materials of series with the qualified model material, the program of qualification and specifications of tests associated, the anomalies of test, the reports of test and the report of qualification.
- The approach of ambience families determines, on the basis of the time of mission of the equipment, the customized conditions of environment envelopes of the constraints resulting from design accidents and severe accidents including seismic loads.
- Electrical and electronic materials qualification master list.

Supplemented requirements are raised for the construction of the small electric and electronic components such as the sensors, electronic circuits, the terminals and clips, the cabinets, boxes etc… Those requirements make it possible to conceive all the industrial aspects for this equipment. They are supplemented by requirements about the obsolescence of the components, electronic cards.

The great principles of nuclear safety are identical in all the countries. However, the differences in their application can lead to differences in the requirements in safety, even on different levels of safety. The approaches of safety were indeed constituted progressively of the construction of the successive generations of nuclear installations, and were developed by the originators according to the technologies selected.

The various actors, authorities of safety, experts, research organizations, owners, and manufacturers for a long time tied relations for exchange information on their approaches and their practices, to even harmonize them. In addition to the numerous relations and bilateral agreements, it is necessary to underline the work of harmonization made within international agencies.

The regulation concerns the responsibility for the authorities for each country, but, today, several interests convergent to go further in the harmonization:

- in the long term, the requirements as regards protection of the populations and the environment should not be significantly different,

- The harmonization of safety is one of the answers to the opening of the markets and the internationalization of the nuclear safety operators at least in the European plan, for the nuclear power plants.

5. CONCLUSION

RCC-E Evolutions have been requested by:

- The export of nuclear power stations,
- The development of the EPR in collaboration with SIEMENS, AREVA and of the German owners.
- The UK EPR licensing process,
- DIDLESYS recommendations.

These modifications have already purged the code of the discriminatory requirements.

A last stage consists to maintain the code as close as possible with the evolution of:

- the feedback experience of the Chinese users and manufacturers;
- IEC standards,
- IAEA safety guides and relevant good practices,
- The WENRA Safety Reference Levels.
- The Fukushima and ROBELSYS feedback experience.

ACRONYMS

NNSA: National Nuclear Safety Authority

EDF: Électricité de France, French nuclear power station operator

CEA: French Atomic Agency

NPP: Nuclear Power Plant

AFCEN : French Association in charge of RCC writing

REFERENCES

[1] SFEN - AFCEN November Conference, 23rd 1989.

[2] RCC-E 2012 AFCEN and projects data books

ANNEX A FIGURES

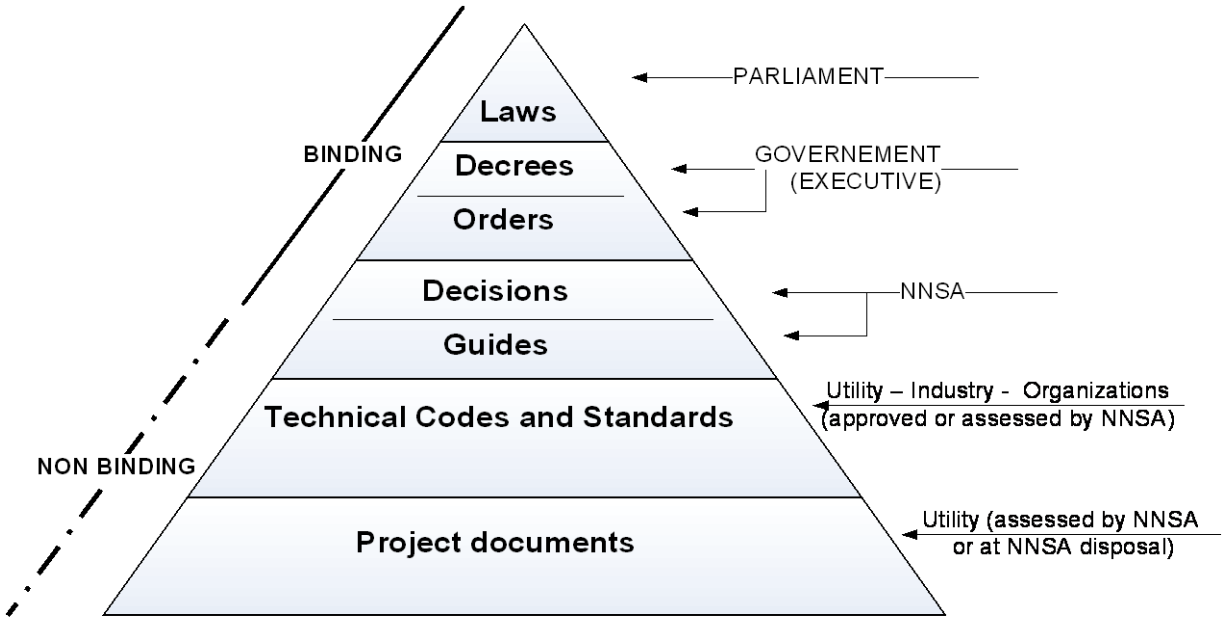


Figure 5: A regulatory pyramid

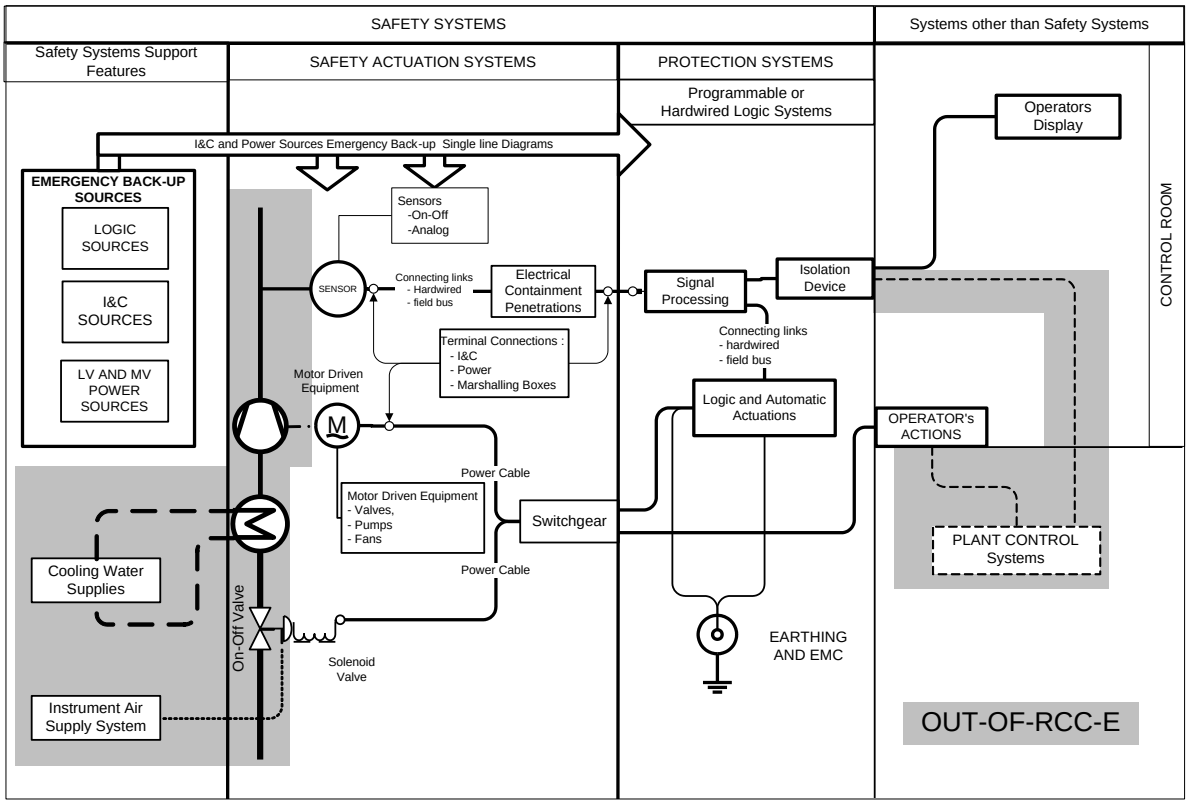


Figure 2 : Scope of RCC-E

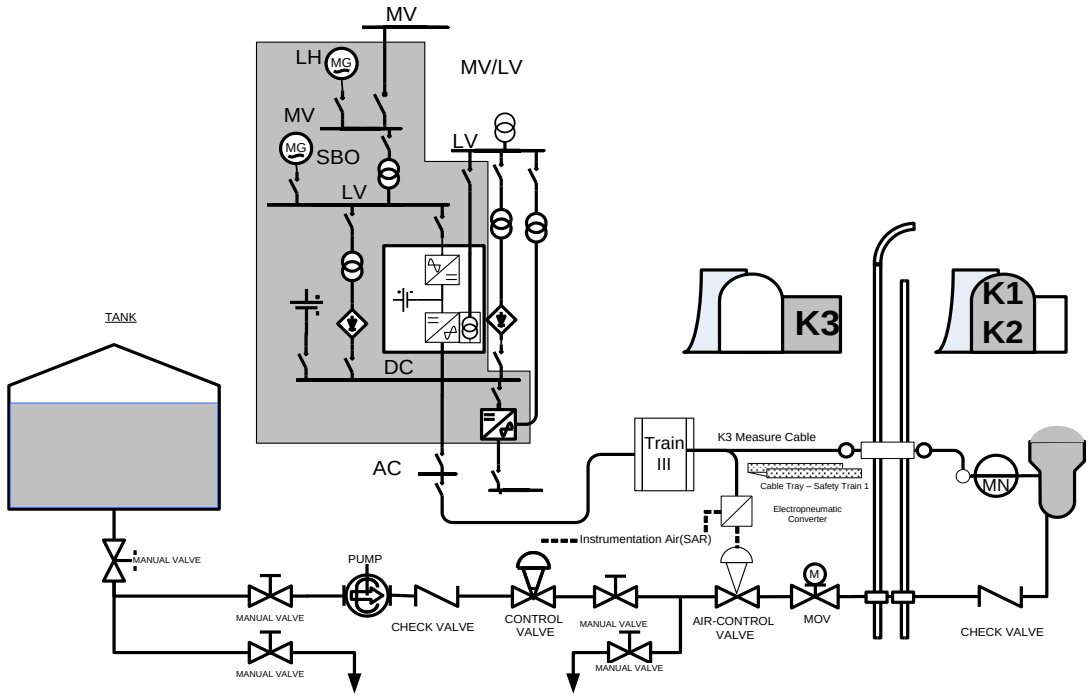
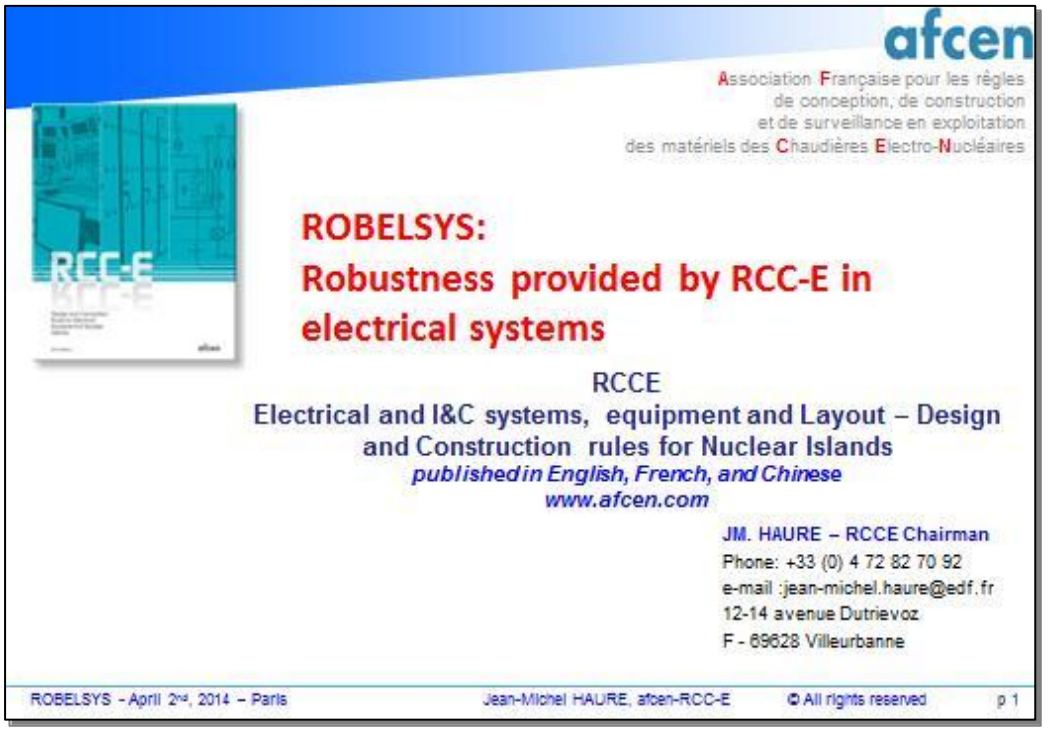


Figure 3: Establishing Qualification, list of qualified Equipment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Association Française pour les règles de conception, de construction et de surveillance en exploitation des matériels des Chaudières Electro-Nucléaires
RCC-E
ROBELSYS:
Robustness provided by RCC-E in electrical systems
RCCE
Electrical and I&C systems, equipment and Layout – Design and Construction rules for Nuclear Islands
published in English, French, and Chinese
www.afcen.com
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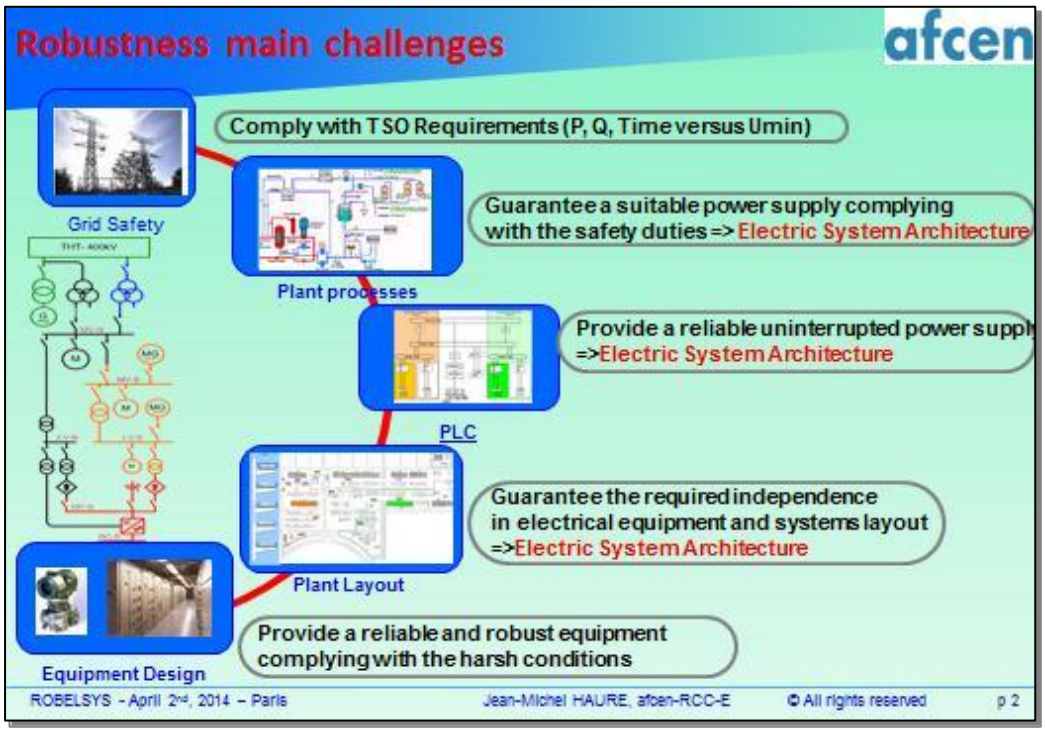
Robustness main challenges
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Comply with TSO Requirements (P, Q, Time versus Umin)
Grid Safety
Guarantee a suitable power supply complying with the safety duties => Electric System Architecture
Plant processes
Provide a reliable uninterrupted power supply
=>Electric System Architecture
PLC
Guarantee the required independence in electrical equipment and systems layout
=>Electric System Architecture
Plant Layout
Provide a reliable and robust equipment complying with the harsh conditions
Equipment Design
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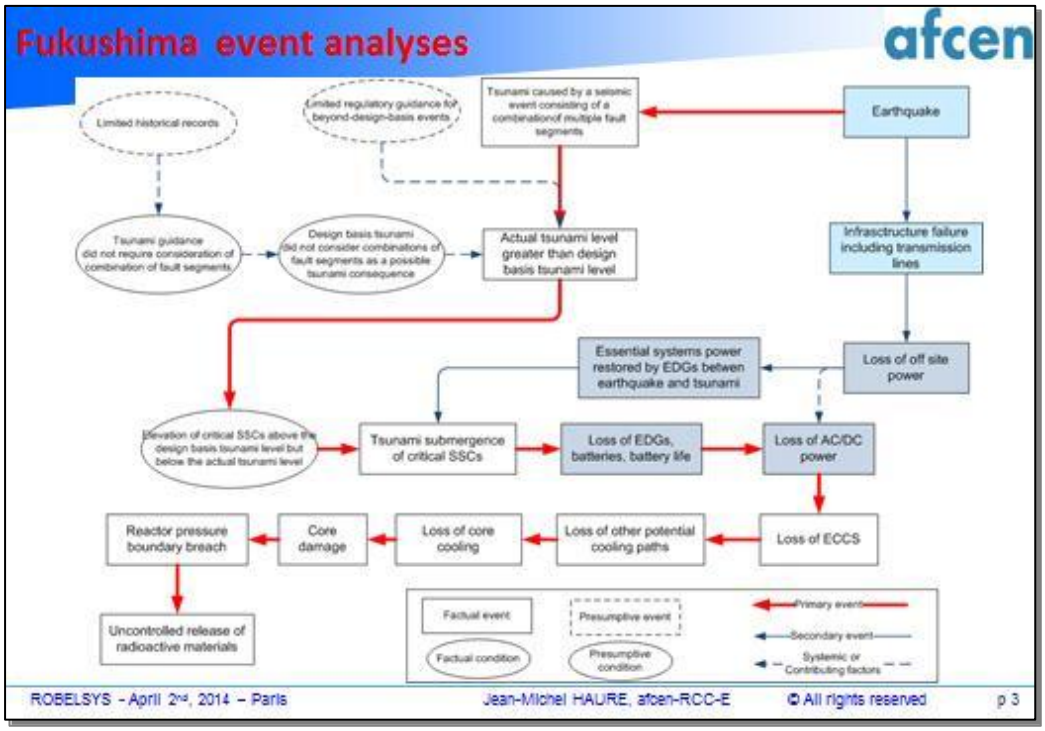
Fukushima event analyses
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Limited historical records
Limited regulatory guidance for beyond-design-basis events
Tsunami caused by a seismic event consisting of a combinationof multiple fault segments
Earthquake
Tsunami guidance did not require consideration of combination of fault segments
Design basis tsunami did not consider combinations of fault segments as a possible tsunami consequence
Actual tsunami level greater than design basis tsunami level
Infrastructure failure including transmission lines
Essential systems power restored by EDGs betwen earthquake and tsunami
Loss of off site power
Elevation of critical SSCs above the design basis tsunami level but below the actual tsunami level
Tsunami submergence of critical SSCs
Loss of EDGs, batteries, battery life
Loss of AC/DC power
Reactor pressure boundary breach
Core damage
Loss of core cooling
Loss of other potential cooling paths
Loss of ECCS
Uncontrolled release of radioactive materials
Factual event
Presumptive event
Primary event
Secondary event
Factual condition
Presumptive condition
Systemic or Contributing factors
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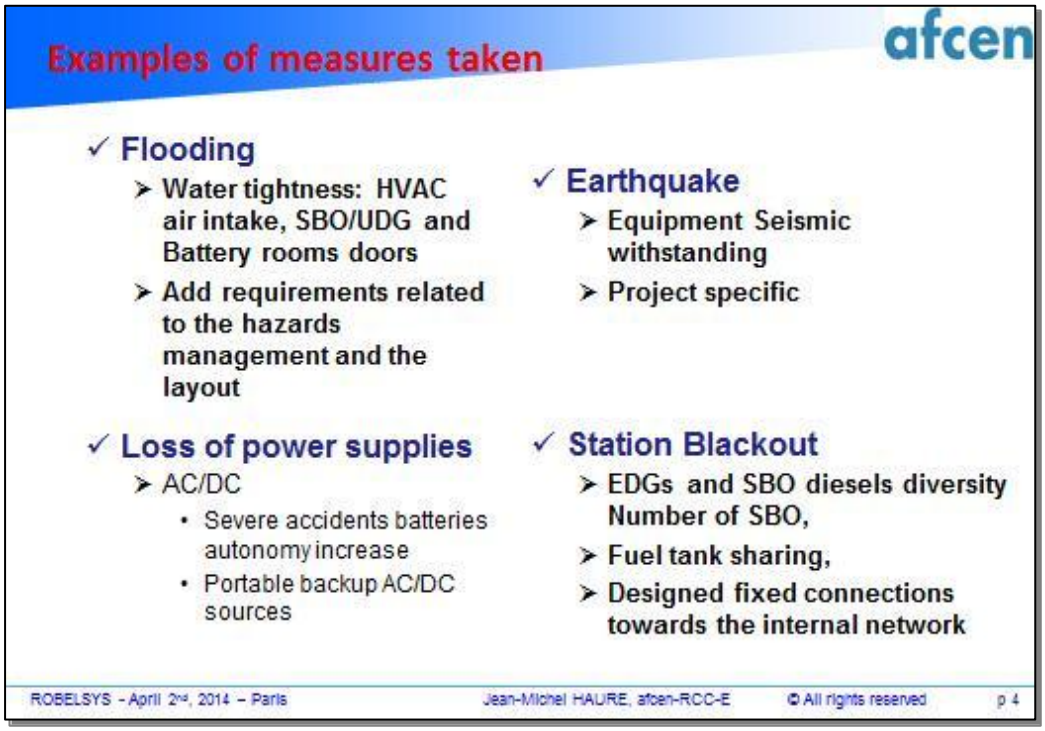
Examples of measures taken
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✓ Flooding
➢ Water tightness: HVAC air intake, SBO/UDG and Battery rooms doors
➢ Add requirements related to the hazards management and the layout
✓ Earthquake
➢ Equipment Seismic withstanding
➢ Project specific
✓ Loss of power supplies
➢ AC/DC
• Severe accidents batteries autonomy increase
• Portable backup AC/DC sources
✓ Station Blackout
➢ EDGs and SBO diesels diversity Number of SBO,
➢ Fuel tank sharing,
➢ Designed fixed connections towards the internal network
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GRID REQUIREMENTS

ENTSOE requirements consequences

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- Nuclear power plant (CI and NI parts) has to fulfill the requirements of the grid code,
  - i.e. the power production part and the auxiliary systems in CI and NI.
- Grid code frequency range requirements induces consequences on the design of
  - electrical systems;
  - fluid and safety systems;
  - reactor core design;
- Discussions shall be launched to define a fair agreement between Grid Operator, Safety Authorities and Plant designers

RCC-E Off site transmission lines independency requirements

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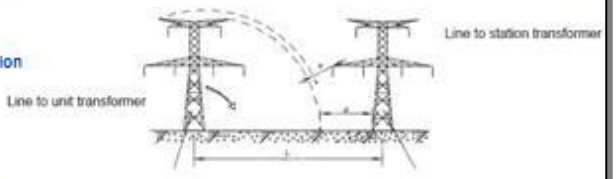
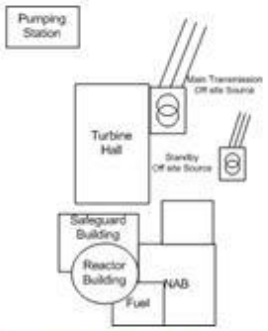
- High reliability of the switchyard station
  - The collapsing of one tower
    - shall not impact the other transmission line.
    - Rotate towards the other line
    - Shall respect electrical distance



- High reliability of the connection to the switchyard station
  - The station transformer and the standby transformer connections of the same unit towards the switchyard shall
    - not be installed on a common tower or gallery.
    - have separate routes



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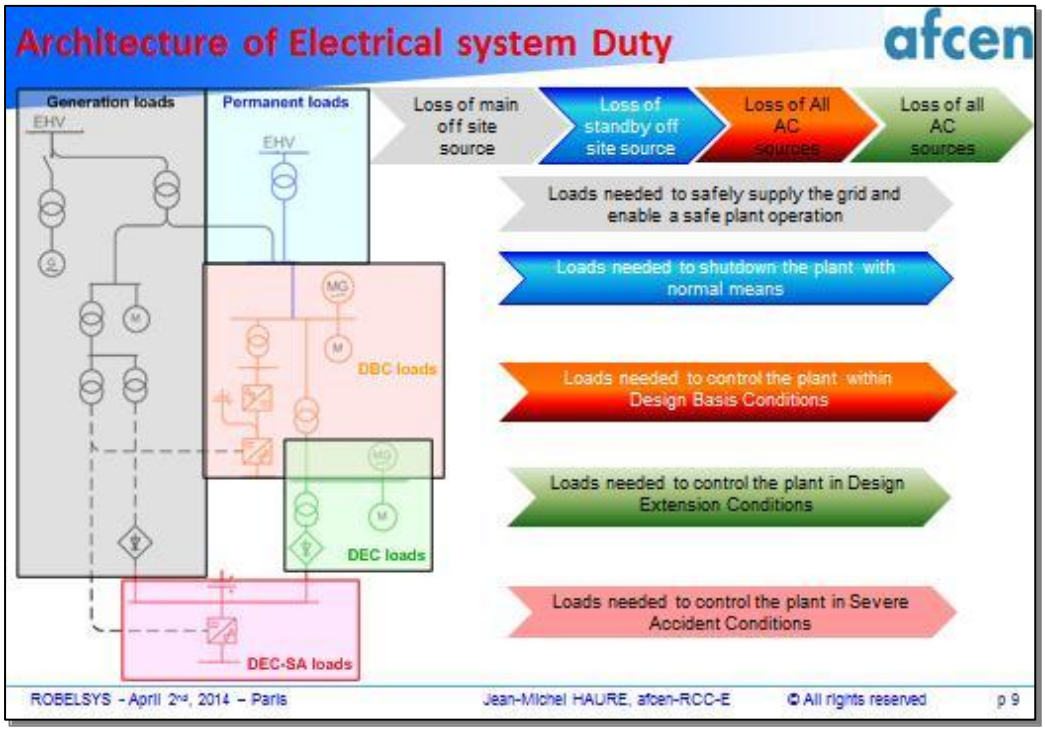
ELECTRICAL SYSTEM ENGINEERING


Architecture of Electrical system Duty
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Generation loads
Permanent loads
EHV
EHV
Loss of main off site source
Loss of standby off site source
Loss of All AC sources
Loss of all AC sources
Loads needed to safely supply the grid and enable a safe plant operation
Loads needed to shutdown the plant with normal means
Loads needed to control the plant within Design Basis Conditions
Loads needed to control the plant in Design Extension Conditions
Loads needed to control the plant in Severe Accident Conditions
DBC loads
DEC loads
DEC-SA loads
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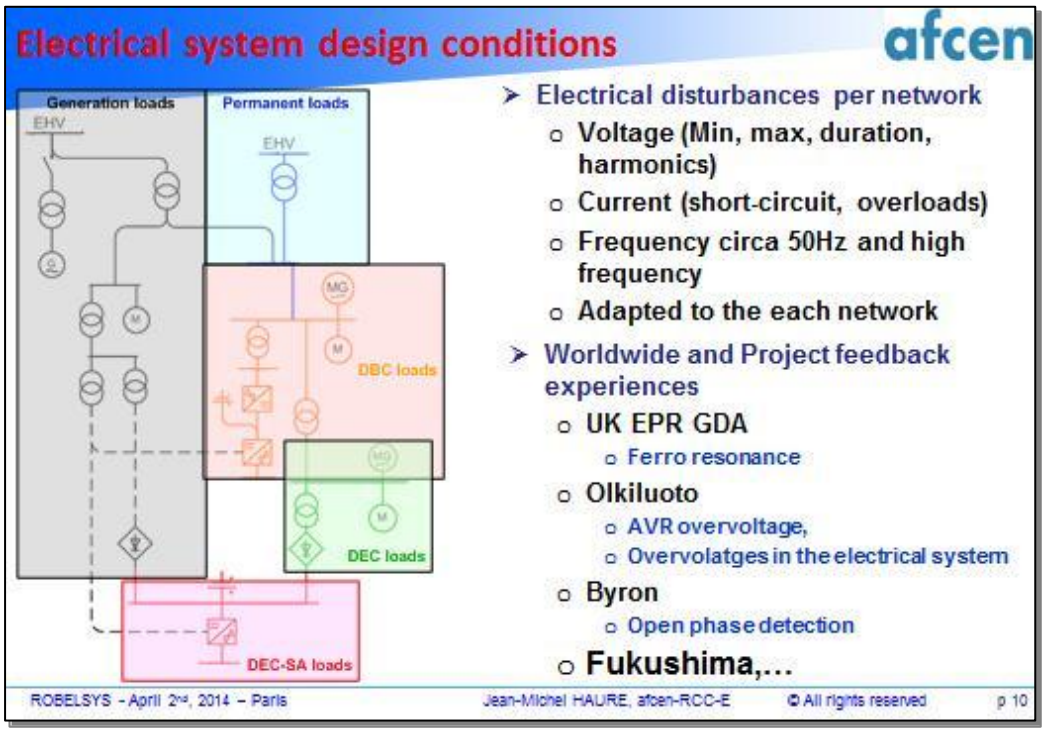
Electrical system design conditions
afcen
Generation loads
Permanent loads
EHV
EHV
DBC loads
DEC loads
DEC-SA loads
Electrical disturbances per network
Voltage (Min, max, duration, harmonics)
Current (short-circuit, overloads)
Frequency circa 50Hz and high frequency
Adapted to the each network
Worldwide and Project feedback experiences
UK EPR GDA
Ferro resonance
Olkiluoto
AVR overvoltage,
Overvolatges in the electrical system
Byron
Open phase detection
Fukushima,…
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Robustness of electrical system

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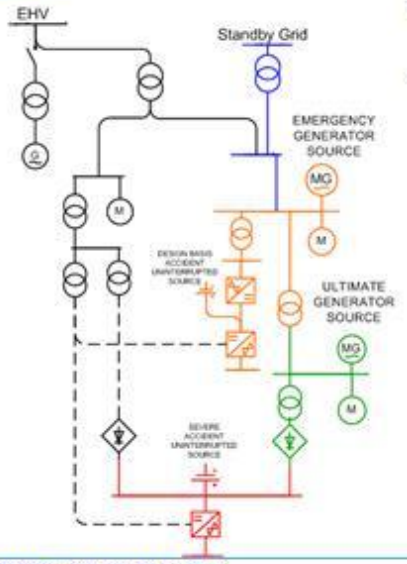

- ✓ Coordination of electrical parameters
  - ➢ Voltage, current and insulation
- ✓ Verification and validation of internal robustness
  - ➢ Circa 50Hz
    - Short-circuit, voltage transients with penalising load balances
    - Ferroresonance
    - Harmonics
    - Resupply by portable sources (fukushima)
  - ➢ High frequency phenomena
    - Overvoltages (ligthning, surges)
  - ➢ Acceptance criteria
    - Variation of voltage in the defined tolerances
    - Breaking capacity of switchgear
    - Transformer reactances

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Robustness to Electrical transient

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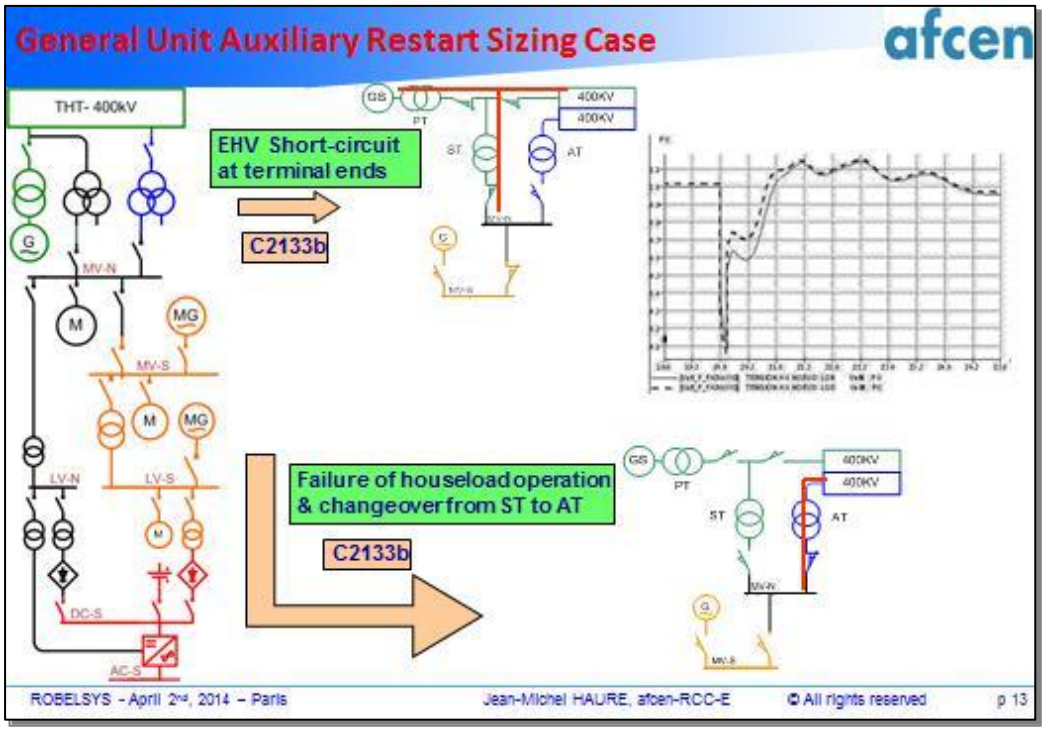
General Unit Auxiliary Restart Sizing Case
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THT- 400kV
EHV Short-circuit at terminal ends
C2133b
Failure of houseload operation & changeover from ST to AT
C2133b
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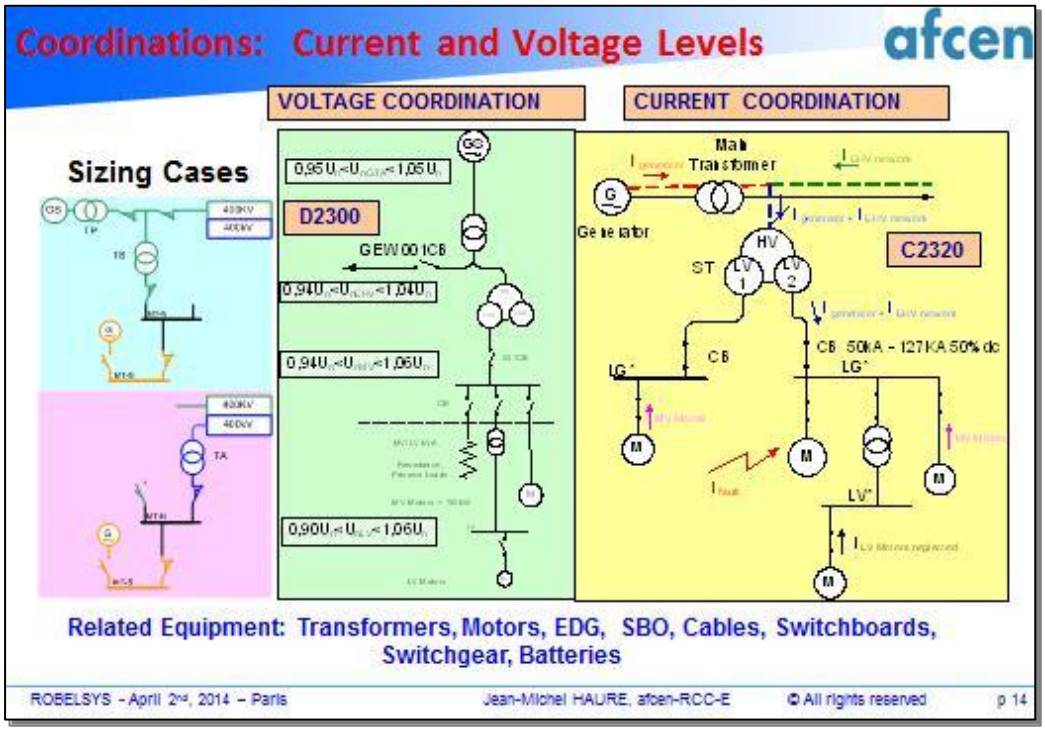
Coordinations: Current and Voltage Levels
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VOLTAGE COORDINATION
CURRENT COORDINATION
Sizing Cases
D2300
C2320
Related Equipment: Transformers, Motors, EDG, SBO, Cables, Switchboards, Switchgear, Batteries
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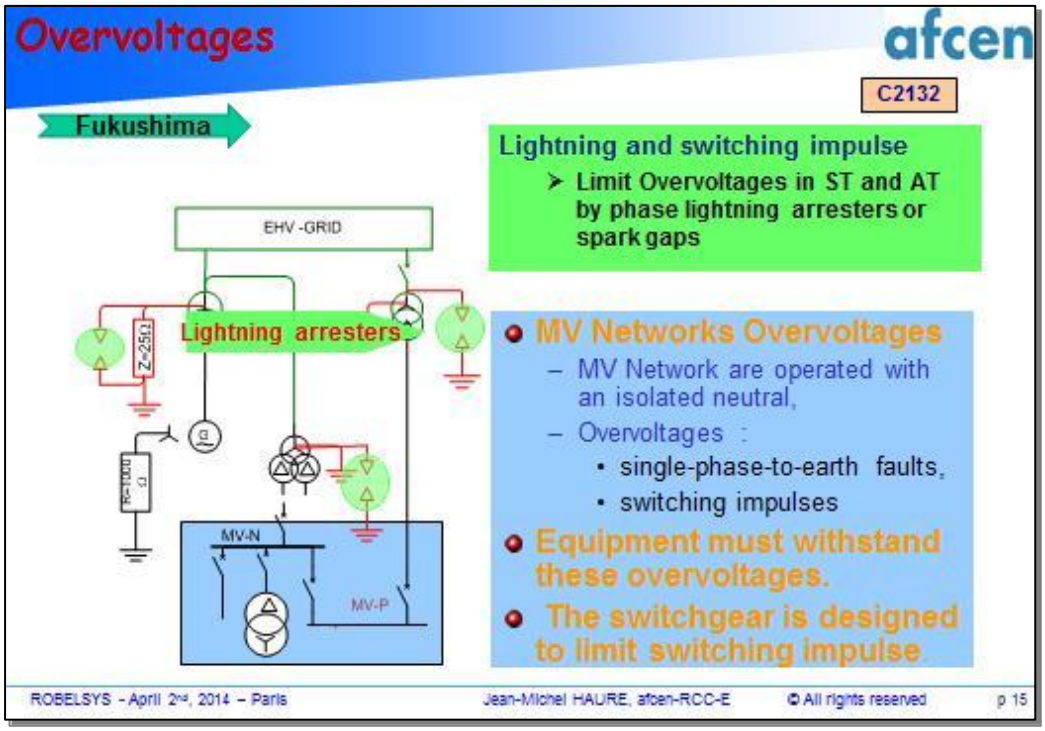
Overvoltages
afcen
C2132
Fukushima
Lightning and switching impulse
Limit Overvoltages in ST and AT by phase lightning arresters or spark gaps
EHV -GRID
Lightning arresters
Z=25Ω
MV-N
MV-P
MV Networks Overvoltages
MV Network are operated with an isolated neutral,
Overvoltages :
single-phase-to-earth faults,
switching impulses
Equipment must withstand these overvoltages.
The switchgear is designed to limit switching impulse
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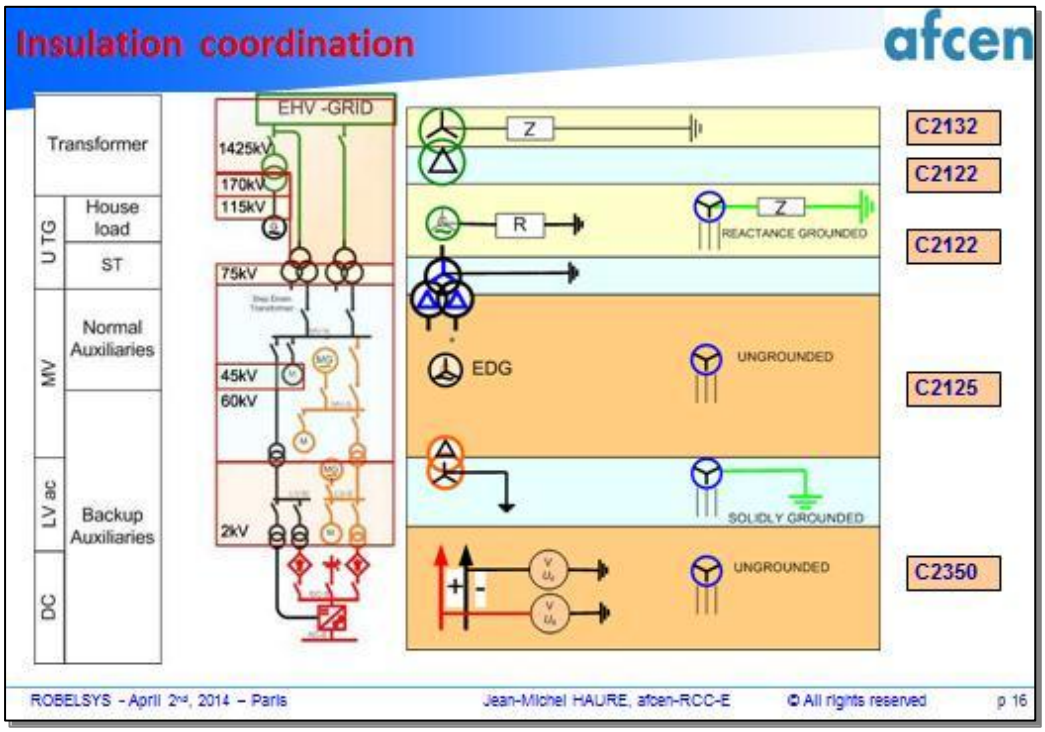
Insulation coordination
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Transformer
U TG
House load
ST
MV
Normal Auxiliaries
LV ac
Backup Auxiliaries
DC
EHV -GRID
1425kV
170kV
115kV
75kV
45kV
60kV
2kV
Z
R
REACTANCE GROUNDED
EDG
UNGROUNDED
SOLIDLY GROUNDED
C2132
C2122
C2122
C2125
C2350
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ELECTRICAL EQUIPMENT ENGINEERING

Emergency Diesel Generator

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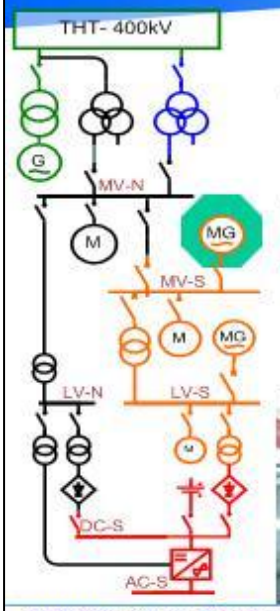
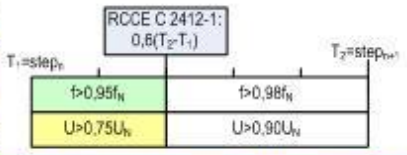
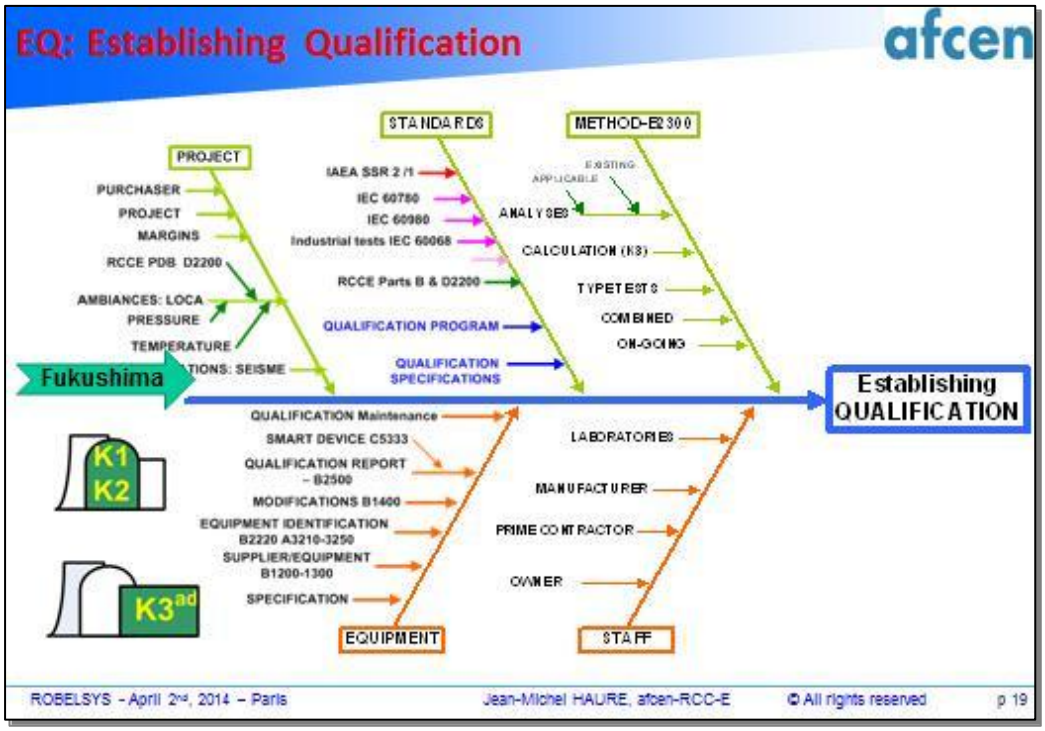
C2400



- ✓ Sizing and operational requirements
  - ➢ Power rating based on load balance for considered situations + 10% oversizing than worst case load
  - ➢ Fuel tank capacity allowing EDG to run for 3 days at full load
- ✓ Loss of off-site power
  - ➢ Automatic Start-up within ~15s
  - ➢ Sequentially loading of busbar and equipment
- ✓ Backup operations required protections
  - ➢ Protection against mechanical overspeed only
  - ➢ Other protections if need be, complying:
    - 2 out of 3 logic vote
    - Protect the generator unit from rapid deterioration
- ✓ Start-up and loading conditions, step available each 5s

C2412




EQ: Establishing Qualification
afcen
STANDARDS
METHOD-E3300
PROJECT
PURCHASER
PROJECT
MARGINS
RCCE PDB D2200
AMBIANCES: LOCA
PRESSURE
TEMPERATURE
IAEA SSR 2 /1
IEC 60780
IEC 60980
Industrial tests IEC 60068
RCCE Parts B & D2200
QUALIFICATION PROGRAM
QUALIFICATION SPECIFICATIONS
EXISTING APPLICABLE
ANALYSES
CALCULATION (K3)
TYPE TESTS
COMBINED
ON-GOING
Fukushima
Establishing QUALIFICATION
QUALIFICATION Maintenance
SMART DEVICE C5333
QUALIFICATION REPORT – B2500
MODIFICATIONS B1400
EQUIPMENT IDENTIFICATION B2220 A3210-3250
SUPPLIER/EQUIPMENT B1200-1300
SPECIFICATION
K1
K2
K3ad
EQUIPMENT
LABORATORIES
MANUFACTURER
PRIME CONTRACTOR
OWNER
STAFF
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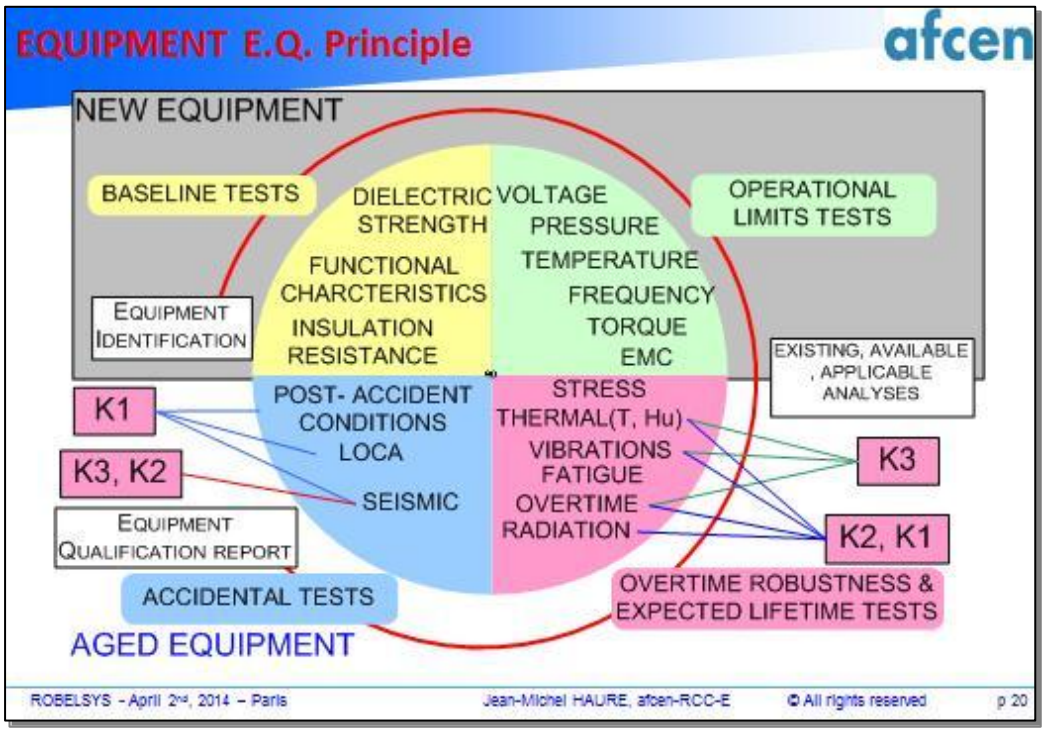
EQUIPMENT E.Q. Principle
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NEW EQUIPMENT
BASELINE TESTS
DIELECTRIC STRENGTH
VOLTAGE
PRESSURE
TEMPERATURE
FREQUENCY
TORQUE
EMC
FUNCTIONAL CHARCTERISTICS
INSULATION RESISTANCE
OPERATIONAL LIMITS TESTS
EQUIPMENT IDENTIFICATION
EXISTING, AVAILABLE , APPLICABLE ANALYSES
K1
K3, K2
POST- ACCIDENT CONDITIONS
LOCA
SEISMIC
STRESS
THERMAL(T, Hu)
VIBRATIONS FATIGUE
OVERTIME
RADIATION
K3
K2, K1
EQUIPMENT QUALIFICATION REPORT
ACCIDENTAL TESTS
OVERTIME ROBUSTNESS & EXPECTED LIFETIME TESTS
AGED EQUIPMENT
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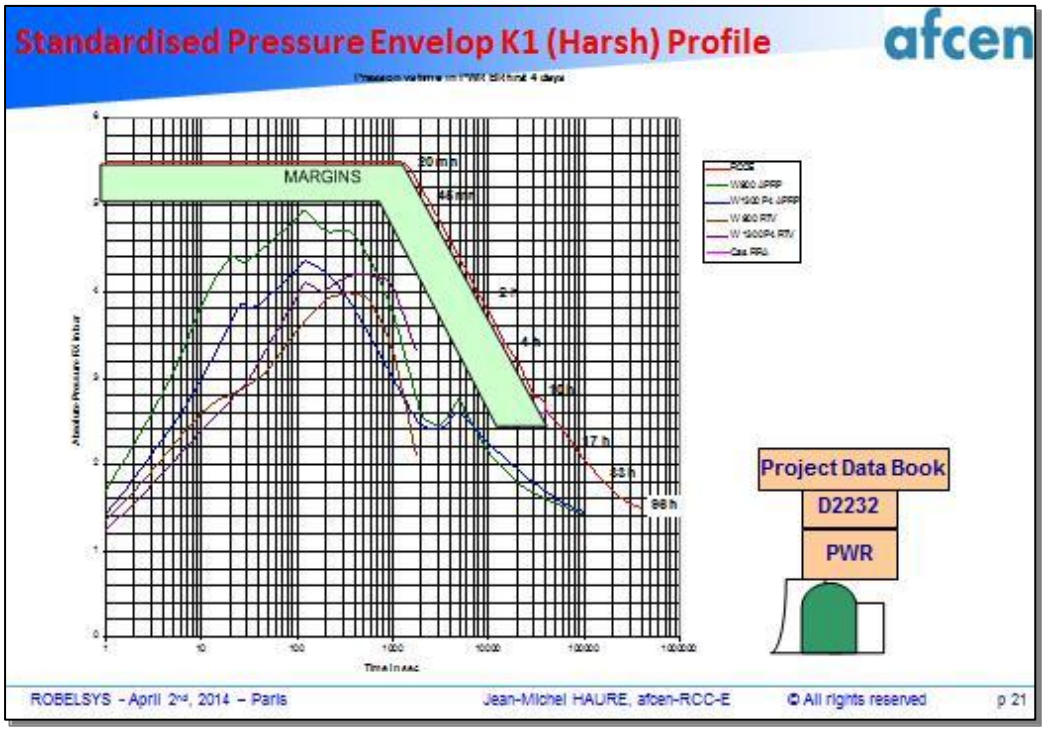
Standardised Pressure Envelop K1 (Harsh) Profile
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MARGINS
Project Data Book
D2232
PWR
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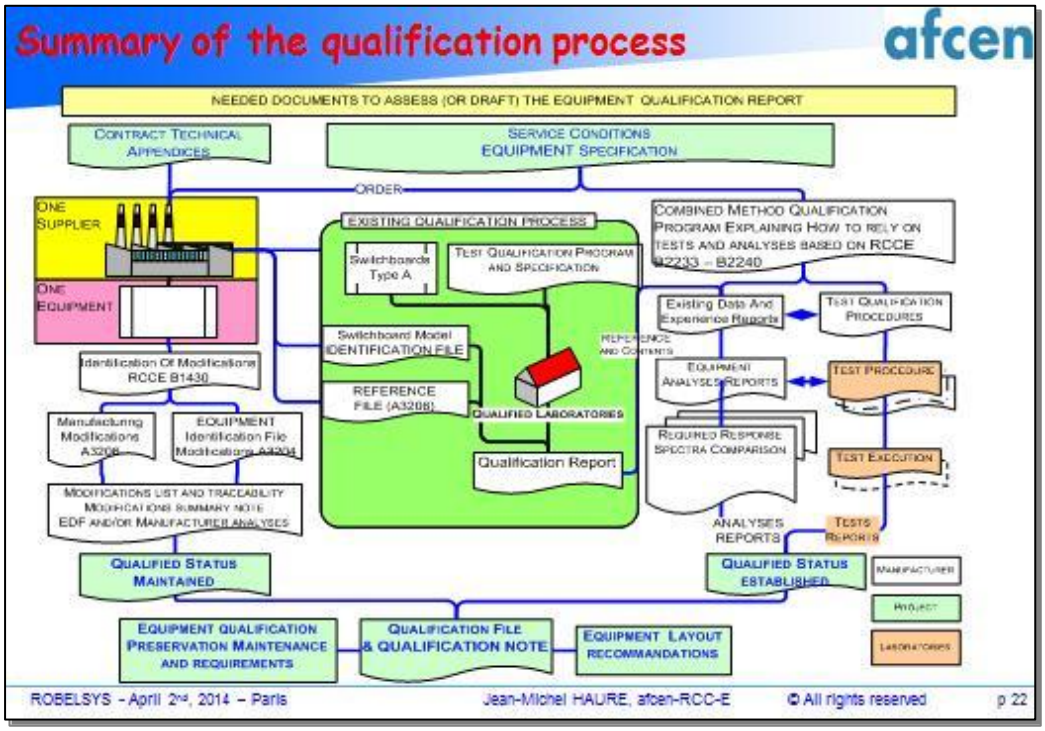
Summary of the qualification process
afcen
NEEDED DOCUMENTS TO ASSESS (OR DRAFT) THE EQUIPMENT QUALIFICATION REPORT
CONTRACT TECHNICAL APPENDICES
SERVICE CONDITIONS EQUIPMENT SPECIFICATION
ORDER
ONE SUPPLIER
ONE EQUIPMENT
EXISTING QUALIFICATION PROCESS
Switchboards Type A
TEST QUALIFICATION PROGRAM AND SPECIFICATION
COMBINED METHOD QUALIFICATION PROGRAM EXPLAINING HOW TO RELY ON TESTS AND ANALYSES BASED ON RCCE
Switchboard Model IDENTIFICATION FILE
REFERENCE FILE (A3208)
QUALIFIED LABORATORIES
Qualification Report
Identification Of Modifications RCCE B1430
Manufacturing Modifications A3208
EQUIPMENT Identification File Modifications A4204
MODIFICATIONS LIST AND TRACEABILITY MODIFICATIONS SUMMARY NOTE EDF AND/OR MANUFACTURER ANALYSES
QUALIFIED STATUS MAINTAINED
QUALIFIED STATUS ESTABLISHED
EQUIPMENT QUALIFICATION PRESERVATION MAINTENANCE AND REQUIREMENTS
QUALIFICATION FILE & QUALIFICATION NOTE
EQUIPMENT LAYOUT RECOMMANDATIONS
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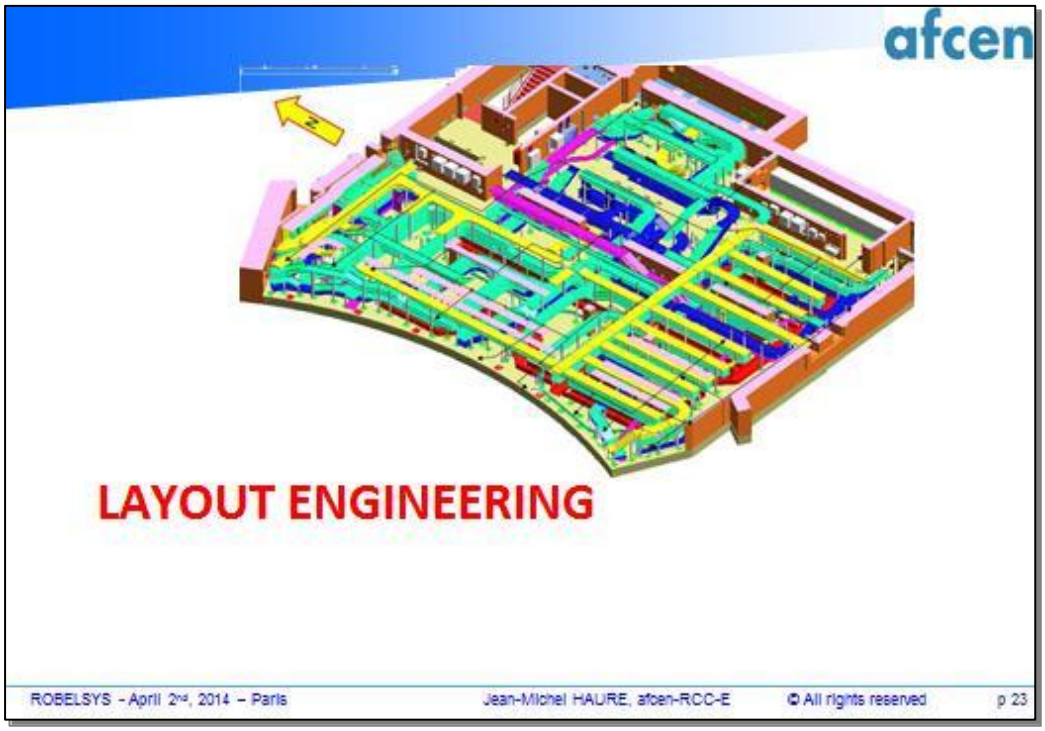
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LAYOUT ENGINEERING
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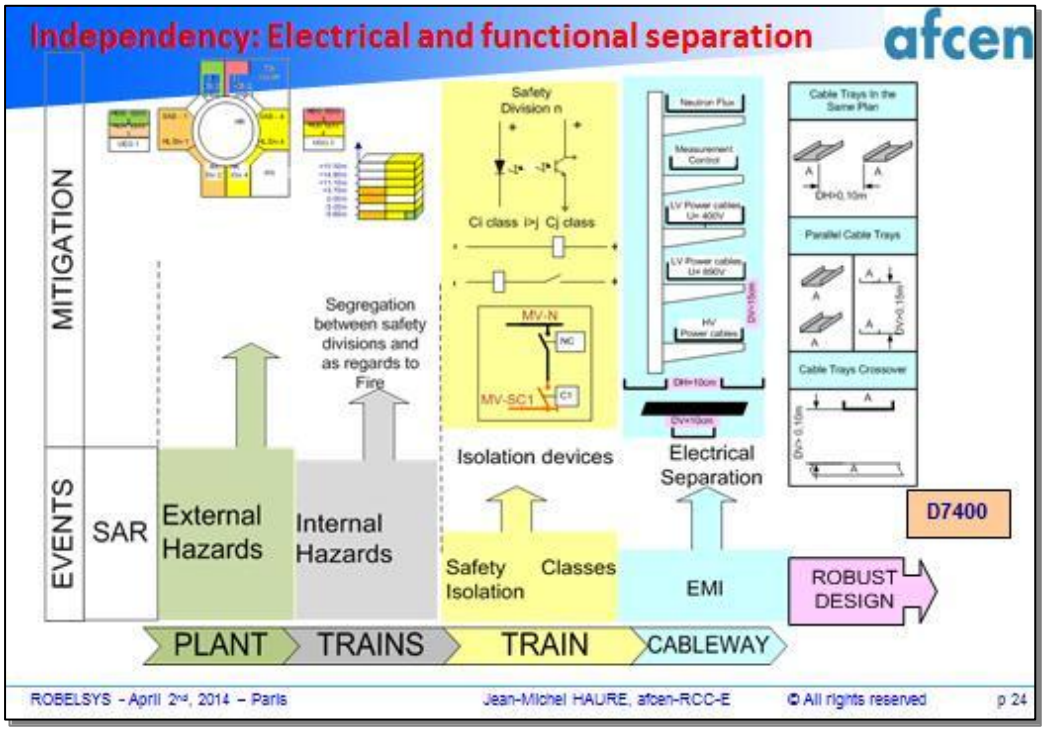
Independency: Electrical and functional separation
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MITIGATION
EVENTS
SAR
External Hazards
Internal Hazards
Segregation between safety divisions and as regards to Fire
Safety Division n
Ci class i>j Cj class
MV-N
MV-SC1
Isolation devices
Safety Isolation
Classes
Neutron Flux
Measurement Control
LV Power cables Un 400V
LV Power cables Un 690V
HV Power cables
Electrical Separation
EMI
Cable Trays in the Same Plan
Parallel Cable Trays
Cable Trays Crossover
D7400
ROBUST DESIGN
PLANT
TRAINS
TRAIN
CABLEWAY
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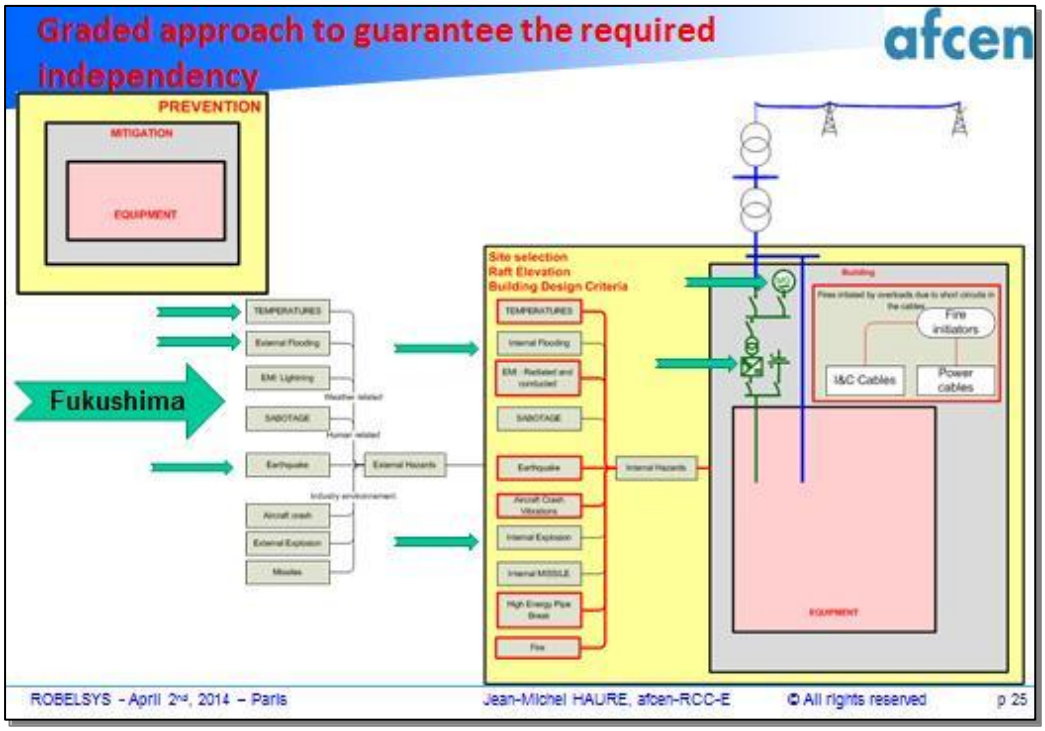
Graded approach to guarantee the required independency
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PREVENTION
MITIGATION
EQUIPMENT
Fukushima
TEMPERATURES
External Flooding
EMI Lightning
SABOTAGE
Earthquake
External Hazards
Aircraft crash
External Explosion
Missiles
Site selection
Raft Elevation
Building Design Criteria
TEMPERATURES
Internal Flooding
EMI Radiated and conducted
SABOTAGE
Earthquake
Aircraft Crash Vibrations
Internal Explosion
Internal MISSILE
High Energy Pipe Break
Fire
Internal Hazards
Building
Fire initiators
I&C Cables
Power cables
EQUIPMENT
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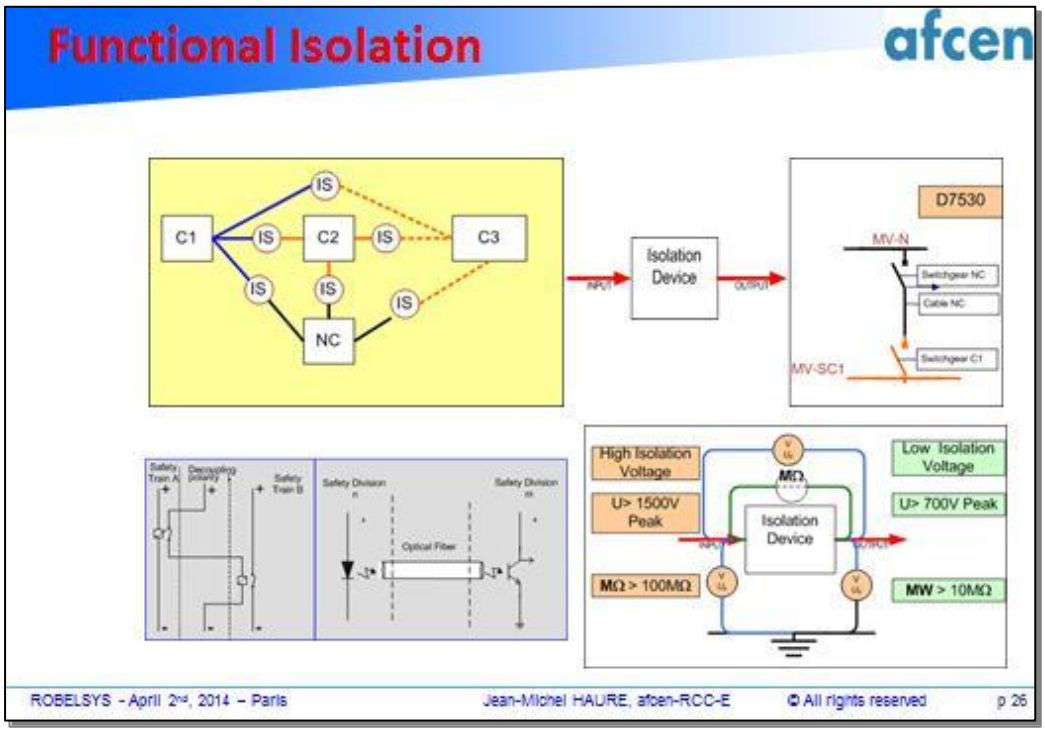
Functional Isolation
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C1
C2
C3
IS
NC
Isolation Device
INPUT
OUTPUT
D7530
MV-N
Switchgear NC
Cable NC
Switchgear C1
MV-SC1
Safety Train A
Decoupling (priority)
Safety Train B
Safety Division n
Safety Division m
Optical Fiber
High Isolation Voltage
U> 1500V Peak
MΩ > 100MΩ
MΩ
Isolation Device
Low Isolation Voltage
U> 700V Peak
MW > 10MΩ
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Summary

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- ✓ **RCC-E is a high level document that**
  - ➢ **provides a comprehensive set of requirements on**
    - Grid connection and transmission lines
    - Plant step-down transformers
    - Internal Interruptible and uninterruptible network and power sources
    - The validation and verifications analyses
    - Equipment design and environmental qualification
    - Layout engineering
    - Suitable documentation
  - ➢ **Provides confidence to the users, robustness to the design and construction processes**
  - ➢ **In other words you ….**

CAN RELY ON RCCE

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AFCEN thanks you for your attention and hope welcoming you in RCC-E committee

Thank You,
Merci
Topic Open for Question

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