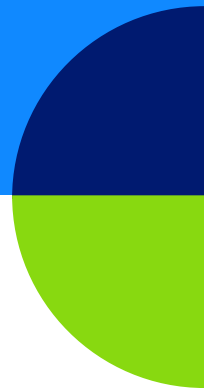


IAEA Technical Meeting
Codes and Standards,
Design Engineering and Manufacturing
of Components for Small Modular Reactors
May 10-13, 2022

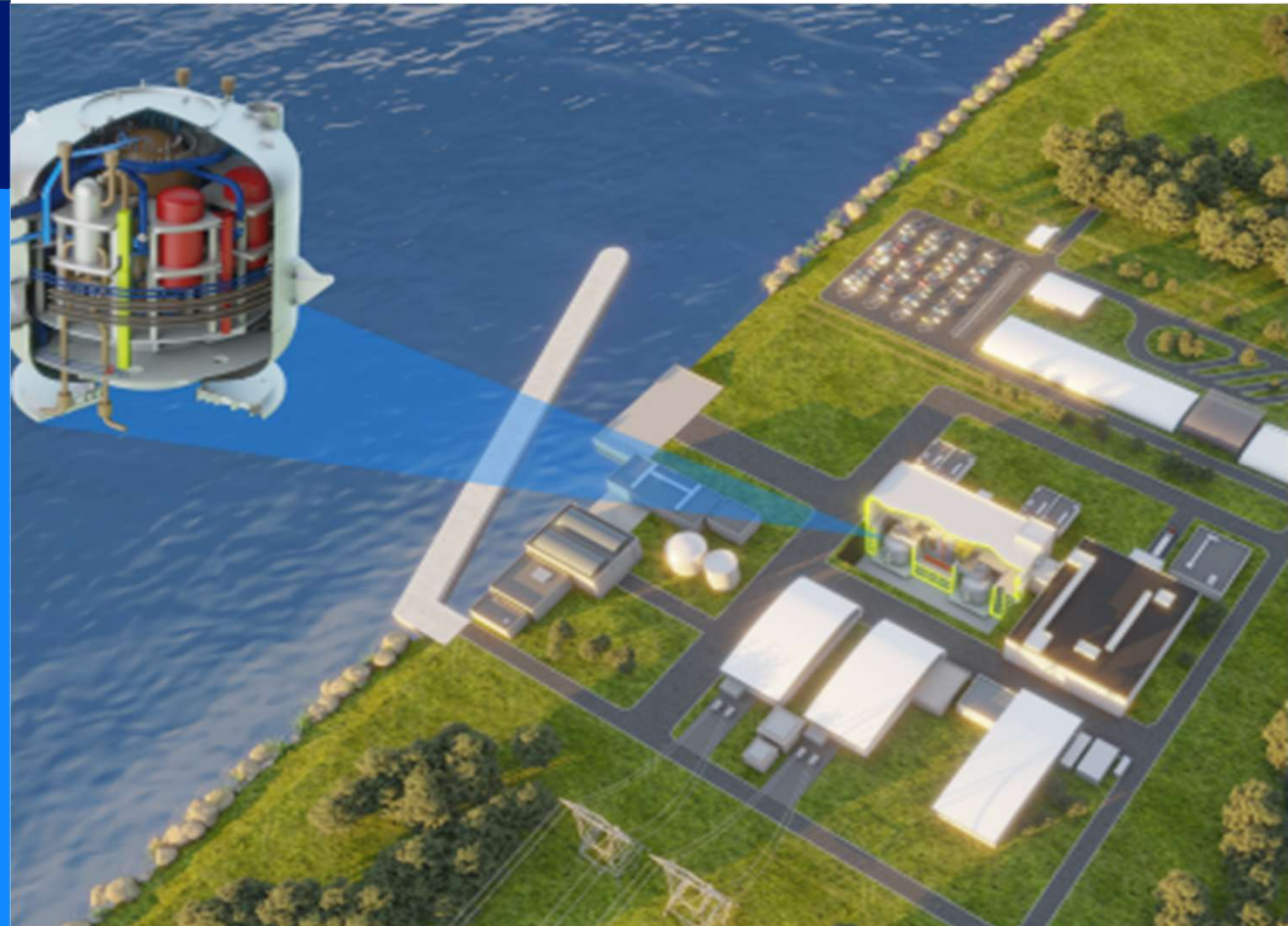


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Establishment of Codes & Standards for NUWARD™ SMR design

Frédéric BEAUD (EDF)
Stéphane BEILS (EDF)



NUWARD™ Leading The
Way To A Carbon Free World



NAVAL
GROUP

framatome



TRACTEBEL
ENGIE

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Content

- ❖ NUWARD™ SMR project and design
- ❖ Codes & Standards for NUWARD™ project
- ❖ Messages on harmonisation of C&S



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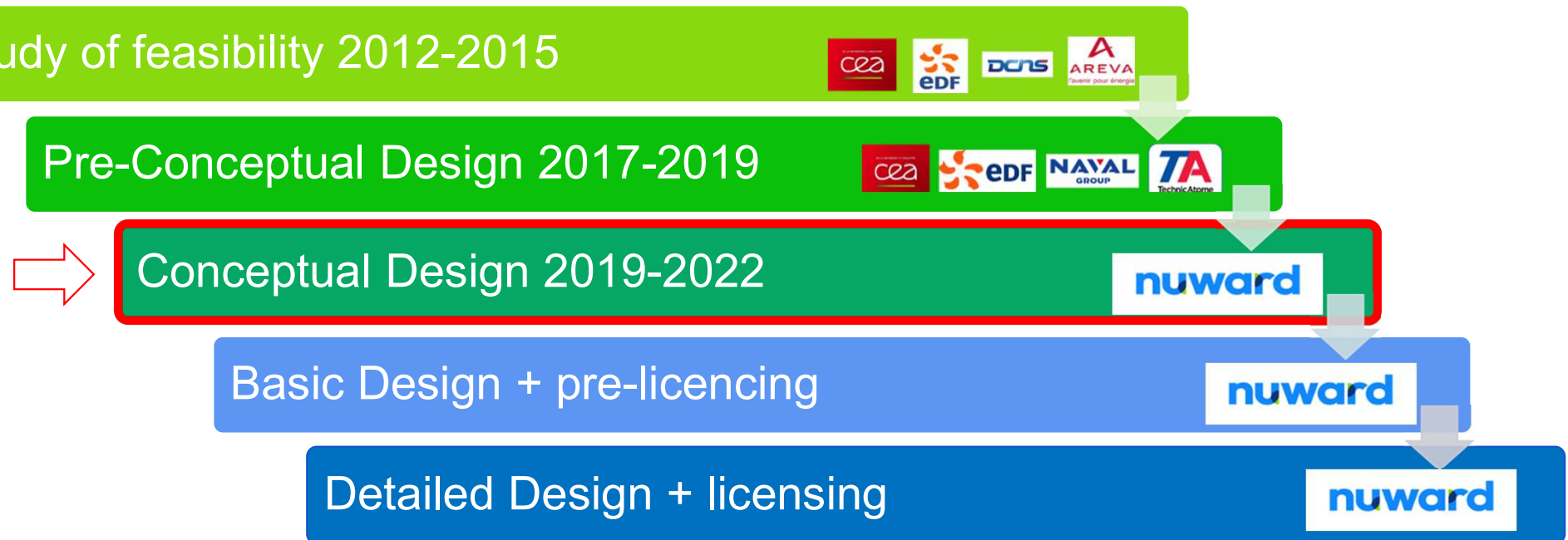


01

NUWARD™ SMR project and design

NUWARD™ SMR project

NUWARD™ is a **340 MWe SMR project** led by **EDF**, with major contributions by **CEA, Technicatome, Naval Group and Framatome**. The project will complete its conceptual design phase in 2022 and is targeting a first operation towards the early 2030's. NUWARD™ integrates proven **PWR technology** into a **compact modular configuration**, benefiting from the long-standing experience of the project stakeholders but also including **some innovative features and components**.

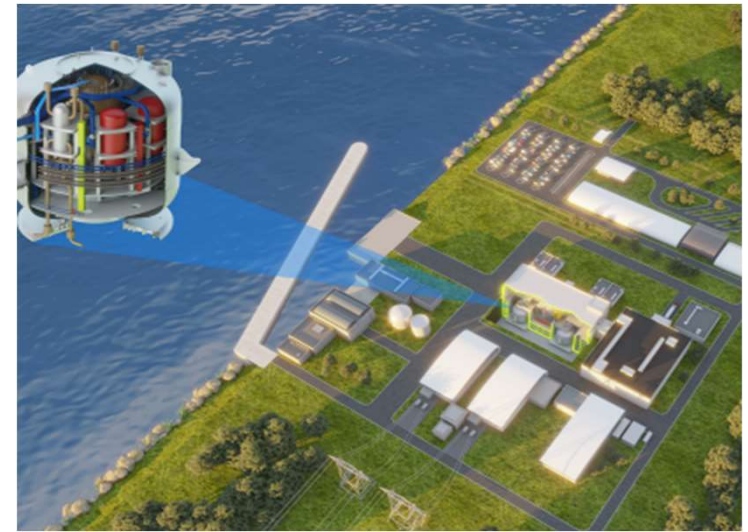


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Brief description of NUWARD™ design

2 units of 170MWe each, and a common fuel storage pool, housed in a semi-buried nuclear building



Vessel head

Electrical penetrations
PZR heaters + CRDM

Steam outlet nozzles

Feedwater inlet
nozzles

Canned Reactor
Coolant Pumps

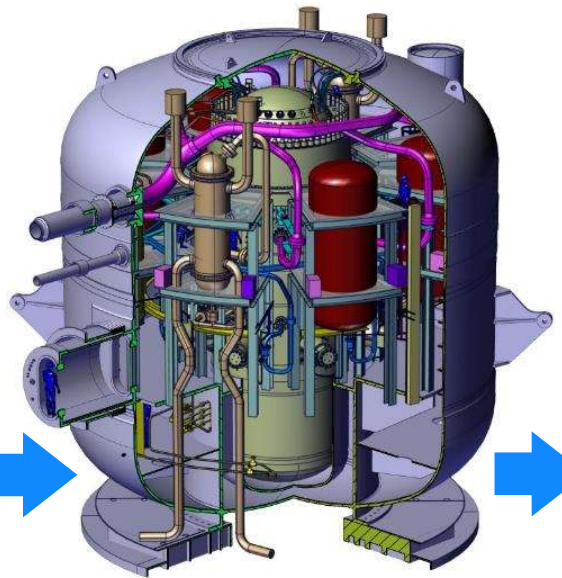
Reactor Pressure
Vessel - RPV

Integrated Pressurizer -
PZR

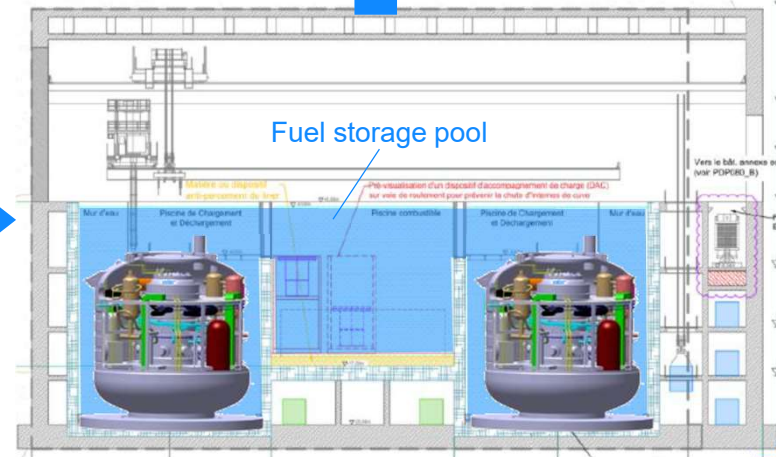
Integrated compact
Steam Generators SG
+ safety exchangers

Immersed Control Rods
Drive Mechanisms -
CRDM

Core = Standard PWR
fuel assemblies 17x17



Confined in a metallic containment
vessel immersed in a water pool



Integrated reactor vessel



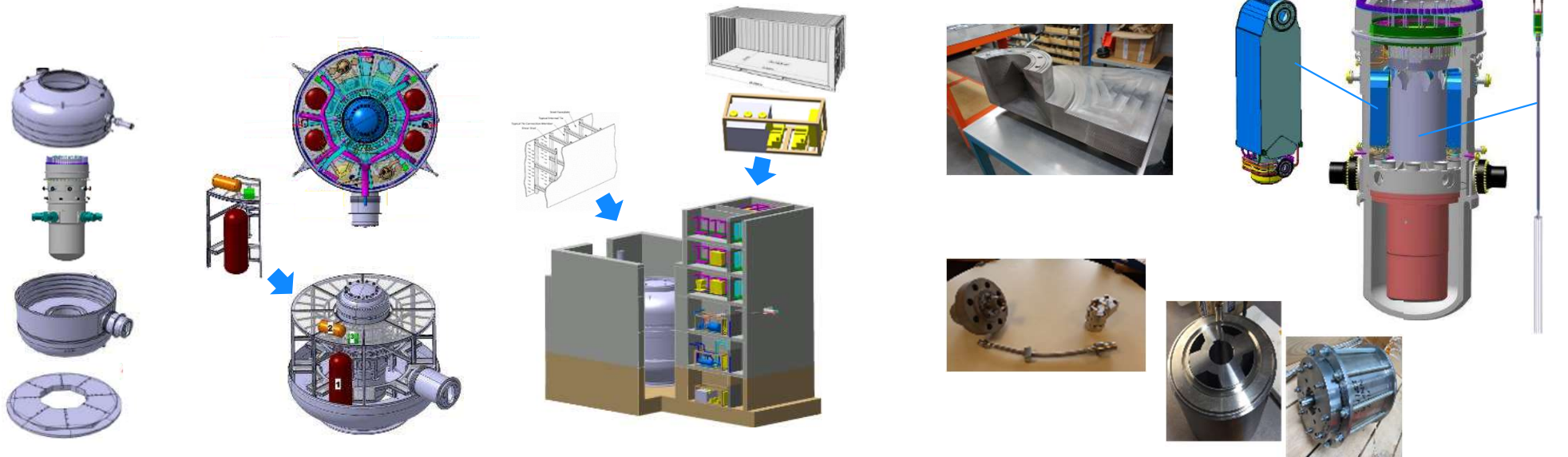
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Example of innovative features and components for NUWARD™

- Compact Steam Generators (CSG): plate type heat exchangers, Titanium alloy, two-step welding process
- Passive emergency heat removal system with safety CSG
- Immersed electrical Control Rod Drive Mechanisms, control and power in-vessel wiring and vessel penetrations
- Steel containment immersed in a water pool (passive cooling of containment in accidental conditions)
- Steel frame structures equipped with pre-assembled NSSS components (inside containment and building rooms)
- Steel Concrete building walls and slabs
- Single control room for both reactors, shared reactor building





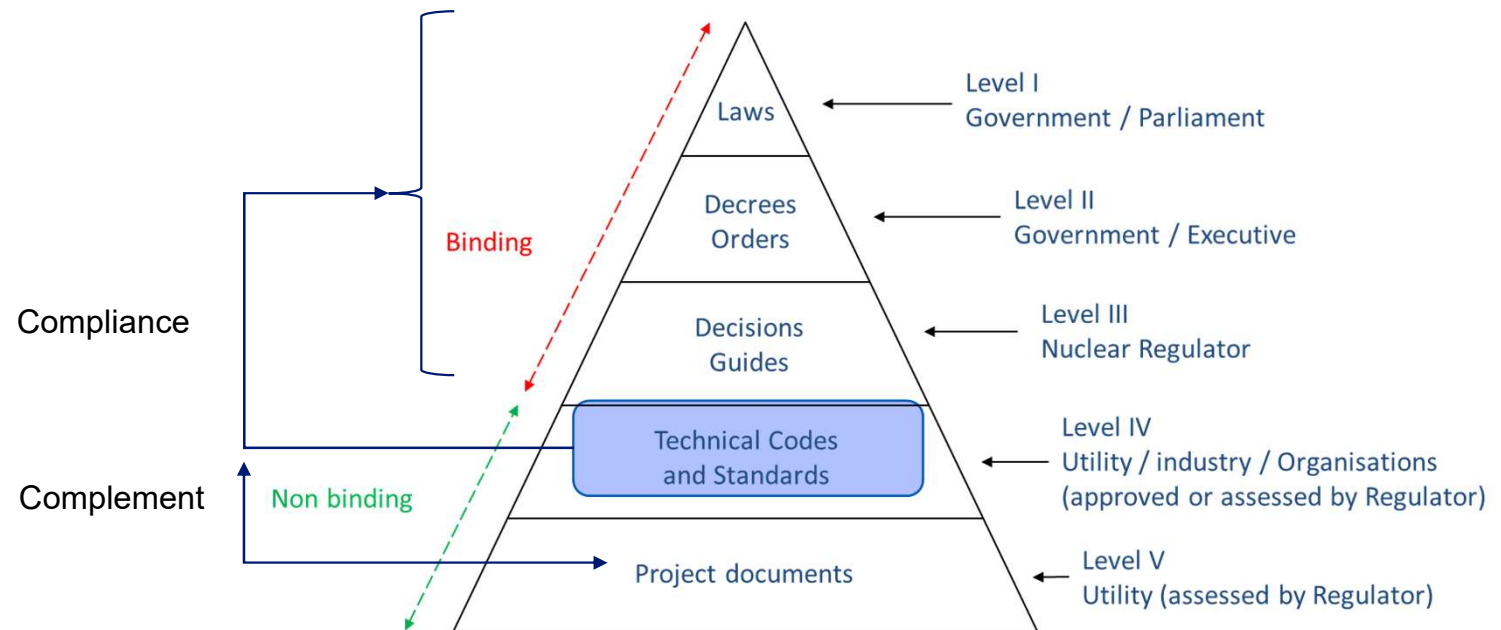
02

Codes & Standards for NUWARD™ project

Codes & Standards

❖ Set of requirements and rules for the design, construction and operation of Structures, Systems and Components (SSC) of a Nuclear Power Plant (NPP)

- Laws and regulations
- Technical codes and standards
- Project documents



❖ Technical Codes and Standards issued by industrial or nuclear Standards Developing Organisations (SDO), for conventional and nuclear SSC

Technical Codes & Standards

- ❖ Requirements for Technical Codes & Standards (C&S) set out in standards
 - IAEA SSR-2/1 (Safety of Nuclear Power Plants: Design)
 - EUR Revision E (European Utility Requirements)
- ❖ Main characteristics expected for C&S
 - Adequate, complete and consistent
 - Proven engineering practices, reflecting industrial up-to-date practices
 - Recognised by regulators, complying with laws and regulations in force
 - Applicable by the supply chain for specifying, designing, building and operating

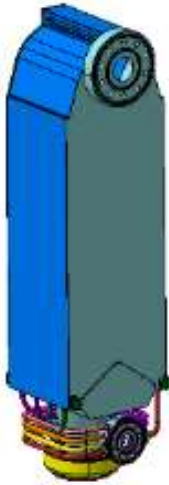
Technical Codes & Standards for NUWARD™ project

- ❖ Project strategy for the establishment of C&S
 - C&S mainly derived from those known and used by NUWARD™ partners, particularly adapted to a European context: ISO/IEC/EN Standards, AFCEN Codes (for nuclear SSC)
 - Identification of complementary needs to cover NUWARD™ specific SSC (CSG, immersed CRDM, steel containment...): establishment of roadmaps for the development of dedicated design and construction rules
 - Comparative studies with alternative C&S
 - ✓ Acceptability of C&S strategy for export markets
 - ✓ Adaptability of design to other C&S

Technical Codes & Standards for NUWARD™ project

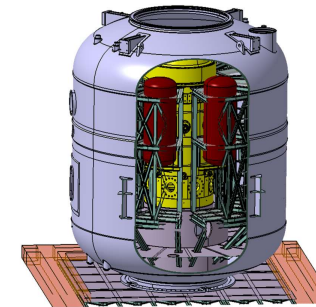
- ❖ Acceptability of C&S in France (for FOAK)
 - C&S strategy particularly adapted to a French and European context
 - ✓ Mainly based on ISO, IEC and EN/Eurocodes (also used as references in AFCEN Codes)
 - ✓ Compliance of EN Standards (EN 13445, EN 13480) with PED (Pressure Equipment Directive)
 - ✓ Compliance of Eurocodes with code of practice for civil structures
 - ✓ Appendices in AFCEN Codes to meet European Directives (PED...) and country specific legislation (ESPN, FR/UK Fire regulations...)
 - ✓ AFCEN Codes accepted by 3 European Regulators (ONR, STUK, ASN) and referenced in several nuclear projects in Europe
 - C&S correspond to the practice of the industry involved in NUWARD™ project
- ❖ Adaptations of C&S for NUWARD™ product ongoing

Technical Codes & Standards for NUWARD™ design



❖ Examples of adaptation to NUWARD™ product

- Compact Steam Generators (CSG): development of a dedicated set of requirements and rules compatible with the design of the component
 - ✓ Based on AFCEN RCC-M / MRx Code structure for safety class 1 components
 - ✓ Accounting for the specific material (Titanium), fabrication (welding, HIP) and mechanical behaviour of the heat exchanger
 - ✓ Supported by a significant programme of tests and analyses
- Steel containment
 - ✓ Rules not available in AFCEN codes
 - ✓ Consideration of ASME III Subsection NE
- Steel Concrete
 - ✓ Development of dedicated rules underway in AFCEN RCC-CW Code for civil structures
 - ✓ Supported by a significant programme of tests and analyses



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Technical Codes & Standards for NUWARD™ project

- ❖ Issues of acceptability of C&S in other national contexts (for NOAK)
 - Specific regulations to be complied with (domestic fire regulations...)
 - Competing international standards (e.g., IEC vs. IEEE)
 - Different practices across the industry
 - C&S enforced by law (e.g., ASME Code in the USA)
 - Limited possibility to enter an assessment process of foreign C&S
 - Technical rules share a same basis, but may not be deemed acceptable anywhere
 - Processes for Quality Control and Assurance may differ

Technical Codes & Standards for NUWARD™ project

❖ Adaptability to other C&S

- Industry players involved in NUWARD™ project may not be familiar with other C&S
- Change of C&S may require modifications in the design
- Impacts of C&S are difficult to assess
 - ✓ Generic comparisons of C&S exist (e.g., ASME III vs. RCC-M)
 - ✓ Further comparative studies are needed to identify the major differences, develop arguments and provide evidence to claim conformity of a design or product with other C&S (e.g., IEEE)
 - ✓ Such analyses are contemplated for NUWARD™ design, with the support of experienced engineering companies



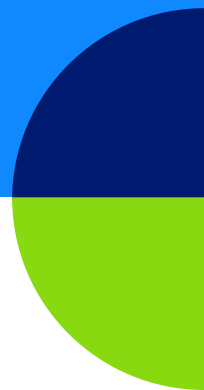
03

Messages on harmonisation of C&S

Messages on harmonisation of Codes & Standards

- ❖ Stability of design and standardisation of components are needed for SMR projects
- ❖ A unique set of Codes & Standards is out of reach in the short term
- ❖ Difficult and expensive for projects to satisfy multiple Codes & Standards
- ❖ Harmonisation takes time, acceptance of equivalence is more achievable
- ❖ International collaboration is required at all levels (from regulators, industry and SDO)
- ❖ Need to facilitate licensing of designs based on variable C&S by regulators

Thank you for
your attention



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