Harmonization and Emerging Codes and Standards

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Content

- ✓ Short introduction:
  - why harmonization?
  - Why Code updating?
  - Few Example?
- ✓ Tools
- ✓ Procedures
- ✓ 2015-2020 International Working Program
  - To-day and Future topics
  - Synthesis
- ✓ Few examples of French Code Updating
- ✓ How EPERC can play a role?

Introduction : why Harmonization and Code updating?

- ✓ Design, Construction and In-service Codes for Nuclear Mechanical components have to be regularly updated, in order to:
  - Be in accordance with New Techniques and State Of the Art
  - Integrate Field Experience
  - Fulfill new Regulatory requirements (National and International)
  - Fulfill new Utility requirements
  - Answer to on-going and future Projects needs
  - Prepare answers for future new Reactor technology
  - Reduce future International Codes divergence- Facilitate areas of convergence

Few Examples (1/2)

- New techniques and State Of the Art, like:
  - Design: static-cyclic-dynamic non linear analyses and associated strain criteria; bolted flange and leak tightness objectives; flaw tolerance of pressure boundary; extreme external hazard consideration…
  - Material: new material, non-metallic material
  - NDE: replace RT by UT, new techniques
  - Welding: new techniques
  - Operation: ISI performance, flaw acceptance methods, partial safety factors, risk informed, repair techniques, LTO
  - Dismantlement
- ✓ Regulatory requirements, like:
  - Unbreakable components, Incredibility of Failure, High Integrity Components
  - Quality of large forged pieces
  - Pre-service inspection and maximum allowable defects
  - "Inspectability" of all welds
  - Non metallic piping: HDPE
  - Non-nuclear / nuclear classified components
  - Pressure Test
  - Overpressure protection

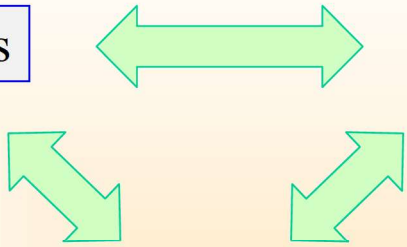
Few Examples (2/2)

- ✓ Fulfill new Utility requirements, like:
  - Consider LTO and dismantlement at the Design stage
  - Consider more Maintenance and Radioprotection at the Design stage
  - Consider largely the field experience (national and international)
- ✓ Answer to on-going and future Projects needs
  - Case by case
- ✓ Prepare answers for future new Reactor technology
  - Different HTRs
  - Fusion Reactors
  - Experimental
  - SMR …

available tools used for Nuclear Codes … (1/3)

International Regulators

MDEP
CSWG and VICWG
www.oecd-nea.org/mdep



Group of Industry: Vendors, Manufacturers, Utilities and their Technical Supports

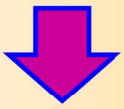
WNA - CORDEL CSTF
EPERC

Code Development Organization
USA-Japan-France-Korea-Canada-Russia

ASME-JSME- AFCEN -KEPIC-CSA-ROSATOM

Soon: China Nucl Code, UK Struct Integr Coder; CZECH Nuclear Codes

Standard Development Organization



- *Minimize Future Code Divergence*
- *Facilitate Areas of Convergence*

the available procedure … (2/3)

On selected topics by Industry or Code Organization

1. Detailed Comparison of existing **Codes**: nuclear + non nuclear
2. Identify: Gaps and Needs
3. International review of corresponding report by each Code Org.
4. Recommended practice document associated with validation for each proposal
5. International Benchmarks on "realistic" cases
6. Final "International Harmonized" **Code Case**
7. Large international participation & review of 4-5-6 by Code Organizations and International Expert Groups

the available procedure … (3/3)

- ✓ **Procedure Successfully applied for**:
  - Class 1 component design rules
  - NDE personal qualification
  - Welding qualification
- ✓ **On-going by Industry Group for:**
  - Non-linear design rules for :
    - plastic collapse, plastic instability, local failure, K_e and fatigue and plastic shakedown / ratchetting
    - Code comparison — available
    - Recommended practice
    - Benchmarking
  - Fatigue design Rules
    - Air fatigue rules
    - Environment Effect — end of 2019
    - Fatigue crack growth — 2019

New Topics proposal for 2018-2020 (1/2)

- ✓ 1. Pressure test : international practices
  - end of Fabrication,
  - in Operation, after Repair/ Replacement
- ✓ 2. Weld Residual Stress distribution and consequences
  - Fabrication
  - Repair/ Replacement
- ✓ 3. Verification and Validation of Mechanical Computer Codes
- ✓ 4. Micro-segregation in forged pieces
  - Belgium flaking
  - French Heterogeneity
- ✓ 5. Alternative to Radiographic NDT end of fabrication (TBC)

New Topic proposals for 2018-2020 (2/2)

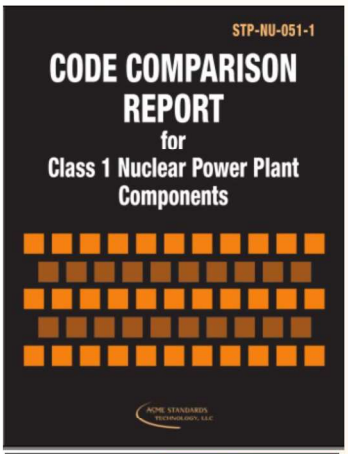
Gaps and Needs
in front of
existing Code Requirements
and Field Experience

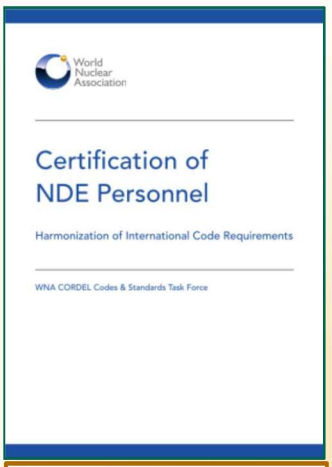
"Reconciliation":
"the process of
making consistent or compatible"
Different Codes

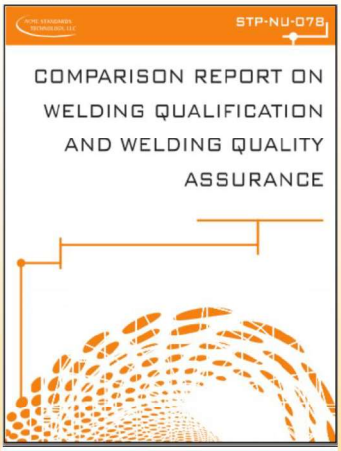
For Example for micro-segregation

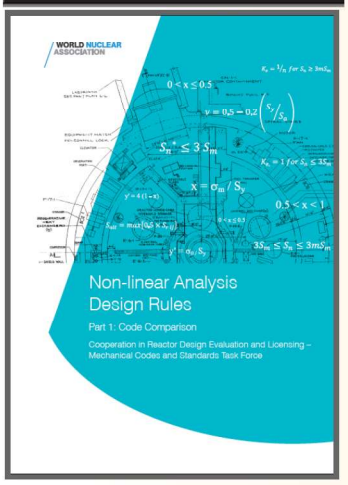
- ✓ 1- Regulation requirements and precise reference
- ✓ 2- Code requirements and precise reference
- ✓ 3- Design specification requirements?
- ✓ 4- Have you encountered "heterogeneity"?
  If yes, explain the root cause

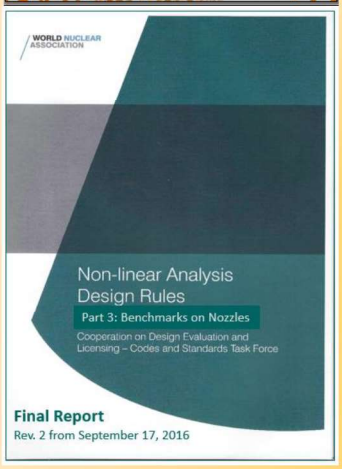
Examples of Comparison of Topics











ASME-JSME-AFCEN -KEPIC-CSA-NIKIET-KTA*-China*

- *Case by case*

+ EN13445 and ASME VIII-Div. 2

Synthesis (1/2)

- ✓ An International Program with proposals on new topics is now available, slightly difficult to run…
- ✓ Regulators put their comments last April 2018 around a dedicated meeting:
  - Move from "harmonization", "convergence" to "Code reconciliation" with a clear understanding of the background of differences
  - Maintain the actual scope: identification and background understanding of the differences, proposal of best practices, but move to Code "reconciliation"; instead of "harmonization" or "convergence"

Synthesis (2/2)

- Enlarge the actual scope of your work:
  - From class 1 thick forging components of LWR
    to: all class 1 aspects of LWR, HTR, SMR, Experimental Reactors
  - Consider Design, Fabrication and Operation
- Become more pro-active on existing Code modifications or new codes
  - new = complete re-writting
  - or new topics
  - or new technologies (as SMR's)
- Consider differences on Standards and Prescriptive level (design specification…)
- Consider Quality Management Systems, in particular personnel homologation and qualification/qualification complement and renewal, as RPE, SQEP, NAFEMS…

FEW EXAMPLES OF UPDATING AND NEEDS ON FRENCH NUCLEAR MECHANICAL CODES (END 2018)

RCC-M	Design, Fabrication, Tests and Protection of PWRs
RSE-M	In-service Inspection Rules of PWRs
RCC-MRx	rules for Research Reactor components, HTR, and Fusion Reactor

Some key example RCC-M developments (1/4)

- ✓ Design: supported by dedicated Guides – 2017 2018
  - Risk analysis
    - All potential damages for given Operating Conditions
    - To be developed by Manufacturer and accepted by notified bodies before "starting fabrication"
  - Instruction notice
    - Guideline for operation following end of Design, Fabrication and Protection
    - To be developed by Manufacturer and accepted by notified bodies before "end of fabrication" stamp
- ✓ Design: Environmental effects in fatigue (2016)
  - 3 RPP (or Code Cases)
  - RPP#1. fatigue design curve for austenitic stainless steels and nickel base alloys.
  - RPP#2. instruction to apply RPP#3 on how to include EAF (Fen integrated factor) with optimization of Fen factor with surface finish effects
  - RPP#3. EAF methodology necessarily used with RR-1 and 2

Note: all the rules for "Break Exclusion" analyses (not basic LBB) are described in SAR and dedicated Guide for Analysis, using many References to RCC-M and RSE-M

Some key example RCC-M developments (2/4)

- ✓ Design: Non linear Design Rules (2017)
  - Non-mandatory App. ZC for FEA using non linear material properties
  - Limit load analyses or Elastic-plastic analysis for:
    - Excessive deformation (plastic collapse)
    - Plastic instability (outside of buckling)
    - Fatigue analyses:
      - *plasticity amplification factor Ke*
      - *Cycle by cycle analyses have to be consistent with ratcheting analyses (on-going)*
  - Fracture analyses

- ✓ Design: Unacceptable Fabrication Defect for Structural Integrity (2017)
  - Non-mandatory App. ZP
  - Analyze of "Technology defects" for all the component life and performance of Fabrication NDE
  - Definition of the Defects by the Manufacturer
  - Supplement requirement to fracture analyses of Class 1 Components
  - Not to Justify defects in Fabrication or in Operation

Some key examples RCC-M developments (3/4)

✓ Welding

- Introduction in Appendix S IV of a formal definition of welding coordination following definition of EN ISO 14731
- Appendix may be satisfied by implementing a quality system fulfilling the requirements of NF EN ISO 3834-2 [12], but formal certification to this standard is not required. Other equivalent standards may also be used to reach that goal,
- Introduction of the new ISO standards for the welders (ISO 9606-1) and operators (ISO 14732 qualification

✓ Examination (2016)

- Alternative techniques to radiography: introduction of advanced UT (phased arrays and TOFD). The instruction file to modify the code covers:
  - the methods for advanced UT
  - and also gives criteria for showing equivalent capability of the examination.
- After tests and analysis, the code bases for case by case acceptation of alternative methods
  - must demonstrate complete equivalence,
  - and must be accepted by the customer.

Some key examples RCC-M developments (4/4)

- ✓ Qualification of active mechanical equipment RPP#4 (2017)
  - General rules for qualification and Documentation
  - Qualification perenity
  - Specific rules for valves – Qualification Procedure:
    - For normal operating conditions
    - Seismic qualification
    - For accidental conditions with degraded ambiance
    - For thermo-hydraulic accidental conditions
    - For conditions of charged active water
    - For severe accident
  - Specific rules for pumps
  - Consistent with Electrical Component qualification and International Standards (QME)

More Information in PVP2018-84409

Some key examples RSE-M developments

- New Class 1 Hydrotest Pressure for International use
- Updating of applicable standards, codes, guides (Appendix 1.3)
- Surveillance in operation; Complement of the articles "to be published" (§ 6000, § 7000) for EPR application
- Inspection of pressure accessories and safety accessories
- Examination methods used for visits; revision of § B 4000,
- Non-destructive testing methods for surveillance and inspection; Update of Appendix 4.4
- Maintenance Activities classification
- Further improvement of
  - Flaw evaluation methods (appendix 5.4), as "WarmPrestressing"
  - Material data (Appendix 5.6) in particular through the development of "EPR" materials, as data for carbon-manganese steels…

Some key examples RCC-MRx developments (1/2)

- ✓ More connected to Project needs: ASTRID, Jules Horowitz Reactor or ITER, but also needs of innovative projects such as MYRRHA (experimental lead-cooled fast reactor – Belgium) or ESS (European Spallation Source – Sweden)
- ✓ Guideline to introduce new materials in RCC-MRx
  - In particular Materials codified in other Standards
- ✓ 2 examples for ASTRID
  - 18MND5 for slab
    - RCC-M material that needs to be supplemented to RCC-MRx material properties
    - Include the EPR experience with Procurement and Fab rication
    - 2 procurement specifications: RPS-G 212-2 and 212-3
    - Material properties in A3.12AS
  - Charpy impact test criteria for stainless steel 316 L(N), from RCC-M
    - KU and KV
    - Base material (wrought) type 316 L(N) butt 316 &304 too,
    - Auusteno-ferriticc weld deposit metal (19Cr12Ni2Mo + others)
    - No tests in HAZ
    - Annnealed and after thermal ageing conditions.

Some key examples RCC-MRx developments (2/2)

- ✓ Clarification of the scope: "Irradiation"
  - A better understanding of the damage,
  - A better definition of the methodology used for the rule and for border curves
  - Consolidation of data used for design.
  - clarification on the nature of the irradiation
  - re-interpretation of the database used
- ✓ Clarification on the applicability of the code to innovative installations
  - guide a potential user by giving him tools to adapt or to develop the code.
- ✓ Harmonization actions
  - With RCC-M common domain (pressure, low temperature, low REC 3253.1 Manufacturing processes: section 3.1, irradiation)

More Information in PVP2018-84706

How EPERC can play a role ???

- ✓ Emerging and Harmonization of PE Codes & Standards
- ✓ Nuclear, Non-nuclear and other Industry Sector
- ✓ Technical comparison of International Codes & Standards
- ✓ Understanding of differences
- ✓ New needs for innovation
  - Next reactors, including Experimental
  - New renewable plants
  - New users of PE from different Industry Sectors : to-day more than 30 CEN PE Technical Committees
  - Find common topics? Common rules? Common R&D programs?
  - New operating condition and consequences
- ✓ Develop R&D programs and associated Road Maps
  - Share part of them at International level
- ✓ Develop "Recommended Practices"
- ✓ Transfer knowledge, Benchmark, Training…

Thanks for your Attention !

Open for Questions !