

# Harmonizing advanced manufacturing codes & standards, a key to the global SMR market



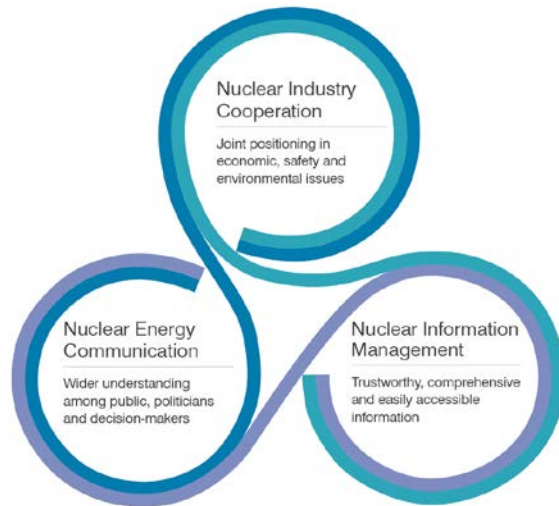
Ronan Tanguy, CORDEL Programme Lead

IAEA Technical Meeting on Codes and  
Standards, Design Engineering and  
Manufacturing of Components for SMRs

10<sup>th</sup> to 13<sup>th</sup> May 2022

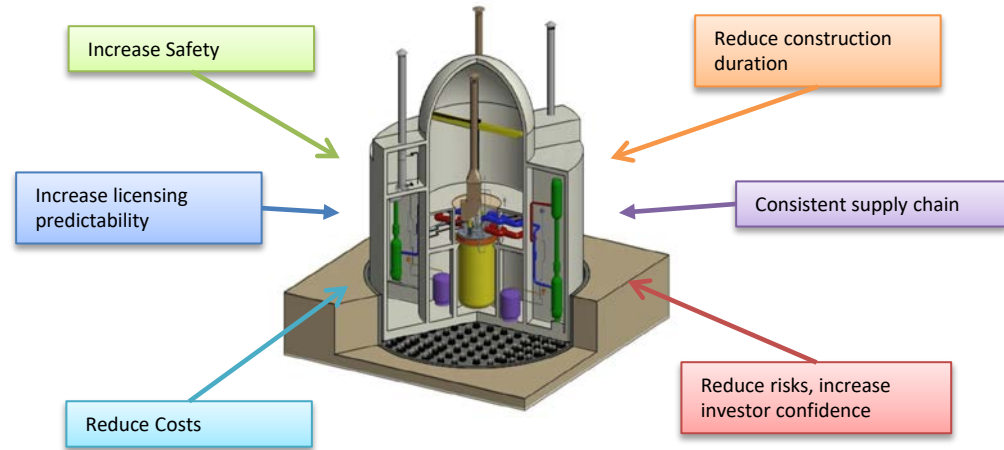
# World Nuclear Association

- The World Nuclear Association is the international organization that promotes nuclear energy and supports the many companies that comprise the global nuclear industry
- World Nuclear Association membership encompasses **all aspects of nuclear energy**
- CORDEL working group aims to standardize reactor designs so they can be deployed internationally without major design changes due to national regulations



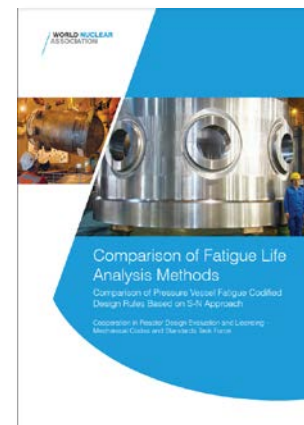
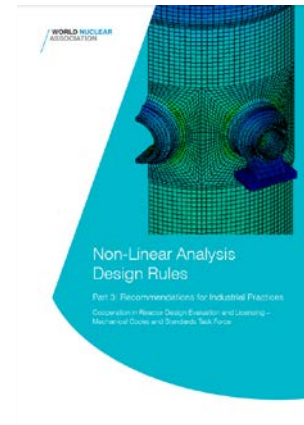
# Cooperation in Reactor Design Evaluation and Licensing (CORDEL) is the industry approach to harmonization

- CORDEL has:
  - Defined the need
  - Developed collaborative relationships with governments and international industry and regulatory fora
  - Addressed some of the specific challenges in relevant reports



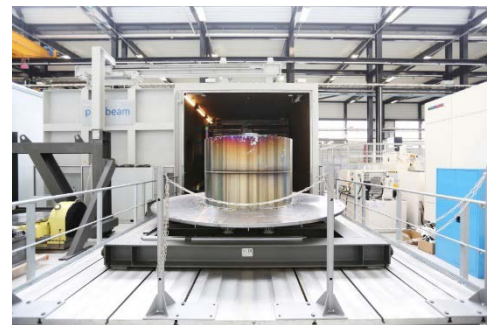
Download them at <https://www.world-nuclear.org/our-association/publications/online-reports.aspx>

- Promoting the convergence of requirements defined in International nuclear mechanical design codes.
- Work focuses on key technical issues.
  - Non-Linear Analysis Design Rules Part 3: Recommendations for Harmonized Industrial Practices (July 2021)
  - Fatigue Life Analysis Part 2: Proposed Common/Harmonized Pressure Vessel Design Rule (under preparation)
  - Non-Linear Analysis Design Rules Part 2b: Assessment of Non-Linear Benchmark Results (September 2020)
  - Comparison of pressure vessel fatigue codified design rules based on S-N approach (July 2020)
  - Non-Linear Analysis Design Rules: Part 1 Code Comparison (February 2017)
- Mutual information sharing and reviews of reports with the SDO Convergence Board
- Close cooperation with NEA/CNRA-WGCS.



# CORDEL Advanced manufacturing paper

- Position paper to present current initiatives within member organizations and the challenges they face with regards to regulation and codes & standards.
- Puts forward a consistent industry position and encourages international harmonization of approaches to codification of advanced manufacturing processes and techniques.
- Using the conclusions to guide efforts and engage with standard developing organisations to influence codification, reducing the potential for divergence between countries/codes and standards.
- Report scheduled for publication in Q2 2022



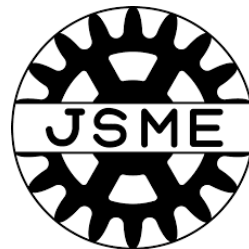
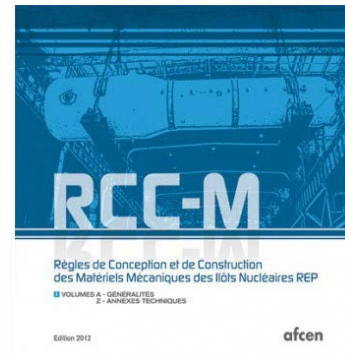
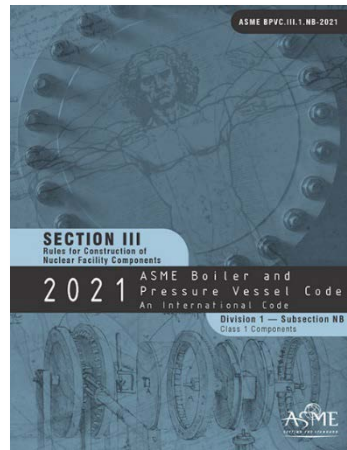
# Selection of WNA member AM initiatives

Item	AM Process	Organization
Channel fastener	Powder bed fusion	Framatome (TVA Browns Ferry)
Heavy shielding	Directed metal deposition	RuSAT
Large and small vessels	Powder metal hot isostatic pressing	NAMRC (NuScale Power)
Piping elbow	Powder metal hot isostatic pressing	EDF/Framatome
Pump impeller	Powder bed fusion	Siemens (NEK Krško)
	Powder bed fusion	RuSAT
Thimble plugging device	Powder bed fusion	Westinghouse
Terminal block	Powder bed fusion	Engie Laborelec
Valve (body)	Powder bed fusion	Neles (Fortum & TVO) Engie Laborelec
Vessel cladding	Diode laser cladding	NAMRC (NuScale Power)



# Codes and standards for advanced manufacturing

- Advanced manufacturing techniques are codified in non-nuclear codes and standards (EBW, PM HIP)
- Requirements must be defined to translate these into the nuclear context
- Gaps have been identified:
  - Inconsistent terminology
  - Specifications for raw materials
  - Specifications for products manufactured using a combination of AM and conventional
  - Inspection and NDE
- Codification is needed for regulators to gain confidence in the application of the techniques.
- Code cases are being submitted to ASME but limited to certain materials.
- RCC-M novel approach that enables use of processes supported by specific documentation



# Codes & Standards/Process qualification

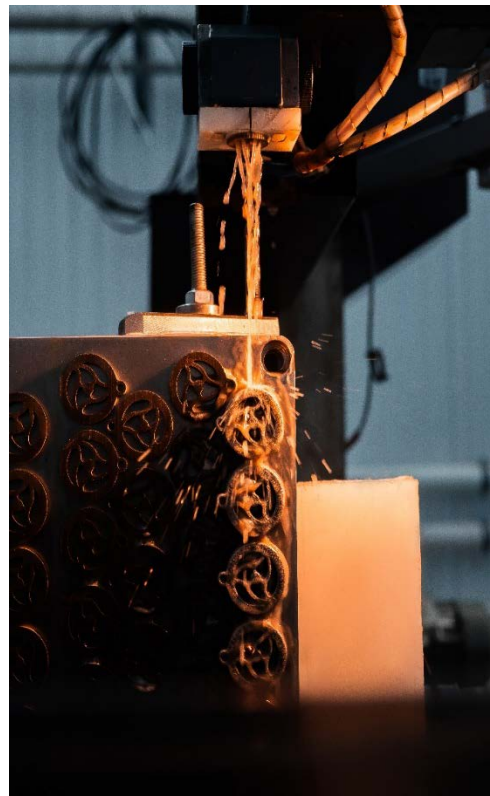
- Process qualification is needed demonstrate that parts can be made in reproducible ways with equivalent properties and quality to traditional manufacturing processes
- Long-term performance of components in nuclear environment is uncertain (thermal ageing, fatigue, irradiation).
- SNETP NUCOBAM project is working to produce a standardized qualification compatible with AFCEN RCC-M, ASME BPVC and EN 13445
  - Raw material procurement
  - Quality control management
  - Heat-treatment
  - Inspection & testing
  - Surface finish





# Recommendations

- Organizations should dedicate more resources to code development activities
- SDO should follow the AFCEN approach to allow unreferenced AM processes supported by specified documentation
- Collaborative international projects to develop harmonized AM techniques submissions to SDOs should be supported by the nuclear industry.
- Regulators should work collaboratively and in unison with the nuclear industry to develop common approaches to the regulation of AM techniques and their use within the supply chain



# Conclusions

- Codification and subsequent regulatory approval is key for adoption of advanced manufacturing processes in nuclear supply chains.
- The current gaps in codes & standards present an opportunity to develop them in a harmonized manner and avoid discrepancies.
- International initiatives and cooperation are needed to prevent divergence.
- Harmonization/equivalence of codes & standards and regulation is essential for regional deployment of SMRs.
- CORDEL will continue to advocate for streamlining of practices and take its findings to the SDO Convergence Board for consideration.





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