apollo+ nuclear

Off-the-shelf SSC Acceptance in support of Lean SMR Deployment

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Technical Meeting on Codes and Standards, Design Engineering and Manufacturing of Components for Small Modular Reactors

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Lean SMR Deployment

How might we facilitate it?

Let's tackle one of today's current pain points which also represents a relatively 'easy' avenue for harmonization: **manufacturer quality assurance and SSC acceptance**

Focus on the ability to accept SSCs which…

- have already been manufactured prior to procurement; or,
- do not undergo any 2nd or 3rd party oversight or inspections during manufacturing

…from both 'nuclear' suppliers and commercial/industrial suppliers to support **serialization** and **rapid global deployment**

Look for opportunities to harmonize nuclear management system expectations

Take advantage of established commercial-grade SSC acceptance methods (e.g. dedication)

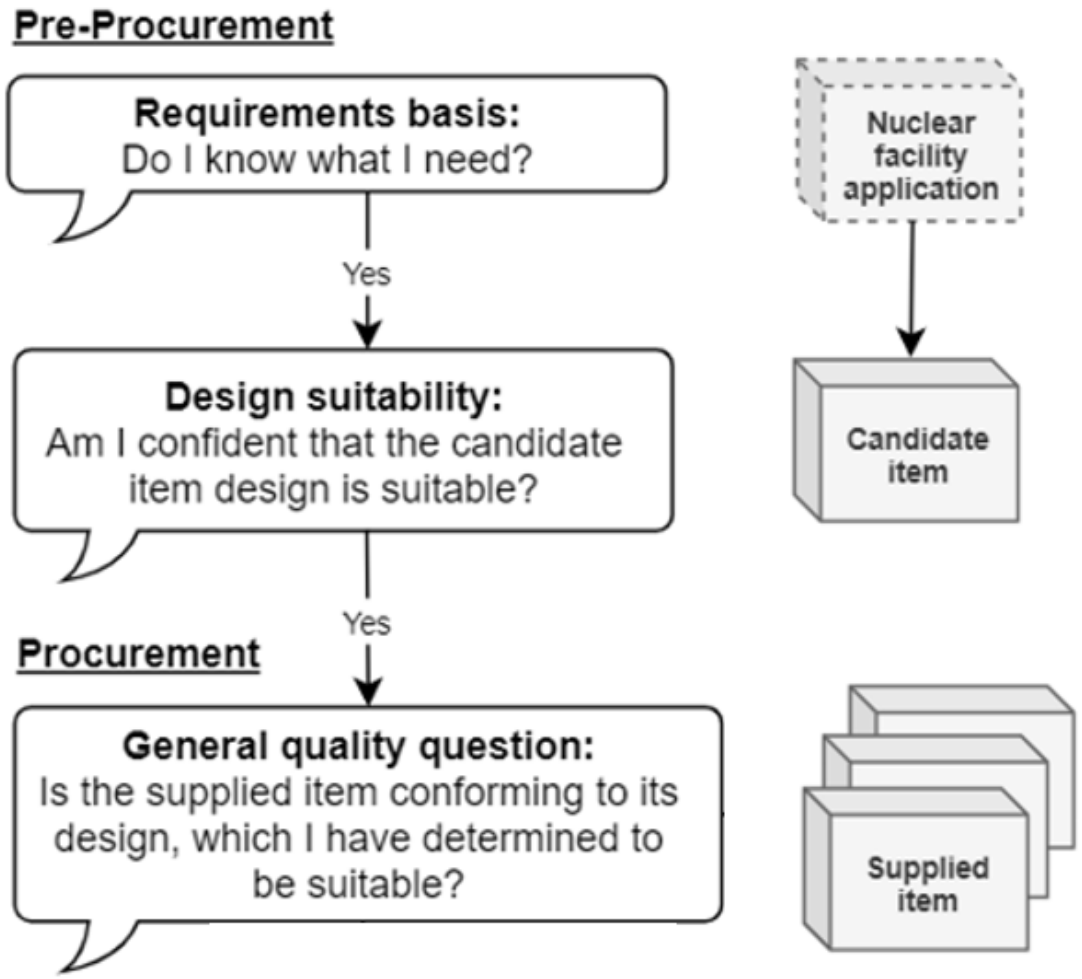
Lessons Learned from large NPPs

- Stringent, unique nuclear vendor/supplier manufacturing quality assurance and quality control requirements (from regulation, codes and standards) **do not always result in a more reliable, higher quality SSC**

  ⓘ Order-specific requirements can introduce confusion and risk into the production of SSCs or execution of a service

- A lack of flexibility with regards to QA/QC requirements (especially supplier oversight practices) **artificially reduces supply options**, increases costs and project risks
- **Nth of-a-kind benefits do not (appear to) materialize** when deploying NPPs across jurisdictions, even if the design code is fixed
- The time needed for reactor vendors and their supply chains to learn and adjust to customer quality assurance/quality control requirements can be **enormous**
- "*most SMR vendors are targeting standardization in several aspects of design, component manufacturing, construction, arrangements etc.*"

Establishing Confidence in SSC Quality



Zoo of Supplier Quality Regs, Codes & Standards

General, Sector-specific, Technology-specific

SMR Vendor (and Supply Chain) Quality Assurance Program

- **Codes & standards requirements**
- **Regulatory requirements**
- **Quality assurance requirements**
- **Quality control requirements**

from domestic and international customers

! The zoo challenges serial production

! The zoo challenges the deployment and business case for SMRs

Items Important to Safety in NPP design

What is *required* by the IAEA

Item design follows proven engineering practices
(IAEA SSR-2/1 Rev. 1 Requirement 9)

↓

Item design basis is specified
(IAEA SSR-2/1 Rev. 1 Requirement 14)

↓

Item is safety-classified
(IAEA SSR-2/1 Rev. 1 Requirement 22)

↓

Item design is reliable
(IAEA SSR-2/1 Rev. 1 Requirement 23)

↓

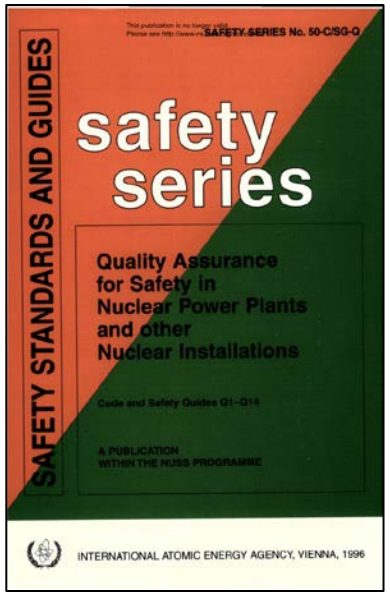
Qualification program verifies item capability to perform safety functions(s)
(IAEA SSR-2/1 Rev. 1 Requirement 30)

What about control of the procured item?

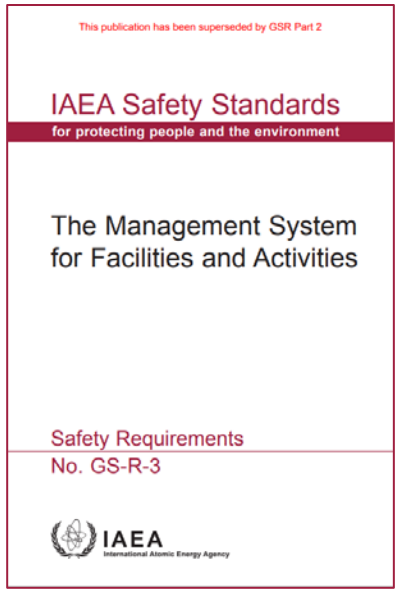
Control of the procured item in the form of manufacturer quality management expectations

> 1 page of relevant requirements → approx. 3 relevant sentences

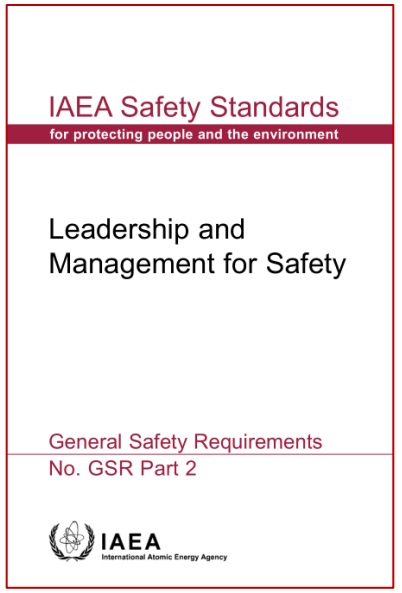
1978



1996

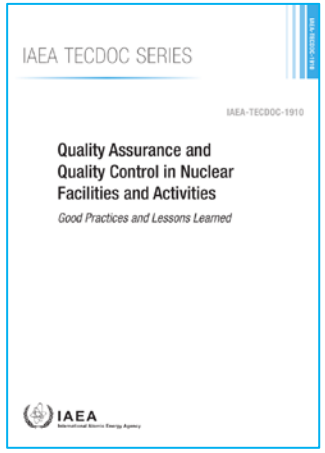


2006



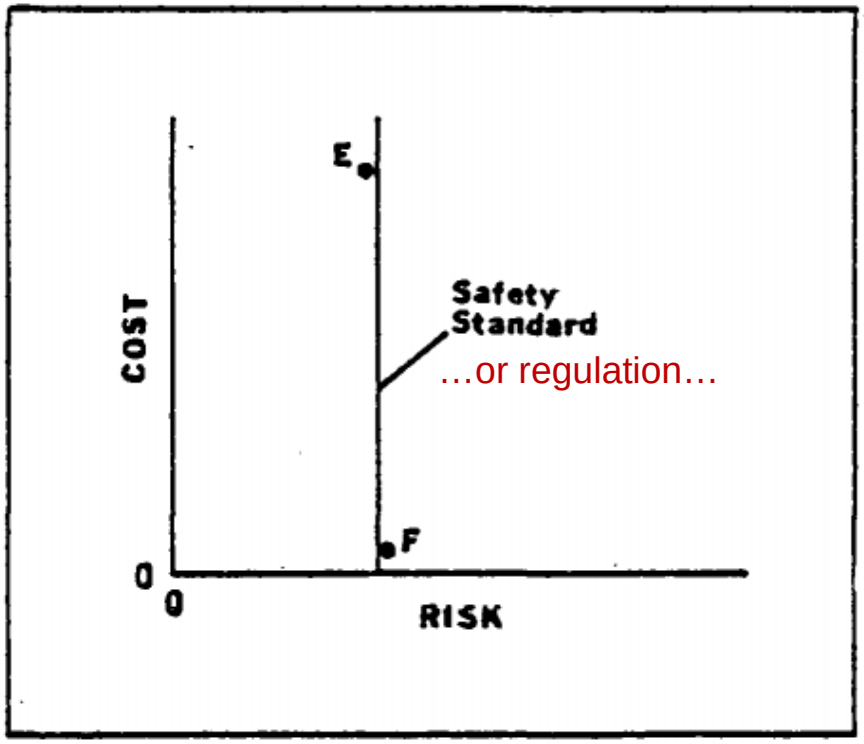
2016

TECDOC 1910



2020

What about control of the procured item?



Published: April 1978

How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits

Baruch Fischhoff, Paul Slovic, Sarah Lichtenstein, Stephen Read & Barbara Combs

Policy Sciences **9**, 127–152 (1978) | Cite this article

5681 Accesses | **1361** Citations | **54** Altmetric | Metrics

The **IAEA** does not publish quality management requirements for suppliers of items important to safety.

Regulatory bodies have **different quality management expectations (or none at all!)** for suppliers of items important to safety (e.g. management systems, licensee oversight, third-party oversight etc.).

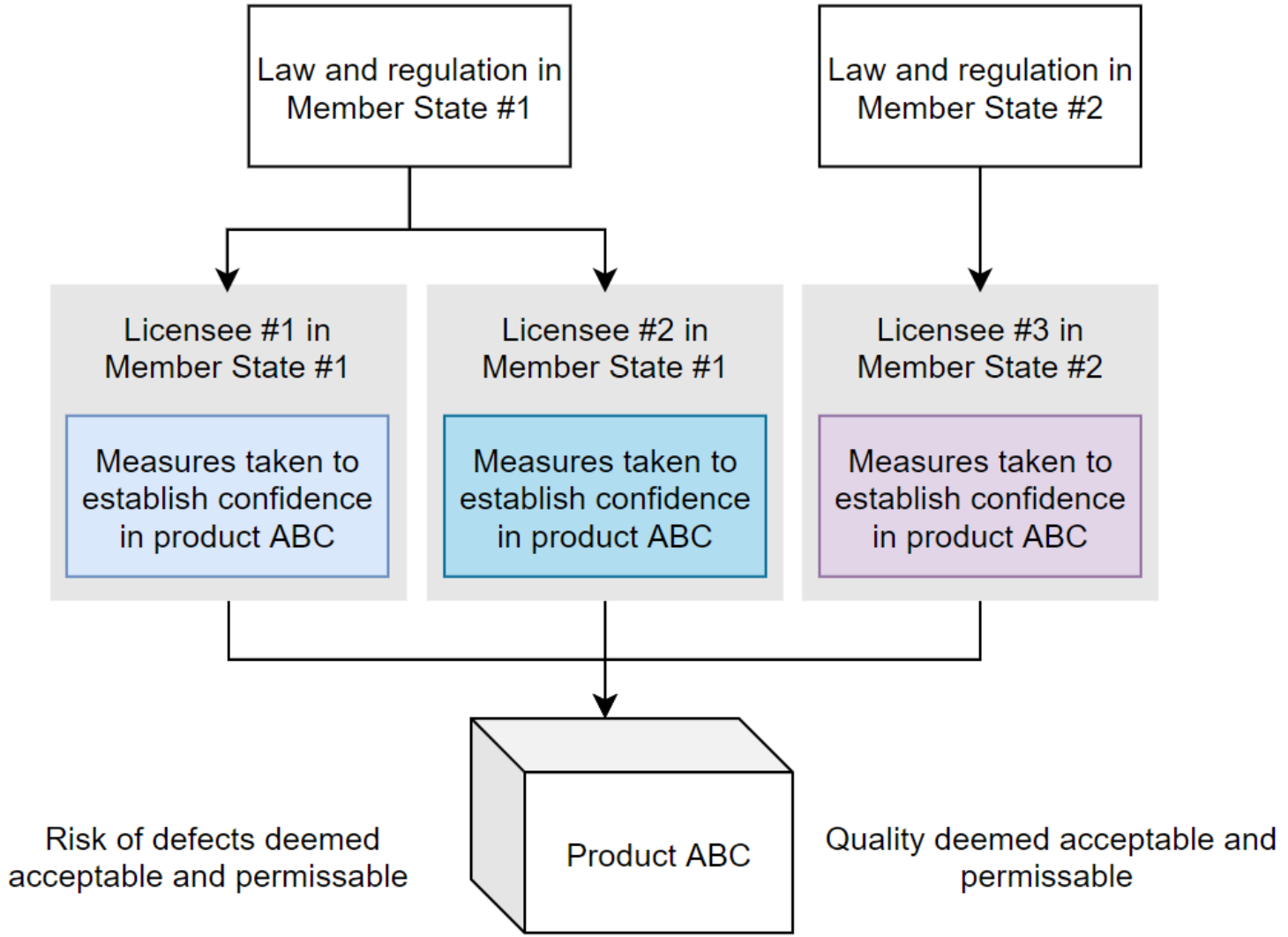
When a **licensee** follows **nuclear regulation/**their licensing basis correctly, the supplied items will have a permissible risk of defects. (i.e. the quality of the procured items is acceptable)

All Roads Lead to Rome

QA/QC of SSCs

Establishing "***confidence***" in a product (or service) is generally achieved by meeting requirements established by law, regulation and the licensee organization itself.

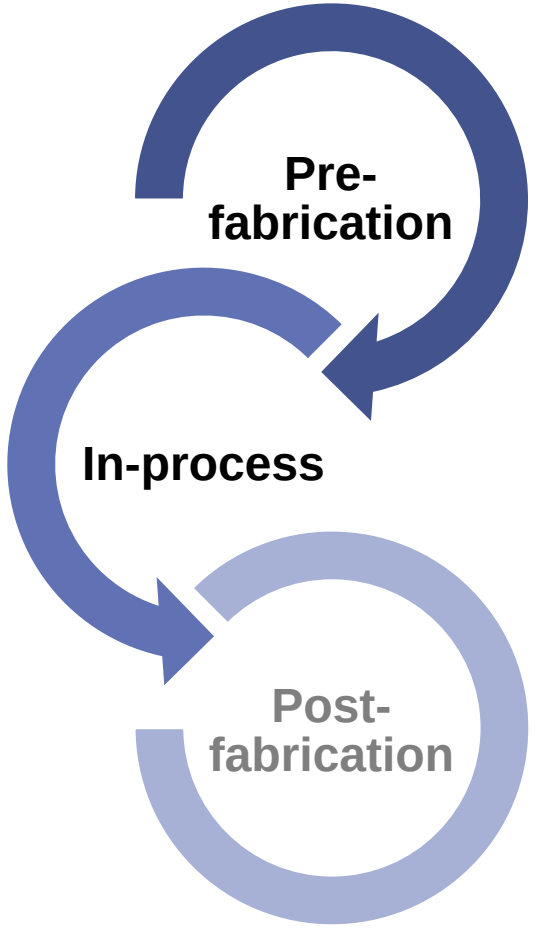
Harmonization of supplier QA/QC requirements is **challenging**, but much **easier** than harmonization of design and licensing.



Measures Taken to Achieve ‘Nuclear-Grade’ Quality

For SSCs important to safety

Regulator	Licensee/Buyer	Vendor/Supplier
Regulation and guides	Contractual terms	Nuclear quality management program
Inspection and oversight	Receiving inspection	Special manufacturing and assembly records
Authorized inspection organizations	Witness/hold points	Special tests, inspections and plans
	Inventory management	Personnel training
	Third-party oversight	Sub-supplier controls
	Audits and assessments of suppliers	



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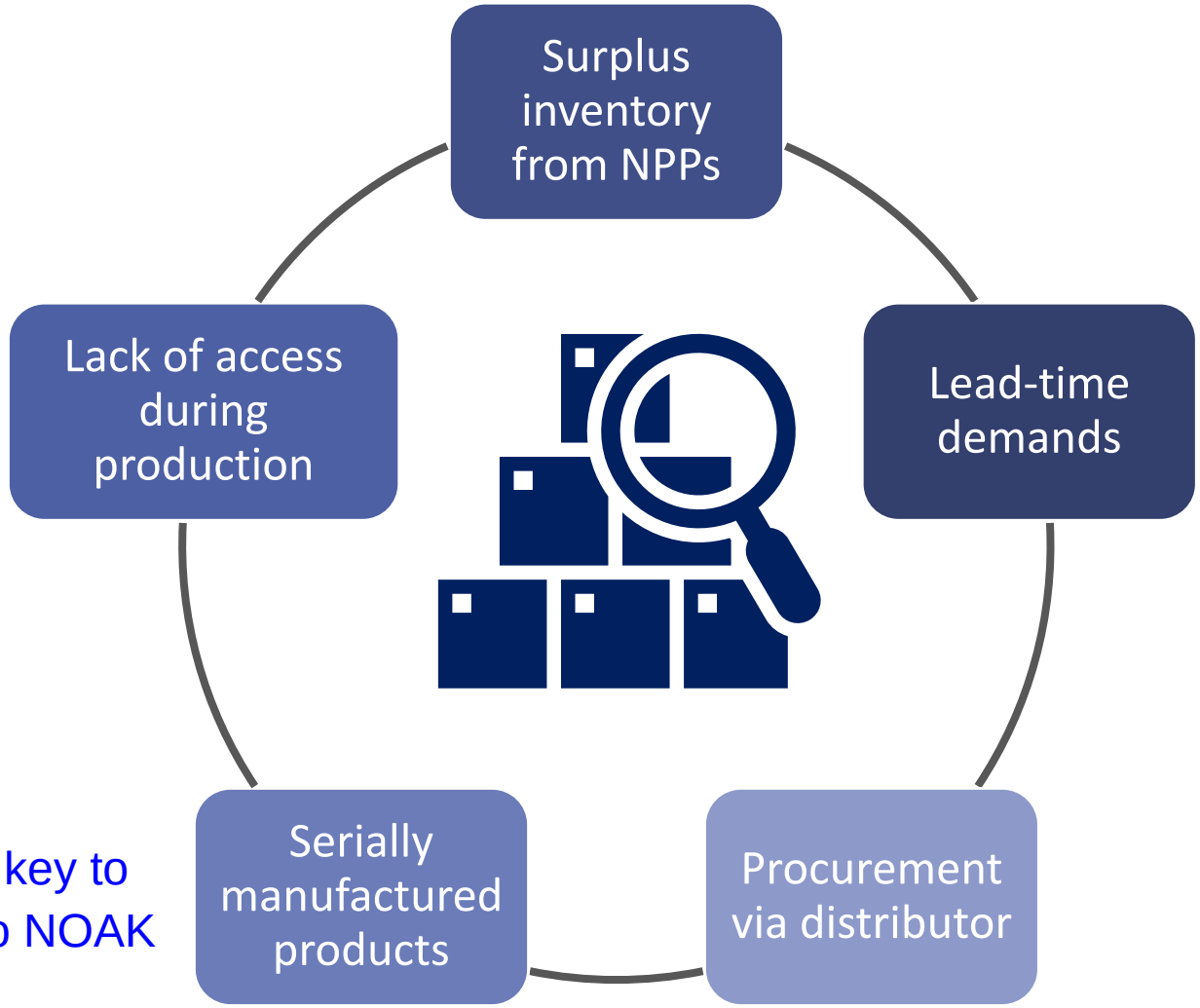
Reasons to Source ‘Off-the-Shelf’

The situation today

Off-the-shelf (OTS) item
Items which undergo no order-specific in-process 2nd or 3rd party inspections

Fully fabricated, unused item which undergoes no further manufacturing or testing activities prior to sale.

! Obsolescense



ⓘ Serial production is a key to moving from FOAK to NOAK

How to source SSCs in a harmonized manner without manufacturing oversight?

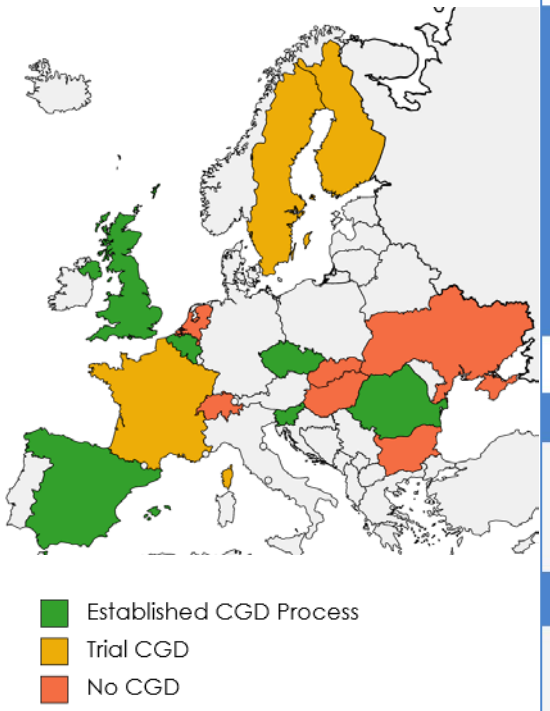
- Reliance on the **supplier's approved management system alone** can be an option
  - ⓘ A large portion of the world's nuclear supply chain is built around a 10CFR50 Appendix B nuclear quality program model (or similar)
  - ⓘ ISO 19443:2018 may help to harmonize supplier quality programs (low- to mid-safety significant SSCs)
- When the original equipment manufacturer (OEM) does not match nuclear quality program requirements (or the OEM is not reachable), the buyer (customer) needs to do more to demonstrate suitable quality
- We can learn from **QA/QC strategies used for accepting "commercial-grade items"**
  - ⓘ Harmonization related to the acceptance of CG items is being achieved across varied regulatory infrastructues!

Lessons Learned from Commercial-Grade Dedication

Alternative Acceptance Paths for OTS Items

Commercial-Grade Dedication…

- ✓ Is a quality assurance methodology for SSC procurement (not design suitability)
- ✓ Is a proven, **40-year-old methodology** which has been continually improved
- ✓ Is applied successfully by approximately **1/3 of today's NPPs** around the world and endorsed by their regulatory bodies
- ✓ Is being implemented in a **harmonized manner** across jurisdictions



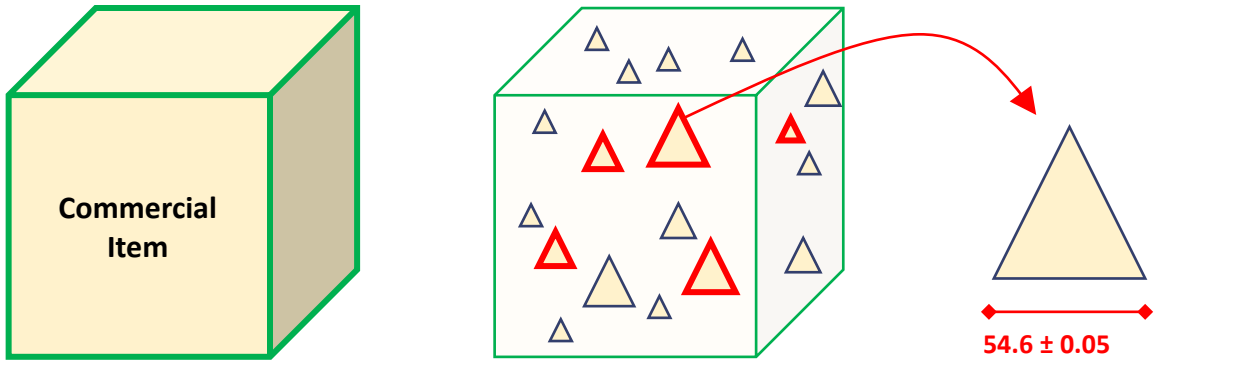
Lessons Learned from Commercial-Grade Dedication

Alternative Acceptance Paths for OTS Items

- **Increase engineering involvement in the procurement process**

  ⓘ With a focus on nuclear safety functions, failure modes and mechanisms of the SSC

- Understand which parts of the SSC are critical to safety (**also a key part of ISO 19443:2018 management systems**)
- Verify **critical characteristics** to gain **confidence** in the item's ability to perform its safety function(s)
- Once verified and documented, the result is an item important to safety equivalent to one procured from a 'nuclear' supplier with 'nuclear' supplier quality management



Intended to be used as a safety-related item (i.e. the item will have to perform safety functions)

Parts, sub-assemblies supporting the safety function(s)

Critical characteristics

Alternative Acceptance Paths for SSCs

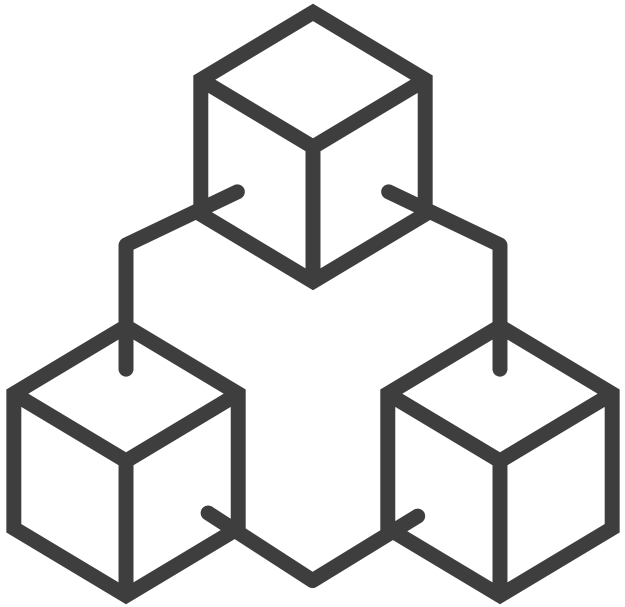
Novel approaches for the next generation – building trust in the supply chain

Goal is confidence in the quality of SSCs…

- **Immutable ledgers (blockchain)** could be used to store and track quality control or inspection data (already seeing trail use for nuclear material accountancy)

Benefits could be…

- **Fully trustworthy** quality data for all stakeholders (regulator, public, licensee)
- Mechanism to **prevent fraud/falsification** of quality data
- **Minimal intrusiveness** during fabrication in supplier organizations



Always use a graded approach

We cannot forget…

- Stringency of quality requirements
- Amount of oversight
- Level of effort and resources spent

… is proportional to …

- Safety significance of the goods or service
- Complexity of the goods or service
- Value of the goods or service

Common Position: The Licensee will be expected to use safety classification to support the justification of ***appropriate quality requirements*** *applied to structures, systems and components for SMRs.*

The SMR vendors may propose greater use of ***commercial items****. There are a number of reasons for this approach, including economic considerations, and taking credit for any inherent safety characteristics in SMR designs. Safety classification permits the s****afety characteristics of any items to be considered and (if proven) allow the use of commercial items.***

Small Modular Reactors Regulators' Forum

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