



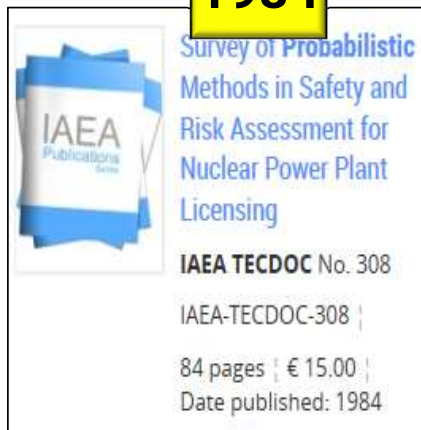
Multi-unit risk: understanding the big picture - opportunities and challenges

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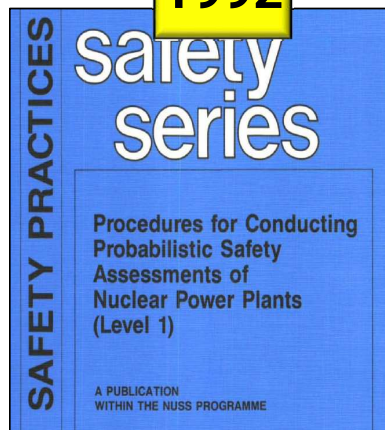
IAEA perspective

- IAEA activities on PSA and risk-informed decision making **started in 80's**
- **Various aspects covered:** implementation of various PSA elements, applications, peer reviews, databases, etc.
- **PSA plays important role** in IAEA framework, **powerful tool** together with DSA
- **Holistic understanding of the risk profile** of nuclear installations

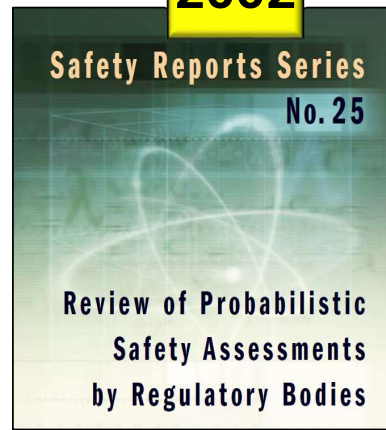
1984



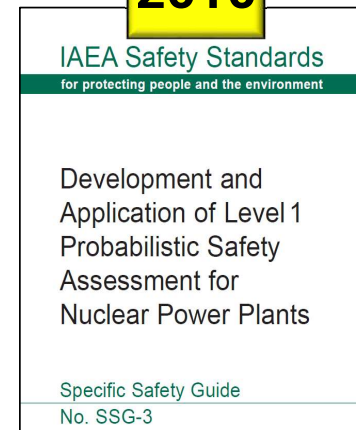
1992



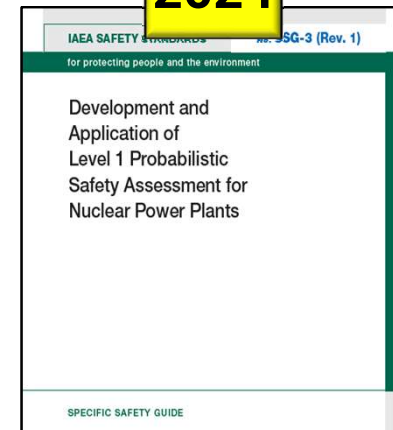
2002



2010

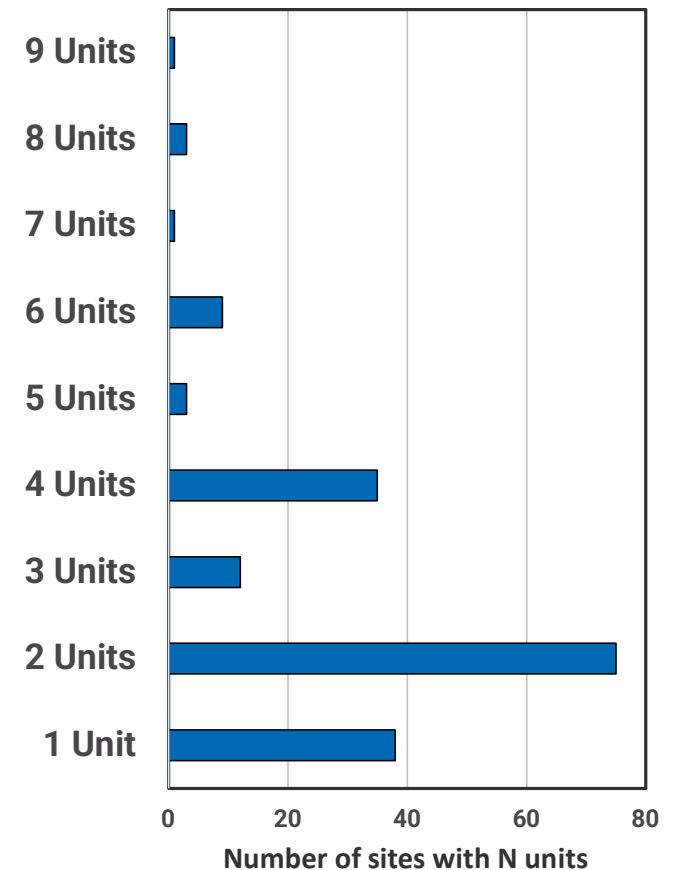


2024



Single vs Multi-unit

- “One reactor at-a-time mind-set” in safety assessment
- Majority of sites have more than one unit (>78% sites are MU sites)
- **MU accident considerations:**
 - Interactions between the units
 - Multi-unit correlations
 - Shared resources (e.g. water, shared SSCs)
 - Shorter times available for operator actions
 - Larger consequences



** Data from IAEA PRIS database, January 2026
(operating NPP, planned units or under construction)*

IAEA Member States' feedback

- Fukushima accident demonstrated importance
- Increasing interest among IAEA Member States

The OP 54 of IAEA General Conference (60)/RES/9 states:

“Encourages Member States ... to perform safety assessments in accordance with international best practice and relevant IAEA Safety Standards, including at multi-unit sites...”

- Negative and positive multi-unit interactions
- Emerging technologies (multi-modular SMRs)

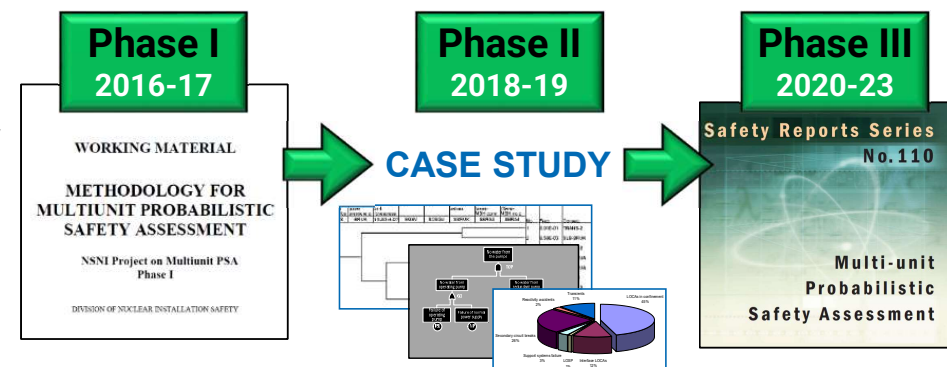
The OP 60 of IAEA General Conference (61)/RES/8:

“Requests the Secretariat to continue efforts to develop guidance on the safety of multi-unit sites”.



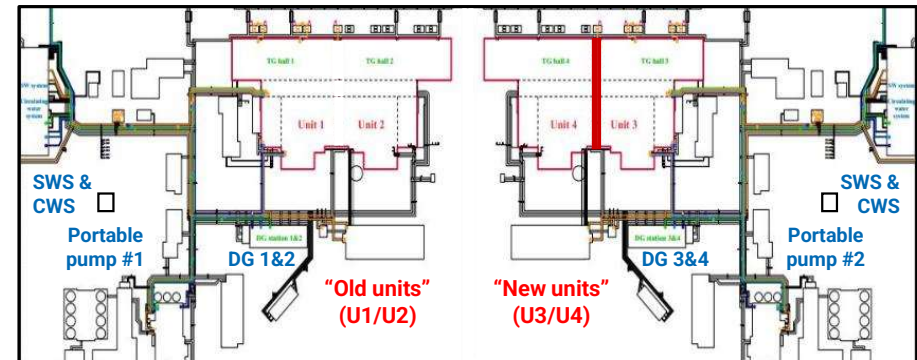
IAEA MUPSA methodology

- **Three phase project** for development of IAEA MUPSA methodology
- **More than 40 experts from 13 Member States** (>10 meetings)
- **'How to do' guidance:**
 - Complementary to **single unit PSA**
 - Consistent with **IAEA Safety Standards**
 - Applicable for **large number of units**
 - Able to address **complexity & asymmetry**
 - Aimed to obtain **multi-unit risk profile**
 - Aimed to support **RI decision making**



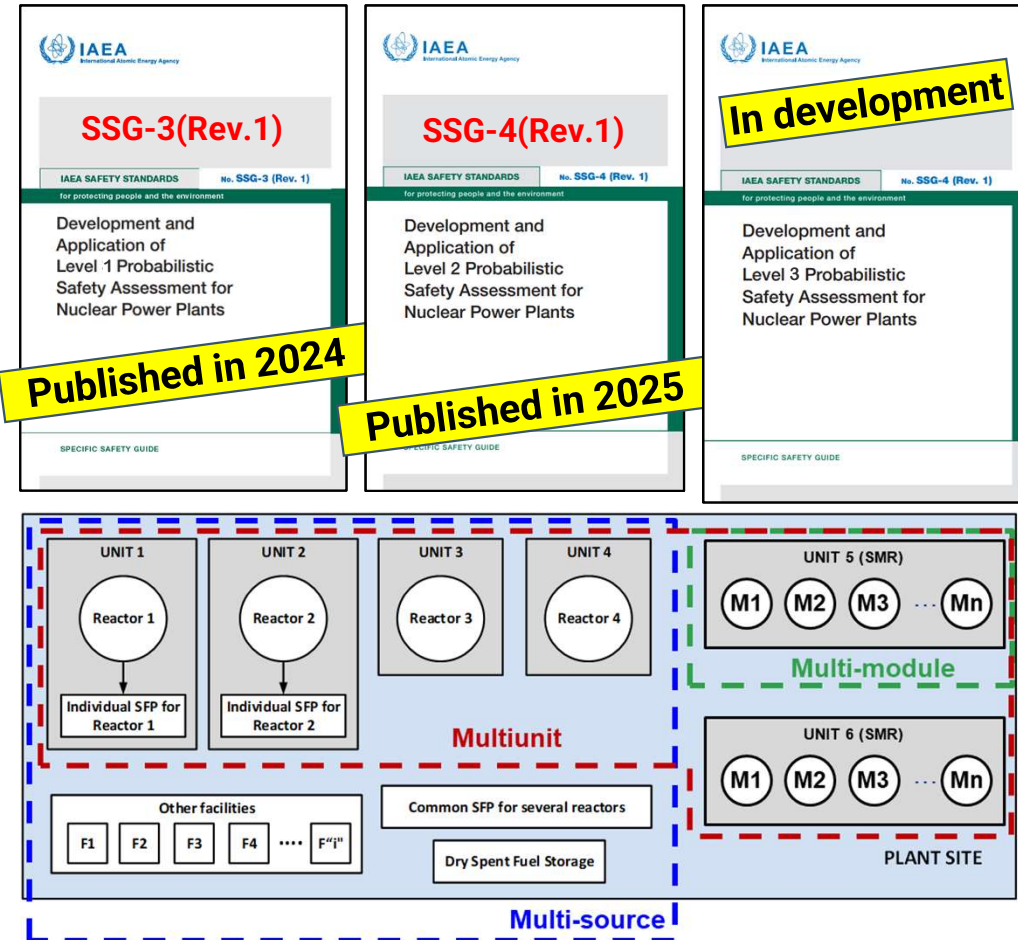
Insight from IAEA MUPSA efforts

- **Realistic case study for 4 unit site**
 - complexity & asymmetry (shared SSC)
 - detailed SUPSA model
- **High level insights**
 - **Understanding** of level of efforts (doable!)
 - **Room for simplifications** based on SUPSA
 - **External hazards** contribution to MU risk
 - **Multi-unit risk insights could not be generalized:** depends on the specific design
 - **Challenges:** MU correlations (e.g. partial seismic), human factor, complexity
- **Feedback** to improve MUPSA methodology and incorporation to IAEA Safety Standards



Utilization of IAEA MUPSA project outcomes

- **Revision of IAEA Safety Standards on PSA**
 - Multi-unit considerations added
 - Elaborated on Spent Fuel Pools
 - New Safety Guide on Level 3 PSA
- **Multi-modular SMR designs**
- **Risk aggregation on a site level** ([TECDOC-1983](#))
- **PSA for non-reactor facilities** (large TM in 2024, new TECDOC)
- **Co-operation** with ASME/ANS PRA



IAEA PSA reviews (TSR missions)

- **IAEA PSA review missions since 1988** (IPERS, IPSART, now TSR)
- **Review of the documentation (incl. model)** and recommendations on improvements per IAEA Safety Standards
- **Scope:** various PSA levels, all hazards, POSs, PSA Applications
- **Multi-unit and multi-module considerations are addressed** (both from SU and MU risk standpoint)



Key messages

- **Shift of mindset** from single unit to multi-unit in safety assessment
- **IAEA MUPSA methodology** (tested and incorporated in IAEA Standards)
- **Challenges:** MU dependencies, correlations (e.g. partial seismic), complexity
- **Understanding the MU risk profile** for risk-informed decision making
- **Use for SMRs** (e.g. safety demonstration, design)
- **IAEA TSR missions** for operating and design stage NPPs





Thank you!

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