GEN IV International Forum℠
Expertise | Collaboration | Excellence

Introducing New Plant Systems Design (PSD) Code

Summary / Objectives:

The nuclear sector is facing **two major challenges**. The first is **to reduce cost of decommissioning old and building new nuclear power plants**. In the UK, the Nuclear Sector Deal issued by the UK Government has called for 20% reduction in decommissioning costs and 30% reduction in the new build cost by 2030. The second challenge is **to increase safety**. The safety requirements have been toughened by the IAEA's Design Extension Conditions that require plants to withstand multiple hazards and extreme hazards. The challenge is to reduce cost whilst increasing safety and that calls for a different design approach. The nuclear industry is responding to this challenge of reducing cost without compromising safety by taking part in the development of new Plant Systems Design (PSD) code that will change the way design and construction is done. This presentation will explain the new initiative that is being taken by committee of international experts under the aegis of ASME to develop the PSD code which is a technology neutral standard that provides a framework, including requirements and guidance, for design organisations. In traditional nuclear industry approach the design process goes through concept, preliminary design, detail design, construction, commissioning, and operation. The emphasis is mostly on component design not on system design and the whole design process is sequential. The PSD standard aims to bring in three main changes: **(a) integrate process hazard analysis** in the early stages of design; **(b) incorporate and integrate existing systems engineering design processes, practices and tools** with traditional architect engineering design processes, practices and tools; and **(c) to integrate risk informed probabilistic design methodologies** with traditional deterministic design. Main features and advantages of systems-based approach to integrate design and safety in the PSD code will be described.

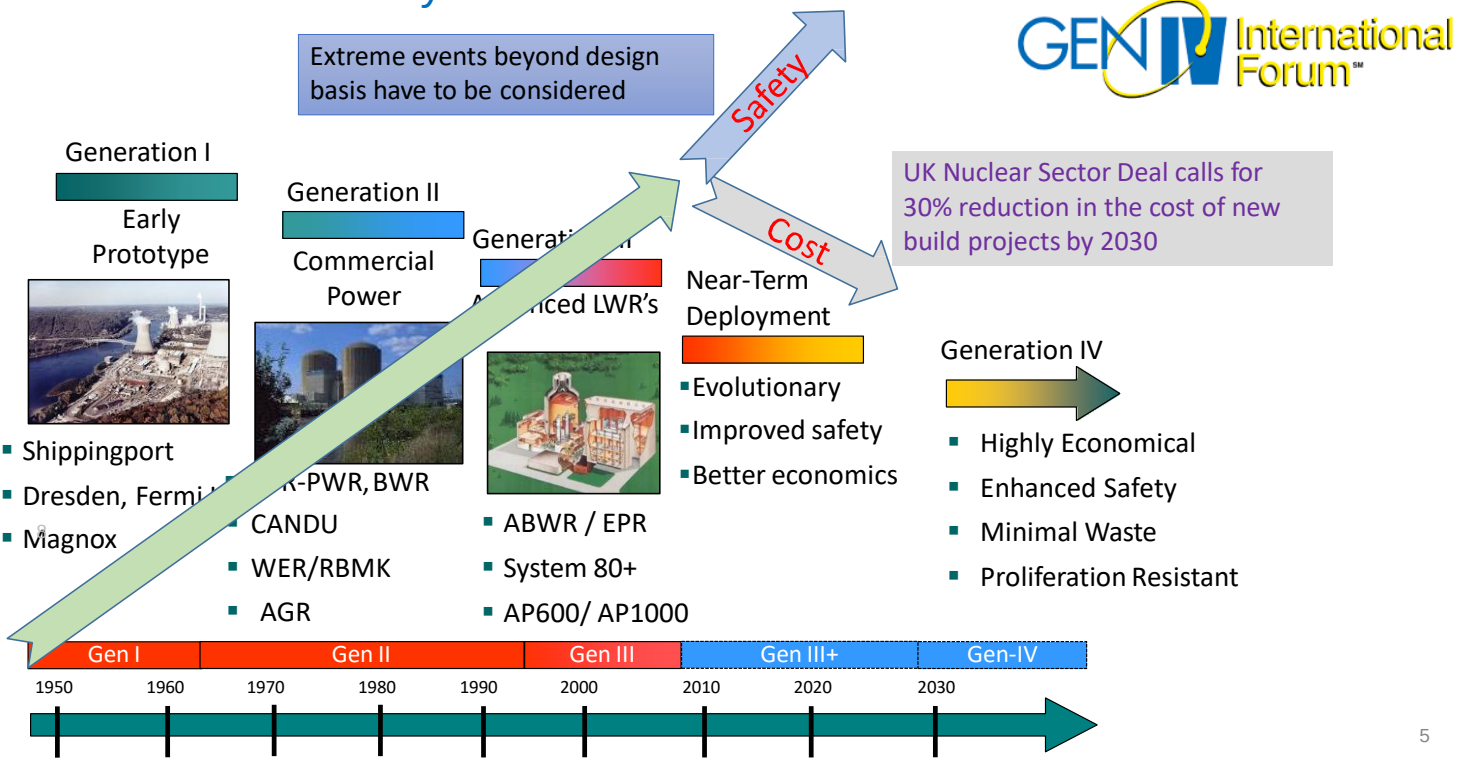
Meet the Presenter:

Prof. Nawal Prinja has 40 years of academic and industrial experience in the nuclear sector. He is the Technology Director of Jacobs (Clean Energy) and holds a position of Honorary Professor at four British universities. Currently he is working with WNA on Harmonisation of Nuclear Codes.

Major challenge on Nuclear sector; Safety and Cost:

Typically, technologies become cheaper with their maturation, but the cost of nuclear power have been increase because of demand on increasing safety. Achieving **both of high safety and low cost** is one of major challenge on the nuclear sector across the world.

Need to Increase Safety and Decrease Cost

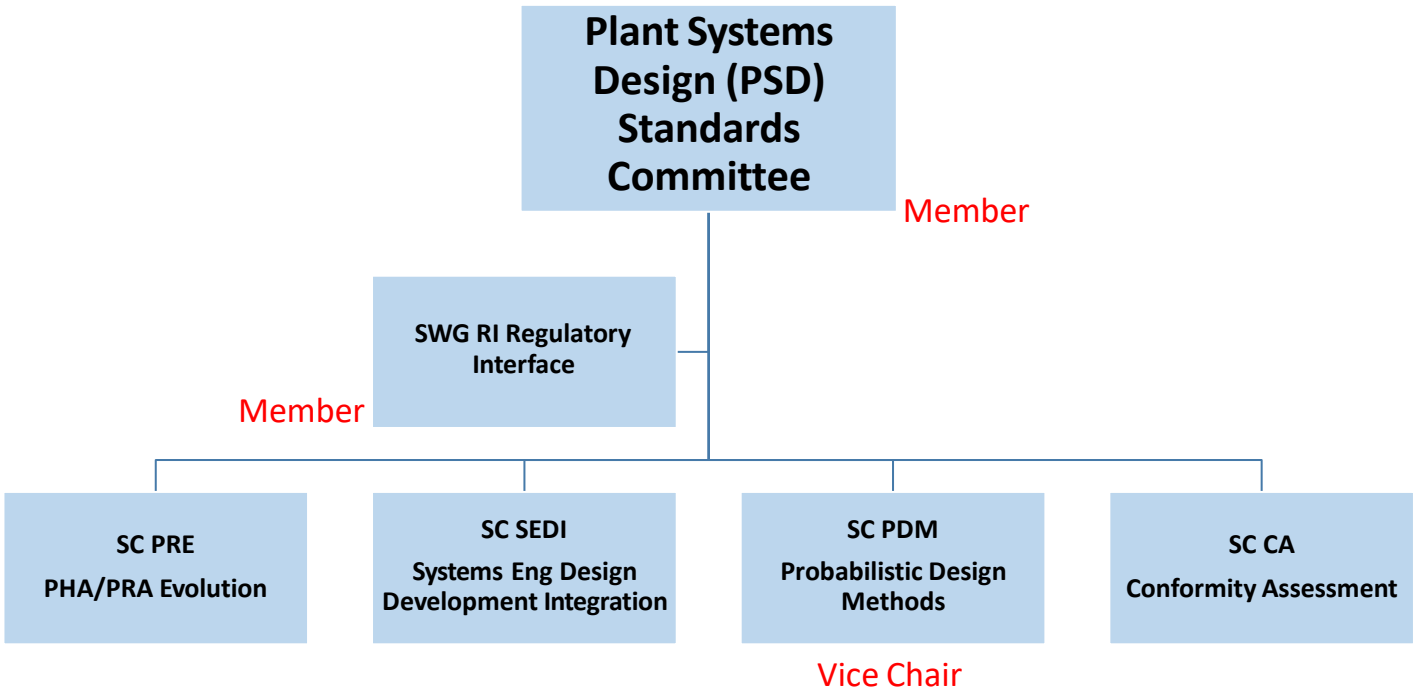


The objectives of new PSD code:

1. Safer and more efficient system designs and design alternatives with **quantified safety levels**
2. More effective **requirements management**
3. **More cost-effective and timely strategies** for issue resolution and design maturation
4. **Combine** risk informed **probabilistic** design methodologies **with traditional deterministic** design methods using reliability and availability targets
5. Cover design of facility plant systems over **the entire life cycle of a plant** (design, construction, operation, decontamination and decommissioning)
6. Be system based, vs. component based, and **cover multiple disciplines**

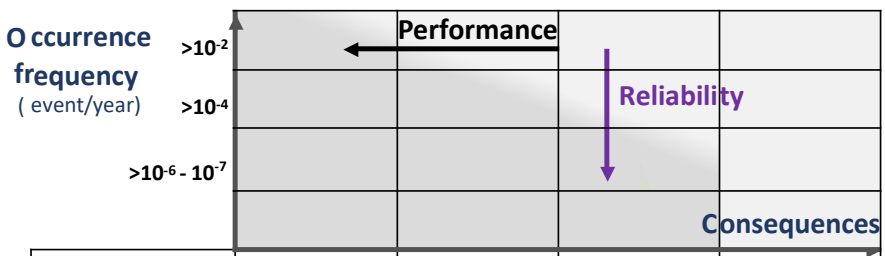
ASME PSD Committee :

ASME constructed a committee to develop new Plant System Design standards that is technology neutral (e.g. power generation, petrochemical, and hazardous waste plants)



Risk-informed Performance based (RIPB) approach:

RIPB approach focuses attention on the most important activities and provides flexibility to determine how to meet performance criteria. In order to meet reliability and availability target, there are 3 kinds of options; reduce frequency, reduce consequence, and their combination.



Plant States	Design basis AOO	Design basis DBA	Design basis DBA / DEC	Beyond design basis
DiD Level	DiD Level 2 No off-site radiological impact	DiD Level 3.a No or only minor off-site radiological impact	DiD Level 3.b No or only minor off-site radiological impact DiD Level 4 Limited protective measures in area and time	No cliff-edge effect & pratically eliminated
Severity Level IAEA SSG 30	Low & Medium	Medium	High	

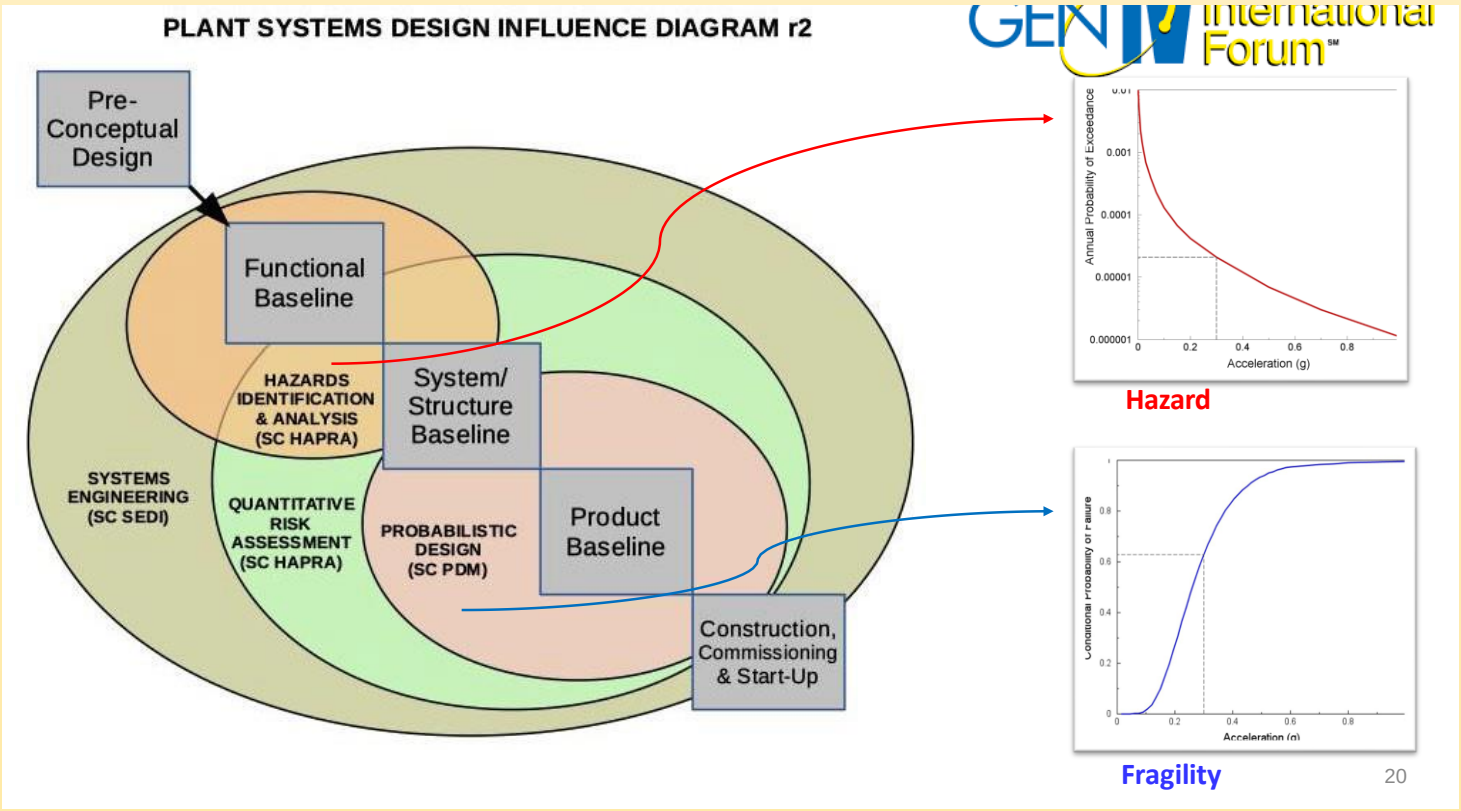
Options to bring an undesirable event that puts a plant into an uncontrolled state back into a controlled or safe state (shaded zone).

A safety related SSC (more generally, a 'layer of provisions') can be introduced, against an (initiating) event with unacceptable consequence, to :

either reduce the severity of consequence
or reduce the frequency of occurrence
or both.

RIPB application to PSD:

Hazard identification is started from the early stage and **hazard curve (frequency of undesirable event)** is produced. **Fragility curve (conditional provability of failure)** is produced later. Risk is evaluated by mathematically combining of these 2 curves.



Spiral approach:

On the Plant System Design, **spiral approach** is adopted. EPRI published a report to describe their procedures based on spiral approach, in which 4 kinds of **procedures are repeatedly carried out**; Design, Hazards Identification, Consequence Analysis and Frequency Analysis.