GEN IV International Forum[SM]
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SFR Safety Design Criteria (SDC) and Safety Design Guidelines (SDGs)

Summary / Objectives:

This webinar provides the outlines of the safety design criteria (SDC) and safety design guidelines (SDG) established to achieve high development goals of Gen IV reactors including safety and reliability. Reflecting the lessons learned from the Fukushima Daiichi nuclear power plant accident, the SDC describes requirements that must be met by Gen IV Sodium-cooled Fast Reactors (SFRs), and the SDG provides guidelines on how to apply the SDC to the actual design. The Gen IV SFRs are required to adopt advanced devices and systems as a built-in safety feature, combinations of active safety systems with passive mechanisms or inherent features to prevent and mitigate core damage. Taking the characteristics of the SFR as liquid metal cooling fast reactor system into account, the SDG recommends specific design measures such as inherent / passive reactor shutdown, natural circulation decay heat removal and in-vessel retention of degraded core.

Meet the Presenter:

Mr. Shigenobu Kubo has been engaged in sodium-cooled fast reactor development since 1989. His specialties are SFR system design, safety design and related R&Ds. He is involved in the development of safety design criteria (SDC) for SFR in GIF as Chair of the GIF SDC task force, and he joined this task force since its inception in 2011. He currently occupies the position of Deputy Director, Reactor Systems Design Department, Sector of Fast Reactor and Advanced Reactor Research and Development, at JAEA. He participated in the Feasibility Study on commercialized fast reactor cycle systems (1999-2006) and the Fast Reactor Cycle Technology Development project (2006-2011). He was also involved in the France-Japan ASTRID collaboration as Design task leader and Severe accident task leader. One of his most impressive work is the EAGLE project (SFR severe accident experiments using IGR and out-of-pile experimental facility in Kazakhstan).
He earned his Master degree in nuclear engineering from the Nagoya University, Japan, in 1989.

GIF's Safety Goals& Basis for Safety Approach :

GIF's Safety & Reliability Goals

SR-1: Excel in operational safety and reliability

SR-2: Very low likelihood & degree of reactor core damage

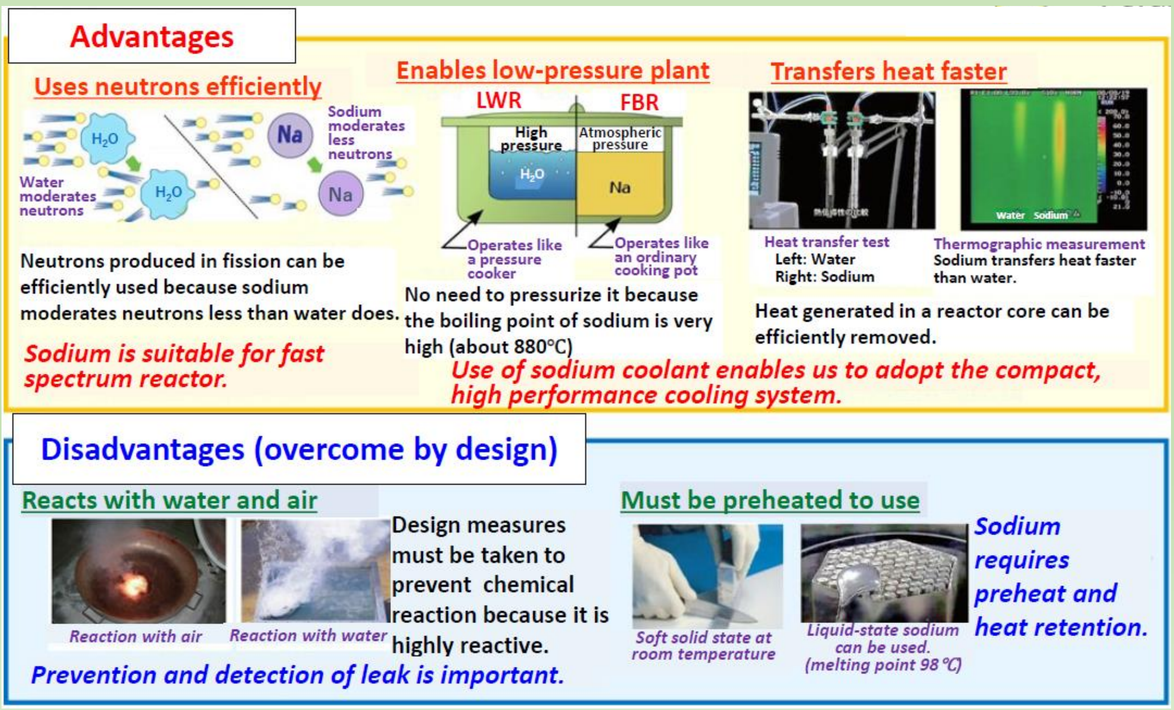
SR-3: Eliminate the need for offsite emergency response

GIF's Basic Safety Approach

- Defence-in-depth
- A combination of deterministic and risk-informed safety approach
- Safety to be built-in to the design, not added-on
- Emphasis on utilization of inherent and passive safety features

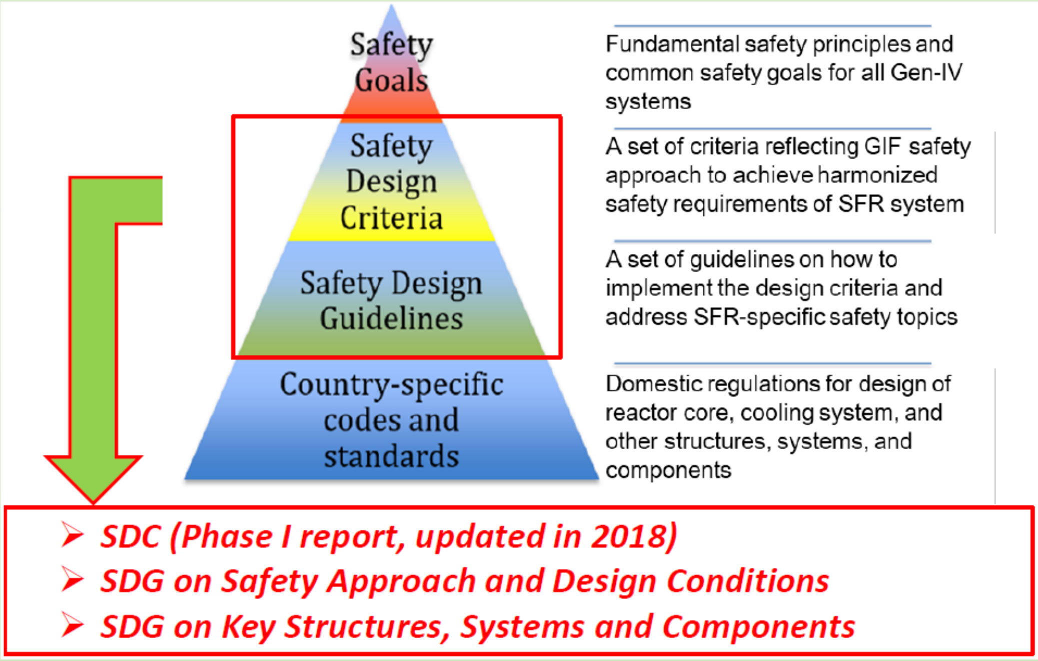
Safety Characteristics of SFR :

Though IAEA has systematically developed international safety standards with a hierarchical structure, the lower-level standards are mainly for existing LWRs. Therefore, we need to develop the global standards for Generation IV Reactors considering each characteristics of their coolant and coolant system.



Development of SDC/SDG for GEN IV SFRs :

Safety Design Criteria Task Force (SDC-TF) have developed SDC and 2 SDGs with hierarchical structure. These documents have been reviewed by external authorities such as national regulatory bodies of the countries, IAEA, and OECD/NEA WGSAR.

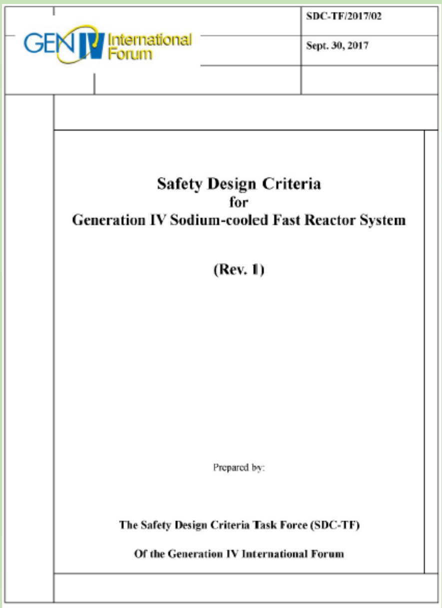


Safety Design Criteria:

The objective of the SDC is to present the reference criteria of the safety design of Structures, Systems and Components (SSCs) of the SFR system.

The criteria are clarified systematically and comprehensively to adopt the GIF's basic safety approach.

Lessons learned from Fukushima Dai-ichi NPPs accident also have been reflected into the SDC.

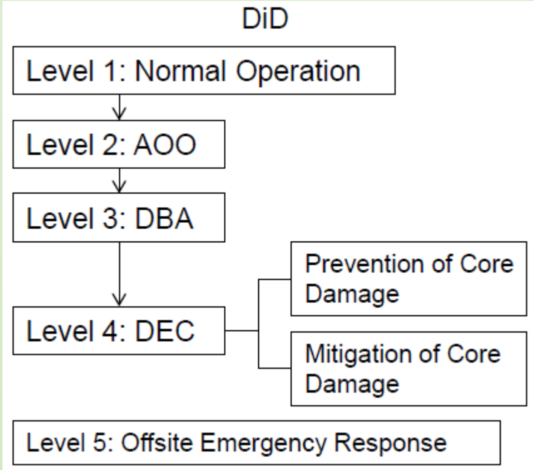


The revised SDC report (Rev.1) is available on GIF web site. (https://www.gen-4.org/gif/jcms/c_93020/safety-design-criteria)

Safety Design Guideline on Safety Approach :

SDG on SA is intended to provide recommendations and guidance on how to comply with the SDC.

This report focuses mainly on "Design approach to Design Extension Condition (DEC)" and "Practical Elimination of Accident Situations". These approaches are required to achieve level 4 and 5 on the Defense in Depth.



The SDG on Safety Approach report is available on GIF web site. (https://www.gen-4.org/gif/jcms/c_93020/safety-design-criteria)

Safety Design Guideline on Structures, Systems and Components :

SDG on SSCs is intended to provide detailed guidelines for SFR designers to support the practical application of the SDC in design process to ensure the highest level of safety in SFR design.

This SDG show recommendations and guidance to comply with the SDC and the Safety Approach SDG with examples, which can be applied to Gen-IV SFR systems in general. Below table shows the SFR-specific safety features and 14 focal points in this SDG.

Systems	Safety features	Focal points	SDC	SDG on Safety Approach
Reactor Core systems	Integrity maintenance of core fuels	1. Fuel design to withstand high temperature, high inner pressure, and high radiation conditions	✔	
		2. Core design to keep the core coolability	✔	✔
	Reactivity control	3. Active reactor shutdown	✔	✔
		4. Reactor shutdown using inherent reactivity feedback and passive reactivity reduction	✔	✔
		5. Prevention of significant energy release during a core damage accident, In-Vessel Retention	✔	✔
Coolant systems	Integrity maintenance of components	6. Component design to withstand high temperature and low pressure conditions	✔	
	Primary coolant system	7. Cover gas and its boundary	✔	
		8. Measures to keep the reactor level	✔	✔
	Measures against chemical reactions of sodium	9. Measures against sodium leakage	✔	
		10. Measures against sodium-water reaction	✔	
	Decay heat removal	11. Application of natural circulation of sodium	✔	✔
		12. Reliability maintenance (diversity and redundancy)	✔	✔
Containment systems	Design concept and load factors	13. Formation of containment boundary and loads on it	✔	
	Containment boundary	14. Containment function of secondary coolant system	✔	