

SDC-TF: Safety Design Criteria Task Force

In 2018 and 2019, the GIF SFR Safety Design Criteria Task Force (SDC-TF) completed the first draft of the SFR Safety Design Guidelines report “Safety Design Guidelines on Structures, Systems and Components for Generation IV Sodium-cooled Fast Reactor Systems” (SSC SDG), which is the second guideline, and revised the “Guidelines on Safety Approach and Design Conditions of Generation IV SFR Systems” (SA SDG), which is the first guideline, by reflecting external feedback from OECD/NEA Working Group on the Safety of Advanced Reactors (WGSAR) and the IAEA.

The SDC-TF completed the SFR Safety Design Criteria (SDC) report in 2013 as the outcome of its phase I activities, distributed it to international organizations (IAEA, MDEP, NEA/CNRA, and regulatory bodies of the GIF member states with active SFR development programmes, namely, China, EC, France, Japan, Korea, Russia and the United States), and revised it on the basis of their comments. To revise it, the SDC-TF adopted many technical descriptions of the IAEA SSR 2/1 revision 1 issued in 2016, including new provisions that reflect lessons learnt from the TEPCO’s Fukushima Daiichi nuclear power plants accident. It published the revised SFR SDC report in 2017 after the GIF Experts Group (EG) and Policy Group (PG) have approved it.

The SDC-TF has prepared the SFR safety design guidelines as a set of recommendations on how to meet the SDC and address SFR-specific safety issues. The purpose of the SA SDG is to facilitate the practical application of the SDC to Generation IV SFR design tracks by clarifying technical issues and providing recommendations with a variety of design options. It describes prevention and mitigation of severe accidents, situations that should be practically eliminated (e.g. issues related to the loss of heat removal), and considerations for SFR reactivity characteristics. The SDC-TF distributed the SA SDG to the NEA GSAR (the predecessor of NEA WGSAR) and the IAEA to receive external review. The SDC-TF integrated solutions to IAEA’s 23 comments and WGSAR’s 128 comments into the revised SA SDG report and sent the revised version to the GIF EG members in 2019 to invite their comment.

The purpose of the SSC SDG is to guide and support SFR designers when practically applying the SDC in design process so that their design can ensure the highest level of safety. The SSC SDG builds bridges between the recommendations of the SA SDG and each SSC design. In addition, the SSC SDG describes recommendations to meet the requirements of the SDC Report which are not covered in the SA SDG. The recommendations in the SSC SDG include measures considering SFR’s reactivity characteristics against Anticipated Transient Without Scram (ATWS), and the measures to practically eliminate the core uncovering and the complete loss of decay heat removal function. The recommendations which are not covered in the SA SDG are on fuels and materials under high-temperature, radiation conditions and on measures against various hazards such as sodium fire, sodium-water reaction, and load factors on the containment system, for example **Figure SDCTF 1** shows the consideration process towards the SSC SDG development. The SSC SDG describes the three fundamental safety systems: the core system, the coolant system, and the containment system, which particularly includes selected 14 focal points regarding the SFR-specific safety features as listed in **Table SDCTF 1**. The SDC-TF referred to design features of Generation IV SFR systems, and the descriptions, definitions, and formats of IAEA NS-G series to develop the recommendations. Although the current SSC SDG primarily covers the main components, it will also address other SSCs such as fuel handling and fuel storage systems. The SDC-TF distributed the SSC SDG in 2019 to OECD/NEA WGSAR and IAEA Department of Nuclear Energy to receive external review.

For the next generation advanced LMFRRs under development worldwide, GIF and IAEA have a mutual interest in harmonizing safety approaches, safety requirements, the SDC, and the SDGs. This has become a significant topic especially after the TEPCO’s accident in 2011, which caused increased attention to nuclear safety and importance of international frameworks for existing reactors currently in operation and for reactors with new designs. In a framework of GIF-IAEA collaboration, there have been eight joint IAEA-GIF technical meetings on SFR safety since 2010. The SSC SDG was introduced in the eighth IAEA-GIF workshop in Vienna in March, 2019.

Figure SDCTF 1. Consideration process of the SSC SDG

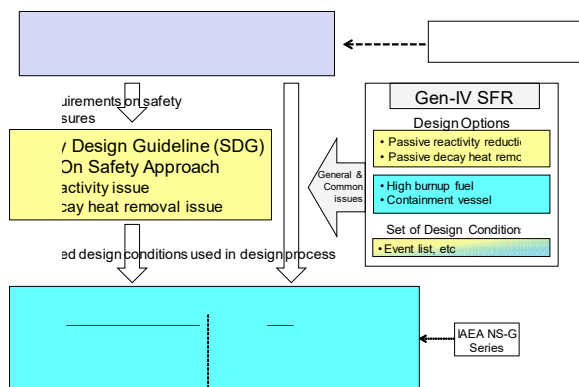


Table SDCTF 1. SFR-specific safety features

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	✓	

The SDC-TF has produced the SFR safety documents listed below and successfully completed most of its missions: (These are currently being reviewed)

- Safety Design Criteria for Generation IV Sodium-cooled Fast Reactor System.
- Safety Design Guidelines on Safety Approach and Design Conditions for Generation IV Sodium-cooled Fast Reactor Systems.
- Safety Design Guidelines on Structures, Systems and Components for Generation IV Sodium-cooled Fast Reactor Systems.

To discuss remaining topics, SDC-TF members proposed to the GIF PG that the SDC-TF joins the RSWG on the GIF PG meeting (Oct. 2019, Weihai, China), and the PG approved it; the SDC-TF members will join the RSWG as new members from the RSWG meeting in April 2020.



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