Analysis of Integrity for Baffle/Former Bolt of Reactor Internal

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1. Structures and materials of reactor internal in Kori Unit 1 nuclear plant

The reactor internals support the core, maintain fuel alignment, limit fuel assembly movement, maintain alignment between fuel assemblies and control rod drive mechanisms, direct coolant flow past the fuel elements, direct coolant flow to the pressure vessel head, provide gamma and neutron shielding, and guides for the incore instrumentation. The components of the reactor internals are divided into three parts consisting of the lower core support structures (including the entire core barrel and neutron shield pad assembly), the upper core support structure and the incore instrumentation support structure.

Materials for reactor internal components are shown in Table 1. The major material for the Kori Unit 1 and 2 reactor internals is type 304 and 316 stainless steel.

Table 1. Reactor internal materials at each component.

Subcomponent	Material
Core barrel, thermal shield, shroud, formers and baffles	Type 304 stainless steel
Upper support structure	Type 304 stainless steel
Lower support structure	Type 304 stainless steel; Grade CF-8 cast stainless steel
Flux thimbles	Type 304 cold-worked stainless steel
Split pins	Alloy X-750
Bolts and dowel pins	Type 316 stainless steel
Flow mixer	Grade CF-8 cast stainless steel
Cruciform instrument guides	Grade CF-8 cast stainless steel
Hold-down spring	Type 316 stainless steel
Radial support key bolts	Alloy X-750
Core support pads	Alloy 600

2. Accidents of baffle/former bolt for reactor internal

The baffle/former blots cracking was reported since 1980's and failed by intergranular cracking. Evaluation of ageing mechanism is based on PWR service experience, pertinent laboratory data, and relevant experience from other industries. According this evaluation, the possible mechanism for baffle/former bolt is embrittlement, fatigue, corrosion, radiation induced creep, relaxation and swelling, and mechanical wear. The neutron irradiation is a significant feature and IASCC is a major mechanism even if the exact mechanism is unknown now. The accidents of baffle/former bolts were shown in Table 2.

3. Investigation and safety analysis of baffle/former bolts for Kori Unit 1

Baffle/Former bolts of Kori Unit 1 were investigated by ultrasonic technique in 1999. Baffle plate was 1" thickness stainless steel. Baffle/former bolt was 5/8" x 11 pitch and edge bolt was 1/2" x 13 pitch and material was CW 316 stainless steel. These bolts were locked by locking bar through baffle/former bolts. Two bolts were cracked and six bolts were not able to inspect because the UT probe could not access to these bolts. For these bolts, Framatome conducted safety analysis for baffle/former bolts. Code to analyze was SYSTUS (Framatome report EER.DC.976/B). Methodology for safety analysis was shown in Fig. 1. According to safety analysis, the integrity for operation was acceptable.

Table 2. Accidents of baffle/former bolts

UP - Upflow
CP - Convert upflow

	Facilities / Power Plant	Operating year	Generating power (MW)	Loop number	BFB number	BFB material	Cool Hole	Cooling system	Defect number	Defect position
FRANCE	Bugey-2	20	955	3	960	316SS	No	CU	87	#2,3 Former
	Bugey-3	20	955	3	960	316SS	No	CU	18	-
	Bugey-4	-	937	3	960		No	CU	3	-
	Fessenheim-1	-	950	-	960		No	CU	28	-
	Fessenheim-2	-	950	-	960	347SS	No	CU	47	-
AMERICA	Farley-1	22	860	3	1024		No	CU	No	-
	Point Beach-2	27	510	2	728	347SS	No	CU	55	#1,3,8 Former
	Ginna	-	600	2	728		-	CU	59	-
KOREA	Kori-1	21	600	2	728	316SS	No	CU	2	#1,6 Former
	Kori-2	16	650	2	800	316SS	Yes	UP	-	-
	Kori-3-4 YoungGwang-3-4	12 ~ 14	950	3	960	316SS	Yes	UP	-	-
	Ulchin-1-2	10 ~ 11	950	3	1029	316SS	Yes	UP	-	-

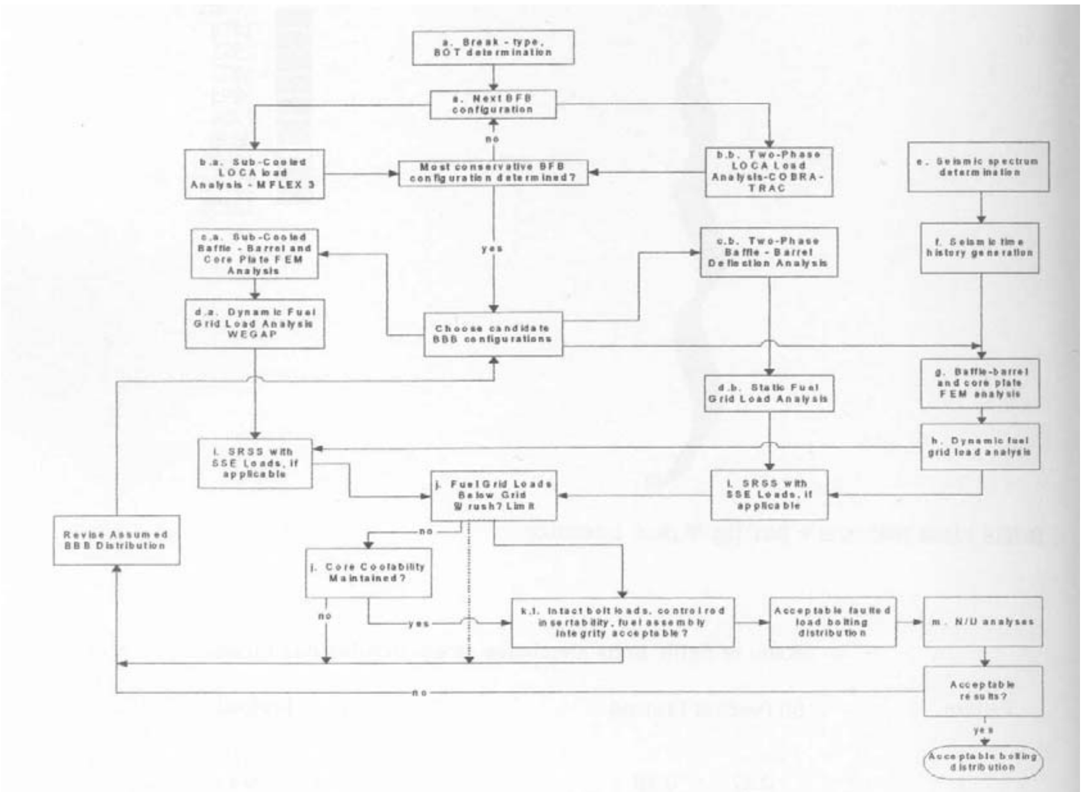

Fig. 1. Safety analysis procedure