Cracks to welds on the nozzle stubs in the steam generator

Eddy Current Tests (ECT) were conducted at Mihama Unit 2 during outage in September 2007 and also at Tsuruga Unit 2during outage in October 2007 to verify the integrity of the inner surfaces of the welds (600 Series nickel-based alloy) on the primary coolant inlet nozzle stubs in the steam generators. The tests identified significant signal indications. The subsequent Ultrasonic Tests (UT) confirmed cracks measuring up to 13mm in depth.

In response to these two incidents, the Nuclear and Industrial Safety Agency (NISA) instructed operators of Pressurized Water Reactors (PWR) on October 18, 2007 to step up their monitoring of any leakage from the welds on the inlet / outlet nozzle stubs in steam generators that use the same 600 Series nickel-based alloy. It also instructed them, on November 16 of the same year, to inspect the inner surfaces of the welds on the inlet / outlet nozzle stubs in steam generators during the next outage. In view of the facts that all the identified cracks ran in the axial direction, and that 600 Series nickel-based alloy is highly ductile, it has been assessed that, even if the cracks aggravated to cause minor leakage, this would not cause immediate damage to piping*.

PWR operators conduct inspections according to the plans. The table below shows the current status (as of March 3, 2008) of inspections on primary inlet nozzle stubs, where 600 Series nickel-based alloy is used for welding. The cracks are so far attributed to primary water stress corrosion cracking (PWSCC) under the primary coolant environment, whereby 600 Series nickel-based alloy, sensitive to stress corrosion cracks, was subject to residual tensile stress generated at the time of welding. No cracks have been found in the welds of outlet nozzle stubs in steam generators.

Operator	Power Station**	Unit NO.	SG	ECT result	UT result	Cause	Inspection plan*	Details
Hokkaido EPCO	Tomari	1	2	TBA	TBA	TBA	8.2008～	TBA
		2	2	TBA	TBA	TBA	3.2008～	TBA
Kansai EPCO	Mihama	2	A	13 locations ***	Up to 17mm in length and 13mm in depth	PWSCC	—	Attachment 1
			B	No indication	—	—		
	Takahama	2	A	3 locations	Not detected	PWSCC	—	Attachment 2
			B	2 locations	Up to 7mm in length and 6mm in depth			
			C	4 locations	Up to 14mm in length and 8mm in depth			
		3	A	7 locations	Up to 28mm in length and 9mm in depth	PWSCC	—	Attachment 3
			B	16 locations	Up to 38mm in length and 15mm in depth			

Operator	Power Station**	Unit NO.	SG	ECT result	UT result	Cause	Inspection plan*	Details
			C	9 locations	Up to 14mm in length and 9mm in depth			
		4	3	TBA	TBA	TBA	2008.8～	TBA
	Ohi	1	4	—	—	—	(USP implemented)	—
		3	4	—	—	—	(USP implemented)	—
		4	4	TBA	TBA	TBA	2008.9～	TBA
Shikoku EPCO	Ikata	3	3	TBA	TBA	TBA	2008.9～	TBA
Kyushu EPCO	Genkai	1	A	3 locations	Not detected	PWSCC	—	Attachment 4
			B	No indication	—	—		
		3	4	TBA	TBA	TBA	2008.5～	TBA
		4	4	No indication	—	—	(USP implemented)	—
	Sendai	1	3	—	—	—	(SGR to be implemented)	—
		2	3	TBA	TBA	TBA	2008.11～	TBA
Japan Atomic Power Company	Tsuruga	2	A	1 location	Not detected	PWSCC	—	Attachment 5
			B	5 locations	Up to 21mm in length and 12mm in depth			
			C	23 locations	Up to 14mm in length and 13mm in depth			
			D	No indication	—	—		

＊ ：Quoted from NISA reference materials dated February 5, 2008.

＊＊：The Power Stations not listed in this column use 690 Series nickel-based alloy with better anti-SCC properties.

＊＊＊：One of the locations had a crack on the safe end (SUS316). It is suspected to have been an intercrystalline crack.

TBA: The results of future inspections will be inserted here as they become available.

— : Not applicable

USP implemented: Ultrasonic Shot Peening has been implemented to enhance anti-SCC properties.

SGR to be implemented: The steam generator will be replaced with one that uses the 690 Series nickel-based alloy in the next outage.