

12. IN-SERVICE INSPECTION PROVISIONS

12.1. Primary vessel and internals

Experimental Fast Reactors

Plant	Primary vessel and internals	
	Provision for routine ISI of inside of primary vessel and internal structure	Provision for routine ISI of outer surface of primary vessel
Rapsodie (France)	DM	-
KNK-II (Germany)	-	-
FBTR (India)	-	AD
PEC (Italy)	optical DM at vessel, mechanical DM of internals	
JOYO (Japan)	USV, UGV, DM	-
DFR (UK)	-	-
BOR-60 (Russian Federation)	AD	-
EBR-II (USA)	-	-
Fermi (USA)	internal-visual with optical aids (limited extent)	
FFTF (USA)	-	TV
BR-10 (Russian Federation)	-	-
CEFR (China)	-	AD, VI

Demonstration or Prototype Fast Reactors

Phénix (France)	-	-
SNR-300 (Germany)	-	-
PFBR (India)	USV, UGV, DM	AD,US,VI
MONJU (Japan)	-	AD,VI
PFR (UK)	-	-
CRBRP (USA)	-	TV
BN-350 (Kazakhstan)	UGV	AD, Elcon
BN-600 (Russian Federation)	UGV	AD, Elcon
ALMR (USA)	-	VI
KALIMER-150 (Republic of Korea)	USV, UGS, DM	VI, Elcon, AD, US, FV
SVBR-75/100 (Russian Federation)	none	-
BREST-OD-300 (Russian Federation)	UGV, DM	VI, AD, US

- USV - under-sodium viewing
- UGV - under-gas viewing, e.g. optical periscope
- DM - displacement monitoring by ultrasonic detectors
- TV - tracked vehicle
- FV - free-moving vehicle
- AD - aerosol detection of primary vessel leak
- VI - visual inspection by optical equipment
- EC - eddy current measurements
- Elcon - electrical contact
- US - ultrasonic measurements

12. IN-SERVICE INSPECTION PROVISIONS (cont.)

12.1. Primary vessel and internals

Commercial Size Reactors

Plant	Primary vessel and internals	
	Provision for routine ISI of inside of primary vessel and internal structure	Provision for routine ISI of outer surface of primary vessel
Super-Phénix 1 (France)	USV*,UGV*	Elcon/VI*,US*,FV*
Super-Phénix 2 (France)	not determined	
SNR 2 (Germany)	not determined	
DFBR (Japan)	-	
CDFR (UK)	US, TV	
BN-1600 (Russian Federation)	not determined	AD, Elcon
BN-800 (Russian Federation)	UGV	AD, Elcon
EFR	UGV,DM	VI,US,TV
ALMR (USA)	-	VI
SVBR-75/100 (Russian Federation)	none	-
BN-1800 (Russian Federation)	UGV	AD, Elcon
BREST-1200 (Russian Federation)	UGV	VI, AD, Elcon
JSFR-1500 (Japan)	USV with free-moving vehicle	VI ,US, FV

* periodic inspection during shutdown

- USV - under-sodium viewing
- UGV - under-gas viewing, e.g. optical periscope
- DM - displacement monitoring by ultrasonic detectors
- TV - tracked vehicle
- FV - free-moving vehicle
- AD - aerosol detection of primary vessel leak
- VI - visual inspection by optical equipment
- EC - eddy current measurements
- Elcon - electrical contact
- US - ultrasonic measurements

12. IN-SERVICE INSPECTION PROVISIONS (cont.)

12.2. Primary circuit pipes

Experimental Fast Reactors

Plant	Primary circuit pipes
Rapsodie (France)	displacement monitoring of the vessel inlet and outlet
KNK-II (Germany)	n.a.
FBTR (India)	-
PEC (Italy)	visual inspection of primary piping at reactor shutdown
JOYO (Japan)	sodium leakage monitoring, visual examination, ultrasonic test, displacement measurement, and test piece surveillance
DFR (UK)	visual (occasional entry)
BOR-60 (Russian Federation)	leak detectors
EBR-II (USA)	n.a.
Fermi (USA)	-
FFTF (USA)	periscopes for visual inspection of primary piping and valves
BR-10 (Russian Federation)	sodium leak monitoring, visual examination
CEFR (China)	n.a.

Demonstration or Prototype Fast Reactors

Phénix (France)	n.a.
SNR-300 (Germany)	n.a.
PFBR (India)	n.a.
MONJU (Japan)	sodium leakage monitoring and visual and volumetric examinations
PFR (UK)	n.a.
CRBRP (USA)	camera mounted on arm to inspect piping and guard vessels
BN-350 (Kazakhstan)	leak detectors
BN-600 (Russian Federation)	n.a.
ALMR (USA)	n.a.
KALIMER-150 (Republic of Korea)	n.a.
SVBR-75/100 (Russian Federation)	n.a.
BREST-OD-300 (Russian Federation)	VI, EC, US, TV, FV*

* steam (water) pipes

- VI - visual inspection by optical equipment
- EC - eddy current measurements
- US - ultrasonic measurements
- TV - tracked vehicle
- FV - free-moving vehicle

12. IN-SERVICE INSPECTION PROVISIONS (cont.)

12.2. Primary circuit pipes

Commercial Size Reactors

Plant	Primary circuit pipes
Super-Phénix 1 (France)	n.a.
Super-Phénix 2 (France)	n.a.
SNR 2 (Germany)	n.a.
DFBR (Japan)	sodium leakage monitoring and visual and volumetric examinations
CDFR (UK)	n.a.
BN-1600 (Russian Federation)	n.a.
BN-800 (Russian Federation)	n.a.
EFR	n.a.
ALMR (USA)	n.a.
SVBR-75/100(Russian Federation)	n.a.
BN-1800 (Russian Federation)	n.a.
BREST-1200 (Russian Federation)*	VI, EC, US, TV, FV
JSFR-1500 (Japan)	VI,US

* steam (water) pipes

- VI - visual inspection by optical equipment
- EC - eddy current measurements
- US - ultrasonic measurements
- TV - tracked vehicle
- FV - free-moving vehicle

12. IN-SERVICE INSPECTION PROVISIONS (cont.)

12.3. Secondary circuit pipes

Experimental Fast Reactors	
Plant	Secondary circuit pipes
Rapsodie (France)	-
KNK-II (Germany)	-
FBTR (India)	-
PEC (Italy)	manned access is permissible
JOYO (Japan)	LD and test piece surveillance
DFR (UK)	VI, LD
BOR-60 (Russian Federation)	LD
EBR-II (USA)	periodic inspection, and as needed*
Fermi (USA)	-
FFTF (USA)	manned access
BR-10 (Russian Federation)	LD, VI
CEFR (China)	VI, EC, US, LD, SD

Demonstration or Prototype Fast Reactors

Phenix (France)	LD, SD
SNR-300 (Germany)	-
PFBR (India)	LD
MONJU (Japan)	LD, VI
PFR (UK)	LD, SD
CRBRP (USA)	in-containment - as 12.2. ex-containment - manual techniques
BN-350 (Kazakhstan)	LD
BN-600 (Russian Federation)	LD, SD
ALMR (USA)	LD, SD
KALIMER-150 (Republic of Korea)	LD, SD, VI, US
SVBR-75/100 (Russian Federation)	n.a.
BREST-OD-300 (Russian Federation)	n.a.

* e.g. after October 1983 earthquake

- VI - visual inspection by optical equipment
- EC - eddy current measurements
- US - ultrasonic measurements
- TV - tracked vehicle
- FV - free-moving vehicle
- LD - leak detectors (electrical contact)
- SD - smoke detectors

12. IN-SERVICE INSPECTION PROVISIONS (cont.)

12.3. Secondary circuit pipes

Commercial Size Reactors

Plant	Secondary circuit pipes
Super-Phenix 1 (France)	LD,VI,SD/US**, X-rays**
Super-Phenix 2 (France)	LD,VI
SNR 2 (Germany)	not determined
DFBR (Japan)	LD,VI
CDFR (UK)	LD,SD
BN-1600 (Russian Federation)	LD,SD
BN-800 (Russian Federation)	LD,SD
EFR	VI,EC,US,LD
ALMR (USA)	LD,SD
SVBR-75/100 (Russian Federation)	n.a.
BN-1800 (Russian Federation)	LD,SD
BREST-1200 (Russian Federation)	n.a.
JSFR-1500 (Japan)	VI,US

** periodic inspection during shutdown

- VI - visual inspection by optical equipment
- EC - eddy current measurements
- US - ultrasonic measurements
- TV - tracked vehicle
- FV - free-moving vehicle

12. IN-SERVICE INSPECTION PROVISIONS (cont.)

12.4. Intermediate heat exchangers (IHX)

Experimental Fast Reactors

Plant	Intermediate heat exchangers (IHX)
Rapsodie (France)	-
KNK-II (Germany)	-
FBTR (India)	-
PEC (Italy)	-
JOYO (Japan)	sodium leakage monitoring and test piece surveillance
DFR (UK)	
BOR-60 (Russian Federation)	leak detectors, control Na level, argon pressure
EBR-II (USA)	as needed
Fermi (USA)	tube bundles can be removed for inspection
FFTF (USA)	periscopes for visual inspection of primary piping and valves
BR-10 (Russian Federation)	radioactive sodium leak monitoring

Demonstration or Prototype Fast Reactors

Phenix (France)	sodium leakage monitoring
SNR-300 (Germany)	-
PFBR (India)	LD
MONJU (Japan)	sodium leakage monitoring and visual examination
PFR (UK)	special flask and lifting equipment available
CRBRP (USA)	camera mounted on arm to inspect exterior and guard vessel
BN-350 (Kazakhstan)	LD, control Na level and Ar pressure
BN-600 (Russian Federation)	control Na level and Ar pressure
ALMR (USA)	-
KALIMER -150 (Republic of Korea)	LD
SVBR-75/100 (Russian Federation)	n.a.
BREST-OD-300 (Russian Federation)	n.a.

- USV - under-coolant viewing
- UGV - under-gas viewing e.g. optical periscope
- DM - displacement monitoring by ultrasonic detectors
- VI - visual inspection by optical equipment
- EC - eddy current measurements
- US - ultrasonic measurements
- TV - tracked vehicle
- FV - free-moving vehicle
- LD - leak detection

12. IN-SERVICE INSPECTION PROVISIONS (cont.)

12.4. Intermediate heat exchangers (IHX)

Commercial Size Reactors

Plant	Intermediate heat exchangers (IHX)
Super-Phenix 1 (France)	LD
Super-Phenix 2 (France)	continuous monitoring of leaks
SNR 2 (Germany)	-
DFBR (Japan)	-
CDFR (UK)	-
BN-1600 (Russian Federation)	control Na level and argon pressure
EFR	LD
ALMR (USA)	-
SVBR-75/100 (Russian Federation)	n.a.
BN-1800 (Russian Federation)	control Na level and argon pressure
BREST-1200 (Russian Federation)	n.a.
JSFR-1500 (Japan)	sodium leakage monitoring and visual examination

- USV - under-coolant viewing
- UGV - under-gas viewing e.g. optical periscope
- DM - displacement monitoring by ultrasonic detectors
- VI - visual inspection by optical equipment
- EC - eddy current measurements
- US - ultrasonic measurements
- TV - tracked vehicle
- FV - free-moving vehicle
- LD - leak detection

12. IN-SERVICE INSPECTION PROVISIONS (cont.)

12.5. Steam generator units

Experimental Fast Reactors

Plant	Steam generator units
Rapsodie (France)	none
KNK-II (Germany)	-
FBTR (India)	continuous monitoring of leaks
PEC (Italy)	none
JOYO (Japan)	none
DFR (UK)	none
BOR-60 (Russian Federation)	leak detectors, control of Na level and Ar pressure, RVI
EBR-II (USA)	periodic and as needed
Fermi (USA)	RVI, tube sheet is accessible
FFTF (USA)	none
BR-10 (Russian Federation)	no steam generator
CEFR (China)	RVI, EC, US, LD

Demonstration or Prototype Fast Reactors

Phénix (France)	LD
SNR-300 (Germany)	-
PFBR (India)	LD, EC
MONJU (Japan)	sodium leakage monitoring and visual and volumetric examinations
PFR (UK)	LD
CRBRP (USA)	exterior-manual techniques tubing-ultrasonic probes
BN-350 (Kazakhstan)	LD, control of Na level and Ar pressure, RVI
BN-600 (Russian Federation)	LD, control of Na level and Ar pressure, RVI
ALMR (USA)	-
KALIMER-150 (Republic of Korea)	LD, US, EC, RVI
SVBR-75/100 (Russian Federation)	LD, US, EC
BREST-OD-300 (Russian Federation)	DM, RVI, US, VI, control of lead level and Ar pressure

- RVI - regular visual inspection of tube-bores and structures
- USV - under-sodium viewing
- UGV - under-gas viewing e.g. optical periscope
- DM - displacement monitoring by ultrasonic detectors
- VI - visual inspection by optical equipment
- EC - eddy current measurements
- US - ultrasonic measurements
- TV - tracked vehicle
- FV - free-moving vehicle
- LD - leak detection

12. IN-SERVICE INSPECTION PROVISIONS (cont.)

12.5. Steam generator units

Commercial Size Reactors

Plant	Steam generator units
Super-Phénix 1 (France)	LD/US*, RVI*
Super-Phénix 2 (France)	accessibility to each tube
SNR 2 (Germany)	not determined
DFBR (Japan)	LD
CDFR (UK)	hydrogen detectors
BN-1600 (Russian Federation)	LD, control of Na level and Ar pressure, RVI
BN-800 (Russian Federation)	LD, control of Na level and Ar pressure, RVI
EFR	RVI, US,LD
ALMR (USA)	not determined
SVBR-75/100 (Russian Federation)	LD, US, EC
BN-1800 (Russian Federation)	LD, control of Na level and Ar pressure, RVI
BREST-1200 (Russian Federation)	DM, RVI, US, VI, control of lead level and Ar pressure
JSFR-1500 (Japan)	EC, US

* periodic inspection during shutdown

- RVI - regular visual inspection of tube-bores and structures
- USV - under-sodium viewing
- UGV - under-gas viewing e.g. optical periscope
- DM - displacement monitoring by ultrasonic detectors
- VI - visual inspection by optical equipment
- EC - eddy current measurements
- US - ultrasonic measurements
- TV - tracked vehicle
- FV - free-moving vehicle
- LD - leak detection