

Modifications on TR-2 Reactor Against an Expected Earthquake

TUNCAY TUNA¹, HAKAN ANAÇ¹

¹TURKISH ATOMIC ENERGY AUTHORITY(TAEK), CEKMECE NUCLEAR RESEARCH
AND TRAINING CENTER, YARIMBURGAZ DISTRICT NO:10 KUCUKCEKMECE,
ISTANBUL, TURKEY

18TH IGORR & IAEA WORKSHOP

4-7 DECEMBER 2017

SYDNEY



TURKISH ATOMIC ENERGY AUTHORITY

Contents

1. Brief Inf. About TR-2 Reactor
2. Improvements Made On Ssc's
Related To Safety After F-d
3. Fixing The Overhead Crane
4. Conclusion



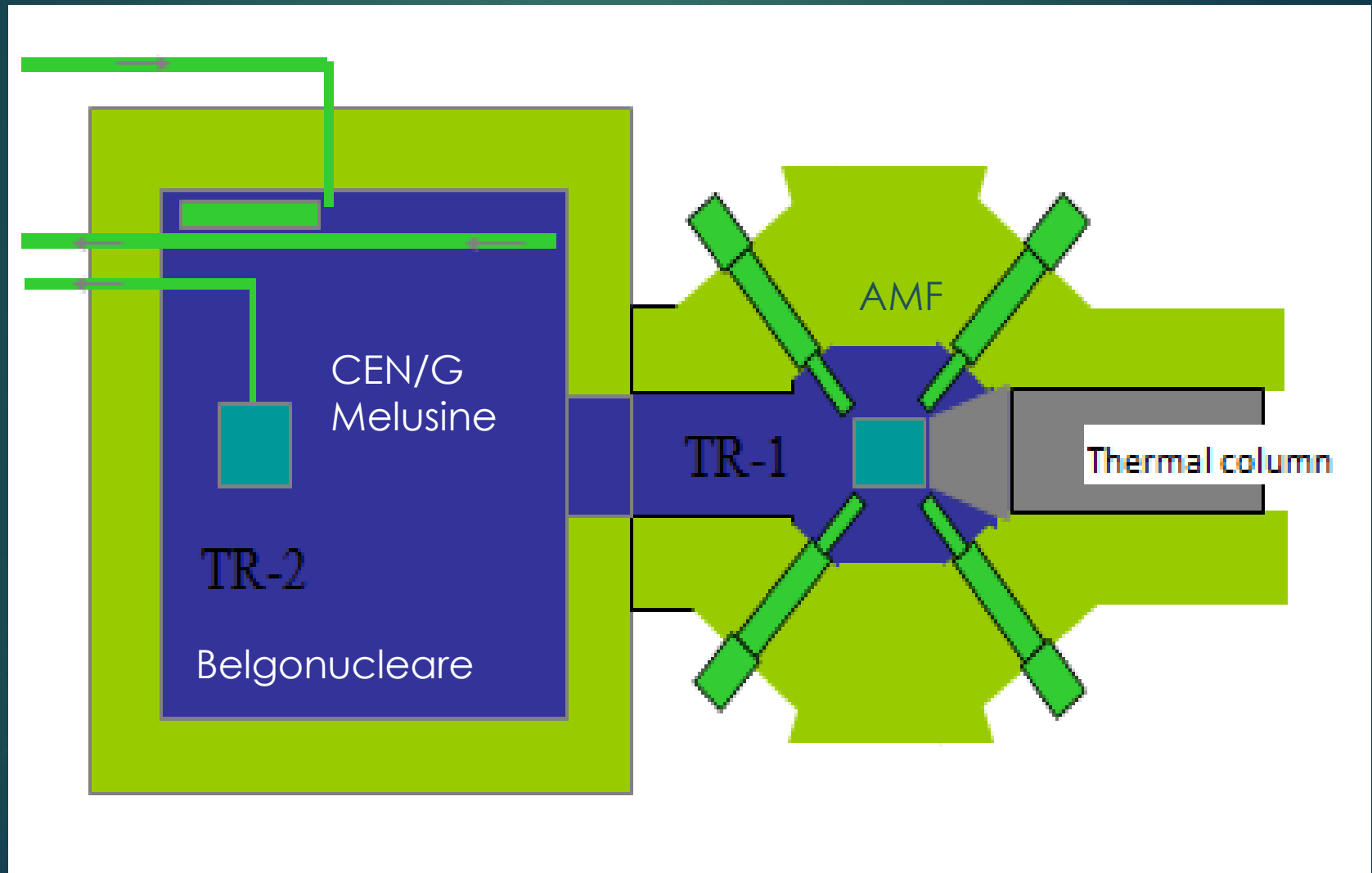
ÇNAEM

Küçükçekmece
Lake

Marmara Sea

Ataturk
Airport

TR-1 & TR-2 Reactors & Reactor Pool



TR-2 RR (tech. data)

Type	: 5 MW open pool type
Moderator/ Coolant	: Light Water
Reflector	: Be, Graphite
Pool	: Heavy concrete, stainless steel lining
Control Rods	: Fork type, 80% Ag, 15%In, 5%Cd alloy covered by Ni
Fuels	: 23 Plates, LEU fuels

TR-2 Research Reactor History

- ▶ **First criticality** of TR-2(**5MW**) at 10 December 1981
- ▶ Operated at 3MW between **1982-1986**
- ▶ Operated at 5MW between **1986-1995**
- ▶ **Utilization:**
 - ▶ Radioisotope production (**^{99}Mo** , **^{192}Ir**)
 - ▶ Neutron Activation Analysis
- ▶ Between **1995 – 2009** operated at 300kW (limited by Reg.Body because of seismic safety)
- ▶ At **2009** spent fuel elements transferred to USA (HEU Fuels)
- ▶ Fresh fuels deposited in storage room (LEU fuels)

IAEA Missions Conducted for Safety

SAR EXPERT MISSION Dec. 2014

INSARR MISSION 23-27 March 2015

REVIEW OF INSARR MISSION 25-28 April 2017

OBJECTIVES AND SCOPE OF THE MISSIONS

- Operating organization and reactor management (RMG);
- Management system (IMS);
- Safety committee (SC);
- Training and qualification (TRQ);
- Safety Analysis Report (SAR);
- Safety analysis (SA);
- Operational Limits and Conditions (OLCs);
- Conduct of operations (COP);
- Commissioning (COM);
- Maintenance and periodic testing (MPT);
- Utilization and experiments (EXP);
- Modifications (MOD);
- Operational radiation protection and radioactive waste management (ORP);
- Emergency planning (EMR);
- Decommissioning plan (DP);
- Protection against external events (SIT)



IAEA-TCR-XXXXX
ORIGINAL: ENGLISH
DISTRIBUTION: RESTRICTED

Report of the
INTEGRATED SAFETY ASSESSMENT OF RESEARCH
REACTORS (INSARR)
MISSION
TO THE
TURKISH REACTOR (TR-2)

Turkish Atomic Energy Authority (TAEK)
Istanbul, Turkey

23 – 27 March 2015

Conducted under IAEA Technical Cooperation Project RER1007:
Enhancing Use and Safety of Research Reactors through Networking, Coalitions and Shared
Best Practices

DEPARTMENT OF TECHNICAL COOPERATION
Division for Europe

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY
Division of Nuclear Installation Safety



IAEA-NSN/INSARR
ORIGINAL: ENGLISH
DISTRIBUTION: RESTRICTED



REPORT OF THE
FOLLOW-UP INTEGRATED SAFETY
ASSESSMENT OF RESEARCH REACTORS
(INSARR) MISSION
TO THE
Turkish Reactor 2 (TR-2)
Turkish Atomic Energy Authority

Istanbul, Turkey
25 - 28 April 2017

INTEGRATED SAFETY ASSESSMENT OF RESEARCH REACTORS (INSARR)
Conducted under IAEA Technical Co-operation Project: RER1016 "Enhancing
Utilization and Safety of Research Reactors"

DEPARTMENT OF TECHNICAL
COOPERATION
Division for Europe

DEPARTMENT OF NUCLEAR SAFETY
AND SECURITY
Division of Nuclear Installation Safety

Improvements Made on SSCs Related to Safety After F-D

- ▶ Improvements on Emergency Ventilation System (EVS)
- ▶ Imps. on Cooling System
- ▶ Imps. for Earthquake Resistance
- ▶ Imps. on Scram System
- ▶ Imps. on Electricity Supply System
- ▶ Imps. to Mitigate Radiological Incidents
- ▶ Improvements on Fire Extinguishing System

Improvements On Emergency Ventilation System

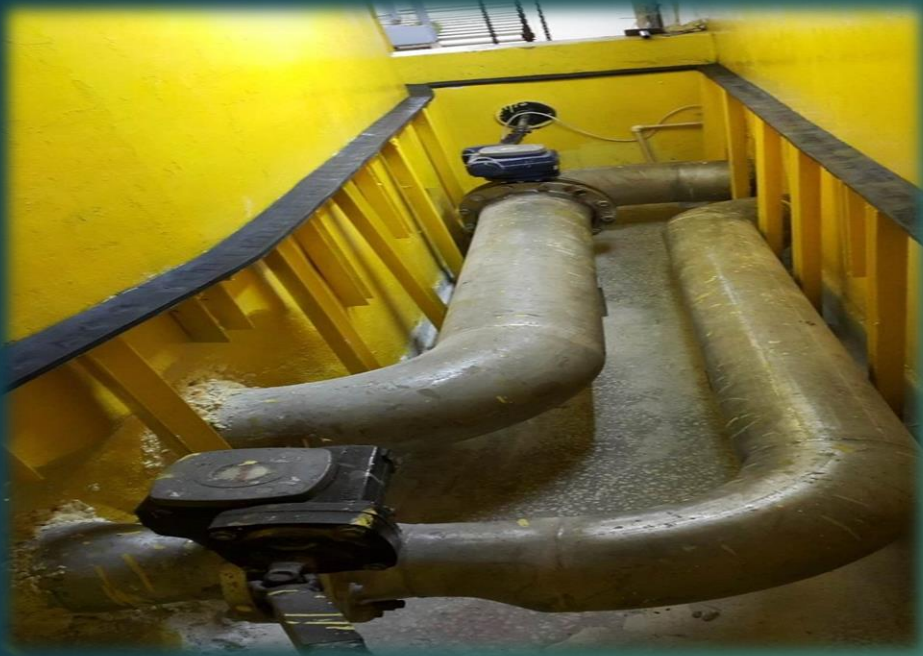
- ▶ Automatic **butterfly valve** at the outlet (to keep the active carbon filter in good condition)
- ▶ Improving **air tightness** of the building (to reduce emergency ventilation air flow rate and release)



The pipeline of the EVS has been reinforced against the expected earthquake with steel construction.

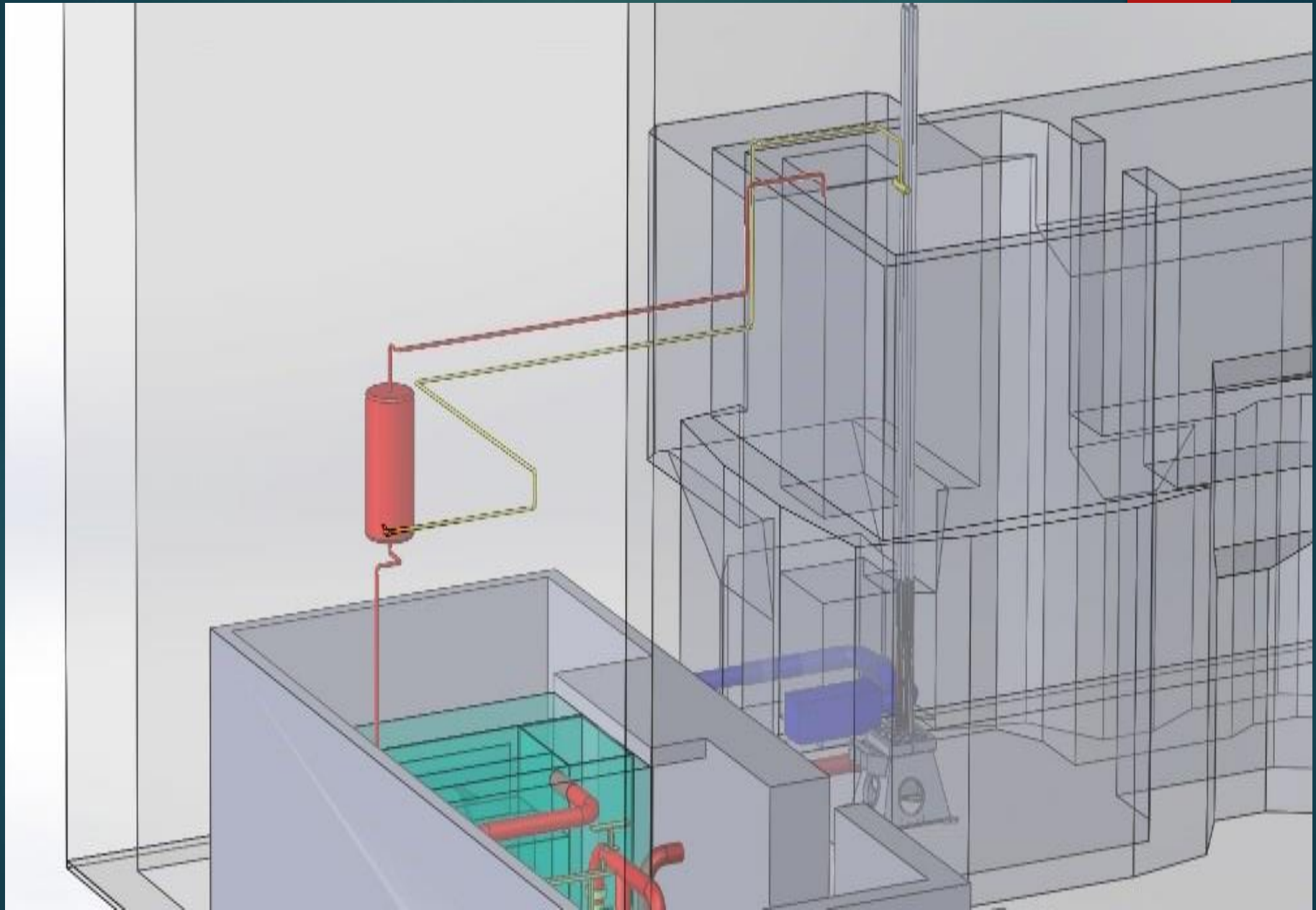
Improvements On Cooling System

- ▶ Operating **two primary pumps** (to eliminate sudden LOFA caused by pump **shaft break**)
- ▶ Adding **pressure sensors** at the primary pumps outlet (to ensure two pumps in operation) (1/1 logic)
- ▶ Two flooding detector was put into service, one is in the tight area and the other was in gama room adjacent to the pool.
- ▶ **Water tight space** at pool outlet (to eliminate LOCA in case of pipe break before pool isolation valves caused by an earthquake)



Improvements On Cooling System

- ▶ Emergency water supply system was implemented.
- ▶ Secondary cooling system renewed completely.
- ▶ Conversion of heat exchanger plates from SS to **Titanium** (to eliminate corrosion problems)



Improvements On Cooling System

- Water supply storage tank with 1000 m³ capacity was put in service. A new fire extinguishing pump adapted to the system.
- Pool isolation valves is modified to close automatically and the primary pumps are deactivated again automatically by the signal from one of the seismic sensor.

New Cooling Towers (10 MW)



New Secondary Circuit Pipes (DN300)



New Secondary Circuit Pumps





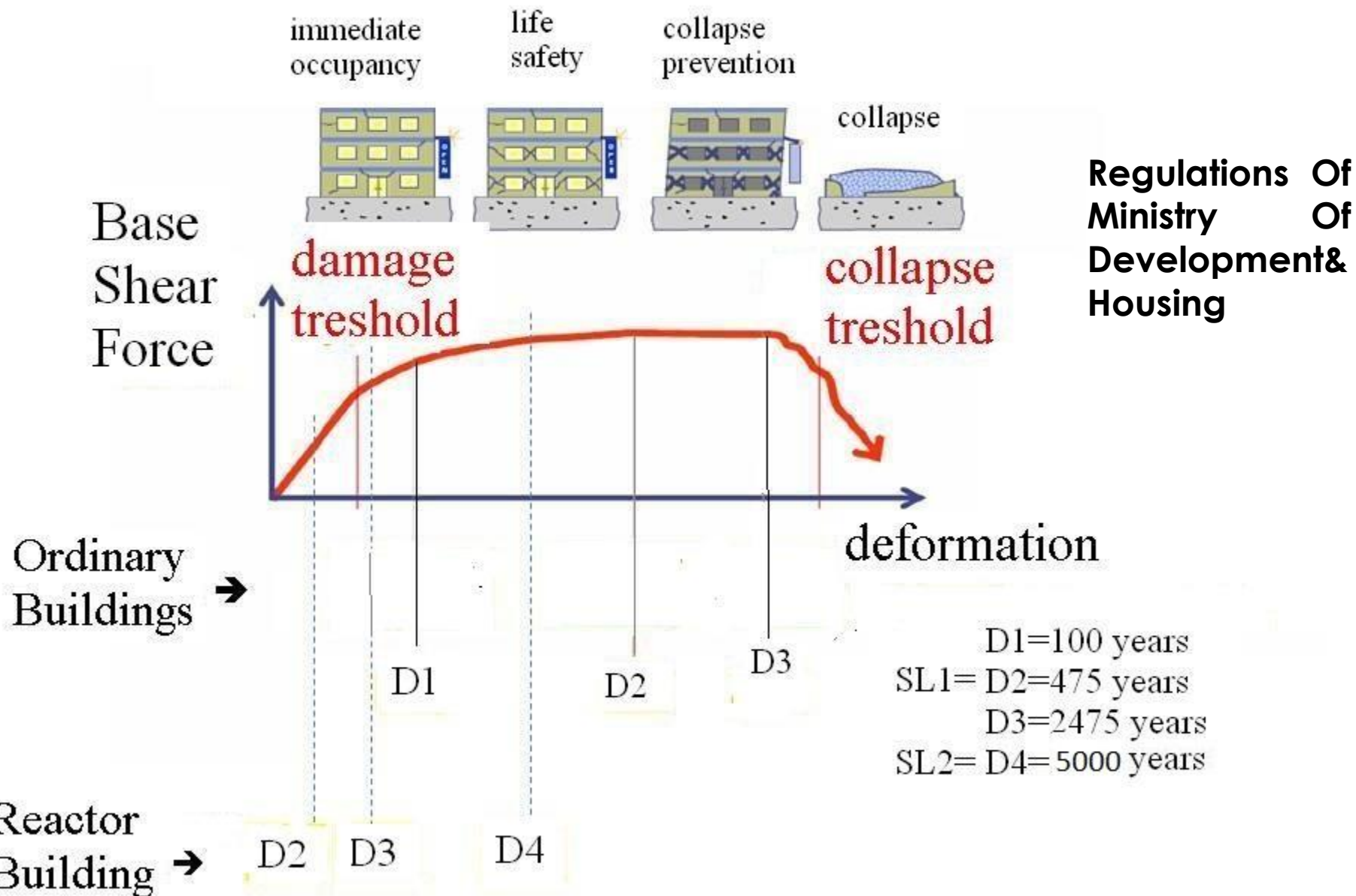
Stainless steel plates of heat exchanger were replaced with Titanium plates

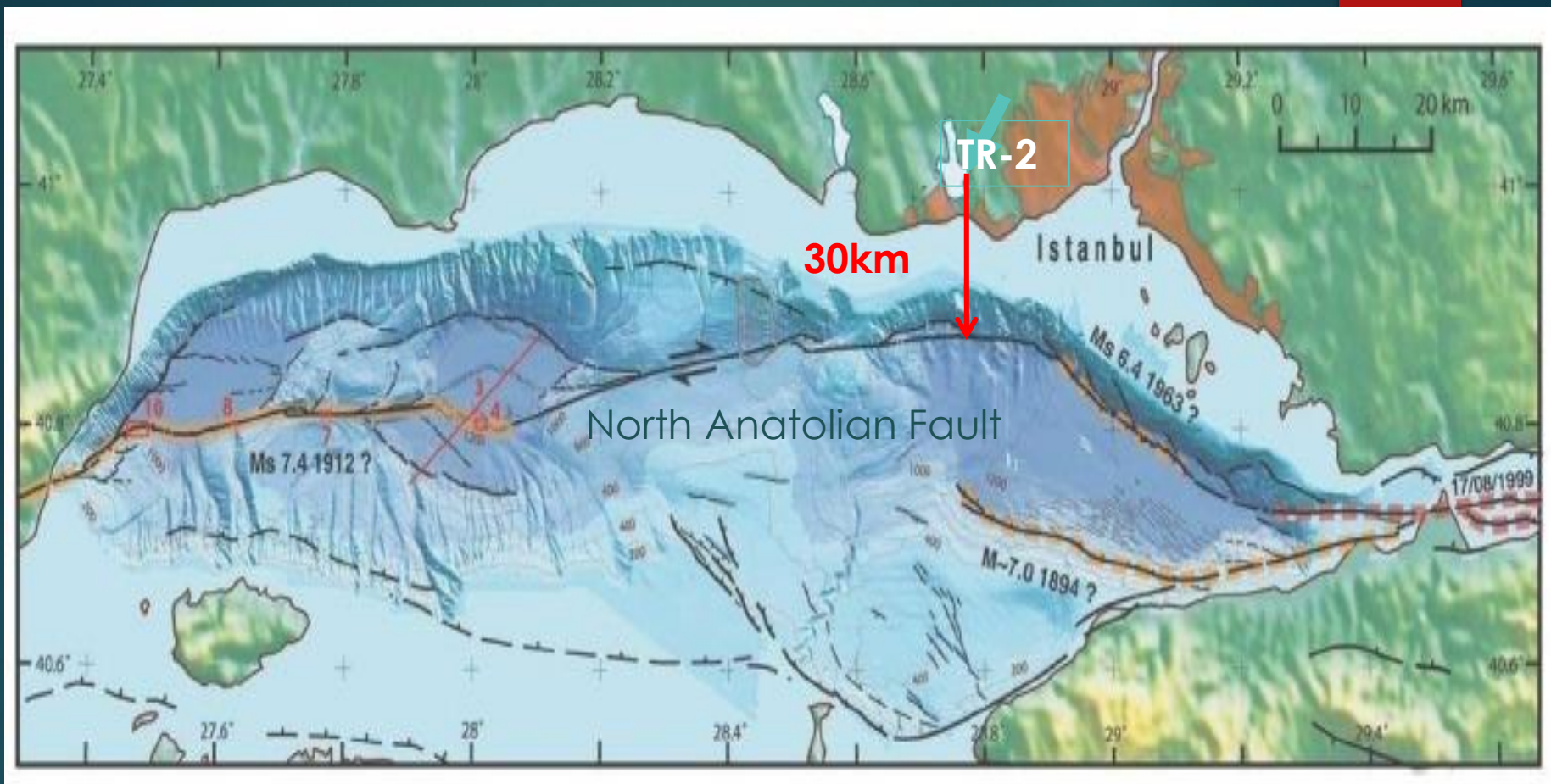
Improvements On Earthquake Resistance

Re-assessment of Seismic Safety After F-D Accident has been carried out and RLE (review level earthquake) Performance targets were determined as follows:

Period(y)	PGA (g)	Exceedence probability in 50 years
475 (SL1)	0.295	10%
2475	0.454	2%
5000 (SL2)	0.53	0.5%

Performance Targets for RLE





Tectonic Fault Structure of Marmara Region

Earthquake History of Marmara Region

<u>Earthquakes :</u>	<u>Magnitudes :</u>
10.09.1509	(Ms=7.2)
10.05.1556	(Ms=7.2)
25.05.1719	(Ms=7.4)
06.03.1737	(Ms=7.2)
02.09.1754	(Ms=6.8)
22.05.1766	(Ms=7.1)
05.08.1766	(Ms=7.4)
28.02.1855	(Ms=7.1)
10.07.1894	(Ms=7.3)
09.08.1912	(Ms= 7.3)
01.02.1944	(Ms=7.3)
18.03.1953	(Ms=7.2)
26.05.1957	(Ms=7.0)
22.07.1967	(Ms=6.8)
17.08.1999	(Mw=7.4)
12.11.1999	(Mw=7.2)

Improvements For Earthquake Resistance

- ▶ **Components** important to safety were seismically analyzed
- ▶ Two **Earthquake sensor** integrated to SCRAM system. (New seismic sensor with high sensitivity and accuracy adapted to the safety systems) (double for redundancy 1/2 logic scram)



FAKTORU





25/01/2013





21/03/2013



24/04/2012



15/04/2012



06/05/2013





TR-2

TR-2

Improvements On Scram System

- ▶ Changing **Period SCRAM** limit setting from **3s to 5s**
- ▶ Re-evaluation of the SCRAM System has been done and some reasonable additions for example one more **pool water level detector**, **primary cooling velocity and activity detector**, **flooding detectors** has been implemented.

Improvements On Electricity Supply System

- ▶ 2 UPS (3 phase) backup is provided (15 kVA)

Improvements to Mitigate Radiological Incidents

- ▶ Local **Radiation Early Warning** System Network
- ▶ Online **Meteorology station.**

Improvements on Fire Extinguishing System

- ▶ Water supply storage tank(1000 m³)
- ▶ New fire suppression system to control room (FM-200 gases)
- ▶ Fire sensors to reactor building

Fixing The Overhead Crane

In comply with the IAEA mission recommendations 10-ton capacity movable crane above the pool were fixed. There were appr. 50 cm huge gaps, between the crane and the columns, reduced to 3 cm by the way using steel construction buffers. Thus, in the expected earthquake, seismic derailling of the crane was eliminated.

Fixing The Overhead Crane

2.4 meters of the 5-meter crane width is covered with buffers and the remaining part is covered with steel rope stretched between the buffers



CONCLUSION

- ▶ **SAR** is updating according to the new national regulatory legislation and almost finished.
- ▶ **Emergency action plan** re-evaluated according to the recent changes on inhabitant populations around the reactor and finished.
- ▶ **Retraining programs** for reactor staff has been updated and implemented. (for operators, supervisors, radiation protection personnel and maintenance staff) (hands on training is the next hardship) Staff licenses has been taken from Reg. Body late 2015.
- ▶ **Ageing Management, Recommissioning and Decommissioning Programs** are also prepared with the SAR. And we are keep going to struggle to be able to ready to retstart our Reactor again soon..

**THANKS FOR YOUR
ATTENTION...**