



# ALARA in Repair of Reactor Vessel Flange Surface at Krško NPP, 2019

CONTRACTOR:  
**FRAMATOME**



# INTRODUCTION



Repair of a reactor vessel flange means repair of corrosion pits and other indications.

They could be the result of many years of the reactor operation and can lead to the damages of the flange face. The flange repair is, therefore, an important maintenance step to help prevent leakages.

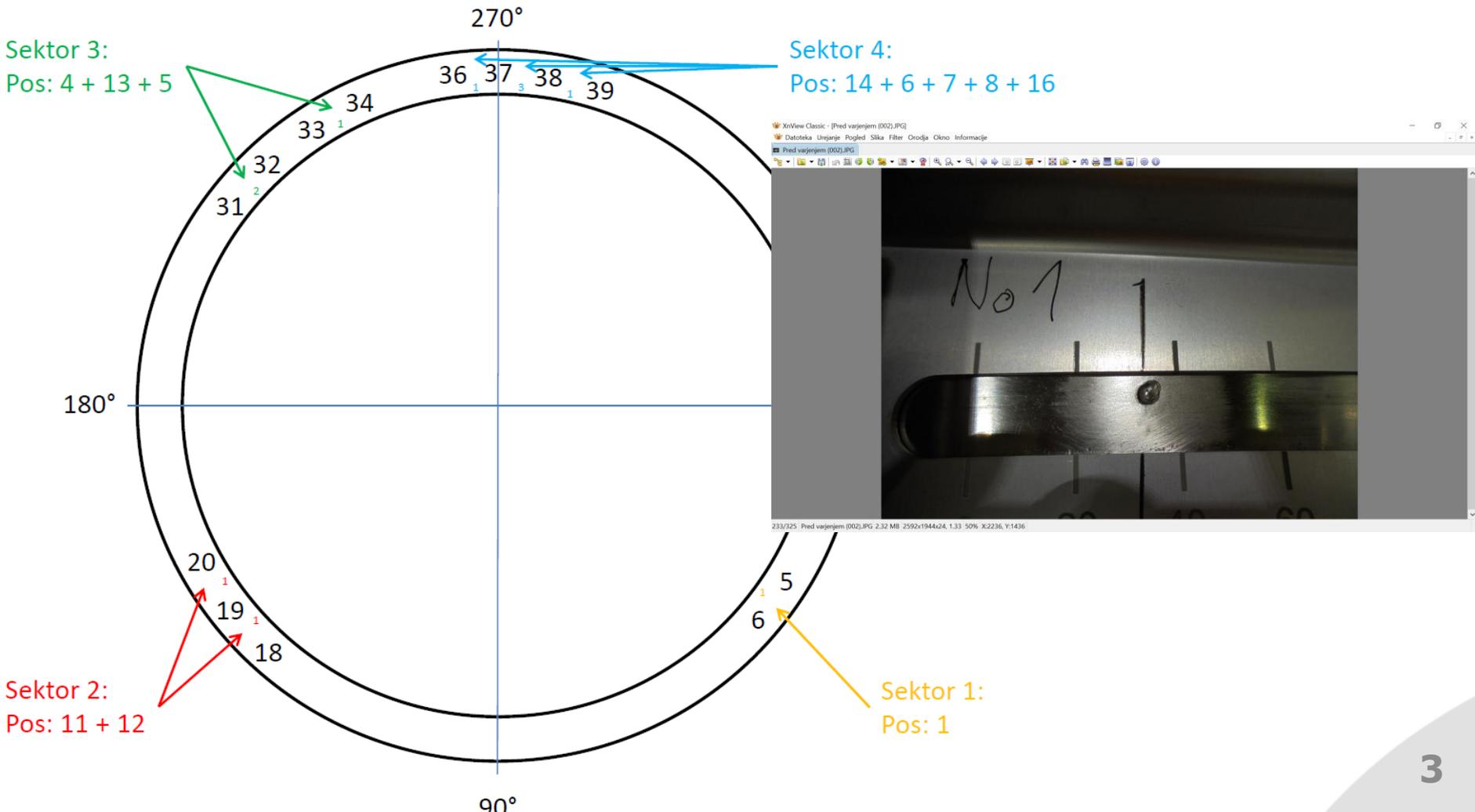
ALARA planning is presented with focus on workplace shielding, personal protection and the dosimetry related to this job.

# Selected Repair Positions

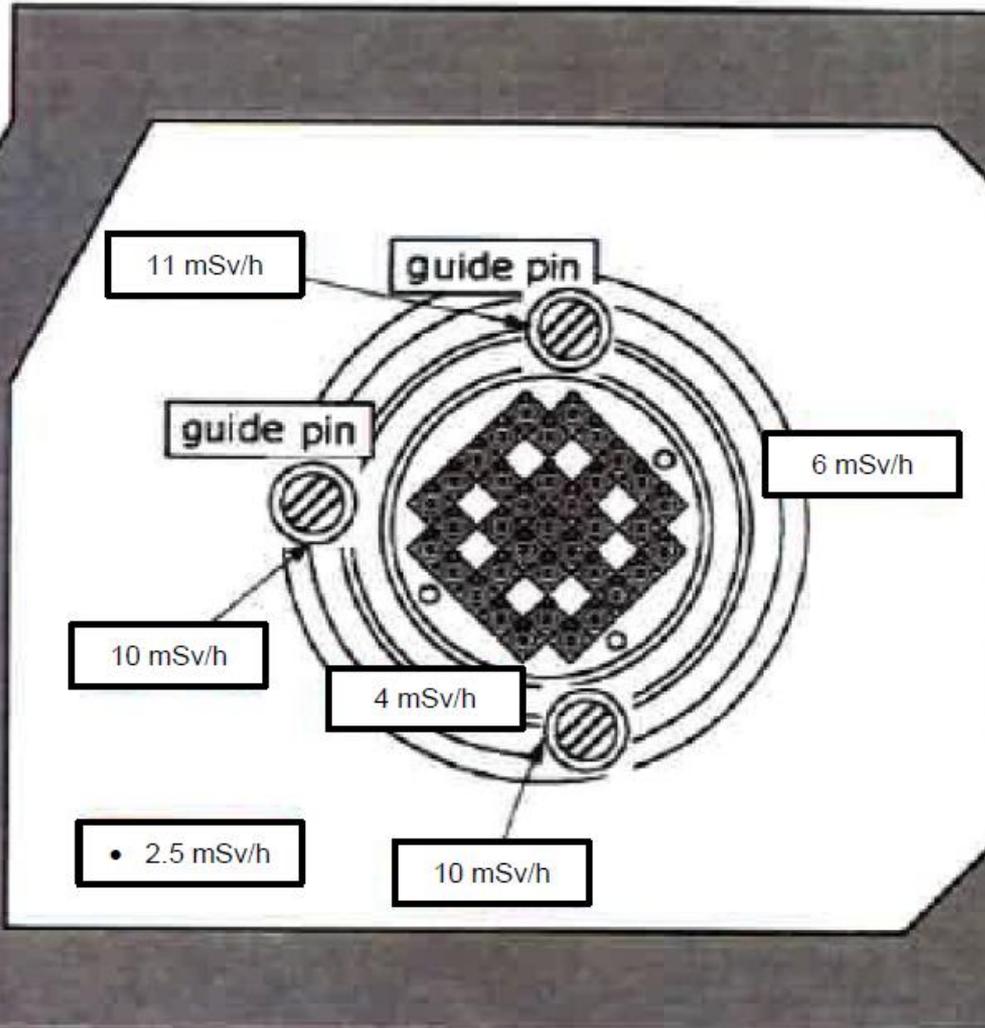


Location of the 11 indications on the RV Flange based on Laser Scanning measurement.

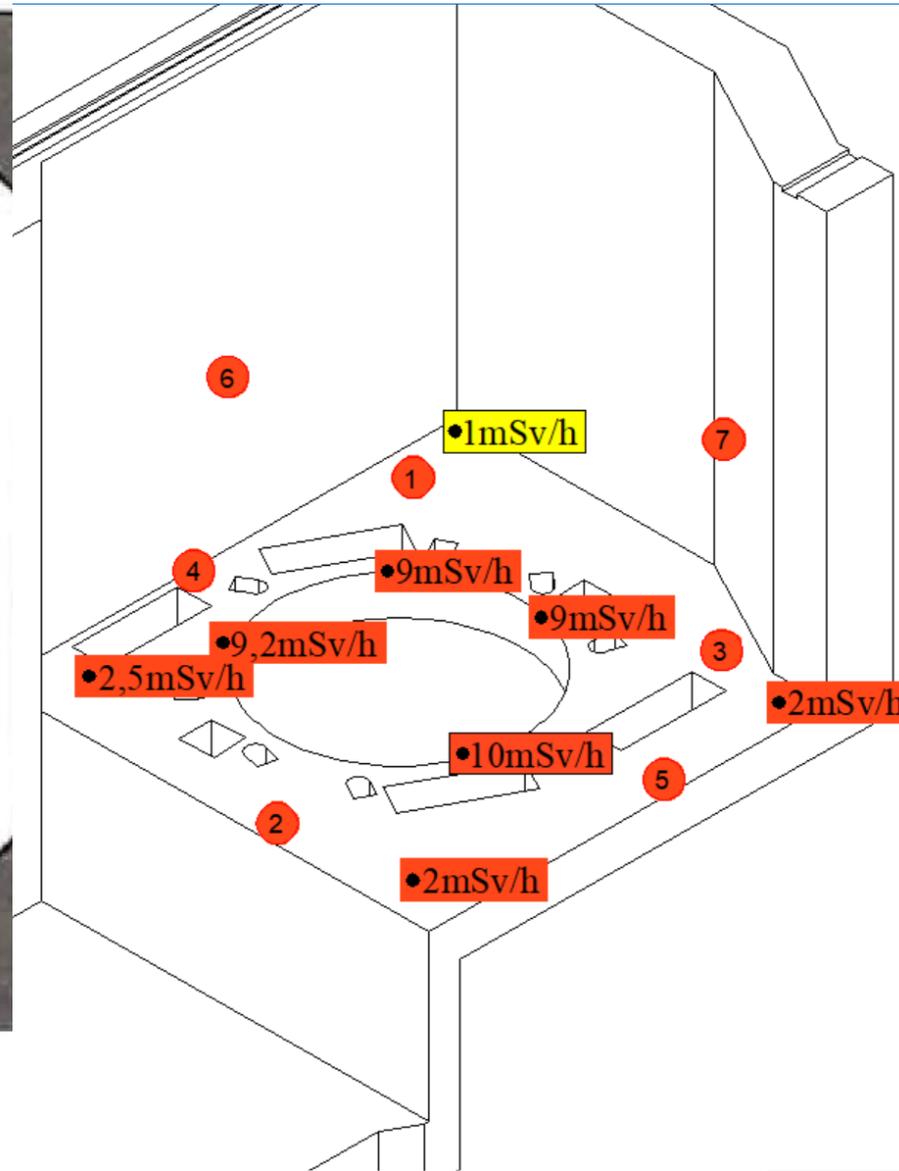
Final decision on repair: 11 + 5



# DOSE RATE SURVEY 2018



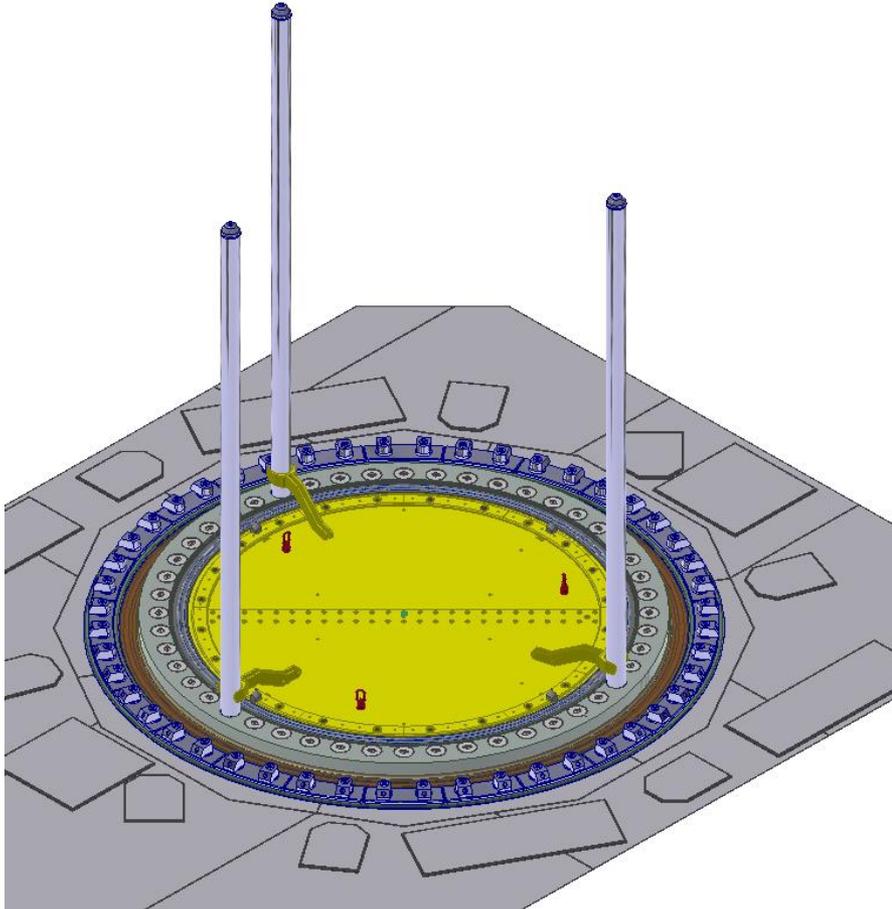
# DOSE RATE SURVEY 2019



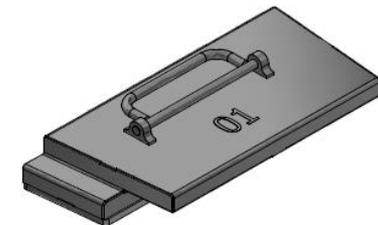
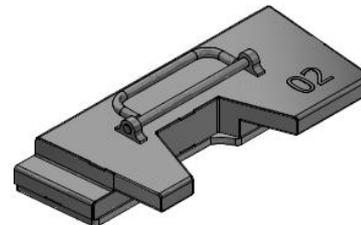
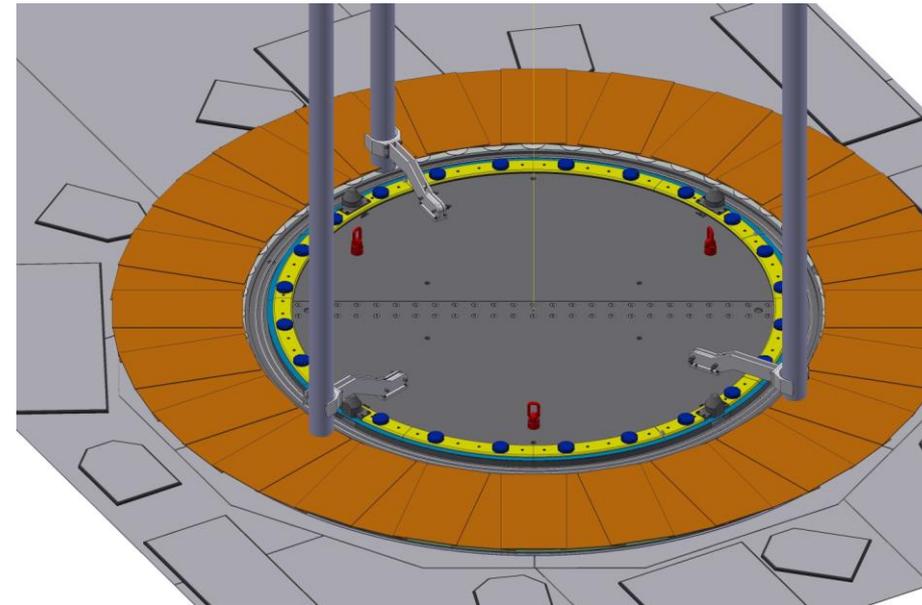
# NEW SHIELDING MATERIAL FOR THE WORK LOCATION



**Shielding cover - Stainless Steel 75mm**



**Lead blankets on the flange – 6 mm**



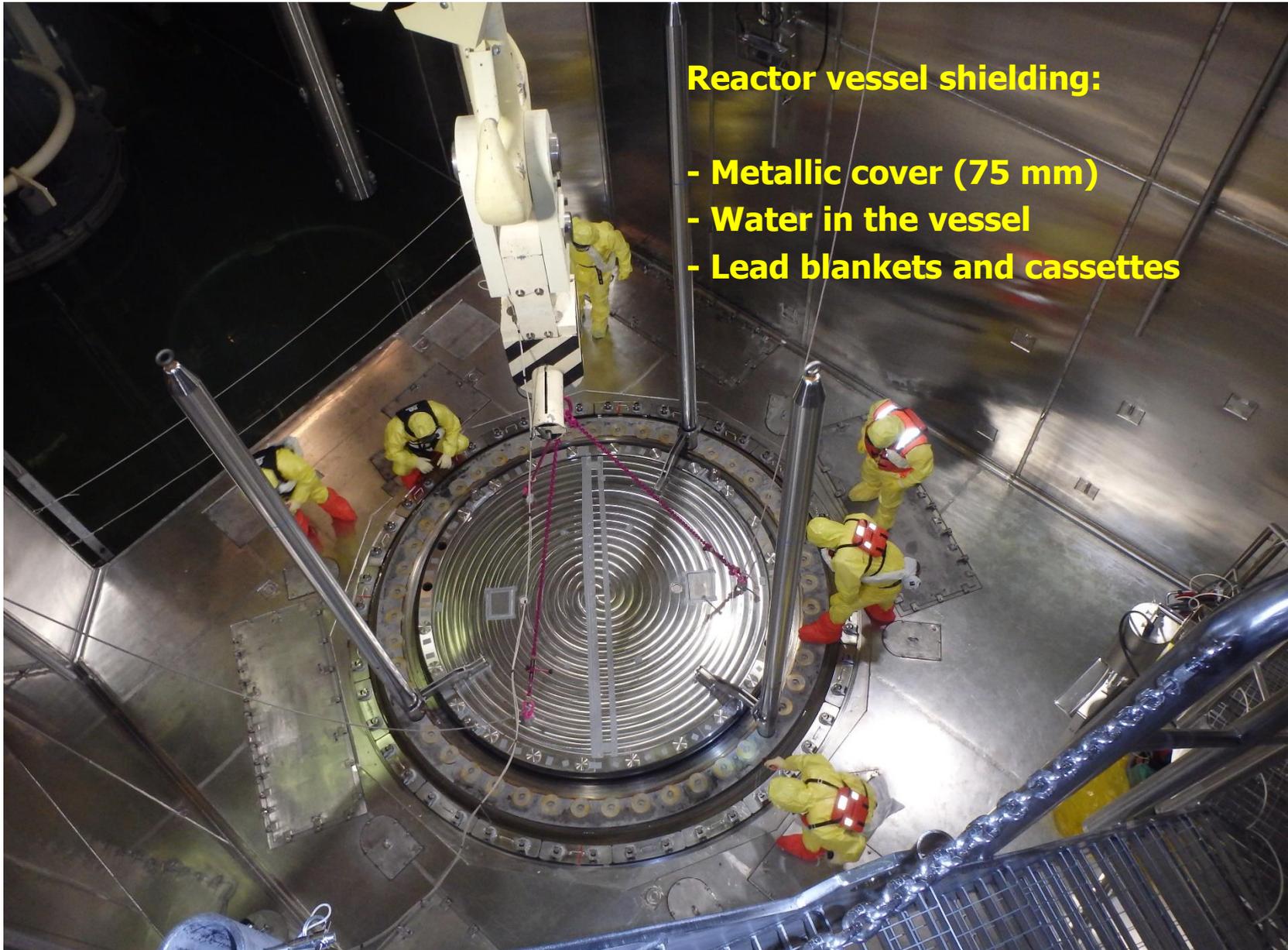
**SHIELDING CASSETTES FOR THE FLANGE – Lead 40mm**

# SHIELDING WORK SEQUENCES



- a) Reactor cavity walls rough washing with demineralized water
- b) Reactor cavity decontamination
- c) Survey of removable and fixed contamination
- d) Cover installation on the reactor vessel**
- e) Sealing flange wiping
- f) Laser scanning
- g) Installation of shielding cassettes**
- h) Placing of lead blankets on reactor vessel flange**  
(prior check removable contamination and wipe locally)
- i) Placing of lead blankets on the shielding cover of the RV**
- j) Performing dose rate measurements (if hot spots detected, additional lead blankets should be used)
- k) Installation of temporary shielding wall**

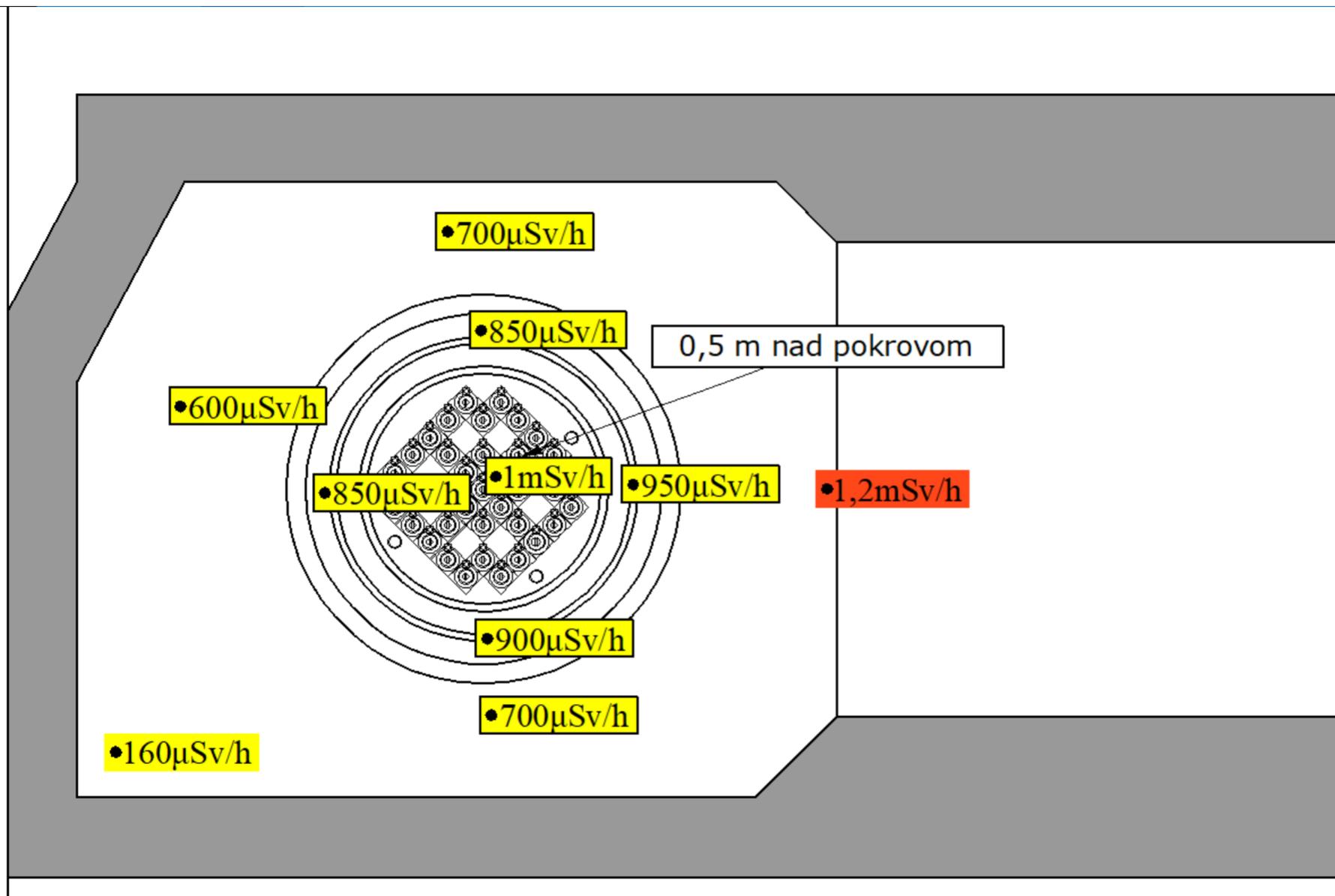
# INSTALLATION OF THE COVER



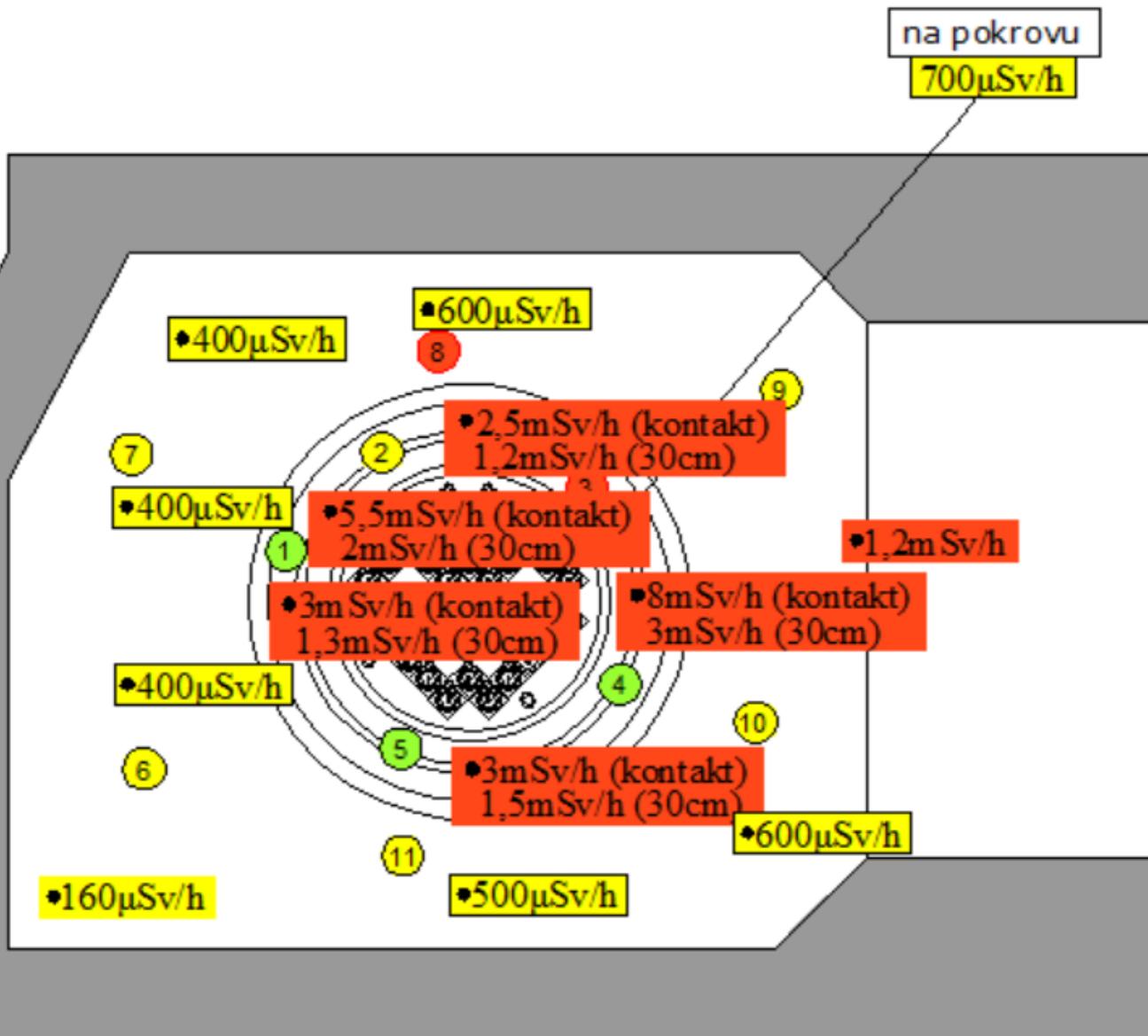
## Reactor vessel shielding:

- Metallic cover (75 mm)
- Water in the vessel
- Lead blankets and cassettes

# RADIATION ABOVE THE COVER (0,5m)



# RV FLANGE CONTACT DOSE RATES AND CONTAMINATION ON THE SMEARS RADIATION SURVEY AFTER INSTALLATION OF THE COVER



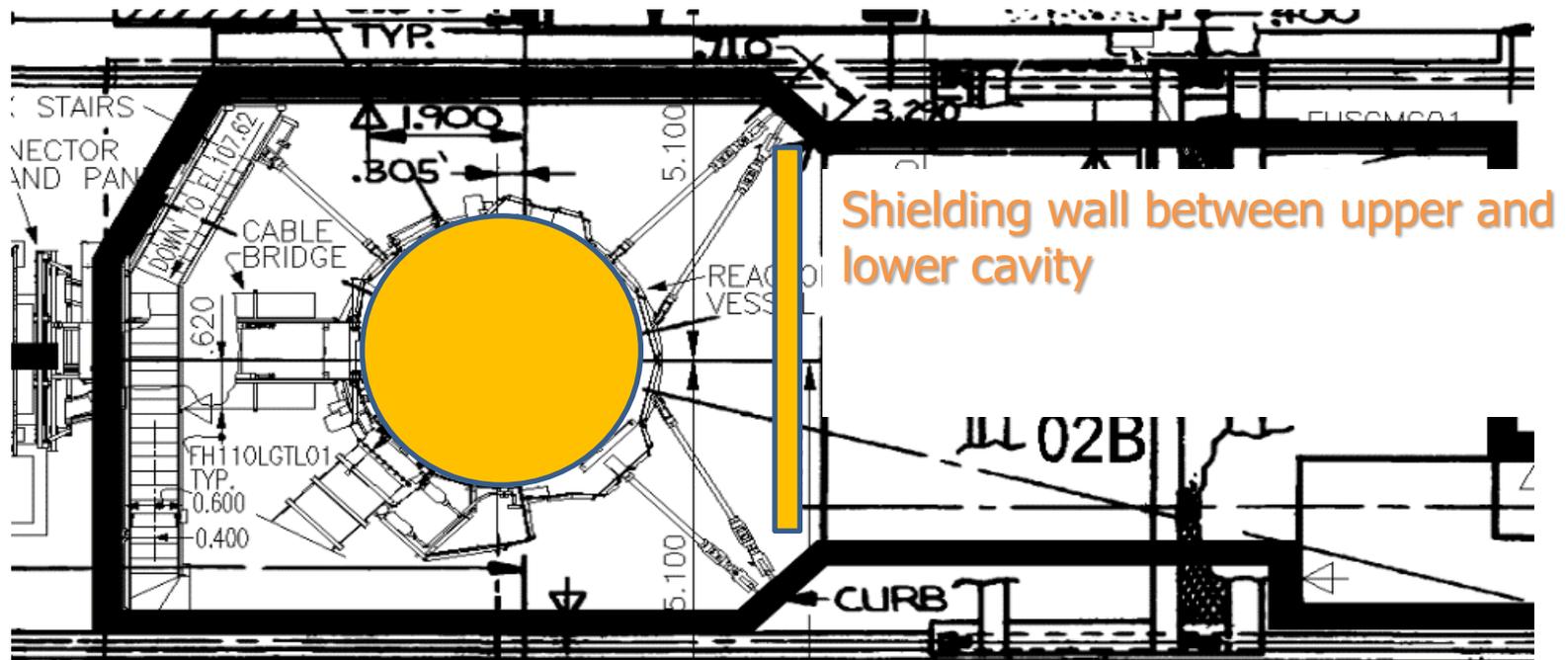
BRIS KONTAMINACIJE	
Bq/100 cm <sup>2</sup>	
8	6000 βγ tla 3 α R <sub>alfa</sub> =0,05%
3	5000 βγ prirobnica 2 α R <sub>alfa</sub> =0,04%
9	2600 βγ tla 0 α R <sub>alfa</sub> =0,00%
6	2500 βγ tla 0 α R <sub>alfa</sub> =0,00%
11	2000 βγ tla 0 α R <sub>alfa</sub> =0,00%
7	1000 βγ tla 0 α R <sub>alfa</sub> =0,00%
10	800 βγ tla 0 α R <sub>alfa</sub> =0,00%
2	800 βγ prirobnica 0 α R <sub>alfa</sub> =0,00%
4	300 βγ prirobnica 0 α R <sub>alfa</sub> =0,00%
5	300 βγ prirobnica 0 α R <sub>alfa</sub> =0,00%
1	100 βγ prirobnica 0 α R <sub>alfa</sub> =0,00%

Locations with dose rate > 0,5 mSv/h need lead blankets

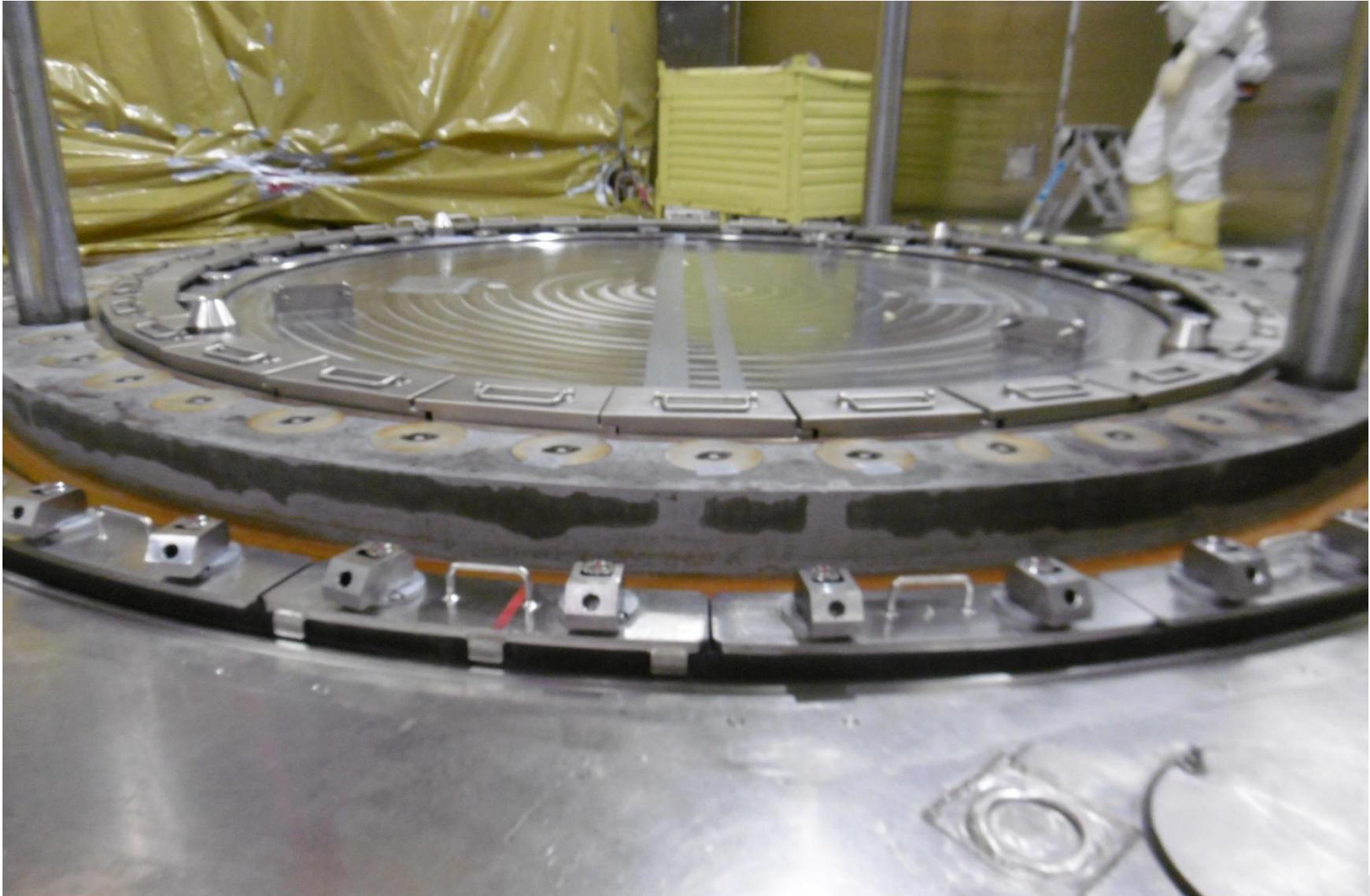
# LEAD BLANKETS and SHIELDING WALL



Working area	Layers	Quantity of lead blankets
Shielding cover	2	76*
RV Flange	3	93
Guide Pins	2	36
<b>Total</b>		<b>205</b>



# Shielding cover and the cassettes





## Shielding wall (against RV upper internals)



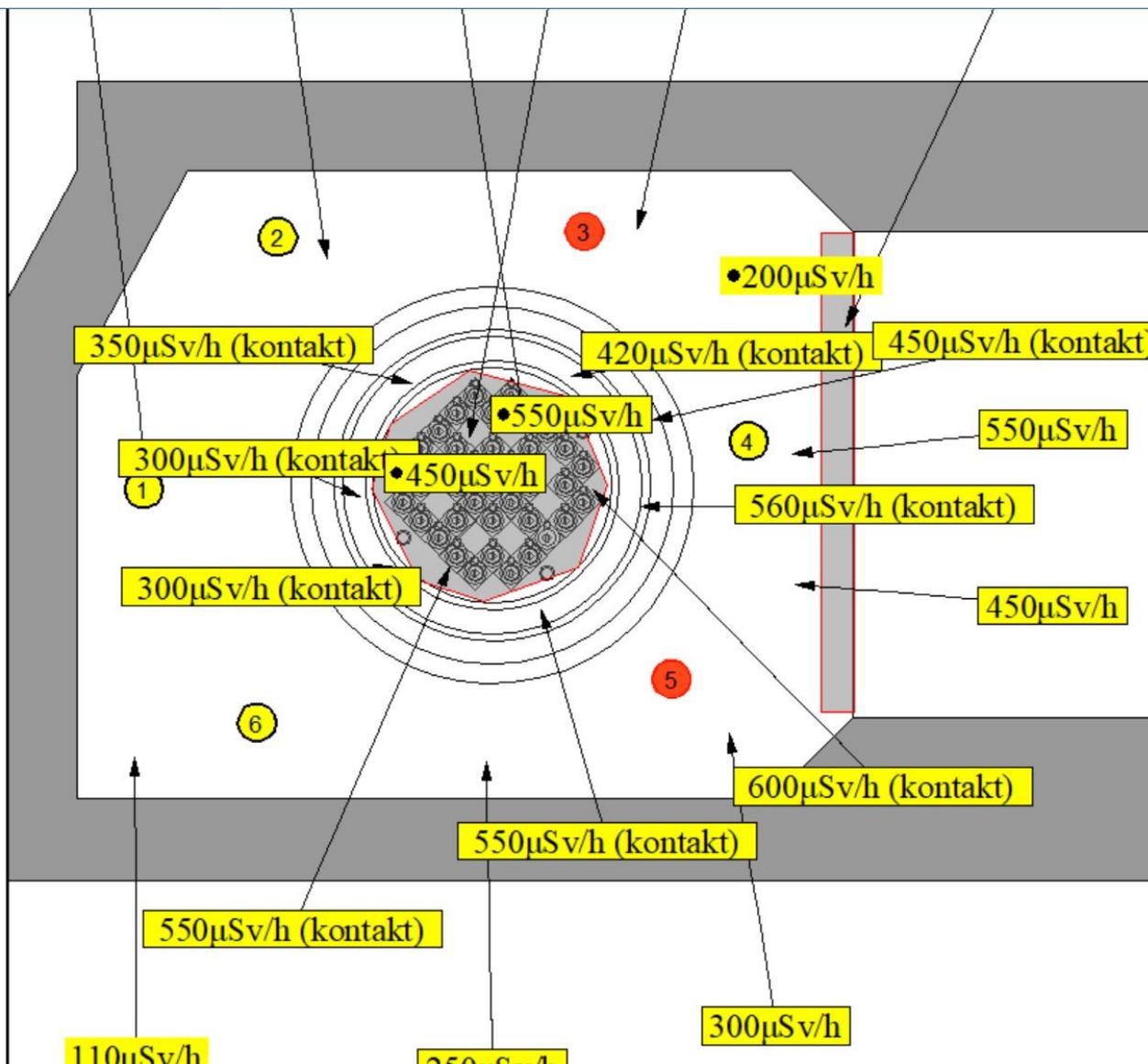
support structure with lead blanket



RV upper internals



# DOSE RATES WITH THE SHIELDS



BRIS KONTAMINACIJE Bq/100 cm <sup>2</sup>	
5	6500 $\beta\gamma$ tla 0 $\alpha$ R <sub>alfa</sub> =0,00%
3	5300 $\beta\gamma$ tla 0 $\alpha$ R <sub>alfa</sub> =0,00%
2	3300 $\beta\gamma$ tla
1	1900 $\beta\gamma$ tla 0 $\alpha$ R <sub>alfa</sub> =0,00%
6	1200 $\beta\gamma$ tla 0 $\alpha$ R <sub>alfa</sub> =0,00%
4	750 $\beta\gamma$ tla
BRIS VELIKEGA PODROČJA Bq/100 cm <sup>2</sup>	
DIREKTNA MERITEV KONT Bq/100 cm <sup>2</sup>	
VZOREC ZRAKA Bq/m <sup>3</sup>	



**WORK STARTS** After finishing the repair works of one position, the unshielded position was shielded again.

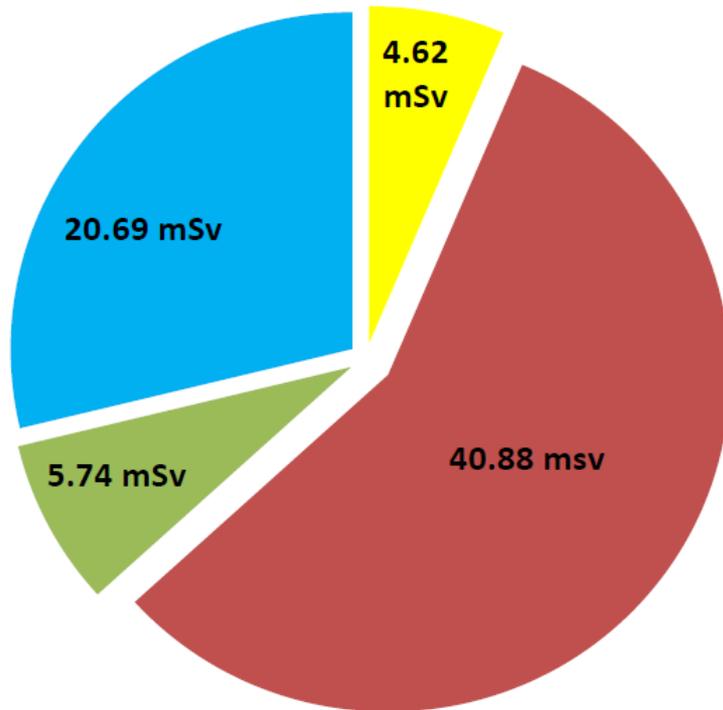


Shielding wall

# ALARA PLANNING FOR DIFFERENT TASKS



## MAIN TASK: Repair by welding, grinding, stoning and polishing



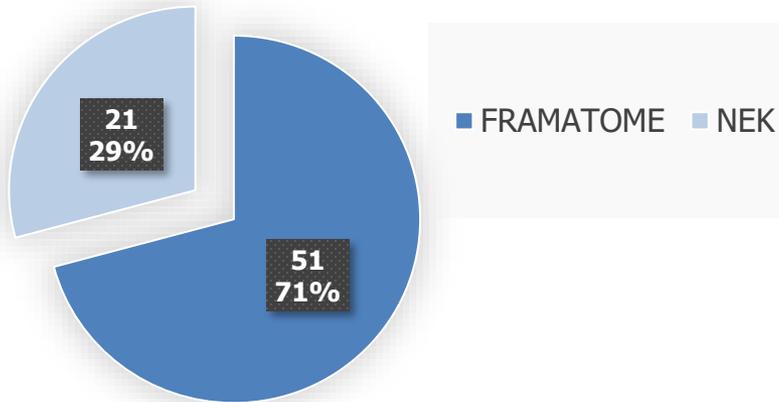
■ Laser Scanning ■ RV flange repair ■ FME ■ Shielding

- **LASER SCANNING**
- **RV FLANGE REPAIR**  
41 man-mSv
- **FME**
- **SHIELDING**  
21 man-mSv

# PROJECTION OF DOSE - DISTRIBUTION BY COMPANY



## Estimated coll. dose 72 man-mSv



## TOTAL COLLECTIVE DOSE

### CONSERVATIVE ESTIMATION

FRAMATOME

Initial ALARA (**dose rate 2 mSv/h**)  
taking into account higher levels of  
radiation and previous experiences

- **TOTAL 72 man-mSv**

### ALARA ESTIMATION of NEK

projection with optimal radiation levels

- **OPTIMAL TOTAL 30 man-mSv**

- **REALISTIC TOTAL 35 man-mSv**

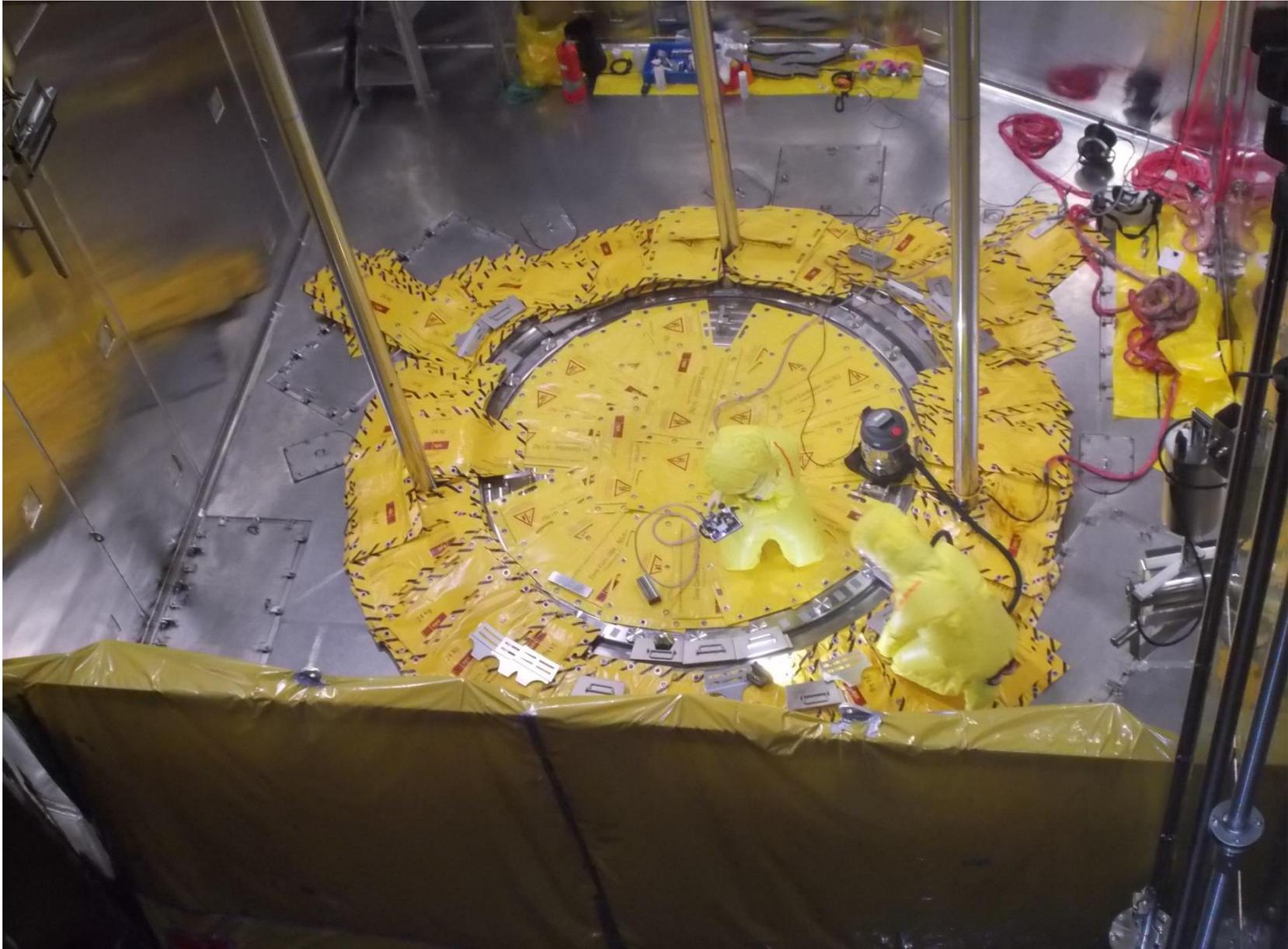
# DOSE LIMIT and TRACKING



- Individual dose limit 4 mSv (FRAMATOME)
- Short duration of work in a high dose rate area

Dose tracking was performed locally by NEK RP engineer with a handy receiver for an additional electronic dosimeters and short radio link.

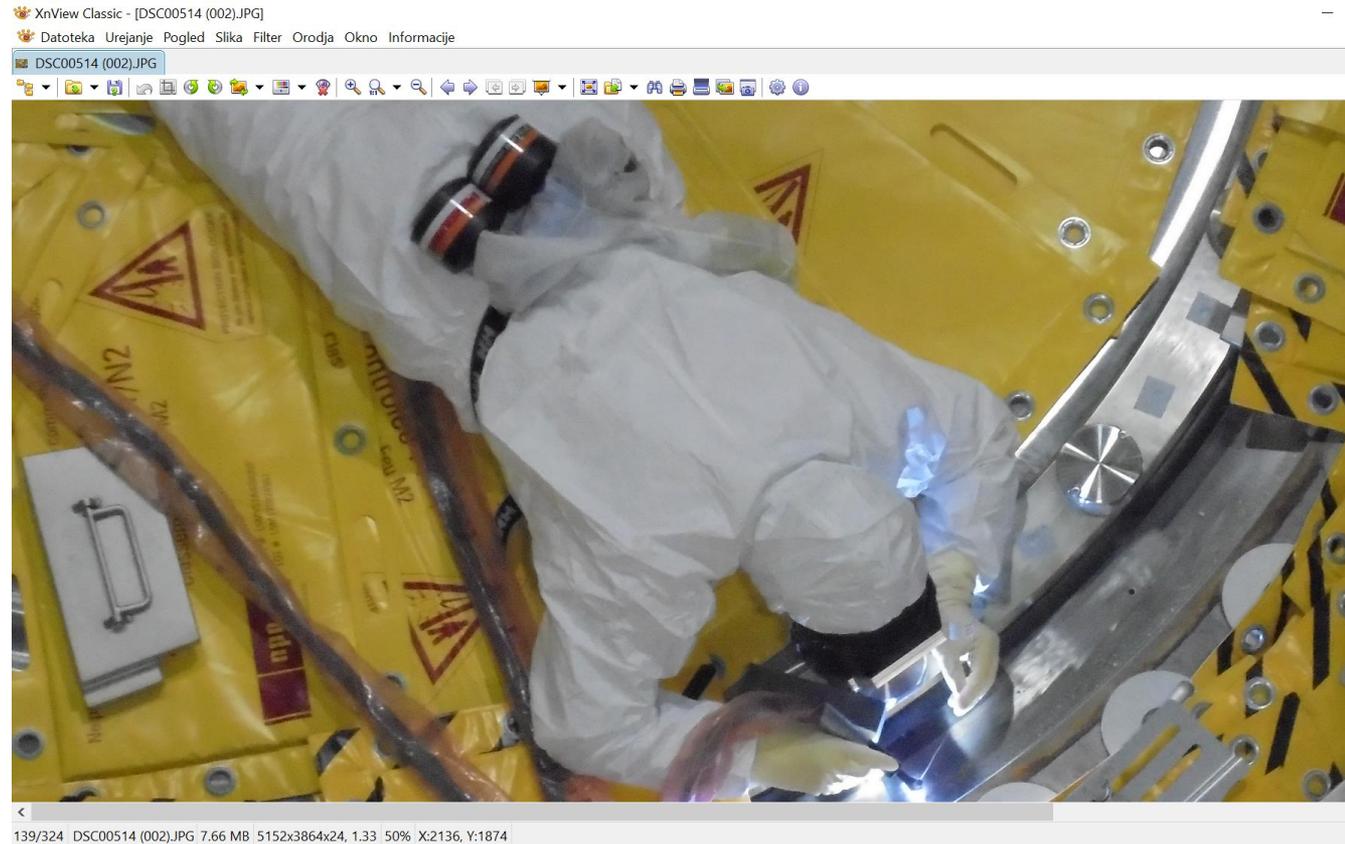
# WORK ON ONE OF THE FLANGE SECTORS



# FULL FACE MASK SCREEN FOR WELDING WORK



- ❑ Full face mask with automatic speed glasses (Scott)



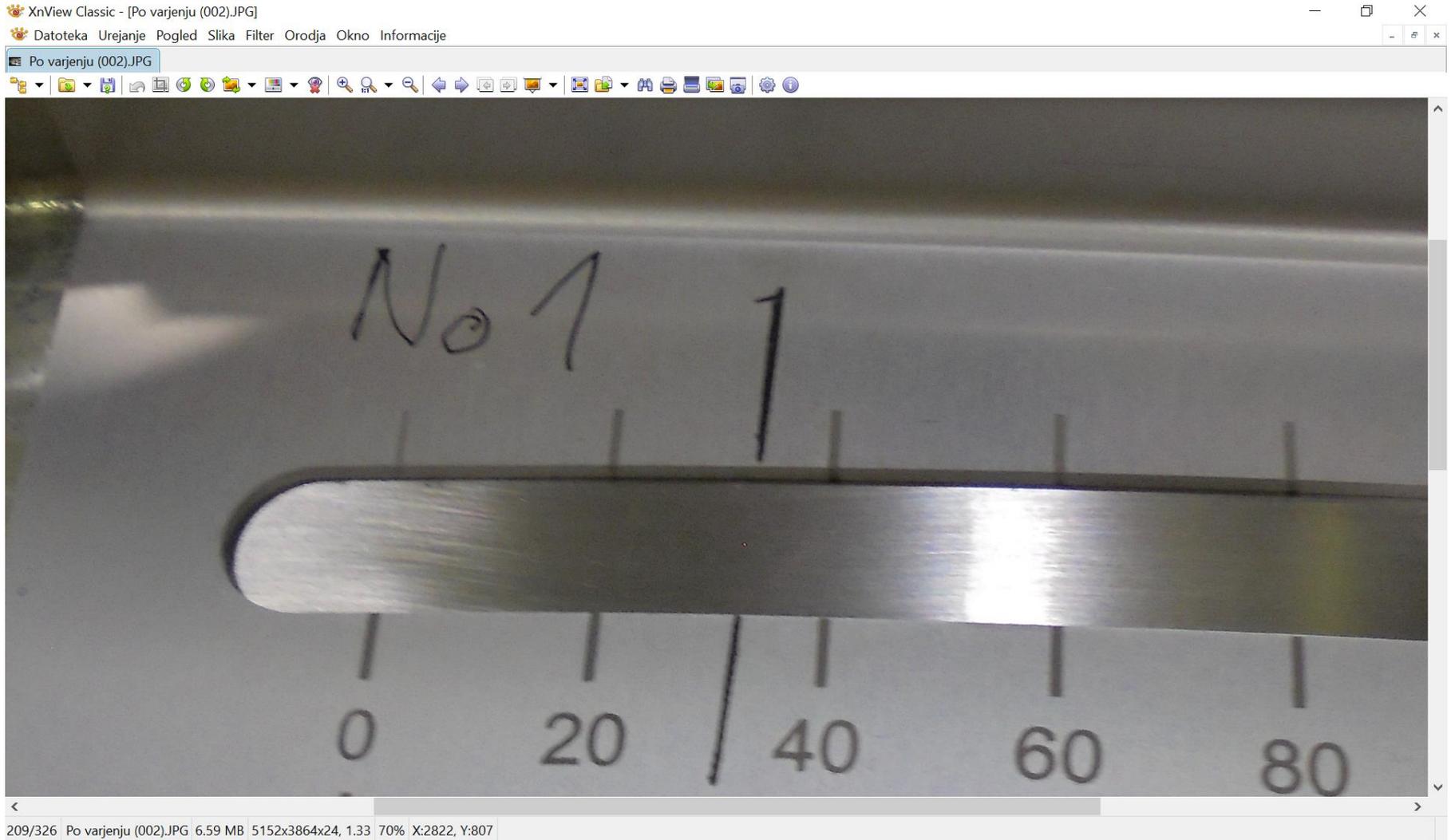
# GRINDING, STONING AND POLISHING



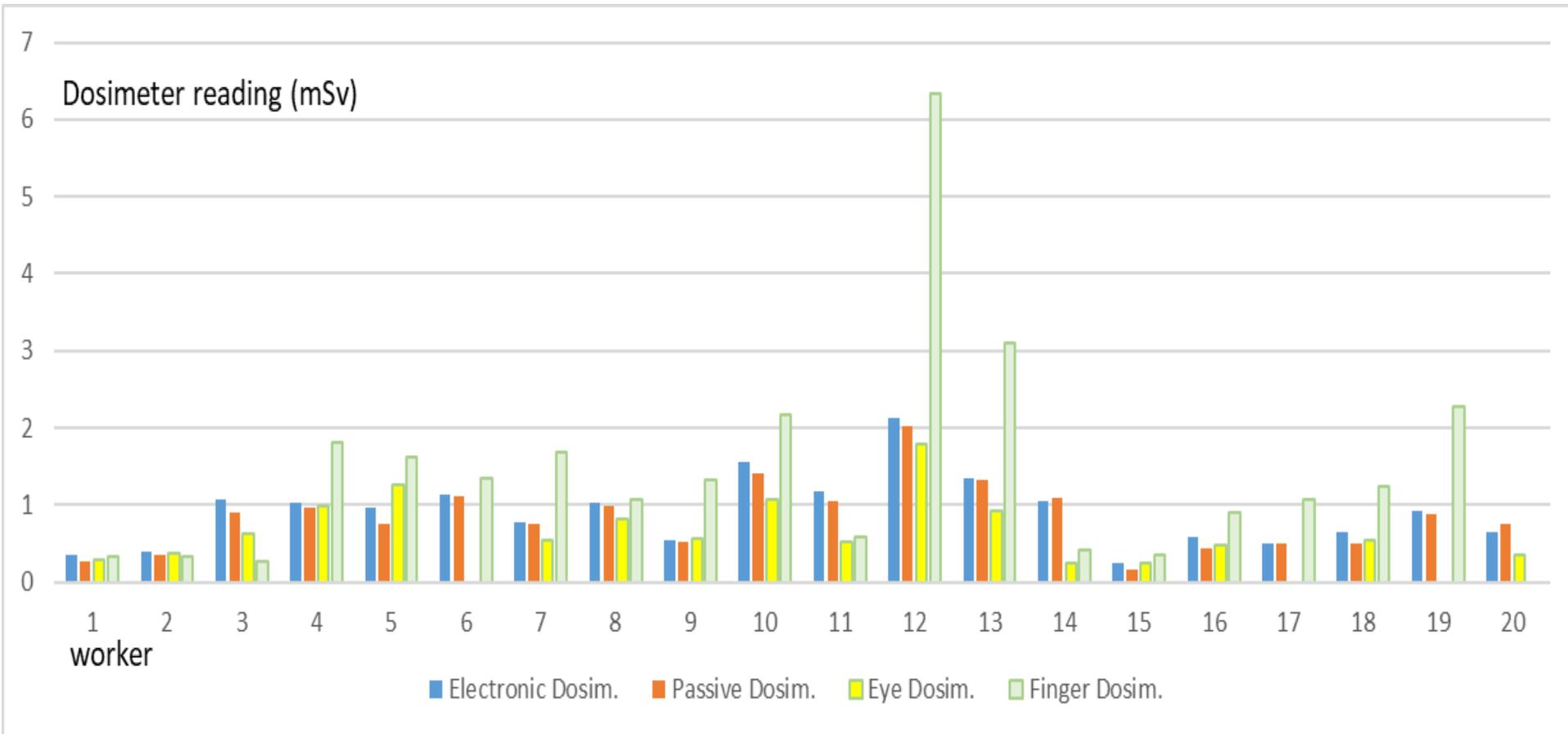
# Radiation Protection Glasses (lead equivalency of 0.75mm)



# EXAMPLE PHOTO OF REPAIRED POSITION No.1

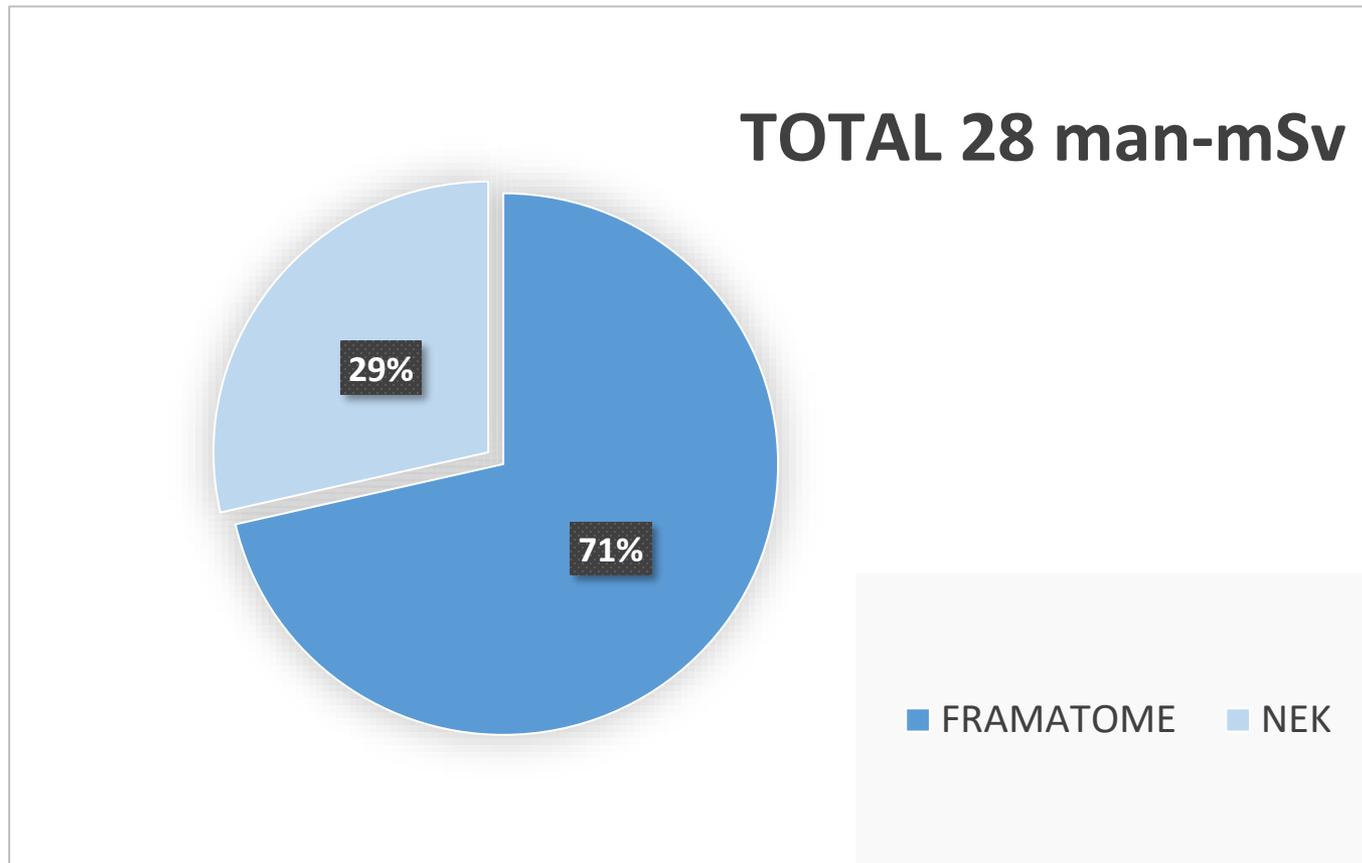


# DOSIMETRY RESULTS - FRAMATOME WORKERS



Eye dosimeters were not practical for welder's use

# FINAL COLLECTIVE DOSE



**FRAMATOME 20 man-mSv**

**NEK 8 man-mSv**

(0.6 man-mSv on shielding wall)

# FINAL REMARKS



- ❑ **TIME - HIGHLY PROFESSIONAL TEAM WELL PREPARED**  
(TO COMPLETE THE WORK IN A SHORT TIME AVAILABLE)
  
- ❑ **SOURCE REMOVAL AND SHIELDING**  
LOWER DOSE RATES THAN EXPECTED AFTER DECONTAMINATION AND SHIELDING
  
- ❑ **INDIVIDUAL DOSE MONITORING**  
SHORT LINK CONTROL BY ADDITIONAL LOCAL ELECTR. DOSIMETER DISPLAY
  
- ❑ **PASSIVE DOSIMETRY – FINGER RINGS AND EYE DOSIMETERS**
  
- ❑ **NO INTERNAL CONTAMINATION DETECTED**
  
- ❑ **MAXIMUM INDIVIDUAL DOSE 2 mSv and  
FINAL COLLECTIVE DOSE - LOWER THAN PROJECTED**