RADIATION PROTECTION MEASURES DURING THE STEAM GENERATOR HEAT EXCHANGER TUBES CLEANING

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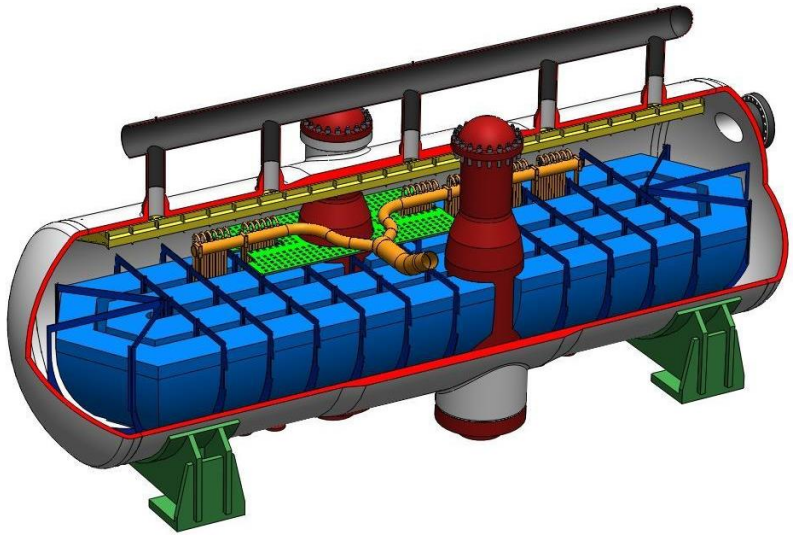
DUKOVANY NPP

- 1st and the biggest NPP in Czech Republic
- construction of NPP began in 1978, the first unit was put into operation in 1985, the last unit in 1987
- 4pcs of pressurized VVER 440 water reactors
  - each reactor unit: 6 main circulation loops with 6 main circulation pumps and 6 horizontal steam generators
- capacity of power plant: 2040MW
- type of steam generator: ***horizontal***

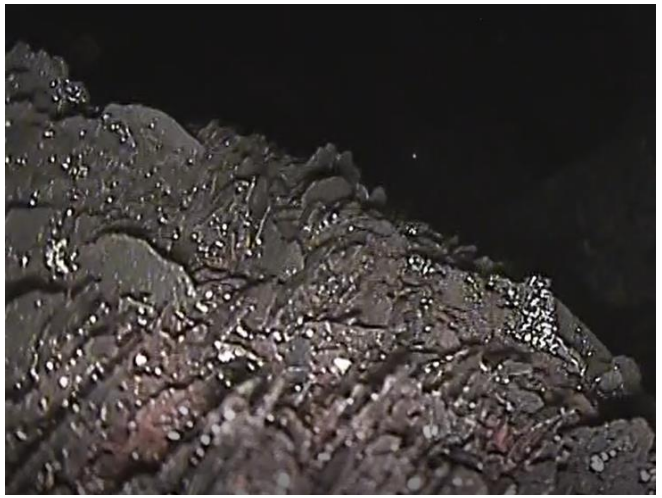


REASONS FOR STEAM GENERATOR HEAT EXCHANGER TUBES CLEANING

REASONS FOR CLEANING: INCREASED EFFICIENCY OF THE STEAM GENERATOR, EXTENDED EQUIPMENT LIFE

- during visual control, a sediment in the secondary part of the steam generator was detected

1) bottom of the steam generator covered by corrosive products



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REASONS FOR CLEANING: INCREASED EFFICIENCY OF THE STEAM GENERATOR, EXTENDED EQUIPMENT LIFE

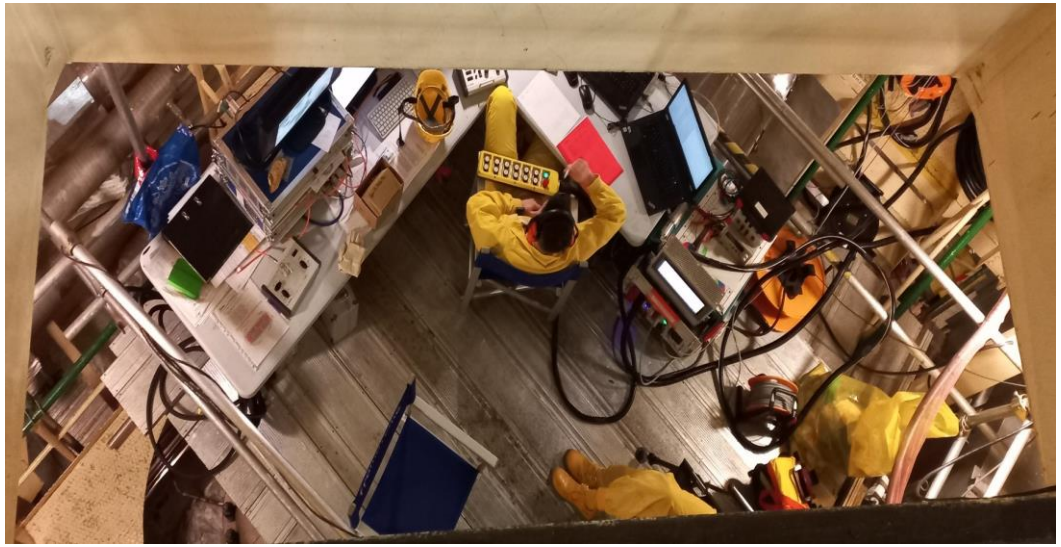
- during visual control, a sediment in the secondary part of the steam generator was detected

2) heat exchanger tubes covered by an impurities

CLEANING PROCESS

1st part – PREPARATION

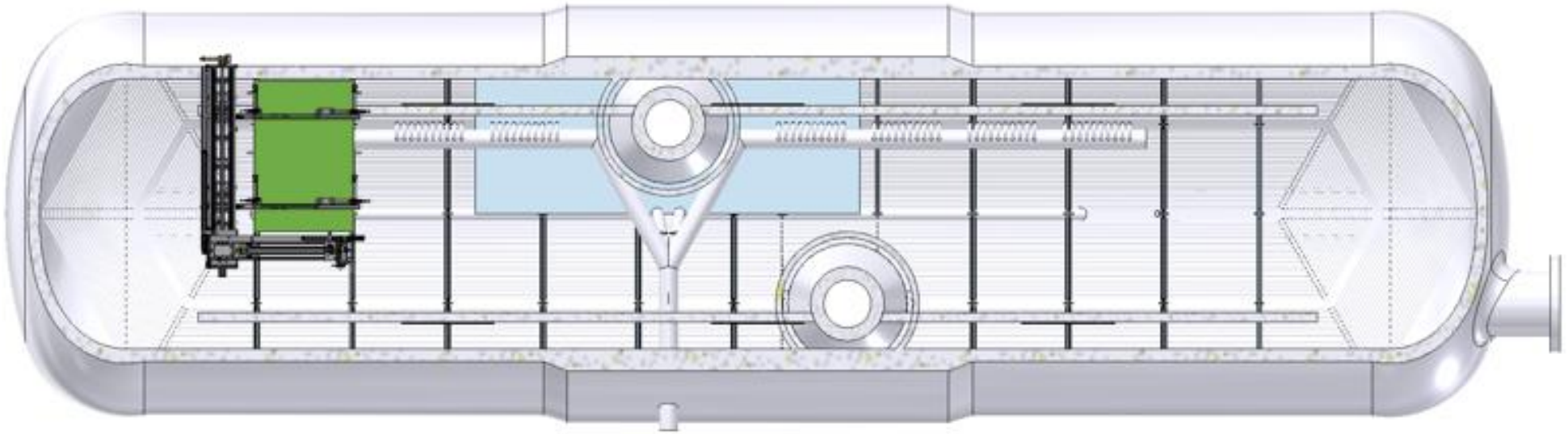
- shielding, electric lightening, ventilation, cutting out struts and installation new ones, designated „radiation safe“ workspace for operators



CLEANING PROCESS

2nd part – EXPERIMENTAL CLEANING

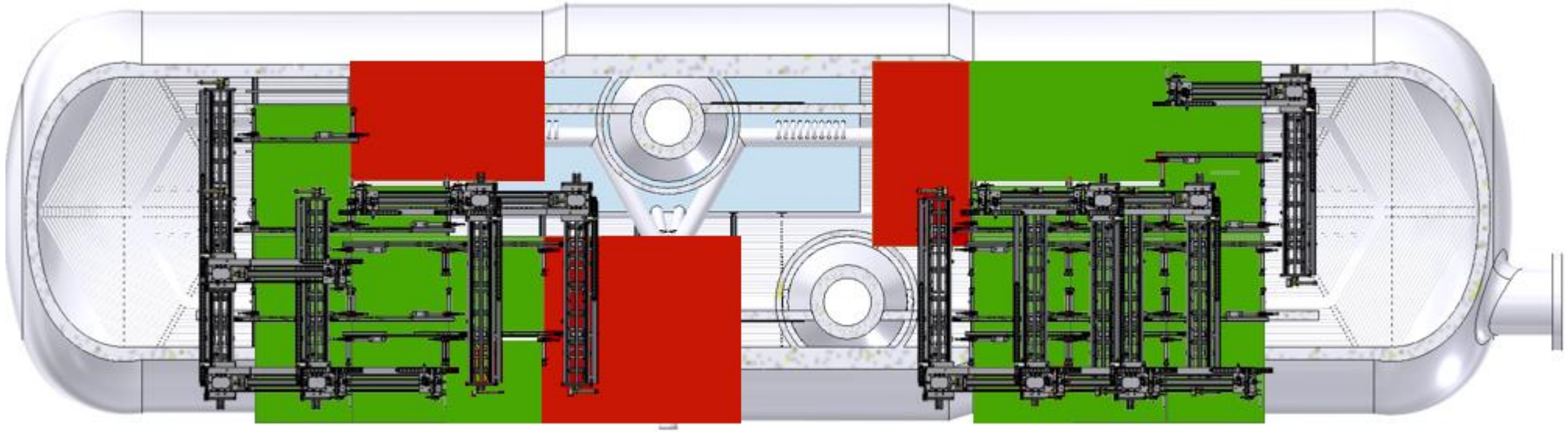
- Is it effective? Should it continue?
- reason for choosing this segment: the largest sediment site



CLEANING PROCESS

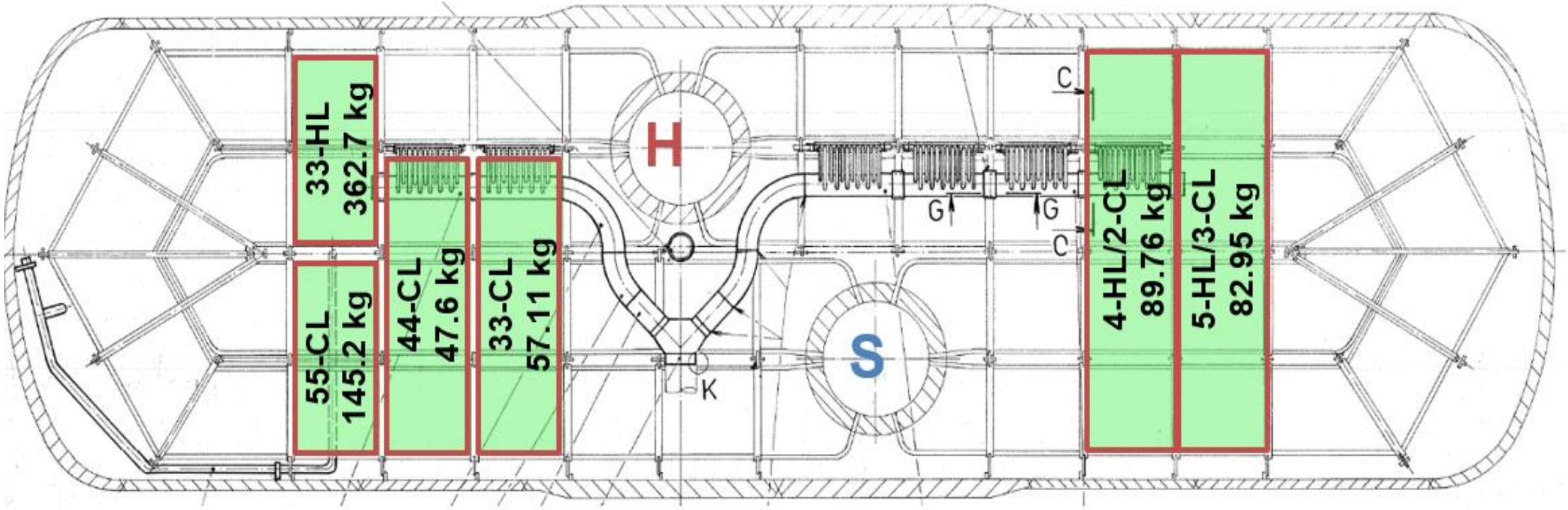
3rd part – CONTINUE OF CLEANING

- result of the experimental cleaning: YES – it is effective
- green parts - cleaned
- red parts - not cleaned – difficult access for the cleaning machine



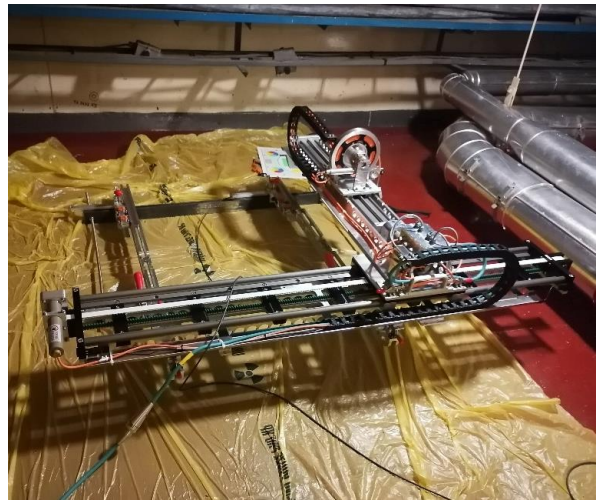
CLEANING RESULTS

Total amount of cleaned waste: 785 kg



OBSTACLES DURING THE CLEANING

- cleaning equipment failure
  - loosening screws
  - cleaning head failure



- curvature of heat exchanger tube – complicated access

- fall of shielding on the bottom of the SG

RADIATION PROTECTION DURING THE CLEANING

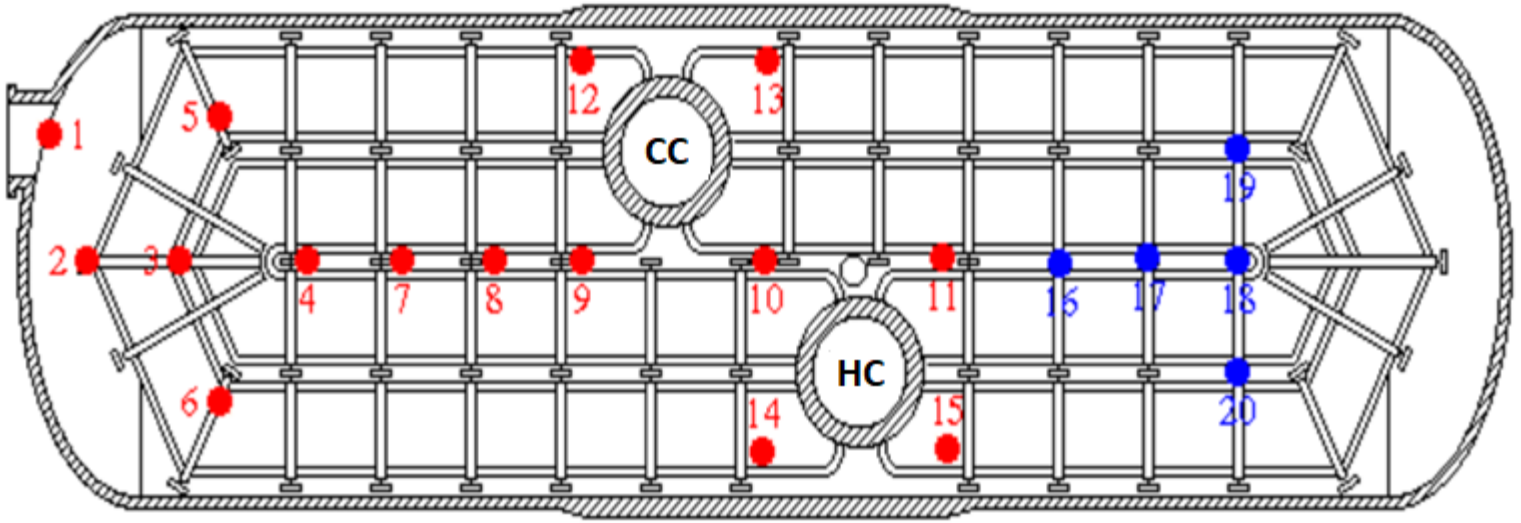
ALARA committe:

- filling a secondary part of a steam generator with water
- shielding installation (80 pcs)
- assessment of exposure situations - optimisation - designated radiation work permit
- dose plan – individual and collective
- individual doses daily check

RADIATION PROTECTION DURING THE CLEANING

Radiation situation inside the secondary part of the steam generator:

Measuring points	Dose rate [µSv/h]	
	without shielding and water	with shielding and water
1	2000	750
2	3500	1800
3	4500	1800
4	4800	2000
5	5500	5000
6	6000	2000
7	5300	2000
8	5400	1800
9	5000	1000
10		2000
11		1300
12		5000
13		4200
14		800
15		800
16		2000
17		2000
18		1500
19		1800
20		1200
Average	4666,7	2037,5



RADIATION PROTECTION DURING THE CLEANING

ALARA committe:

- plan of exposure for experimental part:
  - plan of CED for experimental part: 28 mSv
  - plan of IED for experimental part: 1,3 mSv
- plan of exposure for other parts:
  - plan of CED: 60 mSv
  - plan of IED: 2,9 mSv

- dose distribution among 56 workers expected (real number 43 workers)

RADIATION PROTECTION DURING THE CLEANING

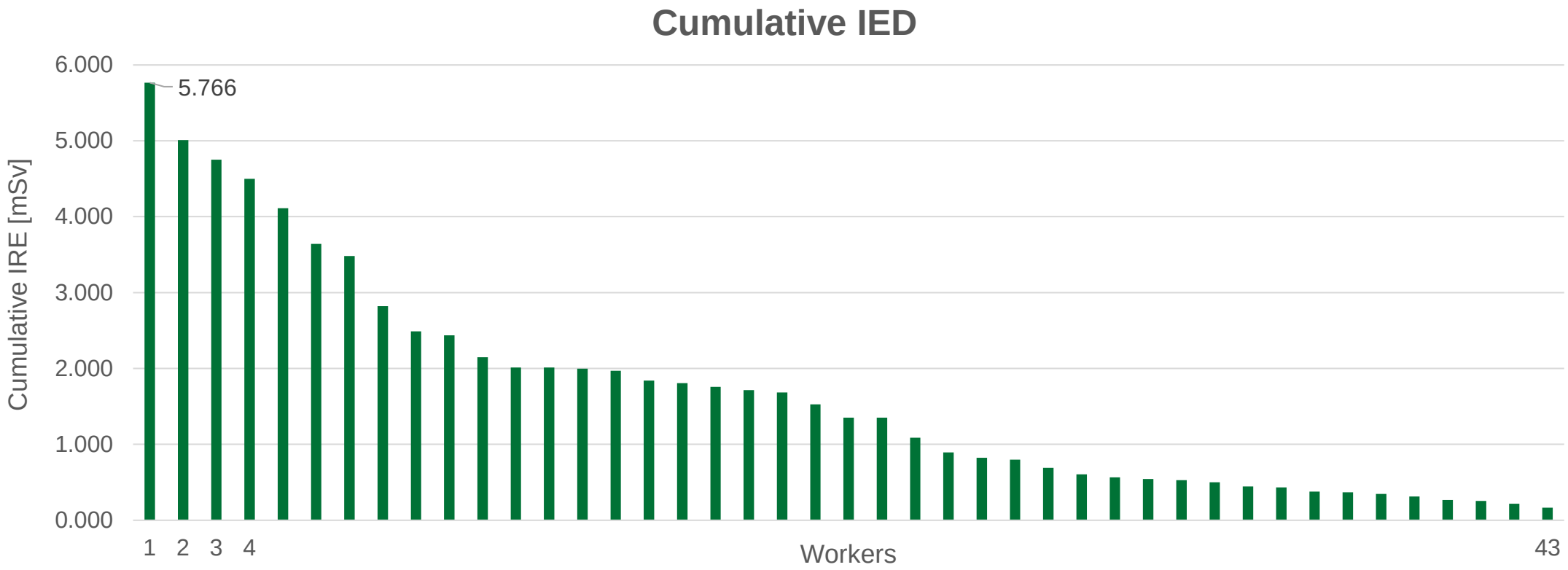
Exposure of personnel

- experimental part:
  - CED: 30 mSv (plan 28 mSv)
  - IED (cumulated): 3,1 mSv (plan 1,3 mSv)

- other parts:
  - CED: 43 mSv (plan 60 mSv)
  - IED (cumulated): 3,5 mSv (plan 2,9 mSv)

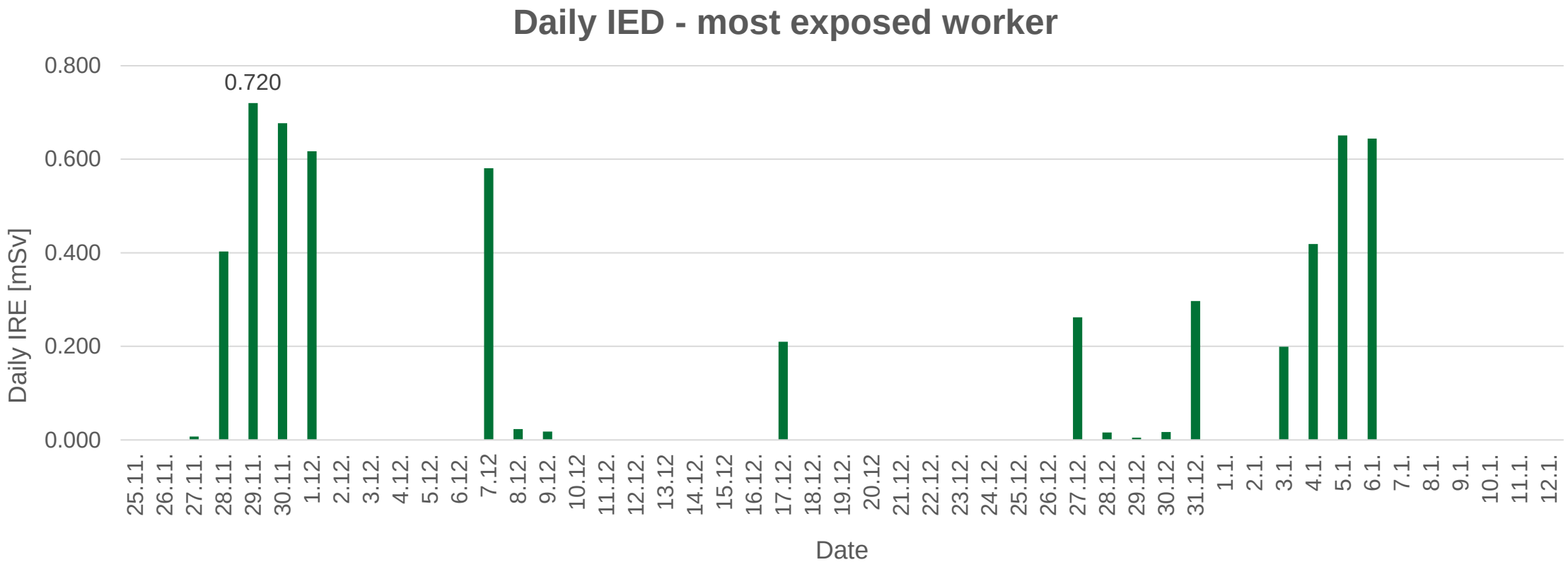
Total CED 73 mSv
Maximal IED (cumulated): 5,8 mSv
Maximal daily IED 0,796 mSv

RESULTS



- 70% IEDs < 2 mSv

RESULTS



- maximum daily dose was 720 µSv
- the total dose for the whole period was 5,8 mSv

SUMMARY AND FUTURE PLAN

- cleaning process was successful
- there was no unplanned exposure
- development cleaning machine support
- next planned unit outage will continue detailed inspection of cleaned steam generator
- assumption of cleaning other reactor units steam generators