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DOSE ASSESSMENT FOLLOWING RADIATION ACCIDENTS AT THE PRIMA FACILITY

ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT

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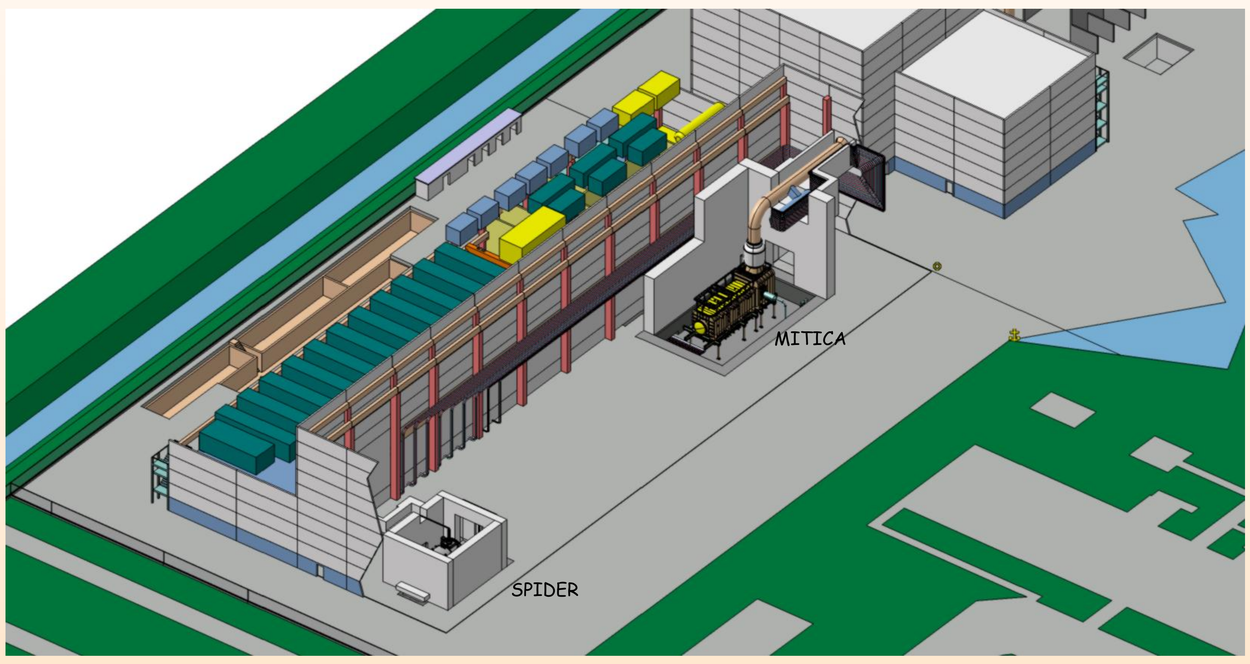
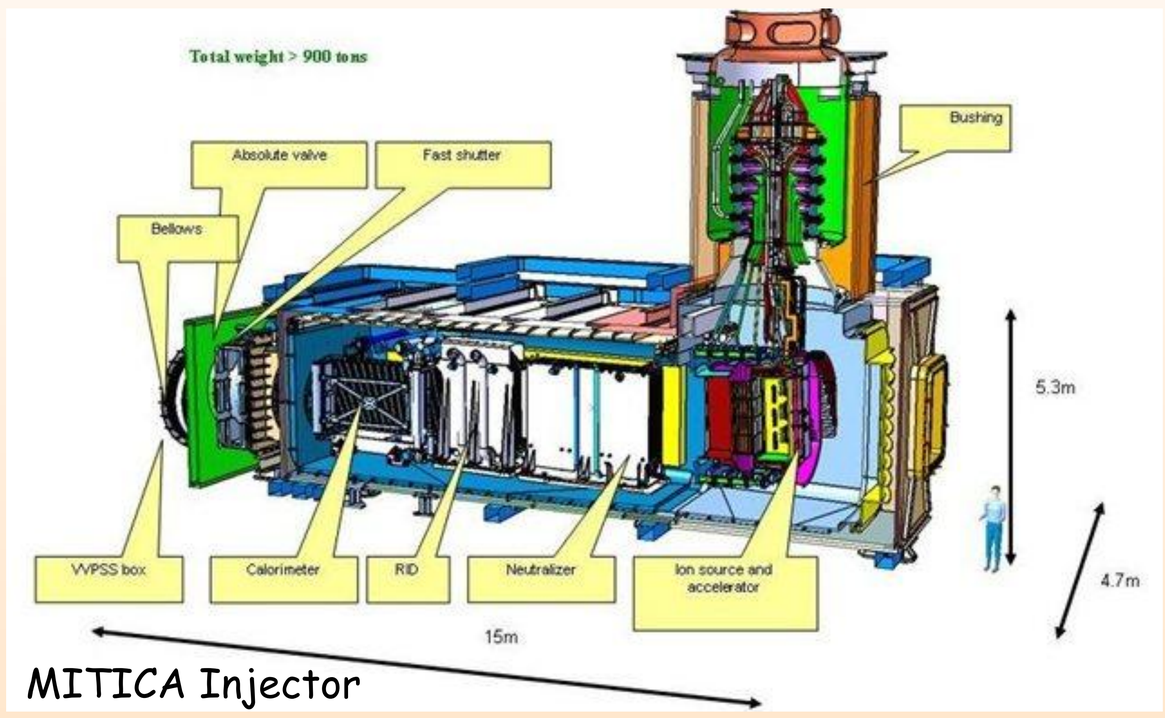
INTRODUCTION. PRIMA (Padova Research Injector Megavolt Accelerated) is the name of the ITER Neutral Beam Injector testing station currently under construction in Padua (Italy). PRIMA consists of two facilities named respectively SPIDER (Source for Production of Ion of Deuterium Extracted from RF Plasma), which represents the ion source, and MITICA (Megavolt ITER Injector Concept Advanced), the main system. During the past years different studies have been devoted to the analysis of the main safety issues related to occupational radiation protection of workers at PRIMA facilities [1-3].
In the present paper the analysis of the possible external exposure and internal contamination following a radiological accident is presented. The dominant event is a postulated fire affecting a significant portion of the facility and involving radioactive material, which is released into the environment. Radioactive material released into the area may pose both internal and external contamination hazards to people operating in the facility or personnel dedicated to emergency operations. The amount of involved radioactive material is derived from past analysis [4]. External exposure assessment is carried out with HOTSPOT code simulating a general fire scenario, while internal dose assessment is performed using OLINDA/EXM code evaluating absorbed doses to the whole body and the main organs at risk. Our analysis indicates that even in case of a severe radiological accident (worst case scenario), and considering both external and internal exposure, the annual dose for workers and emergency team is far below the Italian limits of 20 mSv and 100 mSv respectively.

PRIMA facility and layout

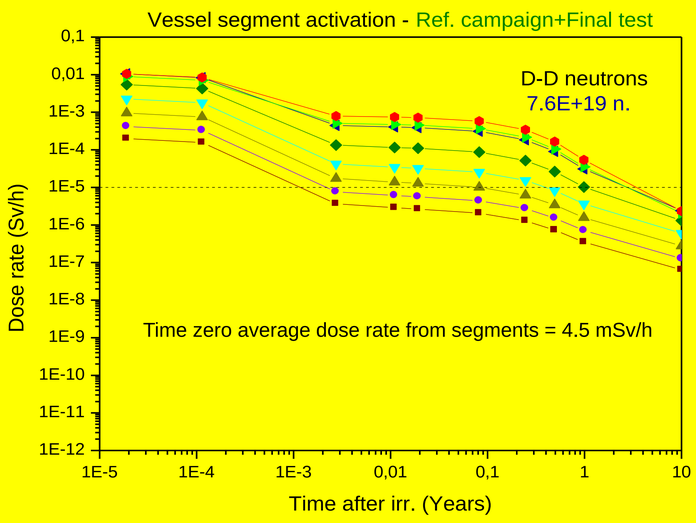




POSTULATED ACCIDENT AND RADIOACTIVITY RELEASE

A GENERAL FIRE scenario INVOLVING THE INSIDE OF THE MITICA BUNKER was considered,
WITH THE FOLLOWING RADIACTIVE RELEASES INTO ATMOSPHERE:
- 10% of the total radionuclides produced by activation from the beam dump made of graphite
- 50% of activated corrosion products (APC) from the cooling system.

Vessel contact dose rate at the time of the accident
From different segment of the Vessel



ACP released in atmosphere

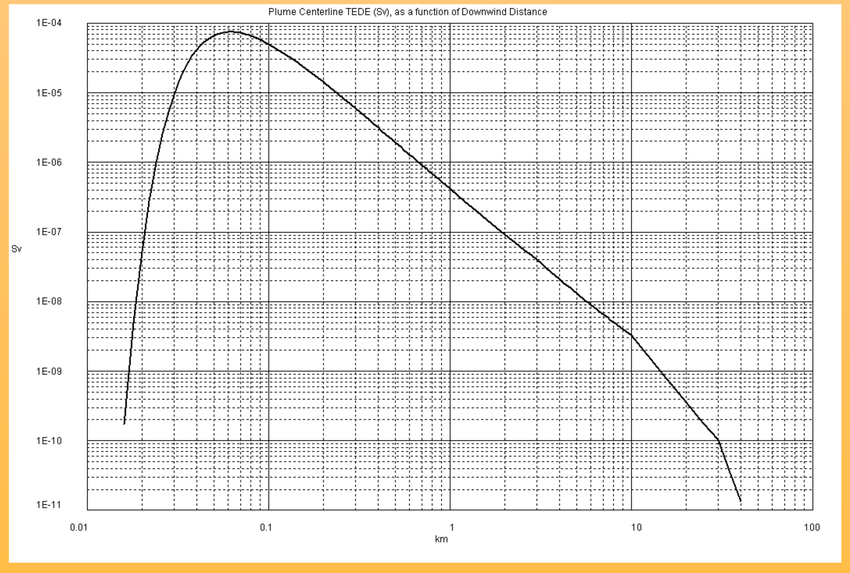
Nuclide	Activity (kBq)
Fe-55	5.2
Fe-59	3.3
Ni-65	48
Co-60	0.5
Cr-51	275
Mn-56	6050
Mo-99	7
Mo-101	7
Cu-64	75
Cu-66	15
Si-31	1

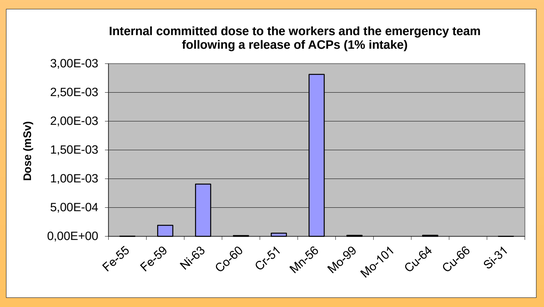
Graphite beam dump activition after 10 years: quantities released in the atmosphere

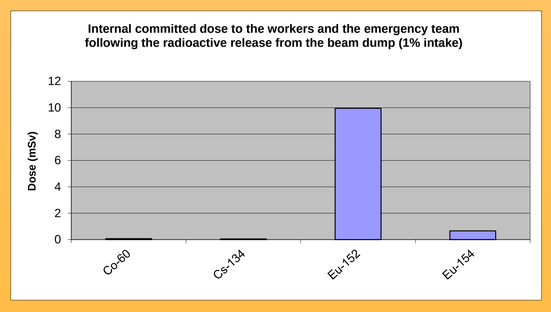
Activation reactions	Total Activity (after 10 years)	Half life (years)
C-13 (n,γ) C-14	0.06 kBq	5.730e+03
Co-59 (n,γ) Co-60	2.8 MBq	5.271
Cs-133 (n,γ) Cs-134	1.3 MBq	2.062
Eu-151 (n,γ) Eu-152	70.6 MBq	13.33
Eu-153 (n,γ) Eu-154	3.5 MBq	8.800
Nb-93 (n,γ) Nb-94	0.250 kBq	20.30e+03

RESULTS

Effective dose to the most exposed individual following accidental release







Maximum EXTERNAL effective dose to the workers and the emergency team (firemen)

The evaluations were carried out considering that the intervention could expose the emergency team to the average contact dose rate from the machine vacuum vessel for a maximum time of one hour. This is a highly conservative approach that takes into account complicated and onerous exposure scenarios.
In this condition, the maximum dose rate to the emergency team individuals is equal to 4.5 mSv/h per 1 h time, leading to the maximum total effective dose of 4.5 mSv.

CONCLUSIONS

The results of the analysis show that following the postulated severe accident scenario:

1) the most exposed individual of the population living at less than 100 m from the facility is likely to receive a total effective dose equivalent lower than 100 microSv
2) the most exposed individual of the emergency team (and the facility staff) will receive an effective dose not higher than 14,5 mSv

Therefore, even in case of a severe radiological accident (worst case scenario), and considering both external and internal exposure, the annual dose for population, workers and emergency team is far below the Italian limits of 1 mSv, 20 mSv and 100 mSv respectively

REFERENCES

[1] D'Arienzo M, Borgognoni F., Coniglio A. et al. Radiation dose due to tritium release from the ITER neutral beam injector, Fusion Engineering and Design, doi:10.1016/j.fusengdes.2010.09.012
[2] D'Arienzo M, Sandri S., Fellin F., Daniele A., Di Pace L, Coniglio A, Assessment of radiation dose rate resulting from activated corrosion products in the PRIMA facility cooling loops, Fusion Engineering and Design, in press
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[4] Sandri S., Coniglio A., Pillon M., D'Arienzo M, Neutron Flux And Activation Calculations For A High Current Deuteron Accelerator. Proceedings of 2005 Particle Accelerator Conference, Knoxville, Tennessee