FUSION FOR ENERGY

BRINGING THE **POWER** OF THE **SUN** TO **EARTH**

Personal Monitor for Tritiated Vapor in Air

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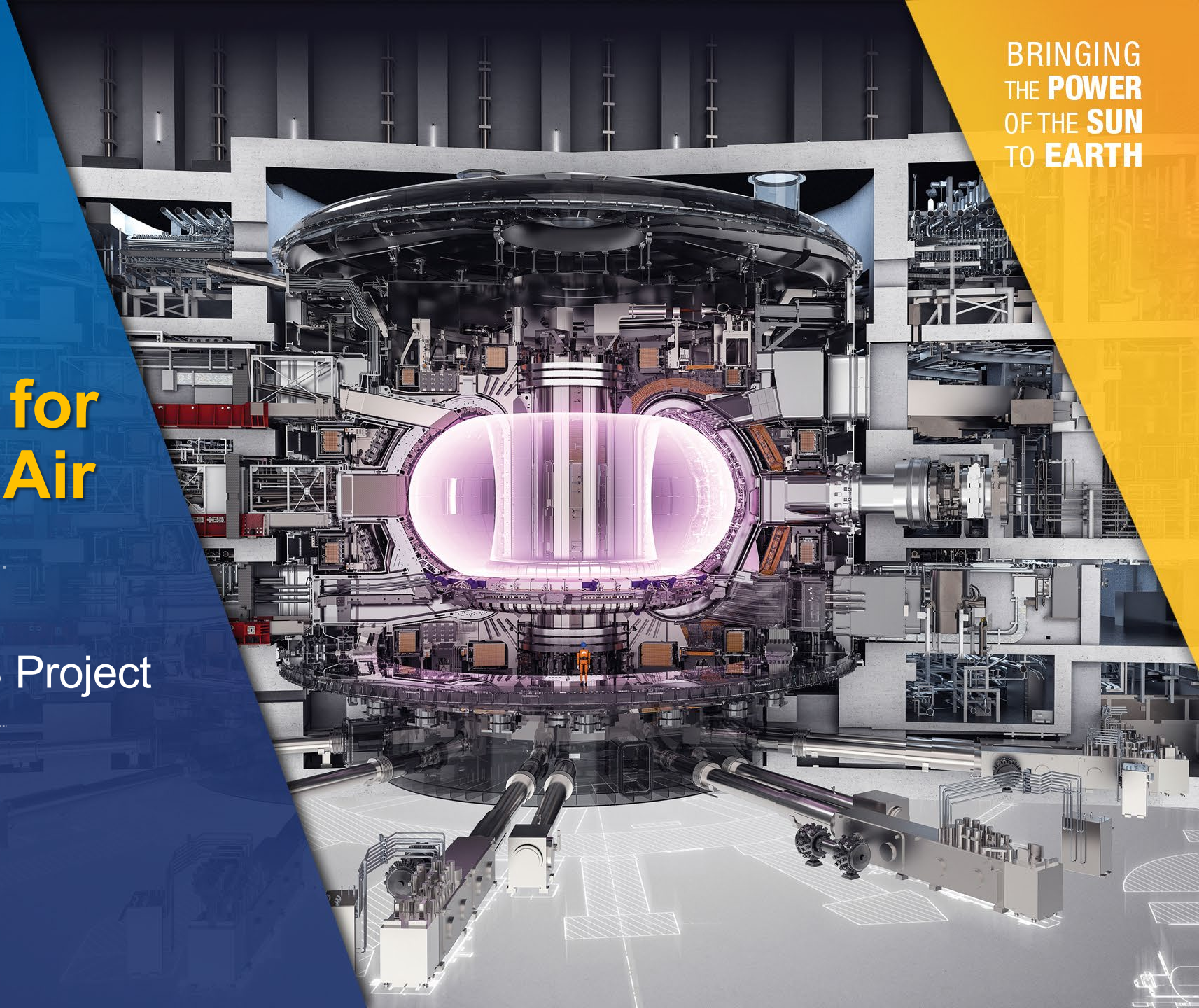
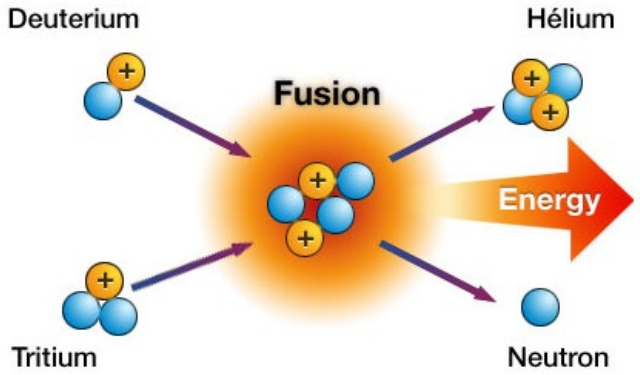
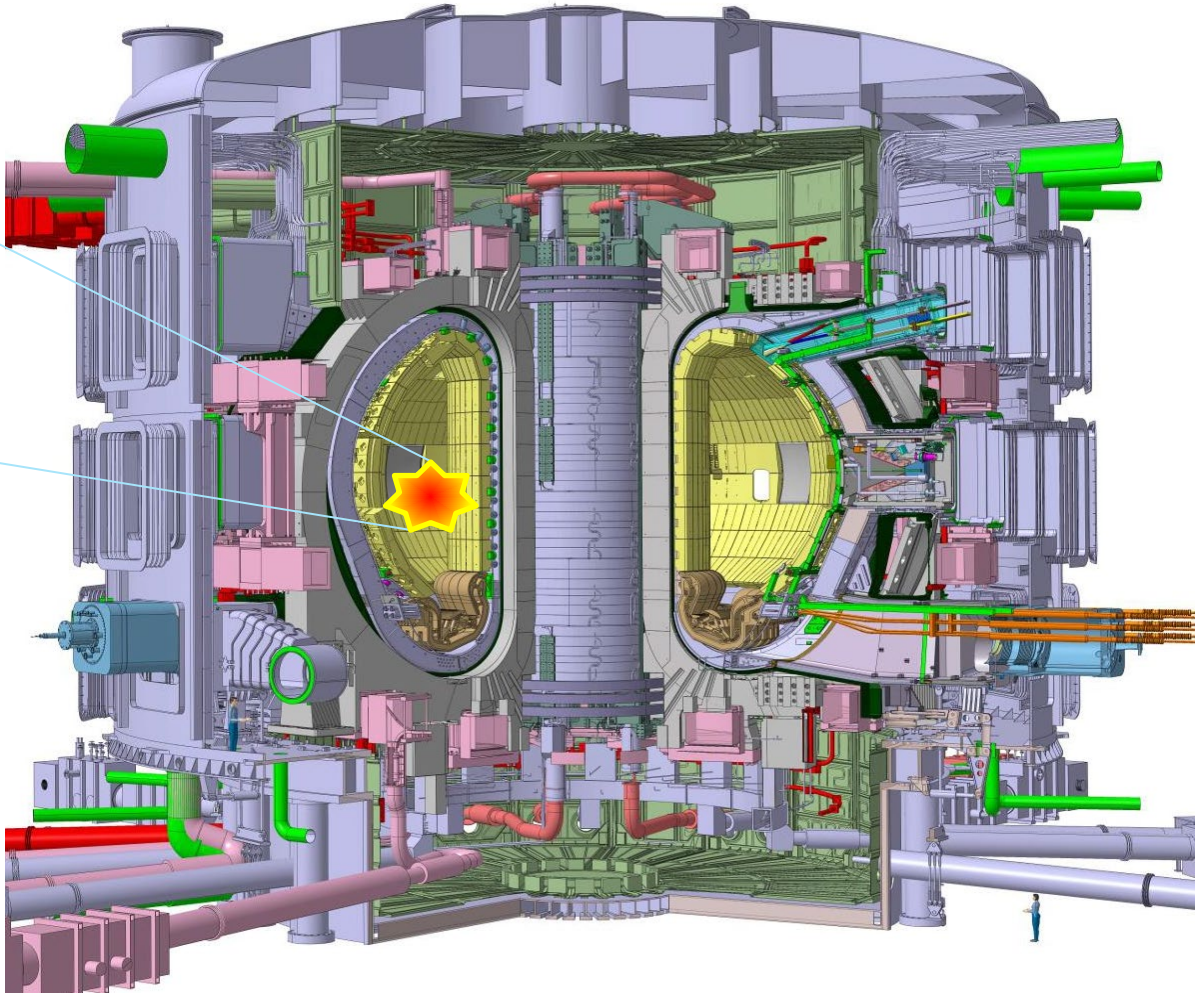


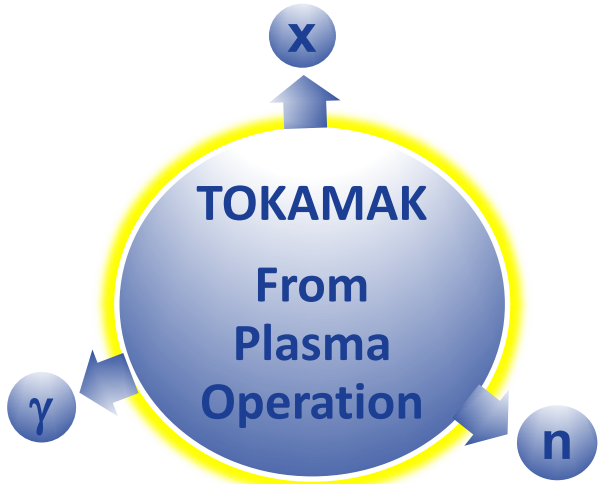
REMS Overview: The TOKAMAK





Energy production by Fusion is accompanied by some radiological hazards

REMS Overview: Radiological Hazards



Radioactive particulate

Activated structural materials erosion/corrosion

Activation of Concrete
^{137}Cs, ^{24}Na

Activation in Structures
^{60}Co, ^{58}Co, ^{54}Mn, ^{55}Fe

activation of air between cryostat and bio-shield, e.g. ^{41}Ar, ^{14}C

activation of impurity inert gases injected into the Torus, e.g. **N**, **Ne**

Radioactive gas

Rn from civil construction materials

Tritium

Fuel diffusing into Plasma Facing Components, cooling water or stored material

Produced by neutrons in Be in the Test Blanket Module.

$^{2}D(n,\gamma)^{3}T$;

$^{17}O(n, \alpha)^{14}C$

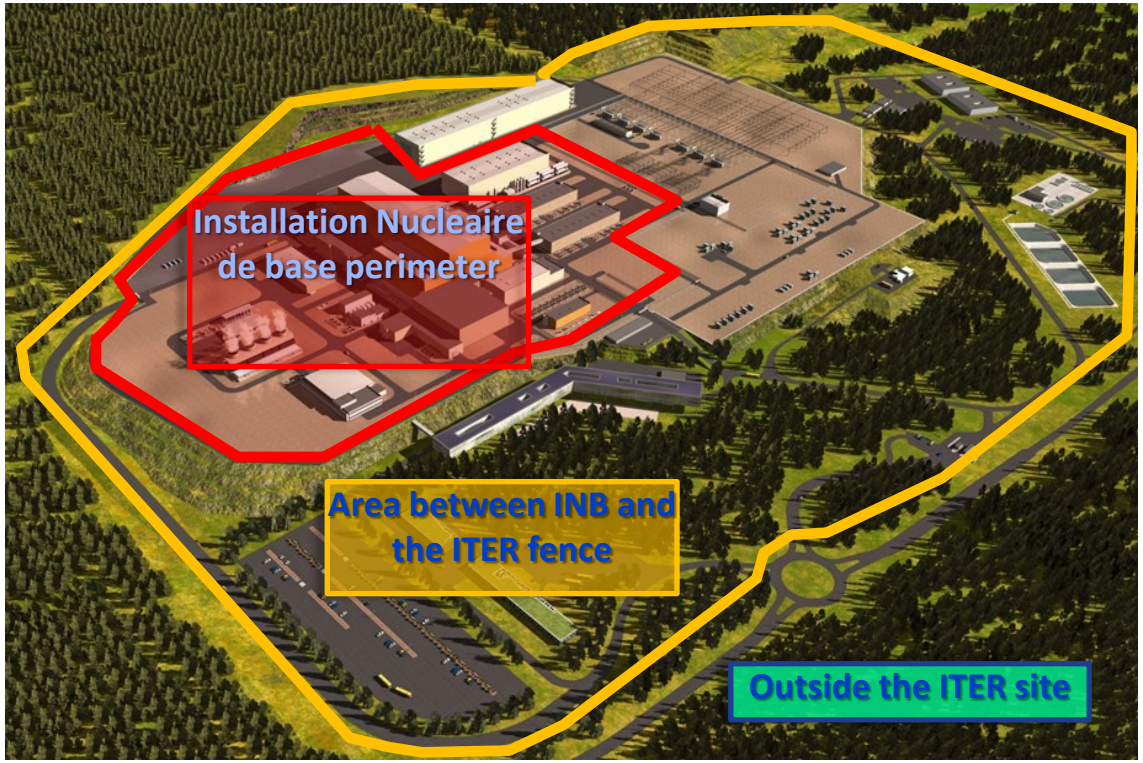
$^{18}O(n,n'\alpha)^{14}C$;

$^{16}O(n,p)^{16}N$ ($T_{1/2}$= 7.12s, γ);

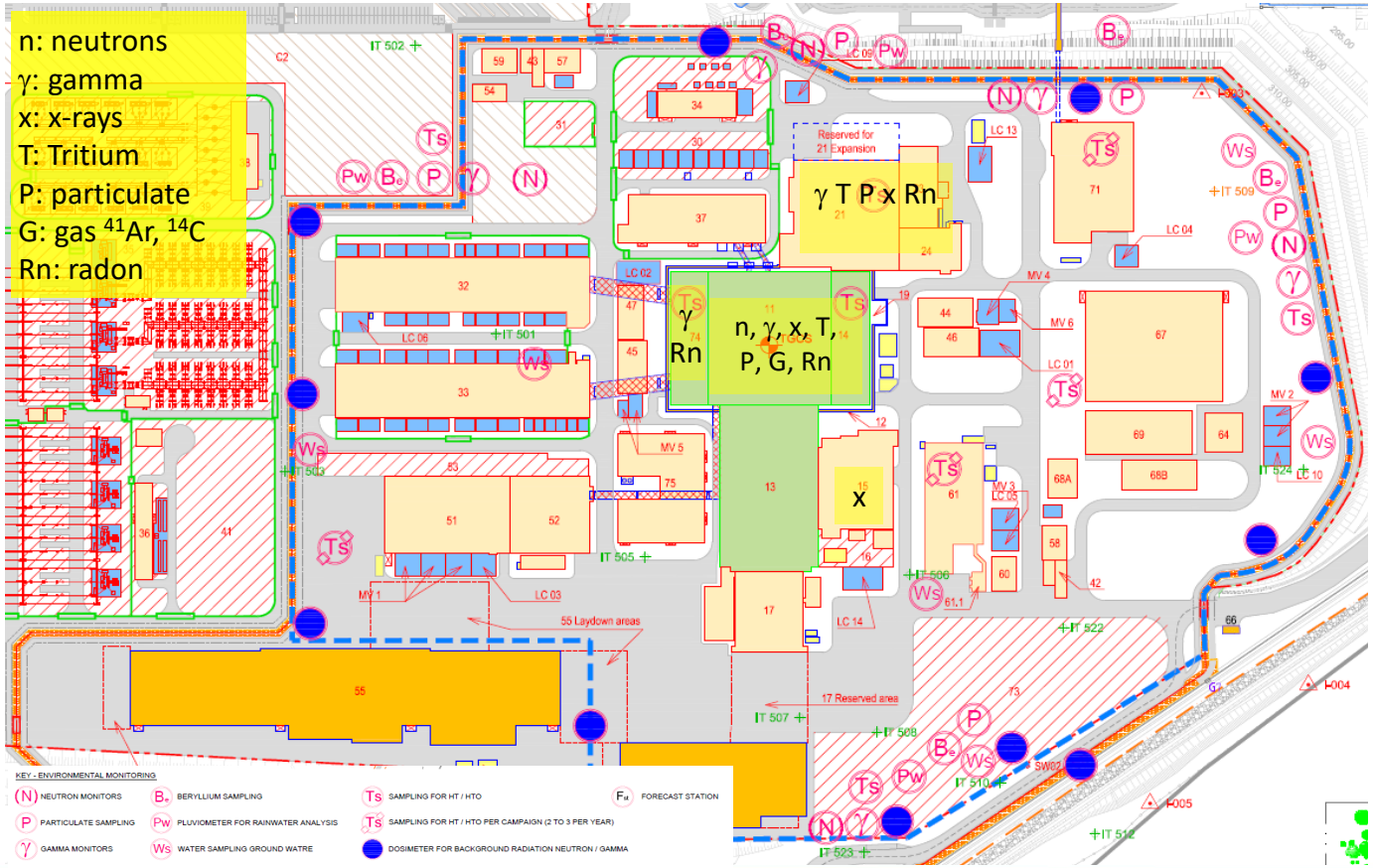
$^{17}O(n,p)^{17}N$ ($T_{1/2}$= 4.12 s n).

Activation in cooling water

Radiological and Environmental Monitoring at ITER



Radiological and environmental monitoring is performed with both portable and fixed equipment



Public, environment and worker protection require monitoring for the radiological hazards both in- and off-site

Radiological and Environmental Monitoring at ITER

- Portable devices providing flexibility in real-time monitoring of contamination or dose to workers are available for the radiological hazards identified at ITER,

whereas

- Tritium air concentration in the working area will be monitored in real time by fixed ionization chambers and, ex-post, by samplers.

- Dose to workers is only obtained ex-post by bioassays or breath analysis.

TDP: Wearable Real-Time Tritium Monitor

- On the market, Tritium portable on-line monitors with portability characteristics similar to the other radiation hazards measurement instruments are not yet available.
- A real-time monitoring approach with small size monitors would allow early detection of tritium in the air that workers are actually breathing with a flexible device and potential advantages for worker protection in cases such as access in not continuously monitored areas.
- Considering the worldwide blooming of fusion reactor concepts with Tritium as fuel, increase in demand for improvement in Tritium handling and monitoring capabilities may be expected.
- Therefore, it may become interesting to develop small portable real-time Tritium monitors.
- In the nineties, a prototype of personal monitor for tritiated vapor in air based on scintillation was developed and tested with encouraging results.

TDP: Wearable Real-Time Tritium Monitor

- Within this project, the design of a personal wearable tritium concentration in air monitor will be developed and a prototype will be manufactured and tested aiming at TRL sufficient for subsequent industrial production and marketing.

Stage 1

State of the Art assessment

- Initial assessment of the state of art.
- Envisaged Success Criterion: the proposed design is not already subject of an existing patent. If a patent already exists, the supplier will investigate the possibility to negotiate with the patent owner.

Stage 2

Design Baseline

- Design of the prototype with a design review at the end.
- Envisaged Success Criterion: Design review is approved by F4E

Stage 3

Manufacturing and Testing

- Manufacturing and testing of the prototype and the definition of an industrial production strategy.

TDP: Wearable Real-Time Tritium Monitor

WBS	Activity
1	**Collection of information on state of the art of personal tritium concentration in air monitors.**
1.1	*Review report on state of the art of tritium concentration in air monitors* ***(D1)***
2	**Definition of the detailed project workplan schedule for the design, manufacturing and testing of a prototype of personal tritium concentration in air monitor**
3	**Development of design focusing on measurement accuracy and operational reliability of the monitor.**
3.1	*Perform design review with F4E*
3.2	*Issue technical specification package for manufacturing of prototype* ***(D2)***
4	**Realization of the prototype**
4.1	*Manufacturing of the prototype and issue manufacturing report* ***(D3)***
4.2	*Functional testing of prototype at factory*
4.3	*Perform manufacturing monitoring meetings with F4E*
5	**Testing of prototype at ITER Static Magnetic Field (SMF) Testing facility**
5.1	*Organization with F4E of test campaign at ITER*
5.2	*Testing at ITER SMF Testing facility*
5.3	*Issue of test report* ***(D4)***
6	**Definition of industrial production strategy with envisaged QA provisions.** ***(D5)***
7	**Finalization of the reports on design, manufacturing, testing of the prototype.** ***(D6)***

TDP: Wearable Real-Time Tritium Monitor Tech. Specs.

The Tritium monitor shall discriminate between HT (gas) and HTO (vapour) with priority to HTO measurement

Tritium in air monitor shall include:

- Display indicating all relevant radiological data.
- Audio and visual alarms.

Reference environmental operational conditions:

- Humidity: 40%-60% R.H.,
- Temperature 12°C - 35°C,
- ECM compatibility following current applicable standards
- SMF (30 mT) compatibility.

Deviations from the above references shall be submitted to F4E for approval before being implemented in the design.

Tritium in air monitors are to be easily carried by workers for the duration of their activity.

Indicative characteristics:

- **Dimensions** (h x w x d): 300 mm x 50 mm x 100 mm
- **Weight**: around 1 kg
- **Range of measurement**: < 10^4 Bq/m^3 to 10^6 Bq/m^3
- **Time of detection**: <150 seconds
- **Autonomy**: 8 hours
- **Accuracy**: ± 20%

Quality Assurance Provisions

- No specific QA requirements are mandated for the activities in the frame of this project.
- The QA provisions envisaged to be adopted later for commercialization and operational purposes will be described in the industrialization strategy report.

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