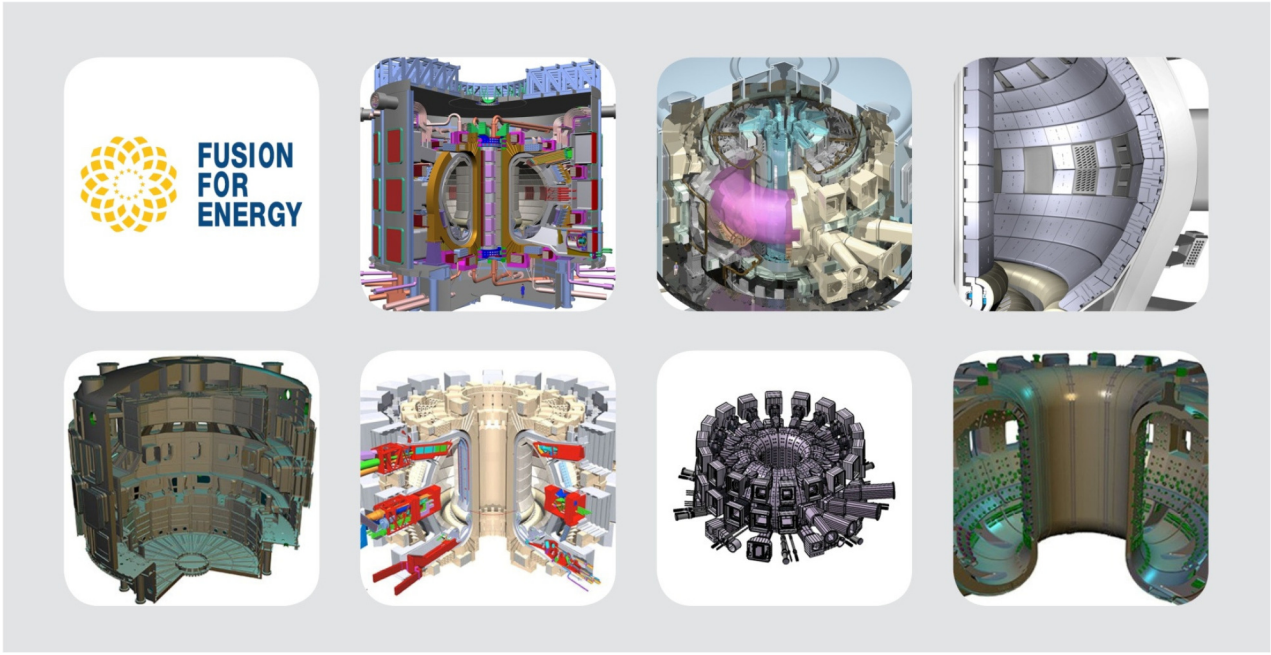
ITER Radiological and Environmental Monitoring System (REMS)

Component Technical Specifications



Executive Summary

This report, REMS Component Technical Specification, has been prepared to satisfy part of the REMS Preliminary Design, First Phase of Task Order 1.

This document defines the components and the applicable technical standards for the procurement, manufacture and testing of those components for the ITER REMS system.

This document along with the Strategy and Plan for Qualification of PIC Components [24] and any other functional and architectural requirements document shall be used as input for REMS detailed design phase.

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Abbreviations and Acronyms

This sub-section describes the abbreviations and acronyms of terms used in Annex B and its Appendices.

Acronyms used in this Technical Annex are as given in the document ITER_D_2MU6W5 ITER Abbreviations.

Some acronyms specific to the Radiological and Environmental Monitoring System under this document are defined below.

ACP	Activated Corrosion Products
ABMS	Area Beryllium Monitoring System
ARMS	Area Radiological Monitoring System
ASN	Nuclear Safety Authority
AU	Alarms Unit
CDR	Conceptual Design Review
CEA	Commissariat à l'Energie Atomique
CODAC	Control, Data Access and Communication
CNB	Neutron Beam Cell shall be NB cell
CSS	Central Safety System
CMM	Configuration Management Model
CTB	Coil Terminal Box
CVCS	Chemical & Volume Control Systems
DAC	Derived Air Concentration
DDD	Design Description Document
Diag	Diagnostic Building
DS	Detritiation System
EMS	Environmental Monitoring System
EPD	Electronic Personal Dosimeter
EPICS	Experimental Physics and Industrial Control System
EUC	Equipment Under Control
EU-DA	European Domestic Agency
FAT	Factory Acceptance Test
FDR	Final Design Review
GM	Geiger-Muller
GPRS	General Packet Radio Services
GPS	Global Positioning System
GSM	Global System for Mobile Communications
He	Helium

HCF	Hot Cell Facility
HEPA	High Efficiency Particulate Air filters
HMI	Human Machine Interface
HP	Health Physics
HT	Molecular Hydrogen containing Tritium
HTO	Tritiated water
HV	High Voltage
HVAC	Heating Ventilation and Air Conditioning
HVAS	High Volume Particulate Sampling
IAEA	International Atomic Energy Agency
IBD	Diatoma Biological Indicator
IBGN	Standardized Global Biological Indicator
IDM	ITER Document Management
I&C	Instrumentation & Control
ICD	Interface Control Document
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiation Units
IEC	International Electrotechnical Commission
INB	Basic Nuclear Institute
IMS	Individual Monitoring System
IP	Indices of Protection
IRMS	ITER Remote Maintenance System
IRSN	Radioprotection and Nuclear Safety Institute
ISO	International Organization for Standardization
IT	Information Technology
ITER	International Thermonuclear Experimental Reactor
LED	Light Emitting Diode
LCS	Local Control System
LTM	Long Term Maintenance
MCR	Main Control Room
MDA	Minimum Detectable Activity
MS	Molecular Sieve
NB	Neutron Beam
NF	French Norm
NF	Nuclear Facility
NPP	Nuclear Power Plant
OSL	Optically Stimulated Luminescence

PACB	Personnel Access Control Building
PCR	Project Change Request
PBS	Plant Breakdown Structure
PDR	Preliminary Design Review
PES	Programmable Electronic Systems
PFD	Process Flow Diagram
PLC	Programmable Logic Control
POS	Plasma Operation State
RAMI	Reliability & Availability, Maintainability & Inspectability
REMS	Radiological and Environmental Monitoring System
RF	Radio Frequency
RFID	Radio Frequency Identification
RNM	Reseau National de Mesure (French national network of environmental radioactivity measurements
RMS	Release Monitoring System
RPL	Radio Photo Luminescence
RPRS	Preliminary Safety Report
RWF	Radwaste Facility
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SIC	Safety Important Class
SISERI	System of information of ionizing radiation exposure
SLD	Single Line Diagram
SR	Safety Relevant
SRD	System Requirement Document
SSEN	Steady State Electric Network
STM	Short Term Maintenance
TBAS	Tokamak Building Access System
TBD	To Be Defined
TBM	Test Blanket Module
TCS	Test & Conditioning State
TCWS	Tokamak Cooling Water System
TC	Tokamak Complex
TK	Tokamak Building
TP	Tritium Plant
TLD	Dosimetry Thermo Luminescent
UPS	Uninterruptible Power Supply

VDU	Visual Display Units
VV	Vacuum Vessel
VVPSS	Vacuum Vessel Pressure Suppression System
ZDN	Nuclear Waste Zones

1 Introduction

This document provides the preliminary specification of the individual system components that constitute the International Thermonuclear Experimental Reactor (ITER) Radiological and Environmental Monitoring System (REMS), and the standards applicable to each of them. The principal features of the components are described to give a better understanding of what is required for operation within and around the ITER facility.

2 Applicable Standards

This section gives a brief overview of the standards that are applicable for Component Technical Specifications of the project. These are the standards expected for equipment for use within the ITER facility. Note that some key standards will refer out to further standards for guidance regarding different aspects of equipment design. E.g. IEC61508. It is expected that some equipment will follow other standards not identified here. These will need to be assessed in each instance to determine the suitability of the equipment for use within the ITER facility.

2.1 IEC 60532

IEC 60532 – Radiation Protection Instrumentation - Installed Dose Rate Meters, Warning Assemblies and Monitors - X and gamma radiation of energy between 50 keV and 7 MeV

IEC 60532 applies to installed dose rate meters, warning assemblies and monitors that are used to prevent or mitigate a minor radioactive release, or minor degradation of fuel, within the nuclear power plants /nuclear facility design basis, and to warn personnel or to ensure their safety during or following events that involve or result in release of radioactivity in the nuclear power plants (NPP) /nuclear facility (NF), or risk of radiation exposure. This equipment is typically classified as category "A" or "B" or "C" or "not classified" in IEC 61226.
It covers equipment intended to isotropically measure air kerma, ambient dose equivalent or other exposure quantities due to X or gamma radiation of energy between 50 keV and 7 MeV.

This standard specifies general characteristics, general test procedures, radiation, electrical, safety, and environmental characteristics.

2.2 IEC 60846

IEC 60846 – Radiation Protection Instrumentation - Ambient and/or directional dose equivalent (rate) meters and/or monitors for beta, X and gamma radiation

IEC 60846 series applies only to portable meters and monitors which are intended to be used in both the workplace and the environment. It applies to devices that measure the dose equivalent or dose equivalent rate from external beta and/or X and gamma radiation in the dose range between 0.01 μSv and 10 Sv and the dose rate range between 0.01 μSv h–1 and 10 Sv h–1.

This standard specifies:

a) general characteristics, the functions and performance characteristics of dose equivalent (rate) meters;

b) the methods of test to be used to determine compliance with the requirements of this standard.

2.3 IEC 62303

IEC 62303 - Radiation Protection Instrumentation – Equipment for Monitoring Airborne Tritium

This International Standard is applicable to tritium samplers and tritium monitors intended to provide the following functions:

– the measurement of the volumetric activity of tritium and its variation with time in the workplace, in gaseous effluents at the discharge point and in the environment;

– the actuation of an alarm when a predetermined volumetric tritium activity or tritium concentration or a predetermined total activity of released tritium is exceeded;

– the determination of the total tritium activity discharged over a given time;

– the sampling and analysis of air or gas containing tritium.

This standard specifies the general characteristics, general testing procedures, mechanical, electrical and electronic, radiological, safety and environmental characteristics, and the proper identification and certification of the equipment. If this equipment is part of a centralized system for continuous radiation monitoring in a nuclear facility, there may be additional requirements from other standards related to those systems.

2.4 IEC 60761-1

IEC 60761-1, Equipment for Continuous Monitoring of Radioactivity in Gaseous Effluents - Part 1 General Requirements

IEC 60761-1 is applicable to equipment for continuous monitoring of radioactivity in gaseous effluents during normal operations and during anticipated operational occurrences.

This standard is restricted to equipment for continuously monitoring radioactivity in gaseous effluent. It does not deal with sample extraction and laboratory analysis.

2.5 IEC 60761-2

IEC 60761-2, Equipment for Continuous Monitoring of Radioactivity in Gaseous Effluents - Part 2: Specific Requirements for Radioactive Aerosol Monitors Including Transuranic Aerosols.

IEC 6076-21 is applicable to equipment intended for simultaneous, delayed or discrete sequential measurement of aerosols in gaseous effluents discharged into the environment. It is applicable to equipment designed to fulfil the following functions:

– the measurement of the volumic activity (Bq/m3) of the aerosols in gaseous effluents and/or the released total activity of aerosols (Bq);

– the actuation of an alarm signal when either a predetermined volumic activity or a predetermined total released activity of aerosols is exceeded.

This equipment is intended for measurement over a wide range of activity, including very small quantities in the presence of a much larger natural background. The daughters of 222Rn (radon) and 220Rn (thoron) are naturally occurring aerosols contributing to the natural background. The discrimination against natural activity can be an important problem in monitoring low level activity. In order to provide more and better information, complementary or retrospective laboratory analysis of the filters after collection may be performed.

2.6 IEC 61304

IEC 61304 Nuclear instrumentation. Liquid-scintillation counting systems. Performance verification.

IEC 61304 provides the user with a means of verifying the performance of typical liquid-scintillation counting systems. Liquid-scintillation counting systems are used for radionuclide assay. A typical system is a combination of a sample changing device with a liquid-scintillation spectrometer to allow a number of samples to be counted automatically.
This International Standard is particularly useful for Tritium and Carbon 14 counting but is also applicable for the counting of other radionuclides.

2.7 IEC 61098

IEC 61098 Radiation Protection Instrumentation Installed Personnel Surface Contamination Monitoring Assemblies - Second Edition

IEC 61098 International Standard applies to contamination warning assemblies, meters and monitors used for the monitoring of radioactive contamination on the surface of personnel whether they be clothed or not. The standard is applicable only to that type of equipment where the user takes no action other than to present himself and/or his hands and feet to the detectors. It is not applicable to equipment where the user or someone else moves detectors over the area to be monitored or the user passes quickly through the monitor. It is also not applicable to any peripheral equipment which may be associated with a particular type of equipment such as small article monitors.

This standard is applicable to the monitoring of the whole body (including the face), hands and feet but parts of this standard may be used for equipment designed for the monitoring of radioactive contamination on the hands and/or feet only.

2.8 IEC 61005

IEC 61005 Radiation Protection Instrumentation - Neutron ambient dose equivalent (rate) meters.

IEC 61005 Specifies requirements for the performance characteristics of neutron ambient dose equivalent (rate) meters, and prescribes the methods of testing in order to determine compliance with this standard. Specifies general characteristics, general test procedures, radiation characteristics, electrical, mechanical, safety and environmental characteristics, and also the identification certificate.

2.9 IEC 61559

IEC 61559 - Radiation Protection Instrumentation in Nuclear Facilities - Centralized Systems for Continuous Monitoring of Radiation and/or Levels of Radioactivity

IEC 61559 series applies to centralized systems intended for continuous monitoring of radiation and/or levels of radioactivity installed in nuclear facilities, primarily in support of radiological protection in the working areas. This standard specifies general characteristics, general test procedures, radiation, electrical, safety, and environmental characteristics and the identification certificate for the systems addressed by this standard.

This standard applies to normal monitoring functions. IEC 61559-2 applies to Requirements for Discharge, Environmental, Accident, or Post-Accident Monitoring Functions.

2.10 IEC 61226

IEC 61226 - Nuclear Power Plants - Instrumentation and Control Important to Safety - Classification of Instrumentation and Control Functions

IEC 61226 establishes a method of classification of the information and command functions for nuclear power plants, and the instrumentation and control (I&C) systems and equipment that provide those functions, into categories that designate the importance to safety of the function. The resulting classification then determines relevant design criteria.

The design criteria are the measures of quality by which the adequacy of each function in relation to its importance to plant safety is ensured. In this standard, the criteria are those of functionality, reliability, performance, environmental durability (including seismic) and quality assurance (QA).

2.11 IEC 60980

IEC 60980 - Recommended Practices for Seismic Qualification of Electrical Equipment of the Safety System for Nuclear Generating Stations

IEC 60980 is applicable to electrical equipment and the I&C equipment of the safety system that is used in nuclear power generating stations including components or equipment of any interface whose failure could adversely affect the performance of the safety system.

This standard presents acceptable seismic qualification methods and requirements to demonstrate that electrical and I&C equipment can perform their safety-related functions during and after an earthquake. As seismic qualification is only a part of equipment qualification, this standard shall be used in conjunction with IEC 780.

2.12 IEC 61017

IEC 61017 Radiation Protection Instrumentation - Portable, Transportable or Installed X or Gamma Radiation Ratemeters for Environmental Monitoring Part 1: Ratemeters and Part 2: Integrating Assemblies - First Edition

IEC 61017 is applicable to portable, transportable or installed assemblies intended to measure environmental air kerma rates from 30 nGy/h to 10 µGy/h (3 µrad/h to 1 mrad/h) due to X or

gamma radiation of energy between at least 50 keV and 1.5 MeV*. If the assembly is to be used to measure air kerma rates in the area surrounding a nuclear reactor producing 6 MeV radiation it will be necessary to determine the response at this energy.

For the purpose of radiation protection these assemblies comprise at least:
- a detection sub-assembly (e.g. ionization chamber, Geiger-Muller (GM) counter tube, scintillation detector, etc.);
- a measuring sub-assembly including a display device, which may be connected together either rigidly or by means of a flexible cable or incorporated into a single assembly. The installed assembly may also comprise a continuous recorder (e.g. chart or magnetic cassette recorder or telemetry equipment). The requirements of this standard are also applicable to assemblies that use integration of the ionization current, count-rate, etc. to enable a mean air kerma rate to be indicated or determined.

2.13 IEC 61582

IEC 61582 Radiation Protection Instrumentation In Vivo Counters Classification, General Requirements and Test Procedures for Portable, Transportable and Installed Equipment - First Edition

This standard is applicable both to equipment with spectroscopic capabilities and instruments for rapid screening for gross internal contamination only.

This standard is applicable to instruments for the monitoring of certain critical organs (for example, lungs, thyroid gland, etc.) as well as instruments for monitoring the whole body.

The standard applies to equipment for the measurement of the activity of gamma-emitting radionuclides in humans in order to determine the committed dose equivalent due to internal contamination in accordance with the recommendations of the ICRP 60 and ICRP 61.

Depending on the type of instrument and the organ to be checked, measurement geometry may require the subject of the monitoring procedure to stand, sit, or lie.

The standard specifies general types, specific measuring characteristics, main test procedures, electrical and mechanical characteristics of the whole body monitor, as well as the requirements related to background radiation of the environment.

2.14 IEC 61563

IEC 61563 Radiation Protection Instrumentation - Equipment for Measuring Specific Activity of Gamma-Emitting Radionuclides in Foodstuffs - First Edition

This International Standard applies to portable instruments used for measuring the specific or volumic activity of gamma-emitting radionuclides in food/foodstuffs intended for operation under field conditions, particularly in case of a post-accidental situation. It does not apply to low background laboratory instrumentation requiring highly skilled personnel.

The instruments designed for measurement of gamma contamination in foodstuffs under field conditions should not require special sample preparation other than machining (cutting, grinding, etc.).

These instruments may be used, in principle, to measure the gamma emitting surface contamination and other radiation measurements as well, but these applications are outside the scope of this standard.

This standard is to specify the main performance characteristics of instruments, intended for measurement of specific activity of gamma-emitting radionuclides in foodstuffs, their methods of testing and documentation requirements.

2.15 IEC 60325

IEC 60325 is applicable to radiation meters and monitors designed for the direct measurement or the direct detection of surface contamination by alpha and/or beta radiation emitting nuclides and which comprise at least:
– a detection assembly (comprising γ counter tube, scintillation detector or semiconductor detector, etc.), which may be connected either rigidly or by means of a flexible cable or incorporated into a single assembly.
– a measurement assembly.

Some meters and monitors consist of detection assemblies and measurement assemblies where it is possible to separate the detector assembly and use alternative detection assemblies. Conformity with the standard can either be achieved by:

All combinations of the detection assembly and the measurement assembly conforming to the requirements of this standard.
or
The detection assembly and the measurement assembly separately conforming to the relevant parts of this standard in isolation.

This standard is applicable to:
– alpha surface contamination meters;
– alpha surface contamination monitors;
– beta surface contamination meters;
– beta surface contamination monitors;
– alpha/beta surface contamination meters;
– alpha/beta surface contamination monitors.

The latter two are equipment capable of determining alpha and beta contamination simultaneously and displaying the measurement of either:
– Alpha (beta, alpha/beta) surface contamination meter
An assembly including one or more radiation detectors and associated assemblies or basic function units, designed to measure alpha (beta, alpha/beta) surface emission rate associated with the contamination of the surface under examination.
– Alpha (beta, alpha/beta) surface contamination monitor.

This standard is also applicable to special purpose assemblies and to assemblies specifically designed for a surface of a particular nature. However, some of the requirements may need to be amended or supplemented according to the particular requirements applicable to such assemblies.

The object of this standard is to lay down standard requirements and to give examples of acceptable methods, and also to specify general characteristics, general test conditions, radiation characteristics, electrical safety, environmental characteristics, and the requirements of the identification certificate for alpha, beta and alpha-beta contamination meters and monitors.

2.16 IEC 61577

The IEC 61577 series covers the general features concerning test and calibration of radon and radon decay product measuring instruments.

This standard addresses only the instruments and associated methods for measuring isotopes 220 and 222 of radon and their subsequent short-lived decay products in gases.

Its object is to help to define type tests which have to be conducted in order to qualify these instruments.

2.17 IEC 61578

IEC 61578 Radiation Protection Instrumentation Calibration and Verification of the Effectiveness of Radon Compensation for Alpha and/or Beta Aerosol Measuring Instruments Test Methods.

IEC 61578 is applicable to type test methods which permit calibration and measurement of the effectiveness of radon daughters' compensation of radioactive aerosol monitors. This standard defines aerosol characteristics used in these tests and applies the following procedures:
– test method permitting the measurement of the response of the monitor relative to alpha and/or beta defined radioactive aerosols;
– test method permitting the measurement of the response of the monitor relative to radon daughter-defined aerosols;
– test method permitting the measurement of the effectiveness of radon compensation;
– test method permitting the measurement of the response of the monitor relative to a mixture of aerosols constituted by radon daughters and by alpha and/or beta radioactive emitters.

In addition, it specifies the requirements for acceptance.

2.18 IEC 61508

IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems (E/E/PE, or E/E/PES).

IEC 61508 is a basic functional safety standard applicable to all kinds of industry. It defines functional safety as: “part of the overall safety relating to the EUC (Equipment Under Control) and the EUC control system which depends on the correct functioning of the E/E/PE safety-related systems, other technology safety-related systems and external risk reduction facilities.”

Central to the standard are the concepts of risk and safety function. The risk is a function of frequency (or likelihood) of the hazardous event and the event consequence severity. The risk is reduced to a tolerable level by applying safety functions which may consist of E/E/PES and/or other technologies. While other technologies may be employed in reducing the risk, only those safety functions relying on E/E/PES are covered by the detailed requirements of IEC 61508.

2.19 IEC 61513

IEC 61513 Nuclear Power Plants - Instrumentation and Control Important to Safety - General Requirements for Systems.

2.20 IEC 62387

IEC 62387 Radiation Protection Instrumentation - Passive Integrating Dosimetry Systems for Personal and Environmental Monitoring of Photon and Beta Radiation.

IEC 62387:2012 applies to all kinds of passive dosimetry systems that are used for measuring the personal dose equivalent (for whole body dosimetry), the personal dose equivalent (for eye lens dosimetry), the personal dose equivalent (for both whole body and extremity dosimetry), the ambient dose equivalent (for environmental dosimetry), or the directional dose equivalent (for environmental dosimetry). This standard applies to dosimetry systems that measure external photon and/or beta radiation in the dose range between 0.01 mSv and 10 Sv and in wide energy ranges. The dosimetry systems usually use electronic devices for the data evaluation and thus are often computer controlled.

2.21 IEC 61526

IEC 61526 Radiation Protection Instrumentation - Measurement of Personal Dose Equivalents Hp (10) and Hp (0, 07) for X, Gamma, Neutron and Beta Radiations - Direct Reading Personal Dose Equivalent Meter.

IEC 61526:2010 specifies general characteristics, general test procedures, radiation characteristics as well as electrical, mechanical, safety and environmental characteristics. The only requirements specified for associated readout systems are those which affect its accuracy of readout of the personal dose equivalent and alarm settings and those which concern the influence of the reader on the dosimeter. This new edition includes the following significant technical changes with regard to the previous one:
- improved determination of constancy of the dose response and statistical fluctuations;
- abolition of classes of personal dose equivalent meters in relation to retention of stored information;
- inclusion of usage categories of personal dosimeters.

2.22 IEC 61504

IEC 61504 Nuclear Power Plants - Instrumentation and control systems important to safety - Plant-wide radiation monitoring.

IEC 61504:2000 Provides guidance on the design principles and performance criteria for computer-based radiation monitoring systems. Such systems are provided to integrate the monitoring of plant-wide processes, effluent streams, and area radiation. Integrates data processing, storage, optimization, and correlation of data flow and displays.

2.23 IEC 60529

IEC 60529 Degrees of protection provided by enclosures (IP Code)

IEC 60529:2013 Applies to the classification of degrees of protection provided by enclosures for electrical equipment with a rated voltage not exceeding 72,5 kV. The standard has the status of a basic safety publication in accordance with IEC Guide 104.

2.24 IEC 61031

IEC 61031 Design, location and application criteria for installed area gamma radiation dose rate monitoring equipment for use in nuclear power plants during normal operation and anticipated operational occurrences.

IEC 61031:1990 Provides guidelines for the design principles, the location, the application, the calibration, the operation, and the testing of installed equipment for continuously monitoring local gamma radiation dose rates in nuclear power plants under normal operation conditions and anticipated operational occurrences.

2.25 IEC 61322

IEC 61322 Radiation Protection Instrumentation - Installed dose equivalent rate meters, warning assemblies and monitors for neutron radiation of energy from thermal to 15 MeV.

IEC 61322:1994 Applies to installed dose equivalent rate meters, warning assemblies and monitors, and covers equipment intended to measure neutron radiation in dose equivalent quantities of energy between thermal and 15 MeV for the purposes of radiation protection.

2.26 IEC 62138

IEC 62138 Nuclear Power Plants - Instrumentation and control important for safety - Software aspects for computer-based systems performing category B or C functions.

IEC 62138:2009 Provides requirements for the software of computer-based I&C systems performing functions of safety category B or C as defined by IEC 61226. Complements IEC 60880 and IEC 60880-2, which provide requirements for the software of computer-based I&C systems performing functions of safety category A. Is also consistent with, and complementary to, IEC 61513.

2.27 IEC 62302

IEC 62302 Radiation Protection Instrumentation - Equipment for sampling and monitoring radioactive noble gases.

IEC 62302:2007 Is applicable to equipment used for sampling and continuous measurement of radioactive noble gases in the workplace, in gaseous effluents discharged into the environment as well as in the environment itself. Monitoring by definition is the process of continuous and

real-time measurement. The processes of sampling or taking samples for retrospective laboratory analysis are covered as well.

2.28 ISO 9698

ISO 9698:2010 Water Quality, Determination of Tritium activity concentration, Liquid scintillation counting method.

ISO 9698:2010 specifies the conditions for the determination of tritium activity concentration in samples of environmental water or of tritiated water using liquid scintillation counting.

The choice of the analytical procedure, either with or without distillation of the water sample prior to determination, depends on the aim of the measurement and the sample characteristics.

Direct measurement of a raw water sample using liquid scintillation counting has to consider the potential presence of other beta emitter radionuclides. To avoid interference with these radionuclides when they are detected, the quantification of tritium will be performed following the sample treatment by distillation. Three distillation procedures are described.

The method is not applicable to the analysis of organically bound tritium; its determination requires additional chemical processing (such as chemical oxidation or combustion).

With suitable technical conditions, the detection limit may be as low as 1 Bq l^{-1}. Tritium activity concentrations below 10^6 Bq l^{-1} can be determined without any sample dilution. A prior enrichment step can significantly lower the limit of detection.

2.29 ISO 5667

ISO 5667 Water Quality, Sampling, Part 1: Guidance on the design of sampling programmes and sampling techniques.

ISO 5667-1:2006 sets out the general principles for, and provides guidance on, the design of sampling programmes and sampling techniques for all aspects of sampling of water (including waste waters, sludges, effluents and bottom deposits).

2.30 NF M 60 822

NF M 60 822-3:2013 Nuclear Energy - Radioactivity Measurement in Gaseous Effluents - Determination of Tritium and Carbon 14 Activity in Gaseous Effluents and Gas Discharge - Part 1 : Sampling of Tritium and Carbon 14 in Gaseous Effluents.

2.31 NF M 60-312

NF M 60-312:1999 Nuclear Energy. Measurement of Environmental Radioactivity-Air. Determination by Liquid Scintillation of the Activity Concentration of Atmospheric Tritium Sampled by the Sparging Technique (Air Through Water)

2.32 NF M 60-802

NF M 60-802-3:2002 Nuclear energy - Measurement of Radioactivity in the Environment - Water - Part 3 : Beta Emitters Activity Measurement by Liquid Scintillation - Particular Case of Simultaneous Presence of Tritium and Carbon 14.

2.33 NF M 60-760

NF M 60-760:2001 Nuclear Energy - Measurement Of Radioactivity In The Environment - Air - Sampling Of Aerosols For Measurement Of Radioactivity In The Environment

3 Component Design Description

This section provides a description of the individual system components and relevant standards related to the individual system components. The principal features and applicable standards of each component are identified and described. The items of equipment were identified during the task agreement with the European Domestic Agency (EU-DA) in task “trade and alternative analysis” [19].

Two of the standards listed in Section 2 are applicable to almost all of the components listed within this Section. Those standards are:

IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems (E/E/PE, or E/E/PES).

IEC 61513 Nuclear Power Plants - Instrumentation and Control Important to Safety - General Requirements for Systems.

IEC 61513 provides the additional considerations over and above IEC 61508 for nuclear applications. The design of electronic equipment covers a wide range of disciplines, mechanical, electronics, complex hardware devices, and software. The standards make further references to applicable standards for each discipline.

It is to be expected that in some cases that equipment may be designed and manufactured to alternative standards. These will need to be assessed on an individual basis to determine if the alternative standards are equivalent to the required standards, or if additional work is required to ensure that the equipment is suitable for use.

The equipment shall have common requirements/facilities as shown in the following table.

Equipment Particulars	**Comments**
Analogue Output Signals	All installed monitoring equipment shall produce signals in the standard range in mA (usually 4-20 mA). This output shall be galvanically isolated, and 2 analogue outputs are required.
Logic Output Signals (Alarm Relays)	At least one set of relay contacts for each alarm and normal state.
	Normal State: Relay energised, Contact closed.
	Alarm High: Relay de-energised, Contact open.

	Alarm High High: Relay de-energised, Contact open.
Alarm Signals	Signals shall alarm at two levels: High and High High
Audible Alarms	3 Audible alarms at >85 dB at 1 meter with 3 different tones
	Tone 1: for malfunction of the monitors (Frequency TBA)
	Tone 2: High Alarm (Frequency TBA)
	Tone 3: High High Alarm (Frequency TBA)
Visual Alarms	3 Visual Alarms with different colours to indicate the different states of alarm
	Green Light On (with no audible alarm): Normal healthy condition
	Green Light Off or Flashing: Failure state of the monitor
	Amber Light Flashing: First threshold (High) exceeded
	Red Light Flashing: Second threshold (High High) exceeded
Communications	2 Independent and Isolated networks, backbones RS485, 422 or Ethernet
	1 Local network for testing (calibration) and maintenance
Displays	To include as a minimum, the measurement, the monitor status including alarms, the value of the pre-set parameters (alarm thresholds and operational parameters)
Power Supply	Various – See Individual Requirements
Loads - The loads are dependent on the conditions in the rooms that the equipment is to be used. The specified radiological cumulative dose for equipment is the cumulative dose that the equipment will be subjected to in the location as specified in the ITER 'Safety Requirement Roombook [Ref 27].	
Seismic Loads	Variable
Thermal Loads	Inside: 18 ºC to 35 ºC Outside -25 ºC to +45 ºC
Magnetic Loads	Variable <120 mT
Pressure Loads	-50 Pa to -150 Pa
Radiological Load	Variable

3.1 Gamma Monitors (Internal)

Gamma Monitors (Internal)	
Parameter to be Measured	Gamma Radiation HP (10) according to ICPR 60
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
[1] Measurement Range 1	$5x10^{-7}$ Sv/h up to 1000 Sv/h
[1] Measurement Range 2	$5x10^{-7}$ Sv/h up to 1 Sv/h
Energy Range	50 KeV up to 7 MeV
Minimum Detectable Activity (MDA)	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Accuracy	± 20%
Response Time	< 3s at 1 mSv/h
[1] "Wide Range" or "Very Wide Rage" monitors may be available that cover the two detection ranges. However these may not meet all load requirements across the full range. Therefore product requirements specifications for potential suppliers should state that two types of the monitor are required unless the supplier can demonstrate that all required specifications can be met by one monitor type.	
Physical and Electrical	
Weight	Approximately 20 kg, max 100 kg
Size	0.5 m x 0.5 m 0.5 m
Power Supply	230 V AC
Power Consumption	35 W
Wall Mountable	Y
IP Rating	67 (detector module)
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green - Normal/healthy, • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs (Isolated)	High High, High, and Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output (Isolated)	RS 485 or Ethernet
Data Storage	TBD
Loads	
Seismic Loads	As per classification for SC1 (SF) Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2

Thermal Loads	Normal: 12 ºC – 35 ºC (40 % - 60 % RH) During Helium leak: Detecting Unit only: -30 ºC for very short period of time, assuming that the detection unit is located away from the Cryo lines, otherwise -175 ºC. During LOCA: up to 145 ºC (up to 100% RH) this is only applicable to about 30 % of the detecting units. Two ranges may be needed to cover the different detecting unit locations.
Magnetic Loads (Static)	Detecting Unit: up to 150mT Electronic Unit: up to 15mT
Pressure Loads	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa
Radiological Cumulative dose (If applicable)	Detecting Unit: > $8x10^5$ Gy (high measurement range)
	Electronic Processing Unit: > 10 Gy
Applicable Standards	IEC 60532 & IEC 60846 – See Section 2.1 & 2.2

Examples of Equipment

The gamma monitors are composed of:

- Detecting unit,
- Electronic processing unit (signal conditioning associated with a detector)

The detecting unit is based on either proportional counters, ion chambers or solid state devices. The detecting unit usually consists of a cylinder with a support for wall fixing. It is connected to the electronic processing unit by cable (up to 100 meters in length).

The electronic processing unit associated with the detecting unit calculates the measurement, compares this measurement with predefined thresholds, and initiates alarms for personnel evacuation where the measurement exceeds the predefined thresholds. The data is displayed and sent to the centralised system (ARMS and CSS).

The electronic processing unit includes a display, status lights and a termination panel.

Potential Equipment:	Mirion GIM 204K, Canberra G64 or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.2 Gamma Monitors (Environmental)

Gamma Monitors (Environmental)	
Parameter to be Measured	Gamma Radiation
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range 1	$50x10^{-9}$ Sv/h up to 1 Sv/h
Energy Range	50 KeV up to 3 MeV
Minimum Detectable Activity (MDA)	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Accuracy	± 20%
Response Time	< 3s at 1 mSv/h
Physical and Electrical	
Weight	Approximately 5 kg, max 10 kg (monitor)
Size	0.2 m x 0.5 m x 0.2 m
Connectivity	Wireless GPRS
Power Supply	Internal Battery with long life > 6 months
Power Consumption	35 W, max 50 W
Wall Mountable	Y, or mast mountable
Enclosure IP Rating	IP67
Outputs	
Alarm Outputs	N/A
Relay Outputs	N/A
Network Output	RS 485 and Ethernet
Data Storage	Yes – 3 months
Loads	
Seismic Loads	X = 6.46 m/s^2, Y = 6.46 m/s^2, Z = 9.24 m/s^2
Thermal Loads	-25 ºC to +45ºC
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa
Radiological Cumulative dose (If applicable)	N/A
Radiological Dose Rate / Day	N/A
Other Loads	These monitors may be susceptible to: extreme wind conditions of up to 166 Km/h, 100% Humidity, 30 g/KG, and mass of snow 150 daN/m2
Applicable Standards	IEC 61017 – See Section 2.12

Example of Equipment	
These Gamma Monitors are composed of a detector located in the environment that requires monitoring. The detector sends the measurement data to the Environmental Monitoring System (EMS) in the ITER HP office in the PACB by modem or GPRS. Usually, the detector is composed of two GM counters in order to cover the large range of measurements required. The detectors and the associated electronics are housed within a single, IP67 rated, weatherproof aluminium enclosure designed to provide stable, reliable performance in demanding operating environments.	

3.3 Neutron Monitors (Internal)

Neutron Monitors (Internal)	
Parameter to be Measured	Neutron Radiation
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
[1] Measurement Range 1	$5x10^{-7}$ Sv/h up to 10 Sv/h
[1] Measurement Range 2	$5x10^{-7}$ Sv/h up to $1x10^{-2}$ Sv/h
Energy Range (If applicable)	0.0025 eV (thermal neutron) up to 14 MeV
Minimum Detectable Activity (MDA)	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Accuracy	± 20%
Response Time	< 3s at 1 mSv/h
[1] "Wide Range" or "Very Wide Rage" monitors may be available that cover the two detection ranges. However these may not meet all load requirements across the full range. Therefore product requirements specifications for potential suppliers should state that two types of the monitor are required unless the supplier can demonstrate that all required specifications can be met by one monitor type.	
Physical and Electrical	
Weight	Approximately 30 kg, 100 kg max
Size	0.5m x 1m x 0.5m
Power Supply	230 V AC
Power Consumption	60 W
Wall Mountable	Y
IP Rating	N/A
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green - Normal/healthy, • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs (Isolated)	High High, High, and Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output (Isolated)	RS 485 or Ethernet
Data Storage	TBD
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2

Thermal Loads	Normal: 12 ºC – 35 ºC (40 % - 60 % RH) During Helium leak: Detecting Unit only: -30 ºC for very short period of time, assuming that the detection unit is located away from the Cryo lines, otherwise -175 ºC. During LOCA: up to 145 ºC (up to 100% RH) this is only applicable to about 30 % of the detecting units. Two ranges may be needed to cover the different detecting unit locations.
Magnetic Loads (Static)	Detecting Unit: up to 150mT Electronic Unit: up to 15mT
Pressure Load	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa
Radiological Cumulative dose (If applicable)	Detecting Unit: > $8x10^5$ Gy (high measurement range)
	Electronic Processing Unit: > 10 Gy
Applicable Standards	IEC 1005 – See Section 2.8

Example of Equipment

The neutron monitors are composed of:

- Detecting unit
- Electronic processing unit

These devices are based on proportional counters filled with a gas or a material with high effective absorption section (like B-10 or He-3). As these materials are efficient for thermal neutrons, the detecting units are surrounded with a moderator to slow the neutrons.

Usually, the detector is placed inside a polyethylene sphere or cylinder with a mounting bracket. This is connected to the electronic processing unit by a cable (up to 100 metres in length).

The electronic processing unit associated with the neutron sensor calculates the measurement, compares this measurement with predefined thresholds and initiates alarms for personnel evacuation where the measurement exceeds the predefined thresholds. The data is displayed and sent to the centralised system (ARMS and CSS). The electronic processing unit includes a display, status lights and a termination panel.

Potential Equipment:	Mirion NIM 201K,Canberra NP 100H or equivalent

	Note – all will require seismic and magnetic qualification against the ITER expected loads

3.4 Neutron Monitors (Environmental)

Neutron Monitors (Environmental)	
Parameter to be Measured	Neutron Radiation
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
[1] Measurement Range 1	$5x10^{-7}$ Sv/h up to 10 Sv/h
[1] Measurement Range 2	$5x10^{-7}$ Sv/h up to $1x10^{-2}$ Sv/h
Energy Range	0.0025 eV (thermal neutron) up to 14 MeV
Minimum Detectable Activity (MDA)	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Accuracy	± 20%
Response Time	< 3s at 1 mSv/h
[1] "Wide Range" or "Very Wide Rage" monitors may be available that cover the two detection ranges. However these may not meet all load requirements across the full range. Therefore product requirements specifications for potential suppliers should state that two types of the monitor are required unless the supplier can demonstrate that all required specifications can be met by one monitor type.	
Physical and Electrical	
Weight	Approximately 30 kg, 100 kg max
Size	0.5m x 1m x 0.5m
Power Supply	230 V AC
Power Consumption	60 W
Wall Mountable	Y
Enclosure IP Rating	IP67
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green - Normal/healthy, • Green flashing – Monitor in failed state, • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs	High High, High, and Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	RS 485
Data Storage	None

Loads	
Seismic Loads	X = 6.46 m/s^2, Y = 6.46 m/s^2, Z = 9.24 m/s^2
Thermal Loads	-25 ºC to 45 ºC
Magnetic Loads	N/A
Pressure Load	-93 kPa to -104 kPa
Radiological Cumulative dose (If applicable)	N/A
Radiological (Dose Rate / Day)	Min: Max:
Other Loads	These monitors maybe be susceptible to: extreme wind conditions of up to 166Km/h, 100% Humidity, 30g/KG, and mass of snow 150 daN/m2
Applicable Standards	IEC 1005 – See Section 2.8

Example of Equipment

The neutron monitors are composed of:

- Detecting unit
- Electronic processing unit

These devices are based on proportional counters filled with a gas or a material with high effective absorption section (like B-10 or He-3). As these materials are efficient for thermal neutrons, the detecting units are surrounded with a moderator to slow the neutrons.

Usually, the detector is placed inside a polyethylene sphere or cylinder with a mounting bracket. This is connected to the electronic processing unit by a cable (up to 100 metres in length).

The electronic processing unit associated with the neutron sensor calculates the measurement, compares this measurement with predefined thresholds and initiates alarms for personnel evacuation where the measurement exceeds the predefined thresholds. The data is displayed and sent to the centralised system (ARMS and CSS). The electronic processing unit includes a display, status lights and a termination panel.

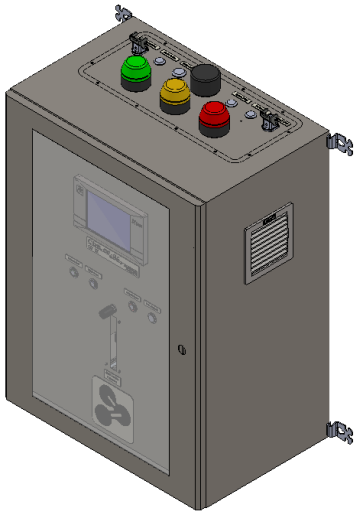
Potential Equipment:	Mirion NIM 201K, Canberra NP 100H or B or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.5 Tritium Monitors (Internal)

Tritium Monitors (Internal)	
Parameter to be Measured	Tritium
Quality Class	Q1
Safety Class	SIC-1A
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
[1] Measurement Range 1	10^4 Bq/m^3 up to 10^{10} Bq/m^3 (Room monitoring)
[1] Measurement Range 2	5 x 10^3 Bq/m^3 up to 10^{10} Bq/m^3 (Release monitoring)
Energy Range	18 KeV
Minimum Detectable Activity (MDA)	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Accuracy	± 10%
Response Time	< 15 s at the second decade
[1] "Wide Range" or "Very Wide Rage" monitors may be available that cover the two detection ranges. However these may not meet all load requirements across the full range. Therefore product requirements specifications for potential suppliers should state that two types of the monitor are required unless the supplier can demonstrate that all required specifications can be met by one monitor type.	
Physical and Electrical	
Weight	Approximately 30 kg, Max 50 kg
Size	0.5 m x 0.5 m x 1 m
Power Supply	230 V AC
Power Consumption	500 W
Wall Mountable	Y
IP Rating	N/A
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green - Normal/healthy, • Green flashing – Monitor in failed state, • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs (Isolated)	High High, High, and Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output (Isolated)	RS 485 or Ethernet
Data Storage	TBD
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)

	During a LOCA: 100% humidity of the sampled air is possible.
Magnetic Loads	15 mT
Pressure Load	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa
Radiological Cumulative dose (If applicable)	Detecting Unit: > 20 Gy (high measurement range)
Compensation	Radon and Gamma Background, Argon 41
Applicable Standards	IEC 62303 – See Section 2.3

Examples of Equipment



The online tritium monitors are based on standard flow-through ionization chambers via a continuously pumped sampler.

Each tritium monitor is composed of:

- Detecting unit (ion chamber),
- Pumping unit (to collect the air to be measured),
- Electronic processing unit (signal conditioning, elaboration of measurement, comparison with threshold, initiates alarm).

The volume of the ion chambers will be chosen depending on the range of the measurement required. This range of measurement has to cover the lower concentration of tritium (less than 1 DAC) up to the high level concentration of tritium due incident or accident conditions (10^{10} Bq/m^3).

The ion chambers will be protected against the particulates.

The electronic processing unit associated with the detector assembly calculates the measurement, compares the measurement to predefined thresholds, displays the status of the unit, displays the data, and sends the data to the Area Radiological Monitoring System (ARMS Plant Control System) and the Central Safety System (CSS) for the Tokamak Building Access System (TBAS system).

All the items of equipment (ion chamber, pump, filter, processing unit, etc.) that comprise the tritium monitor are contained in a single box. The monitor includes a display, status lights, a speaker for the audible alarm and a termination panel.

Two independent monitors are installed to check for tritium release at the stack;

- One online tritium monitor is based on standard flow-through ionization chamber via a continuously pumped sample,
- The other online tritium monitor is based on a proportional counter via a continuously pumped sample.

Tritium Monitor Based on an Ion Chamber

This tritium monitor based on the ion chamber is identical to those used in the room monitoring, but the volume of the ion chamber is larger (8 litres) in order to improve the detection limit (5000 Bq/m^3).

Tritium Monitor Based on the Proportional Counter

The air to be measured is mixed with a suitable counting gas and passed through a 1.3 litre volume proportional counter tube. Methane (mixing ratio air/gas 1:3), Argon-Methane (P10, mixing ratio air/gas1:4) or Argon-CO2 can be used as the counting gas.

The ionizing created by tritium is collected in the proportional counter. A discrimination method based on rise time of pulse allows discriminating between tritium pulses and other nuclides or from gamma radiation.

The processing unit associated with the proportional counter calculates the measurement, compares the measurement to predefined thresholds, displays the status of the unit, displays the data and sends the data to the Area Radiological Monitoring System (ARMS) and to the Central Safety System (CSS).

This item of equipment is mounted in a 19” rack. The 19” rack can be wall mounted.

Potential Equipment:	Mirion TM202, Canberra TAM100DSI, Berthold LB110, Overhoff 421 NPPM, Premium Analyse DTIonix or equivalent

	Note – all will require seismic and magnetic qualification against the ITER expected loads Due to the nature of the tritium hazard in ITER, diverse manufacturers are recommended, particularly for SIC-1A functions. Required Tritium detection functions and specifications for the HVAC DS application should be checked in final specifications

3.6 Contamination in Air Monitors (Internal)

Contamination in Air Monitors (Internal)	
Parameter to be Measured	Beta & Gamma Radiation
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Measurement Range 1	0.1 Bq/m^3 up to 10^5 Bq/m^3
Energy Range	50 KeV up to 2 MeV
Minimum Detectable Activity (MDA) 95%	0.8 Bq/m^3 in 1 Bq/m^3 of Radon and 0.1 µSv/h background
Trapping Efficiency	> 99%
Air Flow & Accuracy	Yes
Compensation (If applicable)	Radon and gamma
Accuracy	±10%
Response Time	< 60 mn at 5 Bq/m^3 and < 15 mn at 100 Bq/m^3
Physical and Electrical	
Weight	Approximately 200 kg
Size	1.5 m x 1 m x 0.5 m
Power Supply	230 V AC
Power Consumption	< 0.5 kW
Wall Mountable	N – mounted on the ground.
IP Rating	N/A
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green – Normal/healthy • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs	High High, High, and Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Data Storage	TBD
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH) During a LOCA: 100% humidity of the sampled air is possible.
Magnetic Loads	15 mT
Pressure Load	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa

Radiological Cumulative dose (If applicable)	Detecting Unit: > 20 Gy (high measurement range)
Compensation	Radon and Gamma Background
Applicable Standards	IEC 60761 – See Section 2.4 & 2.5

Example of Equipment

These particulates are usually trapped on a filter following iso-kinetic sampling from a duct. A radiation detector mounted in front of the filter measures both alpha and beta radioactivity in the material deposited on the filter. The air flow rate is also measured directly and recorded by the instrument. A processing unit with appropriate algorithm calculates the measurement, compares this measurement to predefined thresholds and initiates alarms if needed. The data is sent to the Area Radiological Monitoring System (ARMS) and the Central Safety System (CSS).

The airborne radon/thoron alpha, beta background and gamma background radiation will be compensated for during the measurement.

In addition, the monitors can have a dedicated sampling line for periodic analysis of the filters in laboratory.

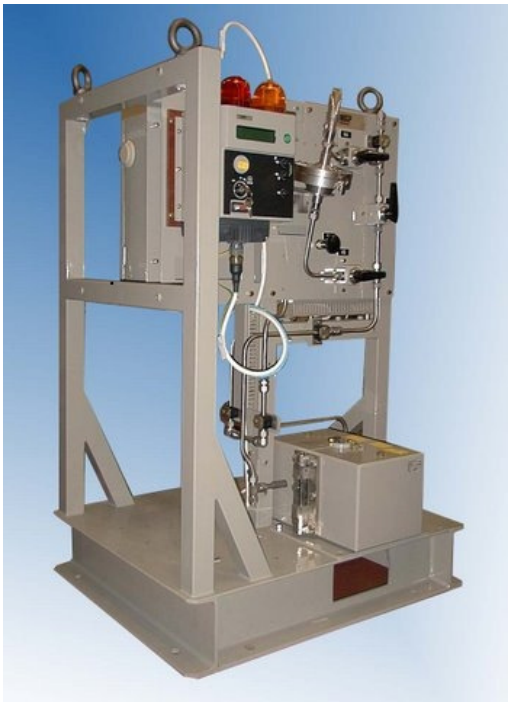
The monitor includes a display, status lights and a termination panel.

3.7 Gas Monitors (Internal)

Gas Monitors (Internal)	
Parameter to be Measured	Beta & Gamma Radiation
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Measurement Range 1	10^4 Bq/m^3 up to 10^8 Bq/m^3
Measurement Range 2 (Stack)	10^2 Bq/m^3 up to 10^8 Bq/m^3 (Ar^{41} reference)
Energy Range (If applicable)	> 80 KeV
Minimum Detectable Activity (MDA) 95%	1000 Bq/m^3 in background < 7.5 μSv/h for stack monitoring
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation	Tritium, Radon and Gamma Background
Accuracy	±10%
Response Time 1	< 60 s at 10^4 Bq/m^3 and < 10 s at 10^5 Bq/m^3
Response Time 2 (Stack)	< 30 mn at 100 Bq/m^3, < 60 s at 1000 Bq/m^3, < 10 s at 10^5 Bq/m^3
Physical and Electrical	
Weight	Up to 500 kg
Size	1.3 m x 1 m x 1 m max
Power Supply	230V AC
Power Consumption	0.5 kW
Wall Mountable	N
IP Rating	N/A
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green – Normal/healthy • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs	High High, High, and Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Data Storage	TBD
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH) During a LOCA: 100% humidity of the sampled air is possible.
Magnetic Loads	15 mT

Pressure Load	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa
Measruement Range (If applicable)	>85% CO and CO2
Radiological Cumulative dose (If applicable)	Detecting Unit: > 20 Gy (high measurement range)
Compensation	Tritium, Radon and Gamma Background
Applicable Standards	IEC 60761 – See Section 2.4 & 2.5

Example of Equipment



These devices are based on a detector in front of a measurement chamber where the air is continuously pumped by a sampling line. The detector discriminates signals coming for low energy (<80 KeV) in order to monitor only Ar^{41} and C^{14} and eliminate tritium (energy 18 KeV). Shielding around the measurement chamber protects against background gamma radiation.

The airborne radon/thoron alpha, beta background and gamma background radiation will be compensated for during the measurement.

The monitor includes a display, status lights and a termination panel.

The data is displayed and sent to the centralised computers systems (ARMS and CSS).

The main objective of the stack gas monitors is the capability to measure the low level of Argon 41 (around 500 Bq/m^3) in order to be compliant with the annual limit of release.

These devices are based on detectors (scintillation or proportional counter) around a measurement chamber where the air is continuously pumped by a sampling line.

The detector discriminates signals coming for low energy (<80 KeV) in order to monitor only Ar^{41} and C^{14} and eliminate tritium (energy 18 KeV).	
Potential Equipment:	Mirion TM202, Canberra CAM100G Radioactive Gas Monitor, or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.8 Tritium Samplers (Internal)

Tritium Samplers (Internal)	
Parameter to be Measured	Tritium and Discriminative HT/HTO
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Measurement Range 1	N/A
Energy Range (If applicable)	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	> 95 % HT and HTO
Air Flow & Accuracy	10 up to 100 l/h $\pm$5%
Compensation (If applicable)	N/A
Accuracy	N/A
Response Time	N/A
Physical and Electrical	
Weight	Approximately 30 kg, 50 kg max
Size	1 m x 0.6 m x 0.6 m
Power Supply	230 V AC
Power Consumption	700 W
Wall Mountable	Y
IP Rating	N/A
Outputs	
Alarm Outputs	N/A
Relay Outputs	Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	Ethernet
Data Storage	Flow rate and sample duration
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	15 mT
Pressure Load	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa
Radiological Cumulative dose (If applicable)	Detecting Unit: > 20 Gy (high measurement range)
Compensation	N/A
Applicable Standards	IEC 62303 – See Section 2.3

Examples of Equipment

Online tritium samplers are used to determine the Molecular Hydrogen Containing Tritium/Tritiated Water (HT/HTO) ratio and to check for low level of tritium concentrations (low level leak) or absence of tritium.

Online tritium samplers use the bubbling principle in which tritium is trapped in water followed by analysis performed in the Health Physics laboratory.

Tritiated water vapour is trapped in the first two feeding bottles due to the bubbling principle. To trap the tritium which is combined with organic materials, an oxidation reaction is created in the oven. A catalyser is used to lower the combustion level. This causes tritium to react chemically to form tritiated water vapour which is trapped in feeding bottles number 3 and number 4.

After a specified sampling period the tritiated water contained in the bottles is measured in a laboratory by liquid scintillation counting. The quantity of tritium measured is compared to the volume of air which has passed through the equipment.

A Health Physics program will be established which will define the frequency of analysis (periodic and/or before access in room where tritium concentration is expected).

For seismic characteristics, missile effects are not considered but maintained structural integrity is essential (units can be replaced following seismic events).

Potential Equipment:	CANBERRA TBC100 tritium bubbler, SDEC MARC 7000 or equivalent

	F&J MRB500 Overhoff Technology TASC Note – all will require seismic and magnetic qualification against the ITER expected loads.

3.9 Carbon 14 Samplers (Internal)

Carbon 14 Samplers (Internal)	
Parameter to be Measured	Carbon 14 and Discriminative CO/CO_2/Organic C
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Energy Range (If applicable)	N/A
Minimum Detectable Activity (MDA) 95%	1 Bq/m^3 after measurement in laboratory
Trapping Efficiency	> 85% CO and CO_2
Air Flow & Accuracy	10 up to 100 l/h $\pm$5%
Compensation (If applicable)	N/A
Accuracy	N/A
Response Time	N/A
Physical and Electrical	
Weight	Approximately 30 kg, 50 kg max
Size	1 m x 0.6 m x 0.6 m
Power Supply	230 V AC
Power Consumption	0.7 kW
Wall Mountable	N
IP Rating	N/A
Outputs	
Alarm Outputs	N/A
Relay Outputs	Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	Ethernet
Data Storage	Flow rate and sample duration
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH) During a LOCA: 100% humidity of the sampled air is possible.
Magnetic Loads	15 mT
Pressure Load	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa
Radiological Cumulative dose (If applicable)	Detecting unit: > 20 GY (high measurement range)
Compensation	N/A
Applicable Standards	IEC 61304 – See Section 2.6

Example of Equipment

One line Carbon 14 samplers are used to evaluate the C^{14} (as form CO_2, CO gas or organic C) concentration.

The principle is the same as tritium samplers but the water is replaced by a soda solution. Carbon 14 is trapped in a soda solution or a scintillating liquid for further spectrometry analysis in a laboratory.

The CO_2 gas is directly trapped into the first and second bottles. The CO gas and organic C are oxidised in the oven to form CO_2 which is trapped in the third and fourth bottles.

After a defined sampling period, the CO_2 contained in the bottles is measured by liquid scintillation counting in the health Physics laboratory. The ratio between radionuclides quantity measured in the bottles, and volume of air through the sampler allows C14 concentration to be calculated.

A Health Physics program will define the frequency of analysis (periodic and/or before accessing rooms where Carbon 14 concentration is expected).

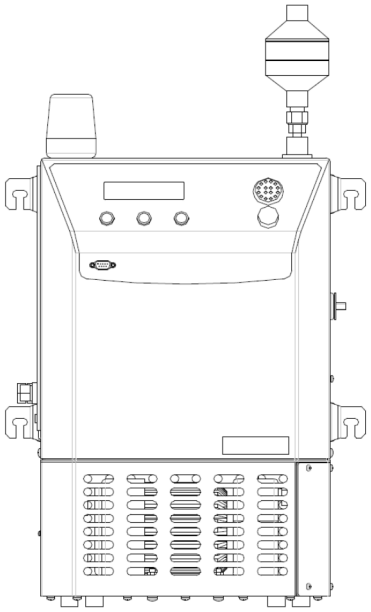
For seismic characteristics, missile effects are not considered but maintained structural integrity is essential (units can be replaced following seismic events).

Potential Equipment:	SDEC HAGUE 7000 , Overhoff Technology TASC or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.10 Particulate Samplers (Internal)

Particulate Samplers (Internal)	
Parameter to be Measured	Radioactive Particulates
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Energy Range (If applicable)	N/A
Minimum Detectable Activity (MDA) 95%	10^{-4} Bq/m^3 after measurement in laboratory
Trapping Efficiency	> 99.9%
Air Flow & Accuracy	10 up to 100 l/mn ±5%
Compensation (If applicable)	N/A
Accuracy	N/A
Response Time	N/A
Physical and Electrical	
Weight	Approximately 50 kg
Size	0.5 m x 0.5 m x 1 m
Power Supply	230 V AC
Power Consumption	< 0.5 kW
Wall Mountable	N
IP Rating	N/A
Outputs	
Alarm Outputs	N/A
Relay Outputs	Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Data Storage	Flow rate and sample duration
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH) During a LOCA: 100% humidity of the sampled air is possible.
Magnetic Loads	15 mT
Pressure Load	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa
Radiological Cumulative dose (If applicable)	Detecting Unit: > 20 GY (high measurement range)
Compensation	N/A
Applicable Standards	IEC 60761-2 – See Section 2.4 & 2.5

Example of Equipment



Particulate samplers are used to determine the type of radioactive nuclides present in air and to check the low level concentration of radioactive particulates.

In online particulate samplers particulates are normally trapped on a filter through iso-kinetic sampling from a duct; analysis is performed offline in the Health Physics Laboratory. The duct air flow is measured directly and recorded by the instrument.

After the period of sampling, the filters will be analysed in the Health Physics laboratory by a beta gamma counting system and by spectrometry in order to determinate the quantity of beta and gamma emitters and the types of nuclide present in ambient air.

A Health Physics program shall be established which will define the frequency of analysis (periodic and/or before accessing rooms where particulate contamination could be expected).

Potential Equipment:	Mirion PIS 205L , F&J DF-1E, AS 5000 SDEC or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.11 Particulate Samplers HVAS (Environmental)

Particulate Samplers HVAS (Environmental)	
Parameter to be Measured	Radioactive Particulates
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Energy Range (If applicable)	N/A
Minimum Detectable Activity (MDA) 95%	10^{-4} Bq/m^3 after measurement in laboratory
Trapping Efficiency	>99%
Air Flow & Accuracy	10 up to 70 m^3/h $\pm$5%
Size of Filters	120/130 filter diameter
Compensation (If applicable)	N/A
Accuracy	N/A
Response Time	N/A
Physical and Electrical	
Weight	30kg, max 120kg
Size	Max 1 m x 1.6m x 1 m
Connectivity	N/A
Power Supply	230V AC
Power Consumption	< 4 kW
Wall Mountable	N
IP Rating	IP67
Outputs	
Alarm Outputs	N/A
Relay Outputs	Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	N/A
Data Storage	Flow rate and duration of sample period
Loads	
Seismic Loads	X = 6.46 m/s^2, Y = 6.46 m/s^2, Z = 9.24 m/s^2
Thermal Loads	-25 ºC to +45ºC
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa
Radiological Cumulative dose (If applicable)	N/A
Other Loads	These monitors may be susceptible to: extreme wind conditions of up to 166 Km/h, 100% Humidity, 30 g/KG, and mass of snow 150 daN/m2
Applicable Standards	NF-M-60-760

Example of Equipment

High volume particulate samplers are composed of an airflow system, a volumetric counter and a support filter protected against rainfall.

The shape of the sampling head (see figure above) reduces the impact from atmospheric turbulence on samples, and minimises the impact on the distribution of the sizes of the aerosols.

The air flow (around 70 m^3/h) is measured directly and reported by the instrument.

The status of the equipment will be sent to the Environmental Monitoring System (EMS) at the HP office.

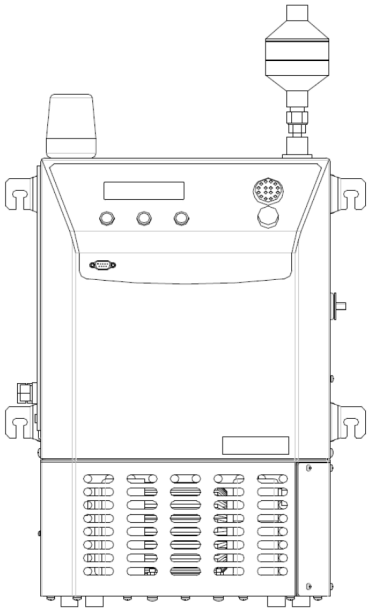
The equipment is installed in the same cabinet as the Tritium sampler.

Potential Equipment:	F&J DFHV-1, EAS-6-100K Algade or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.12 Beryllium Samplers (Internal)

Beryllium Samplers (Internal)	
Parameter to be Measured	Radioactive Beryllium Particulates
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Energy Range (If applicable)	N/A
Minimum Detectable Activity (MDA) 95%	10^{-4} Bq/m^3 after measurement in laboratory
Trapping Efficiency	> 99.9%
Air Flow	10 up to 100 l/min
Compensation (If applicable)	N/A
Accuracy of Air Flow	±5%
Response Time	N/A
Physical and Electrical	
Weight	Approximately 50 kg
Size	0.5 m x 0.5 m x 1 m
Power Supply	230 V AC
Power Consumption	0.5 kW
Wall Mountable	N
Outputs	
Alarm Outputs	N/A
Relay Outputs	N/A
Network Output	RS 485 or Ethernet
Data Storage	Flow rate and sample duration
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH) During a LOCA: 100% humidity of the sampled air is possible.
Magnetic Loads	15 mT
Pressure Load	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa
Radiological Cumulative dose (If applicable)	Detecting Unit: > 20 GY (high measurement range)
Compensation	N/A
Applicable Standards	IEC 60761-2 – See Section 2.5

Example of Equipment



Particulate samplers are used to determine the type of radioactive nuclides present in air and to check the low level concentration of radioactive particulates. Particulate Beryllium is measured using this technique.

Particulate samplers trap the Beryllium particulates on a filter through iso-kinetic sampling from a duct; analysis is performed offline in the Health Physics Laboratory. The duct air flow is measured directly and recorded by the instrument.

After the period of sampling, the filters will be analysed in the Health Physics laboratory by a beta gamma counting system and by spectrometry in order to determinate the quantity of beta and gamma emitters and the types of nuclide present in ambient air.

A Health Physics program shall be established which will define the frequency of analysis (periodic and/or before accessing rooms where particulate contamination could be expected).

Potential Equipment:	Mirion APA91 , F&J DF-1E, PIS 205 from MIRION, AS 500 from SDEC or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.13 Flow Meters (Internal)

Flow Meters (Internal)	
Parameter to be Measured	Exhaust Gas Flow
Quality Class	Q1
Safety Class	SIC-1A
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Measurement Range 1	First Plasma 0 - 320,000 m^3/h
Measurement Range 2	Second Plasma 0 - 500,000 m^3/h
Measurement Range 3	SIC Stack 0 - 12,000 m^3/h
Energy Range (If applicable)	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow	TBD
Compensation (If applicable)	N/A
Accuracy	±5%
Response Time	< 2 seconds
Physical and Electrical	
Weight	Approximately 10 kg
Size	0.5 m x 0.5 m x 0.5 m
Power Supply	230 V AC
Power Consumption	30 W
Wall Mountable	N
IP Rating	N/A
Outputs	
Alarm Outputs	N/A
Relay Outputs	High, Low, Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Analogue Output	4-20 mA
Data Storage	None
Loads	
Seismic Loads	R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	< 15 mT
Pressure Load	-50 Pa to -100 Pa
Radiological Cumulative dose (If applicable)	N/A
Compensation	Temperature
Applicable Standards	TBD

Example of Equipment
(Note: Suitable for pipe but not for stack with large diameter).

The flow meters measure the gas flow rate for the gases that are being released from the exhausts. A pitot static device is recommended to cover the span of the exhausts and give the best measurement range and flow averaging without significantly interfering with the flow rate.

The flow rate is used with the data from the radiation monitors to determine how much activity is being released.

Please note that some of the flow meters are located outside of the buildings, and will therefore be exposed to external environmental conditions.

3.14 Dosimeters (Electronic Personal Dosimeter)

Dosimeters Active (Electronic Personal Dosimeter)	
Parameter to be Measured	X Ray, Gamma, Beta and Neutrons
Quality Class	
Safety Class	
Seismic Class	
I&C Classification	
Measurement	
Measurement Range 1 X Ray	1 µSv up to 10 Sv ±20%
Measurement Range 2 Gamma	1 µSv up to 10 Sv ±20%
Measurement Range 3 Beta	1 µSv up to 10 Sv ±20%
Measurement Range 4 Neutrons	1 µSv up to 10 Sv ±20%
Measurement Range 5 Dose Rate	1 µSv/h up to 10 Sv/h ±20%
Energy Range (X Ray) 1	20 KeV up to 10 MeV ±20%
Energy Range (Gamma) 2	20 KeV up to 10 MeV ±20%
Energy Range (Beta) 3	20 KeV up to 10 MeV ±20%
Energy Range (Neutrons) 4	Thermal n/ to 15 MeV ±30%
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
<Unit specific parameter>	Alarm threshold setting within the complete effective range
<Unit specific parameter>	(Dose and Dose Rate)
Accuracy	–17 % to +25 % as per IEC 61526
Response Time	< 2s above 1mSv/h
Physical and Electrical	
Weight	< 100g
Size	0.1 m x 0.07 m x 0.015 m
Connectivity	Connect to Dosimeter Reader
Power Supply	Battery
Power Consumption	> 6 months with standard batteries
Wall Mountable	N
IP Rating	IP 67
Outputs	
Audible Alarm	> 85 dB at a distance of 30cm
Visual Alarm	By LED or Display
Network Output	Connect to Dosimeter Reader
Data Storage	Data from 500 Dosimeters
Loads	

Seismic Loads	N/A
Thermal Loads	N/A
Drop tests	The Defined Requirement and IEC 61526 cover drop tests, shocks and vibrations that this equipment is expected to survive
Shock	
Vibrations	
EMC Loads	Additional EMC tests will need to be defined.
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	IEC 61526 – See Section 2.21

Examples of Equipment

The Electronic Personal Dosimeters (EPD) will be presented in a pocket sized box. It will be light, dust-proof, waterproof and compact. This device is intended to be worn on a person's body (usually on, or in, the chest pocket, dependent on the design of the coveralls/EPD).

The EPD will be equipped with audible and visual alarms, and the display will be located on the top of the dosimeter to allow reading of the dosimeter whilst worn on, or in, the chest pocket.

The EPDs will be stored in a dedicated rack at the entrance of the PACB building, when not in use.

3.15 Dosimeter (EPD) Readers

Dosimeter Readers	
Parameter to be Measured	Record the Data collected by the Active Dosimeters in the previous section: X Ray, Gamma, Beta and Neutrons
Quality Class	
Safety Class	
Seismic Class	
I&C Classification	
Measurement	
Measurement Range	N/A
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Accuracy	N/A
Response Time	< 2s
Physical and Electrical	
Weight	10 kg
Size	0.5 m x 0.5 m x 0.2 m
Connectivity	Must connect to EPDs
Power Supply	230 V AC
Power Consumption	500 W
Wall Mountable	Y
IP Rating	N/A
Outputs	
Audible Alarm	Yes
Visual Alarm	Restrictions and status to be shown on display
Network Output	RS 485 to REMS. Wireless configuration of dosimeters
Data Storage	30 days logging of all reads and writes to dosimeters
Loads	
Seismic Loads	X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	5 mT
Pressure Load	-50 Pa to -100 Pa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	IEC 61526 – See Section 2.21

Examples of Equipment

The dosimeter readers at the entrance of controlled areas will automatically detect the dosimeters worn by the workers or visitors who want to go into the controlled area. The data related to each worker or visitor will be transmitted and analysed in real time by IMS (dose management system) in order to:

- Record the doses received by the workers within the controlled areas;
- Authorise or deny access into the controlled areas (a signal will be sent to the gate of access control system (PBS 69) by the dosimeter readers).

The dosimeter reader will also configure the Dosimeter (alarms setting, calibration parameters, status of the dosimeter etc.) based on IMS data.

At each entrance or exit of the building within controlled areas, the dosimeter data will be transferred and registered when the worker walks past the dosimeter reader in order to identify the doses received by the worker in each building.

The dosimeter readers enable the exchange of data between the dosimeter and the central unit.

The dosimeter readers will include a keyboard to allow the manual entry of a task code.

Functions of Dosimeter Readers:

Function	Data	Periodicity
Acquisition	All the data from the dosimeters	Automatic when dosimeter is presented to the dosimeter reader at the access/exit controlled areas.
	Work code for the task to be performed in the controlled area	Manual (code entry via keyboard)
Processing	Send a signal to the Access Control System to authorize or deny access to the controlled area based on IMS data	Automatic
	Configuration of the dosimeter (alarm setting, calibration parameters, status of dosimeter etc.) based on IMS data.	Automatic when the dosimeter is presented to the dosimeter reader. (Access to controlled areas and the correct alarm settings, calibration data required for the specific work code) These may differ for workers/visitors.
	Transmit all the information from the dosimeter to IMS	Automatic
Display	Message of alarms/events (tests, status of dosimeter readers, malfunction of components or links, instructions for user	In real time (< 2 s)
	Identification of workers, dosimeters, tasks	Automatic
	Authorization of access	Automatic
Record	All the data from the dosimeter (short term storage in case of power supply failure). The permanent archiving is performed by IMS and the IT system.	Automatic
Administration	Configuration of the dosimeter reader.	Automatic by IMS
	Test/Maintenance	Automatic by IMS
Communication	Between upper level (IMS system) and lower level (dosimeter)	Automatic

3.16 Passive Dosimeters

Dosimeter Passive (Film Badges)	
Parameter to be Measured	X Ray, Gamma, Beta and Neutrons
Quality Class	
Safety Class	N/A
Seismic Class	N/A
I&C Classification	N/A
Measurement	
Measurement Range 1 X Ray	10 KeV up to 10 MeV
Measurement Range 2 Gamma	10 KeV up to 10 MeV
Measurement Range 3 Beta	100 KeV up to 3 MeV
Measurement Range 4 Neutrons	Thermal n/Speed n 17 KeV up to 17 MeV
Energy Range (X Ray) 1	< 0.02mSv up to 10 Sv ±5%
Energy Range (Gamma) 2	< 0.02mSv up to 10 Sv ±5%
Energy Range (Beta) 3	< 0.02mSv up to 10 Sv ±5%
Energy Range (Neutrons) 4	0.1mSv up to 1Sv ±10%
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Accuracy	±10%
Response Time	N/A
Physical and Electrical	
Weight	< 100 g
Size	0.1 m x 0.05 m x 0.01 m
Connectivity	N/A
Power Supply	N/A
Power Consumption	N/A
Wall Mountable	N
IP Rating	N/A
Outputs	
Alarm Outputs	N/A
Relay Outputs	N/A
Network Output	N/A
Data Storage	N/A
Loads	
Seismic Loads	NA
Thermal Loads	-25°C up to +45°C
Magnetic Loads	<120 mT
Pressure Load	-50 Pa to -150 Pa

Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	IEC 62387 – See Section 2.20

Examples of Equipment- Personnel, Zoning and Environmental

The functions of passive dosimeters are to provide integrated external doses for personnel over the required time span within the supervised and controlled areas, to perform cumulative doses and to record individual doses received by the workers.

X-rays, Beta and Gamma Radiation:

For measuring X/γ and β radiation, RPL (Radio Photo Luminescence), TLD (Thermo-Luminescence Dosimeter) or OSL (Optically Stimulated Luminescence) are commercially available. Dosimeters based on RPL are currently the preferred option due to their energy sensitivity and lower detection threshold, and their compliance with the new regulation (IEC 62387). IRSN advise using this dosimeter.

The RPL dosimeters use a material in silver activated phosphate glass and when the silver activated glass is exposed to radiation, stable luminescence centres are created in silver ions. These luminescence centres emit light upon excitation. The readout technique uses pulsed ultraviolet laser excitation and the intensity of the emitted light is proportional to the radiation exposure.

Neutron Radiation

For measuring neutron radiation, the principle of measurement is based on counting the number tracks etched into the surface of a CR-39 detector after irradiation. These tracks are caused by either recoil protons produced by the interaction of neutrons with the hydrogen atoms contained in a polyethylene radiator, or alternatively by alpha particles produced from the 10B(n, α)7Li reaction in boron loaded radiator.
Following irradiation, the material is etched in a bath of sodium hydroxide for approximately 15 hours at 70°C, to enlarge the proton recoil or alpha tracks. The dose is then evaluated by counting the number of tracks.

For measuring neutron radiation, Polycarbonate technology (CR-39) is currently the preferred option.

Passive dosimeters will be mounted in a holder (appropriate to the application) intended to be worn on a person's body (usually on the chest pocket) or, to be installed in the room of the facility in order to check the zoning or, to be located in the environment for example at the INB fence with the aim to measure the background radiation around the ITER site.

The dosimeters used for the personnel dosimetry will be stored on a dedicated rack at the entrance of the PACB building.

The dosimeters will be capable of measuring X-ray, beta and gamma radiations (RPL dosimeter) and neutron radiations (CR-39 dosimeter).

All the required information for the dosimeter shall be recorded on the body of the dosimeter (i.e. the number of the dosimeter, the period of wearing this device, the place of use).

3.16.1 Personnel Beryllium Samplers

Personnel Beryllium Samplers	
Parameter to be Measured	Beryllium Particulates
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Accuracy	Accuracy: ± 5% of compensation range
Flow Range:	0.8 – 5 LPM (800-5000 cc/min) 5-799 cc/min with Universal Low Flow Holder
Compensation Range:	5000 cc/min - 800 cc/min (10” to 15” water back pressure)
Type & Size of Filters	Cellulose or Glass, Diameters 47 mm and 140 mm
Flow Rate, and Accuracy	> 100 l/min and around 2 m^3/h, <±5%
Data Storage	Last flow rate, elapsed clock time and accumulated volume is saved into memory until cleared for next sampling.
Physical and Electrical	
Weight	540 g
Size	11.4 cm H × 10.2 cm W × 5 cm D
Power Supply	Battery and 230 VAC charging
Power Consumption	< 1 kW
IP Rating	N/A
Applicable Standards	TBD

Personal Air Samplers are used to capture Beryllium particulates. The samples will be analysed in the laboratory in the same way as the other particulates and with the same requirements and specifications as other sampling equipment.

Examples of Equipment:

Potential Equipment	F&J - Econoair L-12P, F&J - Econoair L-15P RADECO RAD-Pro 5 PROMINDUS - Algade or equivalent

3.17 Portable Equipment

There are numerous examples of portable equipment that will be used on and around the ITER site.

All portable devices are required to be compact, lightweight, of rugged construction, with sufficient autonomy (battery life, and/or be able to be powered locally) and be easy to use and maintain. They will include:

- Portable X Ray, Beta, Gamma, Dose and Dose Rate Monitors,
- Portable Neutron Dose and Dose Rate Monitors,
- Portable Beta, Gamma Surface Contamination Monitors,
- Portable Tritium Concentration in Air Monitors,
- Portable Air Samplers for Radioactive Particulates,
- Portable Air Samplers for Beryllium Particulates,
- Portable Tritium Air Samplers,
- Portable Carbon 14 Samplers,
- Portable Aqueous Samplers,
- Portable Radon Monitors.

3.17.1 Portable X Ray, Beta, Gamma Dose and Dose Rate Meters

Portable X Ray, Beta, Gamma Dose and Dose Rate Meters (Under HP10)	
Parameter to be Measured	X Ray, Beta and Gamma
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range 1 X Rays	0.01 µSv/h up to 100 µSv/h
Measurement Range 1 Beta, Gamma (Lower Range)	0.01 µSv/h up to 100 µSv/h
Measurement Range 2 Beta, Gamma (Intermediate Range)	1 µSv/h up to 500 mSv/h
Measurement Range 3 Beta, Gamma (High Range)	10 µSv/h up to 10 Sv/h
Energy Range 1 X Rays	5 to 200 KeV
Energy Range 2 Beta, Gamma	30 to 7000 KeV
Physical and Electrical	
Weight	1 kg
Size	0.2 m x 0.2 m x 0.2 m
Power Supply	Battery
Power Consumption	Battery must last 6 months
IP Rating	N/A
Applicable Standards	IEC 60846 and IEC 60325 – See Sections 2.2 & 2.15

Examples of Equipment:

Portable Dose Rate Monitors

X probe

Gamma probe

Basic unit with telescopic probe

These devices collect the ionization created in air or gas (ions chambers, GM counters) by the photon, or particulate radiations, or collect the light emitted by luminescent materials (scintillators) when excited by ionizing radiations. The current or light collected are proportional to the gamma dose rate. Usually, these devices are composed of a basic unit with external probes in order to extend the capabilities of measurement of the instrument. On the basic unit, a large screen displays all the instrument's data (measurement, thresholds, status, etc.) and buttons permit access to internal data. The measurement should be recorded with the location data, such as GPS coordinates, barcode or RFID readers for mapping applications. The portable X, beta gamma dose and dose rate monitors will be compliant with the applicable standards IEC 60846 and 60325.	
Potential Equipment:	Mirion - RDS 200, Canberra - RADIAGE 4000, Berthold Umo - LB123 or equivalent

3.17.2 Portable Neutron Dose and Dose Rate Monitors

Portable Neutron and Neutron Dose Rate Meters	
Parameter to be Measured	Neutrons and Neutron Dose Rate
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	0.01 µSv/h up to 100 mSv/h
Energy Range	0.025 eV (Thermal) to 20 MeV
Physical and Electrical	
Weight	10 kg
Size	0.4 m x 0.3 m x 0.3 m
Power Supply	Battery
Power Consumption	Battery must last 6 months
Applicable Standards	IEC 1005– See Sections 2.8
IP Rating	N/A

Examples of Equipment

The neutrons are typically detected indirectly through absorption reactions ($^{3}He(n,p)\ ^{3}H$, $^{6}Li(n,\alpha)\ ^{3}H$, $^{10}B(n,\alpha)\ ^{7}Li$). Each of these reacts by emission of high energy ionized particles, the ionization track of which can be detected by a number of means (He-3 proportional counter centred in a moderator sphere with a diameter of 250 mm for example). The ionization current detected is proportional to the neutron flux.

Usually, these devices are composed of a basic unit connected to the proportional counters in a moderator sphere.

On the basic unit, a screen displays all the instrument's data (measurement, alarm thresholds, status, etc.) and buttons to allow the access to internal data.

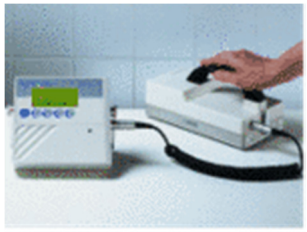
Potential Equipment	Mirion – Model 2363 with 42-41 L, Canberra - Dineutron, Berthold - LB 123N Neutron Dose Rate or equivalent

3.17.3 Portable Beta, Gamma Surface Contamination Monitors

Portable Beta, Gamma Surface Contamination Monitors	
Parameter to be Measured	Beta, Gamma
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Energy Range	50 KeV up to 3 MeV
Detection Limit	< 0.4 Bq/cm^2
Detection area	> 100 cm^2
Physical and Electrical	
Weight	5 kg
Size	0.4 m x 0.3 m x 0.3 m
Power Supply	230 V AC or Battery
Power Consumption	Battery must last 6 months
Applicable Standards	IEC 60325 – See Section 2.15
IP Rating	N/A

Examples of Equipment







The principle of beta gamma surface contamination monitors is to collect the ionization created in gas (proportional counters, GM counters) by the photon, or particulate radiations, or to collect the light emitted by luminescent materials (scintillators) when excited by ionizing radiations. The current or light collected are proportional to the radiation. Usually, these devices are composed of a base unit with external probes in order to extend the capabilities of measurement of the instrument. The probes can also be integrated directly under the basic unit. A large screen on the base unit displays all the instrument's data (measurement, alarm thresholds, status, etc.) and buttons permit access on internal data.	
Potential equipment	Mirion - Quick sweep, Canberra - COLIBRI, RADIAGEM 4000, Berthold - LB123 or equivalent

3.17.4 Portable Tritium Concentration in Air Monitors

Portable Tritium Concentration in Air Monitors	
Parameter to be Measured	Tritium Concentration
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	10^4 up to 10^{10} Bq/m^3
Compensation	Radon and Gamma
Response Time	< 15 seconds in the second decade
Physical and Electrical	
Weight	10 kg
Size	0.4 m x 0.3 m x 0.3 m
Power Supply	230 V AC or Battery
Power Consumption	500 W
Applicable Standards	IEC 62303 – See Section 2.3
IP Rating	N/A

Examples of Equipment

The portable tritium concentration in air monitors are based on an ion chamber, are identical to the monitors used in the room monitoring, but the volume of the ion chamber is adapted to the constraint of the portable devices and the measurement range.
The portable tritium monitor comprises of the following units in the same package:

- A detecting unit (ion chamber)
- A pumping unit (to collect the air to be measured)
- A electronic processing unit (signals conditioning, elaboration of measurement, comparison with predefined thresholds, elaboration of logic signal alarm and display of the data)

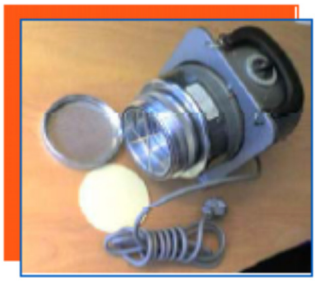
The ion chambers will be protected against particulates.
A screen on the front of the device displays the results of the measurement, the status of equipment, the flow rate of sample and allows access to the instrument's configuration.

A flexible tube can be connected to the air inlet in order to check the air in a glove for example.	
Potential Equipment	Mirion - bionix G8, CANBERRA - T73DSI, BERTHOLD - LB123, Overhoff - Model 200SB or equivalent

3.17.5 Portable Air Samplers for Radioactive Particulates

Portable Air Samplers for Radioactive Particulates	
Parameter to be Measured	Radioactive Particulates
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Trapping Efficiency	> 99.9%
Type & Size of Filters	Cellulose or Glass, Diameters 47 mm and 140 mm
Flow Rate, and Accuracy	> 100 l/min and around 2 m^3/h, <±5%
Sampling Time	setting
Physical and Electrical	
Weight	5 kg
Size	0.4 m x 0.3 m x 0.3 m
Power Supply	230 v AC or battery
Power Consumption	< 1 kW
Applicable Standards	IEC 61172 and NF M 60-760
IP Rating	N/A

Examples of Equipment



Particulate samplers are used to determine the type of the nuclides in the ambient air close to work locations.

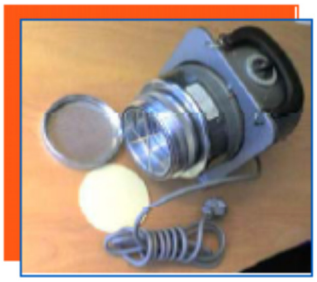
Ambient air is drawn through the device by an internal pump, and airborne particulates are deposited on the removable filter. The air flow is measured and recorded by the instrument in order to calculate the volume of air which went through the filter during the period of sampling.

The filters will be measured in a laboratory or with a portable beta gamma surface contamination monitor to quickly check if the ambient area is contaminated.

Two types of sampling devices are used:

○ Sampling devices with high flow rate: > 100 l/min in order to have a quick response, ○ Sampling devices with low flow rate: around 2 m^3/h (closer to human breathing rate).	
Potential Equipment	Miron - APA 91 NA, F&J Model DFHV-1 High volume air sampling, F&J Model DF-1E NA Low-volume air sampler, PROMINDUS - Algade or equivalent

3.17.6 Portable Air Samplers for Beryllium Particulates

Portable Air Samplers for Beryllium Particulates	
Parameter to be Measured	Beryllium Particulates
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Trapping Efficiency	> 99.9%
Type & Size of Filters	Cellulose or Glass, Diameters 47 mm and 140 mm
Flow Rate, and Accuracy	> 100 l/min and around 2 m^3/h, <±5%
Sampling Time	setting
Physical and Electrical	
Weight	5 kg
Size	0.4 m x 0.3 m x 0.3 m
Power Supply	230 v AC or battery
Power Consumption	< 1 kW
Applicable Standards	TBD
IP Rating	N/A
Examples of Equipment   	
Particulate samplers are used to determine the type of the nuclides in the ambient air close to work locations. Beryllium particulates will be captured by these samplers and processed by the same methods in the laboratory as Portable Air Samplers for Radioactive Particulates.	
Potential Equipment	F&J - Econoair L-12P, F&J - Econoair L-15P, RADECO RAD-Pro 5, PROMINDUS – Algade or equivalent

3.17.7 —Portable Tritium in Air Samplers

Portable Tritium in Air Samplers	
Parameter to be Measured	Tritium in Air
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Trapping Efficiency	100 % for HTO
Detection Limit (No Dilution Factor)	0.1 Bq/m^3 (in a laboratory)
Sampling Time	< 1 hour to obtain 10 ml sample
Physical and Electrical	
Weight	< 30 kg
Size	0.6 m x 0.4 m x 0.4 m
Power Supply	230 V AC
Power Consumption	< 1.5 kW
Applicable Standards	IEC 61303 – See Section 2.3
IP Rating	N/A
Examples of Equipment 	

Two types of instruments are required for tritium air sampling:

- The first instrument uses the bubbling principle to trap the tritium in water,
- The second instrument is based on the collection of the tritium by the cryogenic processing of water vapour in the ambient air.

The instrument that uses the bubbling principle is presented in chapter 3.5. This instrument is the same as those used in room monitoring.

The device that uses the cryogenic process is described below.

The water vapour in the ambient air is collected in a bottle after capturing it using a cold trap.

The water collected is analysed by a liquid scintillation counter in laboratory in order to determine the concentration of Tritium.

The display on the front of the device presents the level of absolute humidity, the time the sample was taken, and the status of equipment. The display allows the user access to all the parameters of the instrument.

3.17.8 Portable Tritium Samplers

Portable Tritium Samplers	
Parameter to be Measured	Tritium and Discriminative HT/HTO
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Trapping Efficiency	> 95 % HT and HTO
Air Flow & Accuracy	10 up to 100 l/h ±5 %
Physical and Electrical	
Weight	Approximately 30 kg, 50 kg max
Size	1 m x 0.6 m x 0.6 m
Power Supply	230 V AC
Power Consumption	700 W
Applicable Standards	IEC 61304 – See Section 2.6
IP Rating	N/A
These samplers are the same as the ones permanently installed in the rooms.	

3.17.9 Portable Radon Monitors

Portable Radon Samplers	
Parameter to be Measured	Radon
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Minimum Detectable Activity	13 Bq/m^3 for 1 hour of sampling
Sampling Time	15 min (typical) also 20, 30, 60 min
Physical and Electrical	
Weight	10 kg
Size	0.4 m x 0.3 m x 0.2 m
Power Supply	230 V AC or battery (must last for 1 week)
Power Consumption	< 10 Watts
Data Storage	TBC
IP Rating	N/A
Outputs	
Network Output	Ethernet for data transfer
Applicable Standards	IEC 61577 – See Section 2.16

Examples of Equipment

The principle of detection is to trap the solid decay products of radon on a filter using a pumping system. Then measure the alpha activity of the Po^{218} collected on the filter with a detector.

3.17.10 Mobile Gamma Monitors

Mobile Gamma Monitors under HP (10) according to ICPR 60	
Parameter to be Measured	Gamma
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	5 x 10^{-7} Sv/h up to 1 Sv/h
Energy Range	50 KeV up to 7 MeV
Accuracy	± 20%
Response Time	< 3 s at 1 mSv/h
Physical and Electrical	
Weight	15 kg
Size	0.5 m x 0.3 m x 0.2 m
Power Supply	230 V AC
Power Consumption	35 W
IP Rating	N/A
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green - Normal/healthy, • Green flashing – Monitor in failed state, • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs	High High, High, and Status (volt free contact, relays energised, contacts closed)
Network Output	RS 485
Data Storage	Yes
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	Normal: 12 ºC – 35 ºC (40 % - 60 % RH) During Helium leak: Detecting Unit only: -30 ºC for very short period of time, assuming that the detection unit is located away from the Cryo lines, otherwise -175 ºC. During LOCA: up to 145 ºC (up to 100% RH) this is only applicable to about 30 % of the detecting units. Two ranges may be needed to cover the different detecting unit locations.
Magnetic Loads	Detecting Unit: up to 150mT Electronic Unit: up to 15mT
Pressure Loads	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa

Radiological Cumulative dose (If applicable)	Detecting Unit: > $8x10^5$ GY (high measurement range)
Applicable Standards	IEC 60532 & IEC 60846 – See Sections 2.1 & 2.2
Examples of Equipment  	
Mobile gamma monitors combine a detecting unit (silicon detectors, or GM, or ion chambers) with an electronic processing unit as a single piece of equipment. The mobile monitor displays the measured dose rate and generates visual and audible alarms whenever pre-set threshold levels are exceeded.	
Potential Equipment:	Mirion GIM204M, Canberra G64 or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.17.11 Mobile Gas Monitors

Mobile Gas Monitors	
Parameter to be Measured	Beta and Gamma
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	10^4 to 10^8 Bq/m^3 (Ar^{41} reference)
Energy Range	80 KeV up to 2.5 MeV
Response Time	< 60 s at 10^4 Bq/m3 and < 10 s at 10^5 Bq/m3
Compensation Measurement	Gamma background, Radon, Tritium
Physical and Electrical	
Weight	100 kg
Size	1.5 m x 1 m x 1 m
Power Supply	230 V AC
Power Consumption	< 0.5 kW
IP Rating	N/A
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green - Normal/healthy, • Green flashing – Monitor in failed state, • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs	High High, High, and Status (volt free contact, relays energised, contacts closed)
Network Output	RS 485
Data Storage	None
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	Normal: 12 ºC – 35 ºC (40 % - 60 % RH) During Helium leak: Detecting Unit only: -30 ºC for very short period of time, assuming that the detection unit is located away from the Cryo lines, otherwise -175 ºC. During LOCA: up to 145 ºC (up to 100% RH) this is only applicable to about 30 % of the detecting units. Two ranges may be needed to cover the different detecting unit locations.
Magnetic Loads	Detecting Unit: up to 150mT Electronic Unit: up to 15mT
Pressure Loads	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa

Radiological Cumulative dose (If applicable)	Detecting Unit: > $8x10^5$ GY (high measurement range)
Applicable Standards	IEC60761 – See Section 2.4

Examples of Equipment

These devices combine a detecting unit (silicon detectors or scintillation detectors), a measurement chamber with a pumping system and electronic processing unit as a single piece of equipment.

This mobile monitor displays the measured concentration in radioactive activated gas and generates visual and audible alarms whenever pre-set threshold levels are exceeded.

The measurement will have compensation for airborne radon/thoron alpha and beta background and gamma background radiation.

3.17.12 Mobile Beta, Gamma Particulate Monitors

Beta, Gamma Particulate Monitors	
Parameter to be Measured	Beta and Gamma Particulates
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	0.1 to 10^5 Bq/m^3
Energy Range	80 keV to 2.5 MeV
Response Time	< 60 mn at 1 Bq/m^3 and < 10 s at 10^3 Bq/m^3
Compensation Measurement	Radon/thoron alpha and beta background and gamma background radiation.
Physical and Electrical	
Weight	100 kg
Size	1.5 m x 0.5 m x 0.5 m
Power Supply	230 V AC or battery (must last for 1 week)
Power Consumption	< 0.5 kW
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green - Normal/healthy, • Green flashing – Monitor in failed state, • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs	High High, High, and Status (volt free contact, relays energised, contacts closed)
Network Output	RS 485
Data Storage	Yes
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	Normal: 12 ºC – 35 ºC (40 % - 60 % RH) During Helium leak: Detecting Unit only: -30 ºC for very short period of time, assuming that the detection unit is located away from the Cryo lines, otherwise -175 ºC. During LOCA: up to 145 ºC (up to 100% RH) this is only applicable to about 30 % of the detecting units. Two ranges may be needed to cover the different detecting unit locations.
Magnetic Loads	Detecting Unit: up to 150mT Electronic Unit: up to 5mT
Pressure Loads	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa

Radiological Cumulative dose (If applicable)	Detecting Unit: > $8x10^5$ GY (high measurement range)
Applicable Standards	IEC 60761

Examples of Equipment

Mobile beta gamma particulate monitors combine detecting unit (silicon detectors), moving system filters for the collection of the particulates with a pumping system and an electronic processing unit on the same support.

This mobile monitor displays the measured activity of the radioactive particulates in air and generates visual and audible alarms whenever pre-set threshold levels are exceeded.

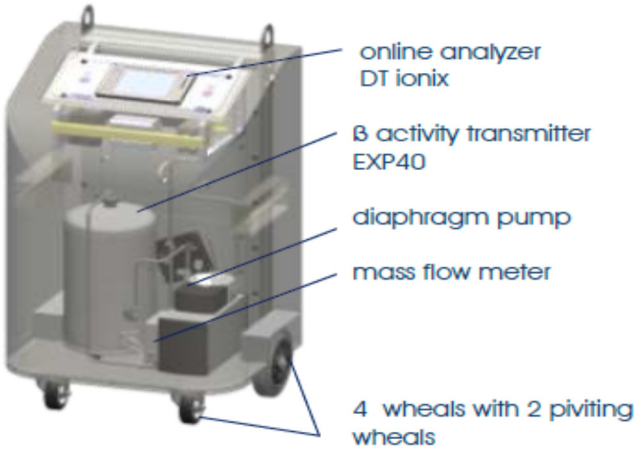
The measurement will be compensated by airborne radon/thoron alpha and beta background and gamma background radiation.

Potential Equipment:	Mirion ABPM 201M , Canberra iCAM, Berthold LB9128 or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.17.13 Mobile Tritium in Air Monitors

Mobile Tritium in Air Monitors	
Parameter to be Measured	Tritium in Air
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	10^4 to 10^{10} Bq/m^3
Accuracy	< 10%
Response Time	< 15 s at second decade
Compensation Measurement	Radon and noble gas (Ar^{41})
Physical and Electrical	
Weight	< 100 kg
Size	1 m x 0.5 m x 0.6 m
Power Supply	230 V AC
Power Consumption	500 W
IP Rating	N/A
Outputs	
Alarm Outputs	Visual: 3 different colour Lights or LEDs • Green - Normal/healthy, • Green flashing – Monitor in failed state, • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter)
Relay Outputs	High High, High, and Status (volt free contact, relays energised, contacts closed)
Network Output	RS 485
Data Storage	None
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s^2, Y = 8.5 m/s^2, Z = 39 m/s^2 Levels L3 to R1 (3% damping) X = 14.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH) During a LOCA: 100% humidity of the sampled air is possible.
Magnetic Loads	15 mT
Pressure Loads	Normal Conditions: -50 Pa to -100 Pa LOCA Conditions: -5000 Pa to 195,000 Pa
Radiological Cumulative dose (If applicable)	Detecting Unit: > 20 Gy (high measurement range)
Compensation	Radon and Gamma Background, Argon 41
Applicable Standards	IEC62303 – See Section 2.3

Examples of Equipment



The online mobile tritium monitors are based on a continuously pumped sample being passed through a standard flow-through ionization chamber.

Mobile tritium monitors combine an ion chamber, a pumping system and an electronic processing unit in a single piece of equipment. It is equipped with wheels to facilitate moving as it quite large and heavy. A display on the front of the equipment shows the status of the monitor and the measurement. Audible and visual alarms on the top of the box indicate if the tritium concentration has been exceeded.

As the mobile tritium monitors are the backup to the room tritium monitors, their performance has to be identical.

Potential Equipment:	Mirion Ionix, Canberra T73DSI, Berthold LB 671, Overhoff 357BWC or equivalent Note – all will require seismic and magnetic qualification against the ITER expected loads

3.18 Whole Body Contamination Monitors

Whole Body Contamination Monitors	
Parameter to be Measured	Beta and Gamma
Quality Class	Q3
Safety Class	SR-CAT-C
Seismic Class	NSC
I&C Classification	
Measurement	
Measurement Range	50 to 3000 KeV
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	0.4 Bq/cm^2 in 15 s with 0.1 µSv/h background
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Accuracy	N/A
Measurement Time	Fixed or variable, depending on background level
Number of Workers to Monitor	30 per hour
Body Coverage	> 90%
Physical and Electrical	
Weight	< 1000 kg
Size	2 m x 1.5 m x 1.5 m
Power Supply	230 V AC
Power Consumption	260 W
Wall Mountable	N
IP Rating	N/A
Outputs	
Audible Alarm / Visual Alarm	Visual: • Green - Normal/healthy, • Red – Contaminated Audible: (>85 dB at 1 meter) Display for the location of the contamination
Output Signal	High High, and Status (volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Data Storage	Yes
Loads	
Seismic Loads	X = 8 m/s2, Y = 8.5 m/s2, Z = 39 m/s2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	< 1 mT
Pressure Load	-50 Pa to -100 Pa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A

Applicable Standards	IEC 61582 & IEC 61098 – See Section 2.13 & 2.7

Examples of Equipment

The objective of the whole body contamination monitor is the detection and identification the contamination which is being carried by workers, or visitors, on their clothes or on or in their body. They also indicate if the persons are contaminated or not, and the location of the contamination.

Usually either a scintillation detector or a semi-conductor detector would be used for such purposes.

The average checking time (15 seconds) will be fixed in order to reach the objectives of detection. This check will be mandatory and access to the changing rooms will only be authorised if the worker is not contaminated. In the case where contamination is detected, the worker will not be authorised access to the changing rooms, and they will be looked after by the Health Physics team.

All the data will be displayed and recorded in the HP office.

The operator positions the person to be counted inside the shield and in front of the detectors. The software starts the count, completes the count, stores the data, displays the spectral data, performs the analysis and prints the report.

Potential Equipment:	Mirion RADOS TwoStep Exit, Canberra - Argos TPS or equivalent

3.19 In-Vivo Contamination Monitors

In-Vivo Contamination Monitors	
Parameter to be Measured	Beta and Gamma
Quality Class	Q3
Safety Class	SR-CAT-C
Seismic Class	NSC
I&C Classification	
Measurement	
Measurement Range	300 keV to 1.8 MeV
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	0.4 Bq/cm^2 in 15 s with 0.1 µSv/h background
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Accuracy	N/A
Measurement Time	Fixed or variable, depending on background level
Number of Workers to Monitor	30 per hour
Body Coverage	> 90%
Physical and Electrical	
Weight	4800 kg
Size	1.24m x 0.9m x 2.11m
Power Supply	230 V AC
Power Consumption	TBC
Wall Mountable	N
IP Rating	N/A
Outputs	
Audible Alarm / Visual Alarm	Audible: (>85 dB at 1 meter) Display for the location of the contamination
Output Signal	High High, and Status (volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Data Storage	Yes
Loads	
Seismic Loads	X = 6.46 m/s^2, Y = 6.46 m/s^2, Z = 9.24 m/s^2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	< 1 mT
Pressure Load	-50 Pa to -100 Pa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	Environmental conditions specified by EN 61010, Installation Category I, Pollution Degree 2.

Examples of Equipment 	
In-Vivo whole body scanners are designed to quickly and accurately monitor people for internal contamination of radionuclides. The operator positions the person to be counted inside the shield and in front of the detectors. The software starts the count, completes the count, stores the data, displays the spectral data, performs the analysis and prints the report.	
Potential Equipment:	Canberra – Fastscan or equivalent

3.20 Hand and Foot Contamination Monitors

Hand and Foot Contamination Monitors	
Parameter to be Measured	Beta and Gamma
Quality Class	Q3
Safety Class	SR-CAT-C
Seismic Class	NSC
I&C Classification	
Measurement	
Measurement Range	50 to 3000 KeV
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	0.4 Bq/cm^2
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Accuracy	N/A
Measurement Time	Fixed (setting within the time range of measurement) or variable depending on the level of background
Physical and Electrical	
Weight	< 150 kg
Size	2 m x 1 m x 1 m
Power Supply	230 V AC
Power Consumption	< 300 W
Wall Mountable	N
IP Rating	N/A
Outputs	
Audible Alarm / Visual Alarm	Operational and measurement data displayed on screen (contamination localization, alarm, status, setting) Status colours: • Green - Normal/healthy, • Red – Contaminated Audible: (>85 dB at 1 meter)
Output Signal	Contaminated and Status (volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Data Storage	Yes
Loads	
Seismic Loads	X = 9.5 m/s^2, Y = 8.5 m/s^2, Z = 185 m/s^2 Note: missile effects are not considered but maintained structural integrity is essential (units can be replaced following seismic events).
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	< 10 mT
Pressure Load	-50 Pa to -100 Pa

Radiological Cumulative dose (If applicable)	N/A
Compensation	Gamma and background
Applicable Standards	IEC 61098 – See Section 2.7
Examples of Equipment	
The aim of hand/foot monitors is to check the hands and feet of the workers for contamination, and to inform them and the HP team when there is a contamination above the threshold. Hands and feet are the body parts most in contact with potentially contaminated surfaces (floor etc.). All the data will be displayed and recorded at the HP office.	
Potential Equipment:	Mirion - Hand-foot-Fibre, Canberra - Sirius-5 AB, Berthold - LB 146 or equivalent

3.21 Tritium in Breath Analysers

Tritium in Breath Analysers	
Parameter to be Measured	Tritium
Quality Class	
Safety Class	
Seismic Class	
I&C Classification	
Measurement	
Measurement Range	10^4 Bq/m^3 up to 10^{10} Bq/m^3 (Not relevant, high initial tritium contamination check prior to urine test)
Energy Range	18 KeV
Minimum Detectable Activity (MDA) 95%	< 10^5 Bq/m^3
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	Gamma, temperature
Number of Workers to Monitor	30 per hour
Accuracy	±10% of range
Measurement Time	< 60 s
Physical and Electrical	
Weight	< 200 kg
Size	1.5 m x 0.65 m x 0.65 m
Power Supply	230 V AC
Power Consumption	< 1 kW
Wall Mountable	N
IP Rating	N/A
Outputs	
Audible Alarm / Visual Alarm	Operational and measurement data displayed on screen Visual: • Green - Normal/healthy, • Red – Contaminated Audible: (>85 dB at 1 meter)
Output Signal	Relay for remote signal status and contamination.
Network Output	RS 485 or Ethernet.
Data Storage	N/A
Loads	
Seismic Loads	X = 6.46 m/s^2, Y = 6.46 m/s^2, Z = 9.24 m/s^2 Note: missile effects are not considered but maintained structural integrity is essential (units can be replaced following seismic events).
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	N/A
Pressure Load	-50 Pa to -100 Pa
Radiological Cumulative dose (If applicable)	N/A

Compensation	Gamma and background
Applicable Standards	TBD

Examples of Equipment

The tritium-in-breath analyser is housed in a "kiosk" which can be located conveniently for operators leaving areas of potential tritium contamination.

The tritium breathalyser comprises a large ion chamber to maximise sensitivity while minimising the time taken to fill it with a breath. It is compensated for gamma and background radiation by the provision of a second and identical chamber.

The tritium breathalyser uses ionization chamber technology which requires no specialty gases to operate. The operators blow into the ion chamber through a special interface. The computer, which controls measurements, compensates for background gamma radiation and any other environmental offsets. The results are displayed on the front of the equipment and simultaneously sent to the Health Physics office for record keeping. It takes between 30 and 60 seconds to process each worker.

Potential Equipment:	Tyne Engineering 7008 or equivalent Please note: This appears to be the only in breath type monitor available on the market.

3.22 Tool and Small Item Monitors

Tool and Small Item Monitors	
Parameter to be Measured	Gamma and Beta
Quality Class	
Safety Class	
Seismic Class	
I&C Classification	
Measurement	
Measurement Range	
Energy Range	50 KeV up to 3000 KeV ±20%
Minimum Detectable Activity (MDA) 95%	< 100 Bq (based on Cs 137) in 60s with 0.1 µSv/h background (also factor weight measurement for activity per g or Kg
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	Gamma background
Chamber Volume	> 300 litres
Accuracy	±10 %
Measurement Time	Fixed (adjustable from 1 to 1000 s) or variable depending on background level
Physical and Electrical	
Weight	< 2000 kg (shielding required)
Size	1.3 m x 1 m x 1.4 m
Power Supply	230 V AC
Power Consumption	Max 250 W
Wall Mountable	N
IP Rating	N/A
Outputs	
Audible Alarm / Visual Alarm	Operational and measurement data displayed on screen Visual: • Green - Normal/healthy, • Red – Contaminated Audible: (>85 dB at 1 meter)
Output Signal	Contaminated and Status (volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Data Storage	Yes
Loads	
Seismic Loads	X = 6.46 m/s^2, Y = 6.46 m/s^2, Z = 9.24 m/s^2 Note: missile effects are not considered but maintained structural integrity is essential (units can be replaced following seismic events).
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	N/A
Pressure Load	-50 Pa to -100 Pa

Radiological Cumulative dose (If applicable)	N/A
Compensation	Lead Shielding
Applicable Standards	IEC 60325 – See Section 2.145

Examples of Equipment

Tool monitors are used to check for the contamination of pens, tools, tool boxes, clothes, shoes, waste bags and small items of equipment in order to identify the correct action to take: allow exit, decontamination or waste.

The tools or working clothes, or waste bags or other miscellaneous items are placed in the monitor cavity in order to detect the contamination (see picture below). The monitor is usually constructed with large plastic scintillator detectors which surround the cavity. These detectors measure the beta and gamma emitters on the objects being checked. Ambient background radiation in the cavity is minimised by lead shielding.

A display and visual alarm are located on top of the instrument. This display will show the type, quantity and location of the contamination.

Potential Equipment	Mirion – RTM661/440, Canberra - Cronos-4 or 11 or equivalent

3.23 Personnel Gas Monitors

Personnel Gas Monitors	
Parameter to be Measured	O^2, CO, CO^2, NOx
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	Adjustable according to the gas to be detected
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	TBD
Measurement Time	N/A
Physical and Electrical	
Weight	500 g
Size	0.2 m x 0.1 m x 0.1 m
Power Supply	Battery
Power Consumption	Batteries must last 1 year
Wall Mountable	N
IP Rating	IP 67
Outputs	
Audible Alarm / Visual Alarm	Adjustable according to the gas to be detected Display Visual: 2 different colour Lights or LEDs • Green - Normal/healthy, • Green flashing – Monitor in failed state, • Red – Alarm Audible: (>85 dB at 1 meter)
Output Signal	N/A
Network Output	N/A
Data Storage	N/A
Loads	
Seismic Loads	N/A
Drop Loads	2m
Thermal Loads	Inside: 18 ºC to 35 ºC Outside -25 ºC to +45 ºC
Magnetic Loads	N/A
Pressure Load	-50 Pa to -150 Pa
Radiological Cumulative dose (If applicable)	N/A

Compensation	N/A
Applicable Standards	TBD

Examples of Equipment

The objective of these portable monitors is to provide an alarm when the gas concentration exceeds a predefined threshold in order to inform the workers to evacuate the workplace.

It is a device worn by individual workers.

3.24 Laboratory Vehicles

Laboratory Vehicles	
Parameter to be Measured	See list of Monitors and Samplers below
Measurement	
Measurement Range	N/A
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	N/A
Size	N/A
Power Supply	N/A
Power Consumption	N/A
Wall Mountable	N
IP Rating	N/A
Outputs	
Audible Alarm / Visual Alarm	N/A
Output Signal	N/A
Network Output	Wireless data communication to EMS Plant Control System
Data Storage	N/A
Loads	
Seismic Loads	N/A
Thermal Loads	-25 ºC to + 70ºC
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	IEC 60331 for cabling

Examples of Equipment

Two laboratory vehicles have to be present on the ITER site to provide essential information for emergency preparedness and response.

The vehicles will provide an autonomous range of radiological and environmental measurements. The types of equipment available on each vehicle have to be defined in compliance with the ASN.

The following items of equipment are required as a minimum:

- Gamma Monitors,
- A gross Beta Gamma activity meter,
- Tritium Samplers,
- Particulate Samplers,
- A liquid scintillation counter,
- Gamma Spectrometer for filters, wipe analysis or liquid samplers,
- Meteorological Instruments,
- A Global Positioning System,
- Equipment for taking water, ground and vegetable samples.
- Diesel Generator

All the data collected is to be managed by a computer with dedicated software enabling fast and accurate decision making based on integrated radioactivity data management.

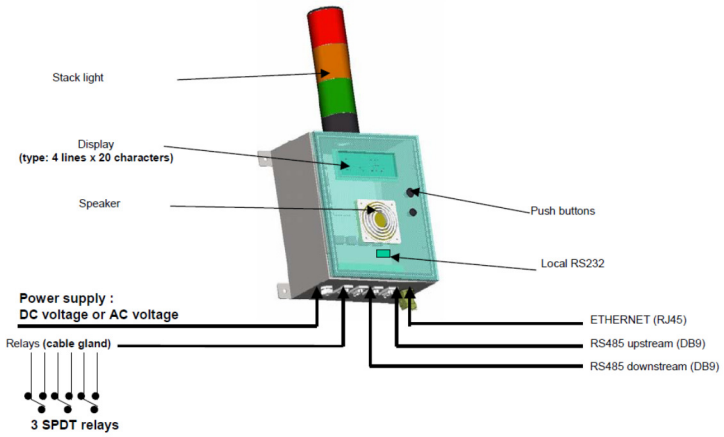
This mobile station will have the ability to send all the collected data to the EMS Plant Control System at the HP office by wireless communication.

3.25 Alarm Units

Alarm Units	
Parameter to be Measured	N/A
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Measurement Range	N/A
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	< 10 kg
Size	0.7 m x 0.5 m x 0.2 m
Power Supply	230 V AC
Power Consumption	< 50 W nominal and 200 W starting peak
Wall Mountable	Y
IP Rating	TBC
Outputs	
Audible Alarm / Visual Alarm	Visual: 3 different colour Lights or LEDs • Green - Normal/healthy, • Amber – High exceeded, • Red – High High exceeded Audible: (>85 dB at 1 meter) – 3 sounds
Input Signals	High High, High, and Status
Output Signals	High High, High, and Status (Fail safe volt free contact, contacts closed for healthy)
Network Output	RS 485 or Ethernet
Data Storage	N/A
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s2, Y = 8.5 m/s2, Z = 39 m/s2 Levels L3 to R1 (3% damping) X = 14.5 m/s2, Y = 8.5 m/s2, Z = 185 m/s2
Thermal Loads	Normal: 12 ºC – 35 ºC (40 % - 60 % RH) During LOCA/Helium leak:

	-175 ºC for very short period of time for a helium leak and up to 145 ºC for a LOCA (up to 100% RH)
Magnetic Loads	Magnetic field inside the Tokamak: < 150 mT (equipment power off) Magnetic field outside the Tokamak: < 15 mT
Pressure Load	-50 Pa to -100 Pa
Radiological Cumulative dose (If applicable)	> 20 Gy (high measurement range, applicable when located in high exposure areas e.g. Tokomak, Vault annex)
Compensation	N/A
Applicable Standards	N/A

Example of Equipment



Alarms Units (AU) generate local audio and visuals alarms, initiated by the local analysis unit in order to provide local warning to personnel in case of excessive radiation levels.

The alarm unit and is equipped with:

- A column of lights on the top of the box (green, amber, red);
- A speaker on the front of the box;
- A display for detailed signalling status of the equipment;
- A connection interface at the bottom of the box.

3.26 Connecting Points

Connecting Points	
Parameter to be Measured	N/A
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Measurement Range	N/A
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	5 kg
Size	0.15 m x 0.2 m x 0.15 m
Power Supply	230 V AC
Power Consumption	500 W when a mobile monitor with pump is connected
Wall Mountable	Y
IP Rating	N/A
Outputs	
Audible Alarm / Visual Alarm	N/A
Output Signal (Isolated)	High High, High, and Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output (Isolated)	RS 485 or Ethernet
Data Storage	N/A
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s2, Y = 8.5 m/s2, Z = 39 m/s2 Levels L3 to R1 (3% damping) X = 14.5 m/s2, Y = 8.5 m/s2, Z = 185 m/s2
Thermal Loads	Normal: 12 ºC – 35 ºC (40 % - 60 % RH) During LOCA/Helium leak (Only applicable to devices within the Tokamak and Vault Annex): -175 ºC for very short period of time for a helium leak and up to 145 ºC for a LOCA (up to 100% RH)
Magnetic Loads	Magnetic field inside the Tokamak: < 150 mT Magnetic field outside the Tokamak: < 15 mT
Pressure Load	-50 Pa to -100 Pa

Radiological Cumulative dose	> 20 Gy (high measurement range, applicable when located in high exposure areas e.g. Tokomak, Vault annex)
Compensation	N/A
Applicable Standards	Cabling C1 NF 32070 IEC 60331 IEC 60332-3

The connecting points are cabling interfaces allowing the connection of the mobile devices to the radiological network.

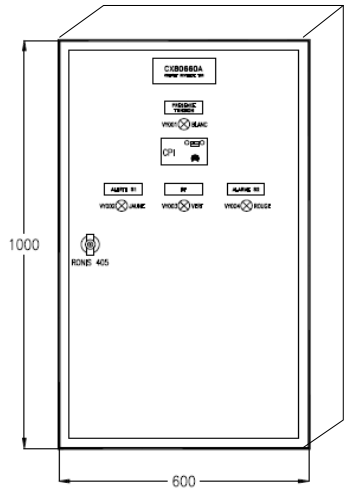
Connecting points are installed in accessible rooms which are not equipped with permanent monitors (low level of radiation/contamination, occupancy only required during e.g. maintenance) or in accessible rooms equipped with fixed monitors to ensure backup of fixed monitors in case of failure.

3.27 RSU1 – Hardwired Local Analysis Unit

RSU1	
Parameter to be Measured	N/A
Quality Class	Q1
Safety Class	SIC-1A
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Measurement Range	N/A
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	50 kg
Size	1 m x 0.6 m x 0.3 m
Power Supply	230 V AC
Power Consumption	500 W
Wall Mountable	Y
IP Rating	TBC
Outputs	
Lights	Visual: different colour Lights or LEDs • Supply on, • Green - Normal/healthy, • Amber – Alert, • Red – Alarm.
Output Signal (Isolated)	High High, High, and Status (volt free contact, relays energised, contacts closed)
Network Output (Isolated)	RS 485 or Ethernet
Data Storage	N/A
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s2, Y = 8.5 m/s2, Z = 39 m/s2 Levels L3 to R1 (3% damping) X = 14.5 m/s2, Y = 8.5 m/s2, Z = 185 m/s2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	< 15 mT
Pressure Load	-50 Pa to -100 Pa
Radiological Cumulative dose	N/A

Compensation	N/A
Applicable Standards	IEC 61508 & IEC 61513 – See Sections 2.18 & 2.19

Example of Equipment



The local analysis unit collects the status and alarms from each monitor in each room and performs a radiological local analysis in order to activate alarm units. RSU1 are SIC-1A rated devices with HIMA PLANAR4 hardwired units performing all logic decisions. RSU1 only output alarms relay contacts to the CSS and alarm units (where applicable). They also provide a RS485 interface to the relevant RSU2. RSU1s are deployed one per train, with two trains monitoring the same hazard by independent means.

The RSU1 does present the use of the HIMA PLANAR4 in environments beyond the expected IO qualification of the HIMA PLANAR to SIC-1A. This will require further qualification due to the increased magnetic, radiological and seismic loads present outside of the SIC-1A cubicle rooms.

The local analysis unit is equipped with:

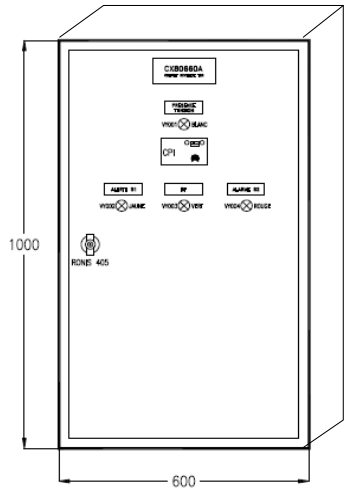
- Lights on the front of the box:
  - Supply on,
  - Operate (green),
  - Alert (yellow),
  - Alarm (red),
- Label (functional reference),
- Connection interface at the bottom of the box.

3.28 RSU2 – PLC Local Analysis Unit

RSU2 – PLC Local Analysis Unit	
Parameter to be Measured	N/A
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Measurement Range	N/A
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	50kg
Size	1 m x 0.6 m x 0.3 m
Power Supply	230 V AC
Power Consumption	500 W
Wall Mountable	Y
IP Rating	TBC
Outputs	
Lights	Visual: different colour Lights or LEDs • Supply on, • Green - Normal/healthy, • Amber – Alert, • Red – Alarm.
Output Signal (Isolated)	High High, High, and Status (volt free contact, relays energised, contacts closed)
Network Output (Isolated)	RS 485, fibre optic, or Ethernet
Data Storage	PLC tags of current status
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s2, Y = 8.5 m/s2, Z = 39 m/s2 Levels L3 to R1 (3% damping) X = 14.5 m/s2, Y = 8.5 m/s2, Z = 185 m/s2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	< 15 mT
Pressure Load	-50 Pa to -100 Pa
Radiological Cumulative dose	N/A

Compensation	N/A
Applicable Standards	IEC 61508 & IEC 61513 – See Sections 2.18 & 2.19

Example of Equipment



The RSU2 PLC Local Analysis Unit takes the status, alarms and outputs from the various monitors and samplers located in and around the monitored zone (typically a room). The RSU2 is rated to SIC-2C and performs computerised analysis of the values for the monitors. RSU2 are used in other areas where SIC-2C is not required, (PIC-EIC) but are manufactured to the same standard where possible. RSU1s are used for SIC-1A application and connect to the RSU2 with RS485. The internals of the RSU2 vary according to the number and nature of the equipment monitored. The internals are a SIEMENS S7-400 series PLC, although RSU2 supporting SIC-1A functions will have S7-FH PLC's inside.

The RSU2 connects to the CSS-N where applicable via the SIC-2C SIEMENS S7 protocol over Ethernet. If the RSU2 is SIC-2C rated, it will also broadcast it's monitoring values/statuses and alarms over fibre-optic links to the relevant ARMS servers. The fibre-optic link is isolated via the use of an optical diode to ensure the ARMS central processing system cannot affect the SIC-2C rated functions of the RSU2. The RSU2 does not receive any data from the ARMS central controller, it broadcasts using UDP into the blind.

The RSU2 does present the use of the SIEMENS S7-400 series in environments beyond the expected IO qualification of the SIEMENS S7-400 series to SIC-2C. This will require further qualification due to the increased magnetic, radiological and seismic loads present outside of the SIC-1A cubicle rooms.

3.29 Distribution Board

Distribution Board	
Parameter to be Measured	N/A
Quality Class	Q1
Safety Class	SIC-2C
Seismic Class	SC1 (SF)
I&C Classification	
Measurement	
Measurement Range	N/A
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	30 kg
Size	0.3 m x 0.5 m x 1 m
Power Supply	230 V AC
Power Consumption	Dependent on connected equipment
Wall Mountable	Y
IP Rating	TBC
Outputs	
Lights	Green light to indicated power is active.
Output Signal	Suitably Current protected AC supply to equipment
Network Output	N/A
Data Storage	N/A
Loads	
Seismic Loads	Levels B2 to L2 (3% damping) X = 8 m/s2, Y = 8.5 m/s2, Z = 39 m/s2 Levels L3 to R1 (3% damping) X = 14.5 m/s2, Y = 8.5 m/s2, Z = 185 m/s2
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	< 15 mT
Pressure Load	-50 Pa to -100 Pa
Radiological Cumulative dose	N/A for Tritium and Diagnostic Building Units,
Compensation	N/A
Applicable Standards	IEC 61508 & IEC 61513 – See Sections 2.18 & 2.19

Distribution boards distribute power from the SSEN and other power systems depending on the classification of the connected equipment. Distribution boards will follow ITER standards from the SSEN in order to ensure standardisation of equipment.

3.30 Fish Test

Fish Test	
Parameter to be Measured	Toxicity of Water
Quality Class	N/A
Safety Class	N/A
Seismic Class	N/A
I&C Classification	
Measurement	
Measurement Range	N/A
Energy Range	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	500 kg
Size	2 m x 0.5 m x 0.5 m
Power Supply	230 VAC
Power Consumption	<100 W
Wall Mountable	N
IP Rating	Sensors: 68
Outputs	
Audible Alarm / Visual Alarm	N/A
Display	Local display for operational status, measurement data and instrument setting
Output Signal	Equipment status, fish status, trout movement alarm, water temperature alarm (water temperature needs to be maintained between 5 – 15 ºC) , water level alarm
Network Output	RS 485 or Ethernet
Data Storage	Local Environmental parameters of the aquarium (temperature, dissolved oxygen and pH)
Loads	
Thermal Loads	12 ºC – 35 ºC (40 % - 60 % RH)
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	N/A

Examples of Equipment

All the effluents are sampled and monitored in the HP laboratory. Devices to take the samples in the tanks, basins (storage, storm, etc.) are necessary.

Prior to discharge of the water into the environment, a “Fish test” is performed in order to confirm the non-toxicity of the water.

This “Fish test” equipment includes:

- Sample lines between each storage basin and the aquarium;
- A valve manifold system to connect the aquarium to the desired basin sample line, whilst isolating it from the other three basin sample lines;
- An aquarium where the test will be performed. The water temperature, pH and dissolved oxygen are measured in real time;
- An aquarium for storing the fish.
- Local display for setting up and data presentation

3.31 Rain Gauges / Pluviometers

Rain Gauges / Pluviometers	
Parameter to be Measured	Amount of Rain
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable/Fixed
I&C Classification	
Measurement	
Measurement Range	> 7 litres (300 mm)
Surface of Rainfall	600 cm^2
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	1 kg
Size	1 m x 0.5 m x 0.5 m
Power Supply	N/A
Power Consumption	N/A
Wall Mountable	N
IP Rating	TBA
Outputs	
Audible Alarm / Visual Alarm	N/A
Output Signal	N/A
Network Output	
Data Storage	N/A
Loads	
Thermal Loads	-25 ºC to +45ºC
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	N/A

Examples of Equipment



Rain Gauges/Pluviometers are designed to collect and measure the amount of liquid precipitation over a set period of time. This water will be analysed in the HP laboratory and in an external laboratory.

Ordinarily rain gauges have no electrical parts, although automatic electronic sensor products are available (e.g. Reinhardt - Rain/Precipitation Sensor (Ombrometer, Pluviometer) RMS 2M/RMS 2TTL):

The electronic sensors can be configured to have data outputs and be expanded with WLAN or GSM-module for long-distance data transmission or TCP/IP-module data transmission via existing networks.

3.32 Rain Drop Size Measurement

Rain Drop Size Measurement	
Parameter to be Measured	Size and Speed of Rain Drops
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	0.2 to 25 mm Intensity: 0.2 up to 1200 mm/h
Particulate Velocity	0.2 to 20 m/s
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	10 kg
Size	0.7 m x 0.6 m x 0.15 m
Power Supply	230 VAC
Power Consumption	< 50w
Wall Mountable	Yes - mounted on 2” diameter pipe
IP Rating	IP 65
Outputs	
Audible Alarm / Visual Alarm	N/A
Output Signal	N/A
Network Output	RS485/Connection compatible with Meteorological Station
Data Storage	N/A
Loads	
Thermal Loads	-25 ºC to +45ºC and 100% Relative Humidity
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	N/A

Example of Equipment

Rain drop size will be measured in one of the environmental stations.

This device uses a laser-based optical sensor. The transmitter unit of the sensor generates a flat, horizontal beam of light which the receiver unit converts into an electrical signal. This signal changes whenever rain falls through the beam anywhere within the measurement area. The degree of dimming of the beam of light is determined by the size of the rain drop, and this together with the duration of the signal, allows the fall velocity to be derived.

This data will be sent to the Environment Plant Control System at the HP office through a data logger by GPRS.

3.33 Meteorological Station

Meteorological Station	
Parameter to be Measured	Wind speed and direction Temperature Humidity Pressure
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	Wind speed and directions : 0-50m/s, 360º Temperature : -30 ºC up to +50 ºC Humidity : up to 30 g/kg Pressure : 93 kPa to 104 kPa Instantaneous values, and average values based on time or number of samples. Time and number of samples to be variable.
Particulate Velocity	N/A
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	Wind Speed/Direction : ± 0.1 m/s and ± 2° Temperature : ± 0.1°C
Measurement Time	N/A
Physical and Electrical	
Weight	50 kg
Size	2 m x 1 m x 1 m
Power Supply	230 VAC
Power Consumption	<50w
Wall Mountable	N – Roof mounted
IP Rating	67
Outputs	
Audible Alarm / Visual Alarm	N/A
Output Signal	Digital and analogue
Network Output	GPRS, RS 422-485 or Ethernet
Data Storage	Local Data Storage
Loads	
Thermal Loads	-25 ºC to +45ºC
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa

Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	N/A

Example of Equipment

The environmental station is composed of:

- Gamma detectors: same as inside the ITER site,
- Particulate samplers: same as those used inside the ITER site,
- Tritium samplers: same as those used inside the ITER site,
- Carbon 14 samplers: same as those used inside the nuclear building,
- Rain gauges: same as those used inside the ITER site,
- Rain drop size measurement, same as those used inside the ITER site,
- Meteorological Station: shows all the sensors (direction and speed of the wind, temperature, humidity, pressure) to be mounted on the cabin/cabinet roof. The other items of equipment are to be installed within the cabin/cabinet.

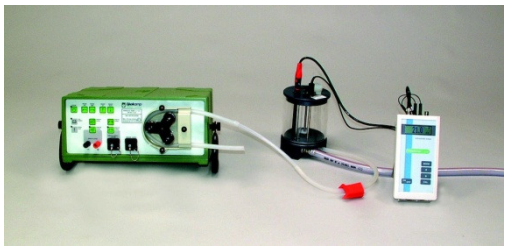
The meteorological measurement equipment will be similar to the METEK equipment as used at CERN.

The weather station can be configured to connect data outputs to WLAN via a GSM/GPRS module for long-distance data transmission.

3.34 Water Samplers

Water Samplers	
Parameter to be Measured	Water collection for Lab analysis. Various types of equipment will be needed to facilitate collecting samples from Tanks, Basins, Manholes etc.
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	Portable
I&C Classification	
Measurement	
Measurement Range	0-90 m below surface
Minimum Detectable Activity (MDA) 95%	N/A
Trapping Efficiency	N/A
Air Flow & Accuracy	N/A
Compensation (If applicable)	N/A
Chamber Volume	N/A
Accuracy	N/A
Measurement Time	N/A
Physical and Electrical	
Weight	5 kg
Size	Dependent on depth required
Power Supply	230 V AC or battery
Power Consumption	< 100W (Only applicable when using a pump for sampling ground water)
Wall Mountable	N
IP Rating	TBA
Outputs	
Audible Alarm / Visual Alarm	N/A
Output Signal	N/A
Network Output	N/A
Data Storage	N/A
Loads	
Thermal Loads	-25 ºC to +45ºC
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	ISO 5667-9698

Examples of Equipment



Peristaltic Pumps

Bailers

Water Samplers for Predetermined Depths

Bottles

Underwater Pumps

Samples will need to be taken of the ground water, surface water, and water from within tanks. Various equipment will be needed to take the required water samples.

All the chemical checks on samples will be performed by external laboratories.

The required equipment includes:

- Peristaltic pumps,
- Bailers (hollow tube) used to retrieve groundwater samples from monitoring wells,
- Underwater pumps to purge the piezometers,
- Water Samplers (with closure) for predetermined depths,
- Bottles for collecting water.

This list is indicative of the types of pumps and sampling containers that will be needed.

Examples include:
Becher 600 mL polypropylene bottle with a 3 m telescopic boom and angle bracket.
PE or PTFE sampling bottle sizes: 0.1 L, 0.5 L, 1 L and 5 L.

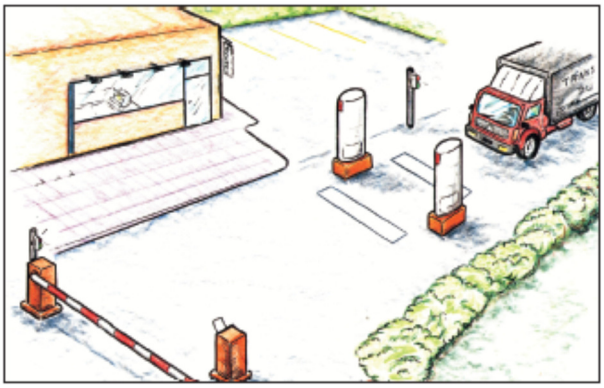
3.35 Personnel Monitoring

Personnel Monitoring	
Parameter to be Measured	Beta and Gamma Radiation
Quality Class	Q3
Safety Class	SR-CAT-C
Seismic Class	NSC
I&C Classification	
Measurement	
Measurement Range	50 to 3000 keV
Detection Limit	3 kBq (Cs^{137}) in 1 s with 99% probability
Accuracy	± TBA
Response Time	N/A
Physical and Electrical	
Weight	< 300 kg if shielding is required
Size	1 m x 0.5 m x 2.2 m
Power Supply	230 V AC
Power Consumption	< 200 W
IP Rating	IP 65
Wall Mountable	N
Outputs	
Alarm Outputs	Visual: 2 different colour Lights or LEDs • Green - Normal/healthy, • Red flashing – Alarm Audible: (>85 dB at 1 meter)
Relay Outputs	High, and Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Display	Value of measurement, alarm thresholds, short term history of all events on the central unit
Data Storage	Short term history
Loads	
Thermal Loads	-25 ºC to +45ºC
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	IEC 60532 & IEC 60846 – See Section 2.1 & 2.2

Example of Equipment	
All personnel are required to pass through a corridor that detects both their presence and any radiation present. The detector signals will be passed to a control unit placed at the guard gate. Alarm Units installed at the guard gate and near the detection unit will alarm if predefined threshold levels are exceeded. All the signals (alarms, status) will be sent to the Access Control and Security System for recording and storing.	

3.36 Vehicle Monitoring at the Exit of INB Fence

Vehicle Monitoring	
Parameter to be Measured	Beta and Gamma Radiation
Quality Class	Q3
Safety Class	PIC-EIC
Seismic Class	NSC
I&C Classification	
Measurement	
Measurement Range	50 to 3000 keV
Detection Limit	60 kBq (Cs^{137}) in 1 s with 99% probability
Accuracy	± TBA
Speed of Vehicle	10 km/h
Physical and Electrical	
Weight	< 300 kg if shielding is required
Size	1 m x 0.5 m x 2.2 m
Power Supply	230 V AC
Power Consumption	< 200 W
Wall Mountable	N
IP Rating	N/A
Outputs	
Alarm Outputs	Visual: 2 different colour Lights or LEDs • Green - Normal/healthy, • Red flashing – Alarm Audible: (>85 dB at 1 meter)
Relay Outputs	High, and Status (Fail safe volt free contact, relays energised, contacts closed)
Network Output	RS 485 or Ethernet
Display	Value of measurement, alarm thresholds, short term history of all events on the central unit
Data Storage	N/A
Loads	
Thermal Loads	-25 ºC to +45ºC
Magnetic Loads	N/A
Pressure Load	93 kPa to 104 kPa
Radiological Cumulative dose (If applicable)	N/A
Compensation	N/A
Applicable Standards	IEC 60532 & IEC 60846 – See Section 2.1 & 2.2

Sketch of Proposed Vehicle Monitoring Setup	
All vehicles must drive through a path equipped with detectors located on each side of the path. The detector signals will be passed to a control unit placed at the guard gate. Alarm Units installed at the guard gate and near the detection unit will alarm if predefined threshold levels are exceeded. All the signals (alarms, status) will be sent to the Access Control and Security System for recording and storing. The detectors used are identical to those used for personnel.	

3.37 Area Radiological Monitoring Plant Control System

The Area Radiological Monitoring System (ARMS) plant control system is based on a central computer with dedicated software for ARMS functions. The aim is to record and display the data and status provided by each monitoring unit in the ITER controlled areas. The data displayed to the operators details the radiological status inside the ITER facility, activity discharge at each exhaust point and beryllium sampler status.

The ARMS plant control system covers all the ITER controlled areas in the Tokamak Building (TK), Diagnostic Building (Diag), Tritium Plant (TP), Hot Cell Facility (HCF), Radwaste Facility (RWF) and Personnel Access Control Building (PACB).

The ARMS plant control system is located in the Health Physics office in the PACB.

The ARMS dedicated Supervisory Control and Data Acquisition (SCADA) software will be based on SIEMENS WinCC OA.

The ARMS is described in detail in Appendix 7 of the REMS System Design Description DDD-PBS 64

An overview of the likely requirements for the ARMS follows:

- Capacity of monitors to manage : 800 (plus a suitable margin for future upgrades)
- Capacity of samplers to manage : 200 (plus a suitable margin for future upgrades)
- Acquisition rate : around 1 Hz,
- Number of data by monitors : < 20
- Short-term storage : all the data for 3 months
- Transfer data to CODAC : every 20 s
- Capacity of analogue inputs : 20
- Capacity of digital inputs : 100

3.37.1 ARMS Central Computer Software

Functions	Data	Periodicity
Acquisition	All data from each RSU2	Automatic with adequate acquisition rate in accordance with the response time of the monitors or samplers (< 2 seconds)
Processing	None other than visual processing	In real time (< 2 seconds)
Display	Record and display alarms and events (tests, malfunctions of components or links,…)	In real time (< 2 seconds)

Functions	Data	Periodicity
	Views: - Facility overview, - Release monitoring - Alarm Screens - Logs and events (archived) - Graph view analysis	In real time (< 2 seconds)
Record	All data acquired for processing All the events (alarms, status, test, etc.) The data processed (cumulative release) Short term storage, the permanent archiving will be performed by IT system	In real time (< 2 seconds)
Administration	Security management (access, 3 Levels at least)	Permanent
	Tests: manual with radioactive sources (for the calibration of equipment)	On demand according to the ITER procedure
	Configuration – No configuration of monitors is conducted at the central control computer	N/A
	Support of maintenance activities (user manuals, procedures)	On demand
Communication	Between upper level (IT system/CODAC system) and SCADA system	Automatic and operator initiated functions

3.38 Dose Management

The main requirements for the Dose Management System are detailed in the following table.

Number of Dosimeter Readers to be managed	10 to 15
Number of Passive Dosimeters to be managed	1000 up to 1800
Number of EPDs to be managed	750 up to 1000
Number of Sub-Areas to be managed	5 to 10
Number of Tasks to be managed	100 up to 200
Capability of Information Storage	Over 10 years
Communications	Ethernet Network
Power Supply	Class II-IP / 230 VAC
	Internal battery or UPS required to cover power supply failure

3.38.1 Dose Management Functions

Functions	**Data**	**Periodicity**
Acquisition	All data from each dosimeter reader (doses received by workers during work in controlled areas, workers identification, parameters of dosimeters, status of devices, etc.)	Automatic with adequate acquisition rate in accordance with the response time of the monitors or samplers (< 2 seconds)
	All data for the workers (civil status, employer, medical status, training, classification of the worker, etc…)	Manual Acquisition
	All data from passive dosimetry (results from external laboratories)	
	All data from internal dosimetry	
	All the data from the dosimeters (period of validity, calibration, etc..)	
Processing	Individual dosimetry management (cumulative dose for each worker)	Day, week, month, 4 months, year, and the last 5 years
	Elaborate official dosimetry report to IRSN	Week, month
	Collective dosimetry management (per group, area, building, task, employer, etc..)	On demand
	Check authorization of personnel for access to controlled areas based on medical status and radiological exposure. Send a signal to Access Control System in order to deny access to personnel when the access to the controlled area is not authorized.	In real time

Display	Record and display alarms and events (tests, malfunctions of components or links,…)	In real time (< 2 seconds)
	Views: - personnel data, - cumulative dose per worker, group of workers, company, etc.. - cumulative dose per task, group of tasks, building, area etc.. - parameters view (alarm setting, calendar...) - list of personnel entering controlled areas, - list of personnel not authorized for access to controlled areas - hardware configuration	In real time (< 2 seconds)
Record	All data acquired for processing All the events (alarms, status, test, etc.) The data processed (cumulative dose) Short term storage, the permanent archiving will be performed by IT system	In real time (< 2 seconds)
Administration	Security management (access, 3 Levels at least)	Permanent
	Tests: manual with radioactive sources (for the calibration of dosimeters)	On demand according to the ITER procedure
	Configuration (parameters of dosimeters, internal storage, alarm setting, Etc..)	On demand according to the ITER procedure
	Support of maintenance activities (user manuals, procedures)	On demand
Communication	Between upper level (IT system and IRSN system) and lower level (dosimeter readers)	Automatic and operator initiated functions

3.39 Environmental Monitoring System

The Environmental Monitoring System (EMS) is based on a central computer with dedicated software. The objective of the EMS software is to record, and display to the HP operators, the data and status provided by each monitoring unit installed within the ITER site, and those installed outside the ITER site.

The EMS Plant Control System is connected to CEA stations in order to collect meteorological data from the Cadarache site, and potential data from environmental stations that may be shared.

This EMS Plant Control System also manages all the environmental sampling programs. It stores, displays and distributes all the results.

The EMS Plant Control System is located in the Health Physics office in the Personnel Access Control Building.

The EMS dedicated software (SCADA) will be based on an industrial platform SIEMENS WinCC OA which will be qualified to category C.

Due to the interface with CODAC, the EPICS software has been selected by ITER and will be implemented.

As with the Area Radiological Monitoring System, the HMI of the Environmental Monitoring System will present different views to the Heath Physics operators in order to supervise the environmental conditions in the vicinity of the ITER nuclear building and outside of the ITER site.

Meteorological data is to be presented on the right hand side of the screen, and the district map with location and status of each environmental station, on the left.

At the bottom of the screen is an alarms/events log/list.

The following views are required:

- General,
- District map,
- Matrix displays (i.e. tabular views of the status of all the monitors, samplers),
- Individual continuous monitors/samplers status,
- Measured radiation levels and alarms,
- Event logs, alarm lists and historic data (for traceability),
- Remote parameter download and configuration,
- Archives,

An overview of the likely requirements of the EMS follows:

- Capacity of monitors to manage : 100,
- Acquisition rate : around 1 Hz,
- Number of data monitors : it depends on the type of monitors < 20,
- Short term storage : all the data collected for 1 month,
- Transfer data to CODAC : every 20 s.

4 References

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